



**RICCAR**

Regional Initiative for the Assessment of  
Climate Change Impacts on Water Resources and  
Socio-Economic Vulnerability in the Arab Region

# Disaster Loss Data and Linkage to Climate Change Impacts for the Arab Region



**TECHNICAL REPORT**



**UNISDR**

The United Nations Office for Disaster Risk Reduction



# Disaster Loss Data and Linkage to Climate Change Impacts for the Arab Region

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Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region

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## PREFACE

The Regional Initiative for the Assessment of Climate Change Impacts on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR) is a joint initiative of the United Nations and the League of Arab States launched in 2010.

RICCAR is implemented through a collaborative partnership involving 11 regional and specialized organizations, namely United Nations Economic and Social Commission for Western Asia (ESCWA), the Arab Center for the Studies of Arid Zones and Dry Lands (ACSAD), Food and Agriculture Organization of the United Nations (FAO), Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the League of Arab States, Swedish Meteorological and Hydrological Institute (SMHI), United Nations Environment Programme (UN Environment), United Nations Educational, Scientific and Cultural Organization (UNESCO) Office in Cairo, United Nations Office for Disaster Risk Reduction (UNISDR), United Nations University Institute for Water, Environment and Health (UNU-INWEH), and World Meteorological Organization (WMO). ESCWA coordinates the regional initiative. Funding for RICCAR is provided by the Government of Sweden and the Government of the Federal Republic of Germany.

RICCAR is implemented under the auspices of the Arab Ministerial Water Council and derives its mandate from resolutions adopted by this council as well as the Council of Arab Ministers Responsible for the Environment, the Arab Permanent Committee for Meteorology and the 25th ESCWA Ministerial Session.

Funding for this technical report was provided by the Government of Sweden through the Swedish International Development Cooperation Agency.



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# FOREWORD

This first edition of the 2016 Report “Assessing weather-related disasters in the Arab States” provides a comprehensive analysis of the weather-related and geological disasters and its socio-economic and environmental impacts over a thirty year time-frame within six countries in the Arab region: Jordan, Lebanon, Morocco, Palestine, Tunisia and Yemen. The findings of this report are based on national disaggregated disaster loss data customized for the 2015 Global Assessment Report on Disaster Risk Reduction (GAR 2015), the main global assessment of disaster risk reduction published biannually by the United Nations Office for Disaster Risk Reduction (UNISDR).

The Sendai Framework for Disaster Risk Reduction, adopted in March 2015 by the international community, was developed to guide efforts on disaster-risk reduction in the period between 2015 and 2030. As in the case of its predecessor -the Hyogo Framework for Action (HFA)- the Sendai Framework calls for countries to systematically account their disaster losses in order to measure and understand their risks in all its dimensions of vulnerability, capacity, exposure of persons and

assets, hazard characteristics and the environment. In this context, this report provides an overview of the national risk context of the selected countries, based on their nationally-accounted disaster loss and focusing attention on frequency, mortality and economic losses indicators. The result is a historical review of disaster trends that provides the basis for well-informed decisions and effective disaster risk reduction interventions.

Using probabilistic methodologies which simulate future possible scenarios, the report also presents hazard and risk results on river flooding in the 5 Arab studied countries, as well as estimated losses with different return periods. The main goal is to increase countries’ awareness and understanding of the potential consequences of disasters.

This Report is a collaborative effort undertaken by UNISDR and the United Nations Economic and Social Commission for Western Asia (ESCWA), within the framework of the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region (RICCAR).

The RICCAR Initiative is implemented jointly by the United Nations, the League of Arab States (LAS) and its respective specialized organizations to respond to the Arab Ministerial Water Council’s and the Council of Arab Ministers Responsible for the Environment’s requests to deepen the understanding of the impact of climate change on water resources and its associated implications for socio-economic and environmental vulnerability in the Arab region.

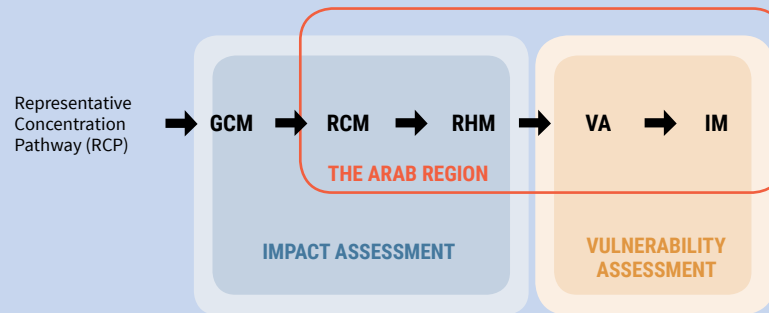
This regional Initiative aims at providing a common platform for addressing and responding to climate change impacts, serving the basis for dialogue, priority setting and policy formulation on climate change adaptation at the regional level. The developed historical disaster loss data bases and their geographical frequency and distributions as shown in this report can be used to validate the hotspot areas of high vulnerability using RICCAR methodology in future projections.



# 1. CLIMATE CHANGE IMPACTS USING RICCAR APPROACH AND LINKAGES TO DISASTER LOSS DATABASES IN THE ARAB REGION

A step-wise approach was followed in the integrated assessment pursued under RICCAR. The impact assessment component is based on the generation of dynamically downscaled regional climate models (RCMs) covering the Arab/MENA Domain nested in a series of general circulation models (GCMs). These outputs are used to run regional hydrological models (RHMs) as well as basin-level hydrological models. The outputs of these models are then used to inform the regional vulnerability assessment based on an integrated mapping approach as shown in Figure 1. The resulting integrated assessment links climate change impact assessment to socio-economic and environmental vulnerability assessment. The application of this integrated assessment approach can be used to inform climate change adaptation policies, measures, monitoring and disaster risk reduction.

Figure 1  
RICCAR Integrated Assessment Methodology



**Legend:**

- GCM:** Global Climate Modelling
- RCM:** Regional Climate Modelling
- RHM:** Regional Hydrological Modelling
- VA:** Vulnerability Assessment
- IM:** Integrated Mapping

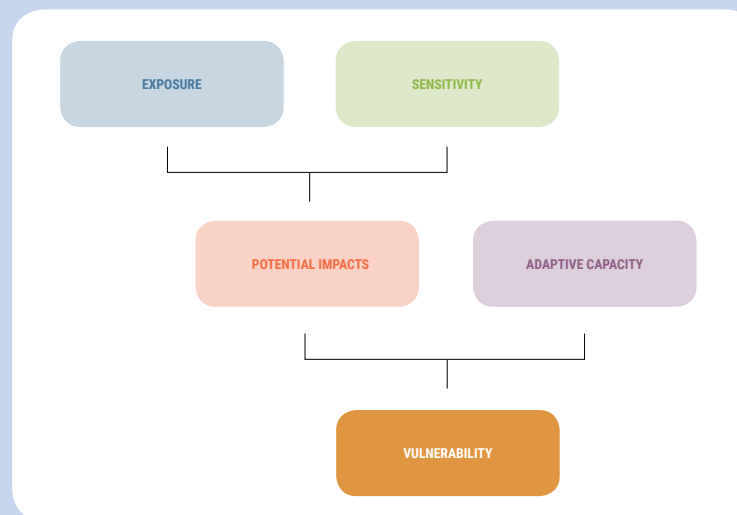
Source: RICCAR

Climate change projections conducted within the framework of RICCAR are based on two representative concentration pathways (RCP's) developed by the Intergovernmental Panel on Climate Change (IPCC) that were developed to inform global and regional climate modeling in its Fifth Assessment Report (AR5). The climate change projections generated in RICCAR were based on two scenarios; RCP4.5 as the moderate case scenario and RCP8.5 as the worst case/business as usual scenario. The climate modeling outputs in RICCAR were generated at a 50 km x 50 km scale. The results presented in RICCAR are based on the regional climate modeling outputs generated by the Swedish meteorological and Hydrological Institute (SMHI) using RCA4.

Extreme climate indices were also projected in RICCAR based on those formulated by the Expert Team on Climate Change Detection and Indices (ETCCDI) which is a joint working group of the Commission for Climatology under the auspices of the World Meteorological Organization (WMO). The change in temperatures indices included the cold spell duration index, summer days with max temperature > 35°C and 40°C and tropical nights. The precipitation indices projected in RICCAR were the maximum length of dry spell, heavy precipitation days ( $\geq 10$  mm), very heavy precipitation days ( $\geq 20$  mm) and other indices.

The vulnerability assessment component in RICCAR is based on the methodology of the Intergovernmental Panel on Climate Change (IPCC) in its Fourth Assessment Report (AR4). Within this perspective, vulnerability is understood to be the function of a system's climate change exposure, sensitivity and adaptive capacity to cope with climate change effects, as illustrated in Figure 2.

Figure 2  
The components constituting vulnerability based on IPCC AR4 approach



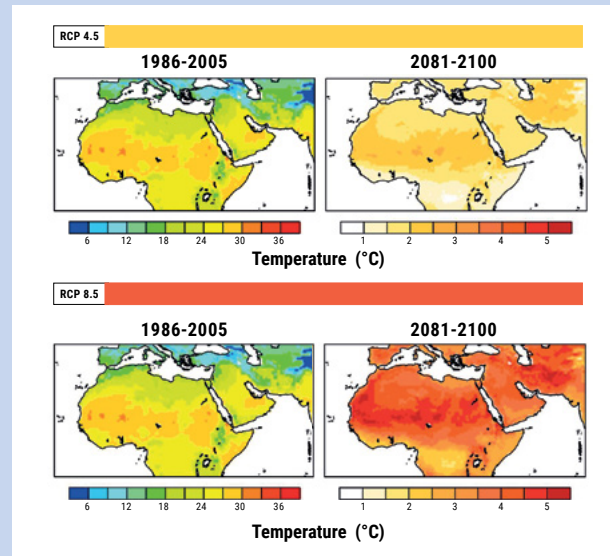
Source: IPCC, 2007

Within this conceptual framework:

- Exposure refers to changes in climate parameters that might affect socio-ecological systems. Such parameters are for example temperature, precipitation and wind speed, which climate change alters with regard to their quantity and quality as well as their spatial and temporal distribution.
- Sensitivity tells us about the status quo of the physical and natural environment of the affected systems that makes them particularly susceptible to climate change. For example, a sensitivity factor could be topography, land use land cover, distribution and density of population, built environment, proximity to the coast, etc.
- Potential Impact is determined by combining exposure and sensitivity to climate change on a system.
- Adaptive capacity refers, according to Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (AR4), to “the ability of a system to adjust to climate change (including climate variability and extremes), to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.”<sup>1</sup>

The integrated vulnerability assessment methodology for the Arab region takes a broader view of vulnerability to allow for a comprehensive assessment that can serve as a basis for dialogue and consultation on climate change across the Arab region. As such, the integrated vulnerability assessment conducted under RICCAR combines a series of single vulnerability assessments for several water-related climate change impacts on different sectors in the Arab region.

Figure 3  
Mean change in annual temperature for end-century for ensemble of three RCP 4.5 and RCP 8.5 projections compared to the reference period



Regional Climate Modeling carried out through RICCAR reflected the impacts of climate change on the water-scarce Arab Region, through higher temperature, and variability in precipitation as shown in Figures 3 and 4.<sup>2</sup> The effect of the change in those in climatic parameters is determined by comparing the forecasted 2081-2100 period with the 1986-2005 reference period. The general change of temperature towards the end of the century shows an increase in the mean annual temperature between 1 to 3°C in RCP 4.5 and from 2 to 5°C with RCP 8.5 on the Arab region.

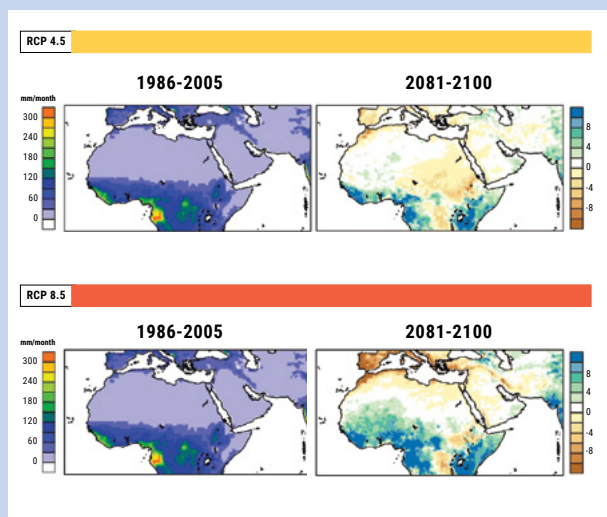
1 Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 717-743 (Appendix I. Glossary).

There are large regional differences as the greatest increases are expected across the region. The Eastern Mediterranean Coast and North Africa will generally experience increases in average temperature around 2.5 °C, with a maximum increase of 3.4 °C expected in Morocco's Atlas Region, Upper Egypt and the southern Sinai peninsula. The Northeastern part of the Arabian Peninsula will see the largest increases in temperature, reaching around 4.2°C in the upper Tigris-Euphrates Basin. In Sub-Saharan Countries, the increase in temperature is expected to reach between 3.5 °C and 4.0°C. The Arabian Peninsula will experience progressive increases in long-term average temperatures over the coming century, reaching 24°C by 2100, and possibly as high as 25°C. The largest increase in the region, 4.2 °C, will occur over the area extending from the northern Hejaz to southern Jordan. This confirms earlier studies that showed that long term average temperatures are projected to increase progressively in the Gulf region, reaching 23.1 °C in the 2020s, 23.9 °C in the 2040s and 25.1 °C in the 2070s.<sup>3</sup>

Average precipitation over the Arab Region is generally projected to decrease throughout the 21st century, but there will be large spatial variability. For instance, Figure 4 shows that by the end of the century, both scenarios indicated a reduction of the average monthly precipitation reaching 8-10 mm in the coastal areas of the domain, mainly around the Atlas Mountains in the west and upper Euphrates and Tigris river basins in the East. These changes in precipitation are correlated with changes in runoff and water availability. Across the Arab Domain, because of the region's varied geography, there are very large variations between various sub-regions and the change will be felt through

the rate of climate change, which is evident in the increased frequency of extreme events, as well as the magnitude of the change the increase in their variability.

Figure 4  
Mean change in annual precipitation for end-century for ensemble of three RCP 4.5 and RCP 8.5 projections compared to the reference period



3 Hemming et al., 2007.

# 2. METHODOLOGY

## 2.1 Disaster Loss Database

The development of national disaster loss databases is the crucial first step to generate the information necessary for risk estimation and to inform public investment planning. As a second step, the physical losses recorded in the databases can be translated into monetary/economic losses enabling an initial evidence-based estimate of recurrent losses.

## 2.2 About the Hazard Profiling

This report uses nationally reported disaster data that was specially customized by UNISDR for the 2015 Global Assessment Report on Disaster Risk Reduction (GAR 2015). This customized dataset, known as “GAR Universe”, only takes into account disasters triggered by natural hazards, and therefore excludes the records that refer to man-made hazards (such as oil spills, technological disasters, etc.)<sup>4</sup>.

These datasets contain a standardized subset of the records of the original datasets as produced by each country. The GAR only uses records of disaster of geological or weather related origin. In addition, several tight criteria of quality has been imposed on these records in order to be analysed.

GAR Universe includes an economic evaluation that consists on a conversion of physical damage (houses damaged, houses destroyed, meters of roads, hectares of damaged crops, among others) into economic value, in order to provide a conservative estimation of disaster damage and loss in monetary values<sup>5</sup>. This conservative economic estimation of losses provides not only a partial picture of the overall economic losses that each country may have, but in some cases numbers have proven to be even superior to those reported internationally. Moreover, as this methodology converts the reported physical damage into monetary value, it should be considered as direct, and not indirect economic loss.

## 2.3 About the time-series trend analysis

The time-series trends presented in this report change from country to country depending on the start and end date of each national dataset. It is important to highlight that the trends –and therefore, the presentation of the results– are highly dependent on the data collection and entry that has been done by each country. It is important to keep in mind that in some cases, less records is not equal to fewer disasters, but that unavailability of data can also play a role in the overall trend. Doing a historical review of disaster losses is sometimes difficult, as precious information may be lost. Part of the intention of presenting the historical trends is to enable a critical thinking around the potential improvements that can be done in each national dataset, so the historical picture of disaster losses can be enhanced by future efforts in data collection.

<sup>5</sup> For more information about the Economic Loss Evaluation used in GAR 2015, please see Annex 2 of the report, which can be accessed on this link: [www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/Annex2-Loss\\_Data\\_and\\_Extensive\\_Risk\\_Analysis.pdf](http://www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/Annex2-Loss_Data_and_Extensive_Risk_Analysis.pdf)

<sup>4</sup> The GAR Universe can be accessed in the following link [www.desinventar.net/DesInventar/main.jsp?countrycode=g15](http://www.desinventar.net/DesInventar/main.jsp?countrycode=g15)



## 2.4 About the Measurement of Disaster Frequency

The indicator “frequency of disasters” used in this report refers to the number of records (also known as datacards) which provide a proxy of frequency. The rationale behind this method for estimating disaster frequency is that disasters can hit at all scales, and have always temporal and spatial footprints. That is why the impact of different hazards (this is, the damage and the loss generated) is recorded at the lowest geographic level as possible, and is always time-stamped with the date of the disaster. Additional to this, each record contains qualitative and quantitative information about damage and loss. When all the records are put together, an approximate picture of frequency can be obtained. It is important to keep in mind that one single record can contain a high number of losses, but will count only as one event. This is the case of intensive disasters (e.g. high magnitude earthquakes), in which one single event can generate important amount of losses –but few records. On the opposite, recurrent and localized floods can generate several records, making this hazard more frequent than others.

## 2.5 About the Concepts of Extensive and Intensive Disasters

In different GARs, the concepts of extensive and intensive risk and disasters have been used to define the difference on the scale and impact of disasters. Intensive disaster risk can be defined as: “The risk associated with situations in which large concentrations of people and economic activities are exposed to intensive hazard events, which can lead to potentially catastrophic disaster impacts involving high mortality and asset loss. Intensive hazard events have high level of intensity with mid-to low-frequency”. Extensive disaster risk can be defined as: “The risk of low-severity, high-frequency disasters, mainly but not exclusively associated with highly localized hazards. Although the loss from an individual event is low, the high frequency of such events lead to significant accumulation of damage and loss”.

The variables used to define the threshold between intensive and extensive disaster losses are mortality and housing destruction. Statistically, the threshold is fixed at: Mortality: less than 30 people killed (extensive); 30 or more killed (intensive); or Housing destruction: less than 600 houses destroyed

(extensive); 600 or more houses destroyed (intensive). This threshold has proved robust even as the universe of national disaster databases continues to grow.

## 2.6 About the classification in “Others”

The classification of some hazards as “Others” was done to facilitate data visualization on the graphs. All disasters classified as “Others” are those that contributed to less than 2% of the total of each indicator.

## 2.7 Flood Hazard and Risk Assessment

An essential step for design, financing, and implementation of any disaster risk reduction policy and investment is to measure and understand the characteristics of the risk. Understanding the potential extent of negative impacts from various hazards, intricacies of underlying risk drivers in various areas and sectors is complex but critical to make informed decisions. While historical loss records provide a good basis for understanding the negative impacts of past disasters and can be used to model extensive risk layers, many intensive disasters may not

have occurred yet or occurred before records were kept. This is especially critical regarding the more intensive risk layers, which are associated with infrequent, high impact losses. As such, probabilistic approaches to hazard and risk estimation are used.

## 2.8 What is a Probabilistic Methodology?

Probabilistic risk assessment uses mathematical models to combine any possible future hazard scenarios, information about the exposed assets and the vulnerability, to provide results of an estimate of probable loss levels in a region of interest. Unlike historical estimates, probabilistic risk assessment takes into account all disasters that can occur in the future, including very intensive losses with long return periods, and does overcome the limitations associated with estimated derived from historical disaster loss data.

## 2.9 Riverine Flood Hazard and Risk Assessment

The hazard maps and risk results presented in this report are from global flood hazard and risk assessment conducted for GAR 15 using a

probabilistic approach for modelling riverine flood major river basins around the globe.

This procedure allowed for the determination of the reference Flood hazard maps for different return periods (6 are shown in the global study: T= 25, 50, 100, 200, 500, 1000 years). The hazard maps were developed at 1kmx1km resolution. Such maps have been validated against satellite flood footprints from different sources (DFO archive, UNOSAT flood portal) and well performed especially for the big events. The flood hazard assessment was conducted by CIMA Foundation and UNEP-GRID.

### Exposure Model

A Global exposure database was developed for GAR15 which includes estimation on the economic value of the exposed assets, as well as their physical characteristics in urban and rural agglomerations. This information is key to assess the potential damages from different hazards to each of the exposed elements. The exposure dataset used in the flood risk assessment presented in this report is developed at 1km spatial resolution at major river basins. It includes economic value, number of residents, and construction type of residential,

commercial and industrial buildings, as well as hospitals and schools.

GAR15 global exposure database is based on a top-down approach where statistical information including socio-economic, building type, and capital stock at a national level are transposed onto the grids of 5x5 or 1x1 using geographic distribution of population data and gross domestic product (GDP) as proxies. The global exposure dataset was developed by UNEP-GRID with close collaboration and inputs from WAPMERR (World Agency of Planetary Monitoring and Earthquake Risk Reduction), EU Joint Research Center (JRC), and Kokusai Kogyo.

### Vulnerability Functions

A vulnerability function defines the level of damage as a function of an intensity measure of hazard. Once the physical characteristics for each building class are defined, it is possible to establish and assign the likely damage, and subsequently losses to that specific building class subjected to various levels of specific hazard intensity. This is done by defining relationships between a measured parameter of the hazard intensity (e.g. water depth

in case of flooding) to the likely damage level of the particular building class. The damage is expressed in relative terms to their replacement value. These relationships are the so-called “vulnerability functions.” Flood vulnerability functions were developed by CIMNE and INGENIAR.

### Probabilistic Risk Assessment

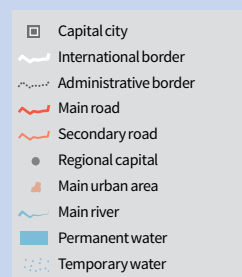
Once the characteristics of hazard including the probabilities of occurrence with geospatial reference (for each grid on earth surface), and the characteristics of assets including their vulnerability to hazard intensities are defined with the same geospatial reference, then the probabilistic risk can be calculated. For GAR15, the risk was calculated with the CAPRA-GIS platform which is risk modelling tool of the CAPRA suite (www.ecapra.org)<sup>6</sup>.

The flood maps with associated probability of occurrence was used by CIMNE as input to the computation of the flood risk for GAR15 as Average Annual Loss (AAL) and Probable Maximum Loss (PML) values for six return periods in each country.

More information about the methodology can be found in GAR 15 Annex I: Global Risk Assessment<sup>7</sup> and in the technical background papers in various components of the flood risk model<sup>8</sup>.

### Map sources and legend

Data sources for maps include the following: United Nations Cartographic Section, Geonames, FAO, OCHA, DCW, Natural Earth, SRTM. The general map legend is presented below.



<sup>7</sup> For more information about flood hazard and risk modelling see GAR 2015, Annex 1 of the report which can be accessed here [www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/Annex1-GAR\\_Global\\_Risk\\_Assessment\\_Data\\_methodology\\_and\\_usage.pdf](http://www.preventionweb.net/english/hyogo/gar/2015/en/gar-pdf/Annex1-GAR_Global_Risk_Assessment_Data_methodology_and_usage.pdf)

<sup>8</sup> All technical background reports on global risk assessment of GAR 15 can be accessed at [www.preventionweb.net/english/hyogo/gar/2015/en/home/documents.html](http://www.preventionweb.net/english/hyogo/gar/2015/en/home/documents.html)

<sup>6</sup> This modelling tool was developed as a partnership between Center for Coordination of National Disaster Prevention in Central America (CEPREDENAC), the UN International Strategy for Disaster Reduction (ISDR), the Inter-American Development (IADB) and the World Bank (www.ecapra.org).

# 3. JORDAN

## National Context

Jordan is a Middle-Eastern country located between Saudi Arabia, Iraq, Syria, Israel and The State of Palestine. Its total surface is 89 320 km<sup>2</sup>, with coast by the Red Sea in the South. Jordan is home to the Dead Sea, which is considered the lowest point on earth lying - 408 meters below the sea level. The highest



Wadi Mujib, Jordan, 2008. Source: Reibai -flickr.com

point in Jordan, in contrast, is Jebel Umm El Dami, which lies 1 854 meters above sea level.

Jordan has a population of 6 607 000 people living in 12 governorates with almost 75% of the country is a desert arid zone. The country is one of the most water scarce nations in the world. Jordan is an upper middle income country with annual GDP per Capita estimated at US\$ 5 422.6 in 2014<sup>9</sup>.

This report and the upcoming information on Jordan are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Jordan has considerable earthquake risk which should be considered in disaster risk reduction planning.

<sup>9</sup> World Bank Development Indicators : <http://data.worldbank.org>

## 3.1 DISASTER LOSS

### 3.1.1 Disaster Risk Reduction

Jordan is exposed to several natural hazards mainly climate-related including drought and extreme events such as snow storms, heat waves and flash floods. The ongoing regional conflict, influx of refugees, vulnerable infrastructure and stressed natural resources system increase the challenges to reduce disaster risk in Jordan and strengthen resilience.

The Supreme Council of Civil Defence, General Directorate of Civil Defence Disaster Management is the body leading disaster risk reduction efforts in the country and operates based on the 1999 Civil Defence Law. Most of the resources at national and

local level are directed to enhancing emergency preparedness and response capacities. A multi-stakeholder, multi-sectoral comprehensive institutional approach to disaster risk reduction still lacking, yet more effort and progress is visible on the national-local coordination front with respect to disaster risk reduction with several cities and municipal councils developing local cities' resilience plans.

Jordan has reported on progress towards the implementation of Hyogo Framework for Action and submitted two national progress reports in 2013 and 2015<sup>10</sup>.

<sup>10</sup> Jordan's national progress reports available on: [www.preventionweb.net/english/countries/asia/jor/](http://www.preventionweb.net/english/countries/asia/jor/)

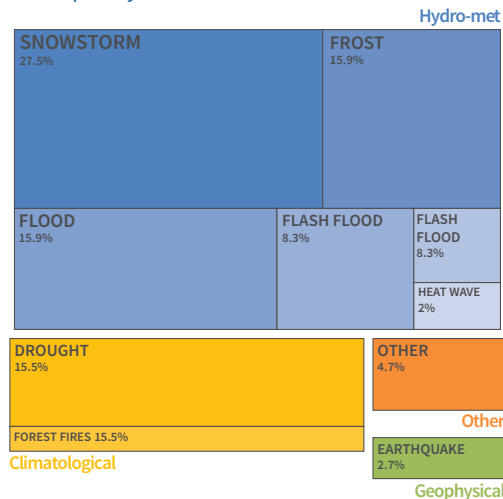
# 3.1 DISASTER LOSS

## 3.1.2 Nationally Accounted Disaster Loss (1982 to 2012)

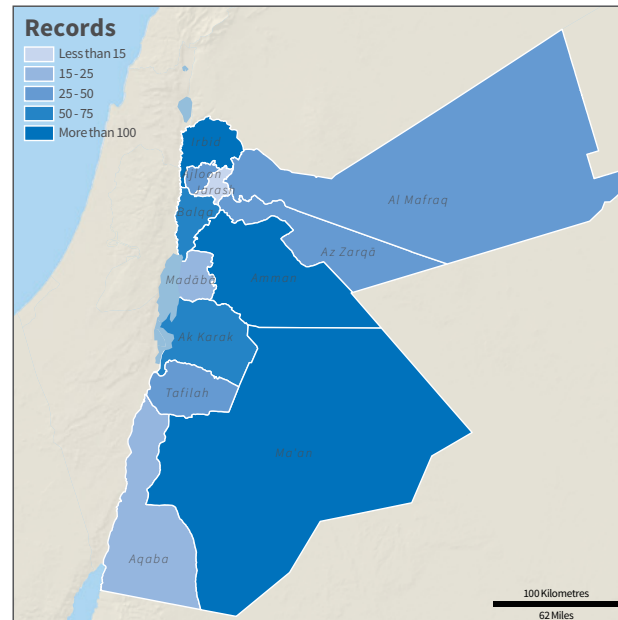
### a. Frequency

From a total of 593 disasters recorded between 1982 and 2012, snowstorms are the most frequent disaster in Jordan, accounting for more than 1/4 of the records (163), followed by frost, flood and drought. Geographically speaking, the Governorate of Ma'an has experienced the highest number of recorded disasters (98), followed by Amman (89) and Irbid (81).

#### Disaster Frequency



Spatial Footprint of Disaster Frequency

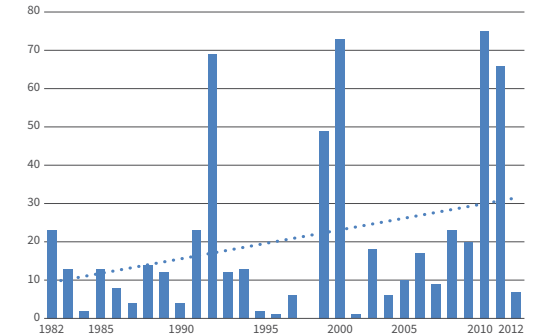


The trend of disaster frequency is increasing, with important fluctuations depending on the year. Four important outliers can be seen in the years of 1992 (snowstorms and cold wave), 2000 (essentially drought), 2010 and 2011 (forest fires and frost). During 2010 and 2011, recurrent frosts were registered in several provinces of the country.

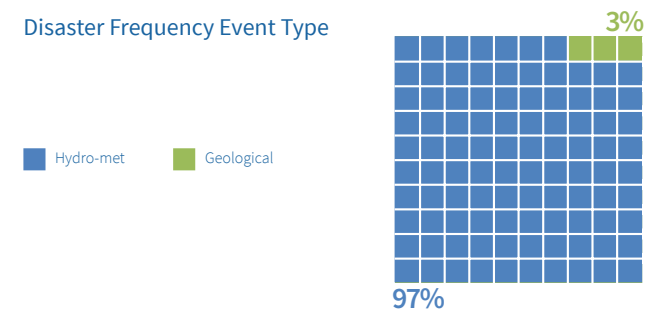
From the entire dataset, only 3% of the records refer to geological events.

No intensive events are registered.

Disaster Frequency Time-Series Trend  
Number of Reports



Disaster Frequency Event Type



Disaster Frequency Risk Type

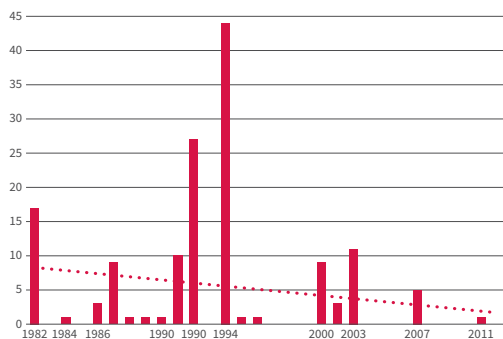


# 3.1 DISASTER LOSS

## b. Mortality

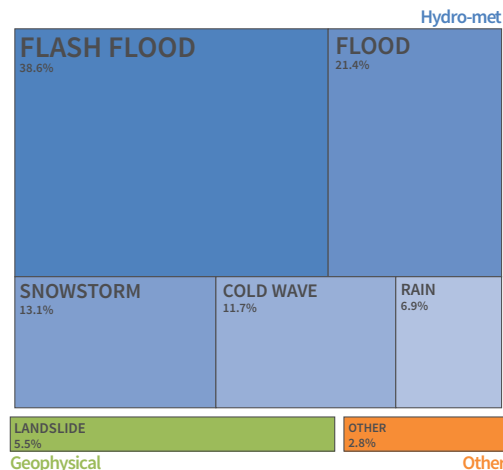
145 people have been killed since 1982, with a historical downwards trend.

Disaster Mortality Time-Series Trend  
Number of Reports



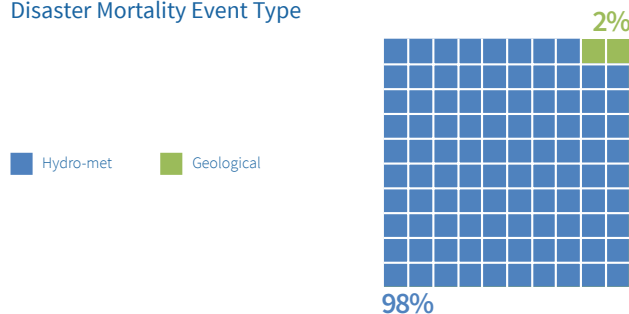
Flashfloods and floods, taken together, have killed 87 persons, the equivalent to 60% of the total mortality registered in the national database.

Disaster Mortality



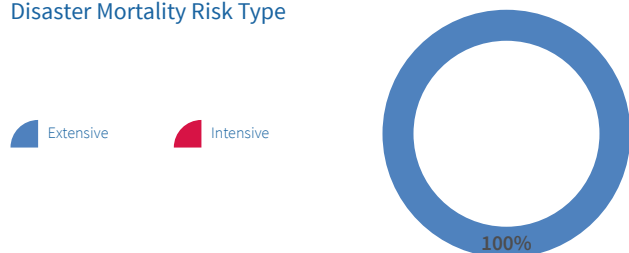
Despite the occurrence of earthquakes and other geological events in the country near the Dead Sea Rift Valley fault system, most of the mortality (97%) is due to disasters of hydro-meteorological origin.

Disaster Mortality Event Type



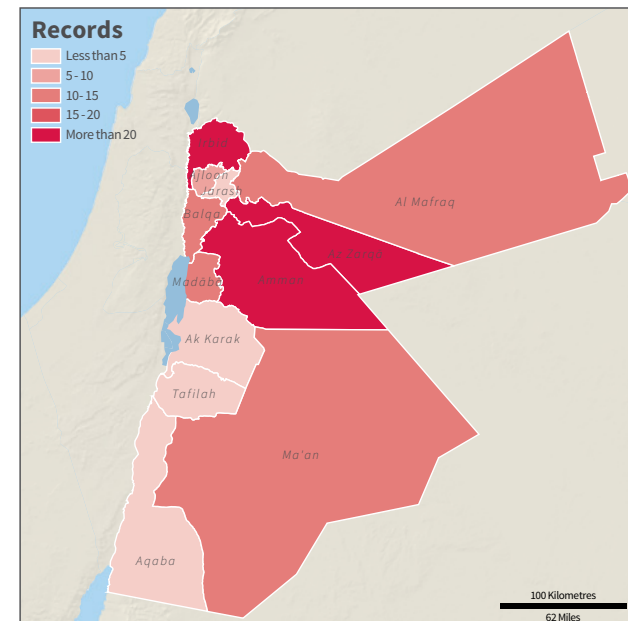
Moreover, all people died in extensive events, which raises the importance that frequent and small-scale disasters have in mortality trends.

Disaster Mortality Risk Type



The governorates concentrating highest mortality due to disasters is Amman (37 people), followed by Az Zarqa (24) and Irbid (23).

Spatial Footprint of Disaster Mortality

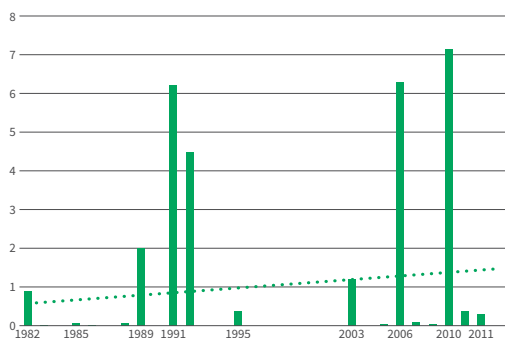


# 3.1 DISASTER LOSS

## c. Economic Losses

A slightly upwards trend shows increasing economic losses in Jordan, with four important hydro-met outliers: Floods in 1991, snowstorms in 1992 and 2009, and heavy rain in 2006.

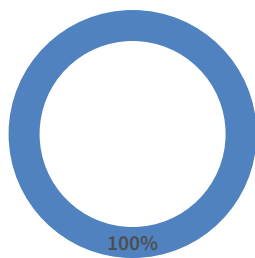
Disaster Economic Loss Time-Series Trend  
Million US\$



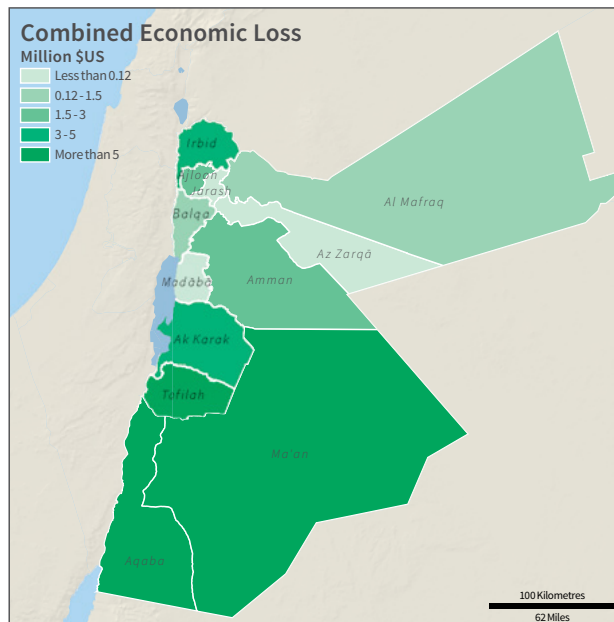
Al Aqabah and At Tafilah are the two most affected governorates in terms of economic losses.

Disaster Economic Loss Risk Type

Extensive Intensive

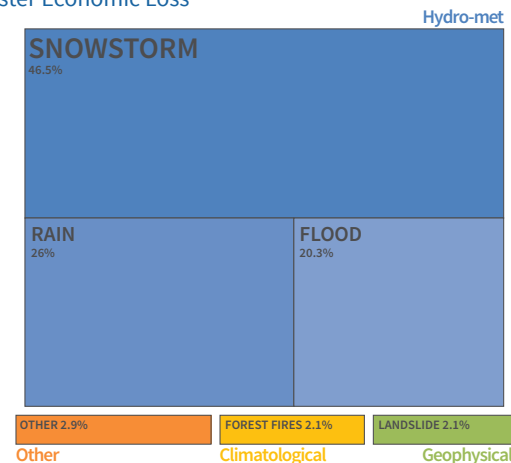


Spatial Footprint of Disaster Economic Loss



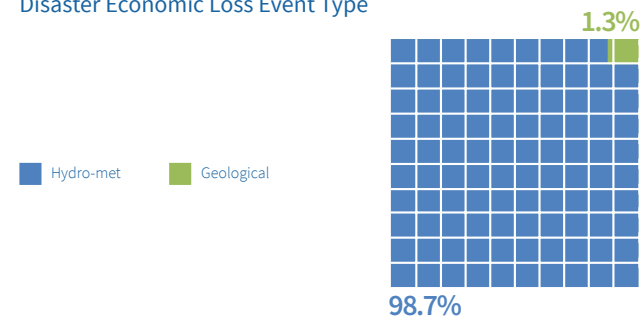
Snowstorms, which are the most frequent disaster registered in the database, are also the most important contributor to the overall economic losses, followed by rain and floods.

Disaster Economic Loss



Hydro-meteorological events have generated more than 95% of the economic losses.

Disaster Economic Loss Event Type





## 3.2 RIVER FLOOD HAZARD AND RISK - ZARQA RIVER

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>11</sup> in Jordan are presented here to showcase the type of information and value of such comprehensive assessments. River flooding is the predominant hazard in Jordan

in terms of mortality. However, the following results do not provide a full picture of disaster risk levels by any means.

The map below show the river flood area in Zarka River basin which is one of the most flood prone basins in Jordan. The map shows the foot print of one of the stochastic scenarios considered in the probabilistic risk assessment.

River flood area in Zarka River basin



<sup>11</sup> From GAR15 Global risk assessment: [www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php](http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php)

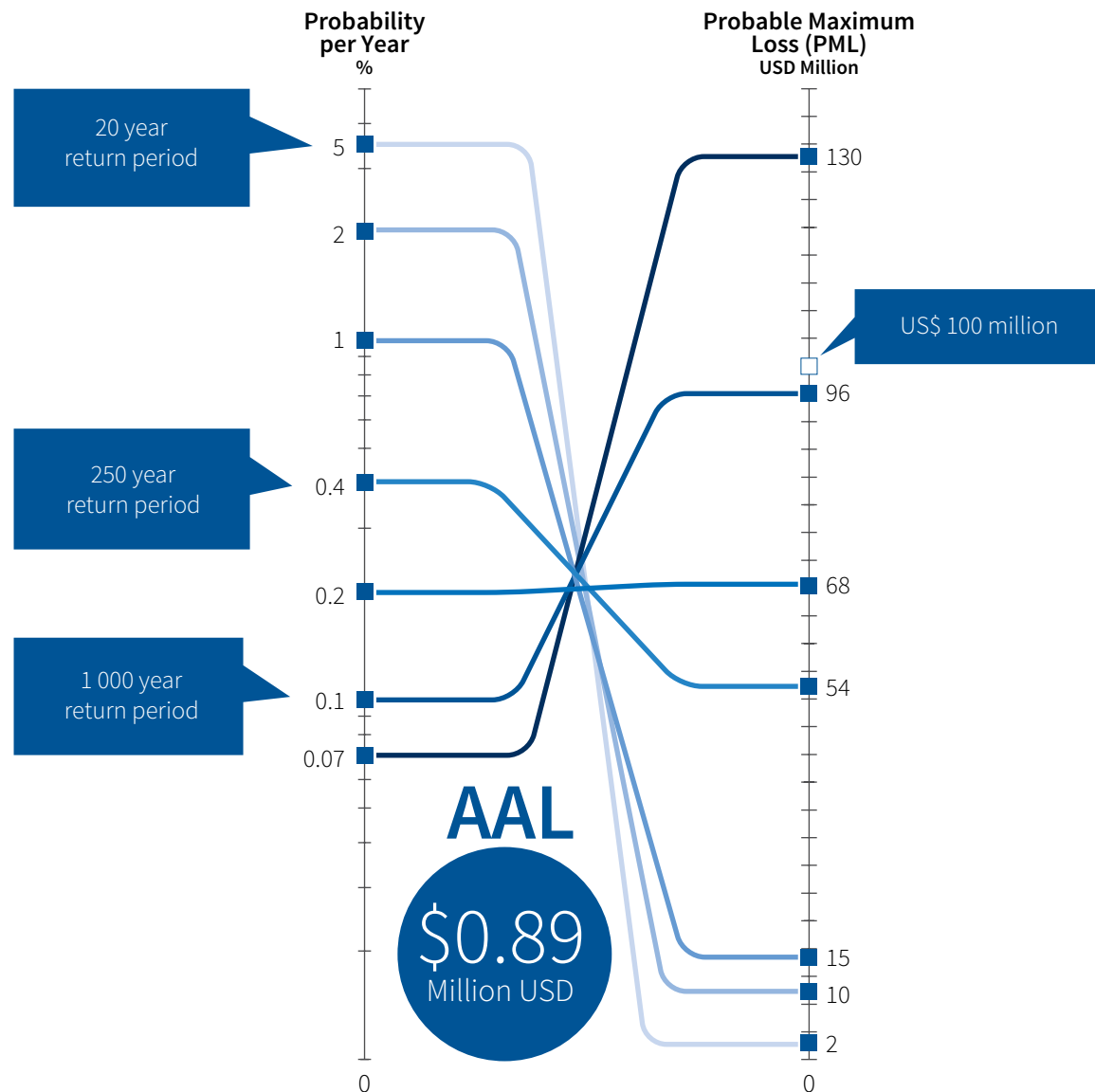
### 3.3 RIVERINE FLOOD RISK VALUES

In average on a yearly basis, floods can cause loss of less than \$1 Million USD across the country. This value is known as Average Annual Loss (AAL) and in the case of Jordan, it is less than 0.1% of annual public health expenditure.

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods. These loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 50 years of time span, there is 2% chance that a river flood cause \$ 9 Million USD.

Probable loss from river floods





# 4. LEBANON

## National Context

Lebanon is a Middle-Eastern country located at the heart of the Eastern shore of the Mediterranean Sea. Lebanon is bordered by Syria to the east and north and by Israel to the south. Its total surface is 10 450 km<sup>2</sup> with a population



Forest fire, Lebanon, 2010. Source: Carol Chouchani Cherfane.

of 4 547 million people living in six governorates. Lebanon is an upper middle income country with annual GDP per capita estimated at US\$ 10 057 in 2014<sup>12</sup>.

A coastal and mountainous country, Lebanon's physical geography is complex with land forms, climate, soils, and vegetation differs markedly within short distances. A major feature of Lebanese topography is the alternation of lowland and highland that runs generally parallel with a north-to-south orientation. The extremely narrow coastal strip stretches for 225 km along the Mediterranean.

This report and the upcoming information on Lebanon are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Lebanon has significant earthquake and tsunami risk which should be considered in disaster risk reduction planning.

<sup>12</sup> World Bank Development Indicators : <http://data.worldbank.org>

## 4.1 DISASTER LOSS

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### 4.1.1 Disaster Risk Reduction

Lebanon’s commitment to adopting a disaster risk reduction approach can be attributed to its unique political history, geography and topography. The ongoing regional conflict and the influx of refugees, the internal governance challenges, unplanned urbanization, poor public infrastructure and services, coupled with recurrent natural hazards ranging from snow storms, floods, landslides, drought, forest fires, earthquakes serve as constant reminders of the nation’s pronounced, complex vulnerabilities<sup>13</sup>.

In the aftermath of major storms in 2002- 2003 and major forest fires in 2007-08, disaster response and coordination was found to be generally weak and ineffective. In 2009, a Disaster Risk Management Unit was established in the Presidency of the Council of Ministers and tasked to coordinate disaster risk reduction efforts across all sectors. Discussions around the establishment of the National Disaster Management Agency are ongoing, based on a draft law addressing this necessity but pending the approval by the National Assembly. In 2013, the National Coordination Committee for DRR was created and the National Response Plan and the National Disaster Management Strategy were developed.

.....  
<sup>13</sup> www.unisdr.org/we/inform/publications/32374

Lebanon has consistently reported on progress towards the implementation of Hyogo Framework for Action since the national reporting biennial cycle started in 2007<sup>14</sup>. Between 2010-2015, the country scaled up its awareness raising campaigns on risk reduction, enhanced the science-policy linkages with respect to disaster risk, engaged and strengthened capacities of local government and municipalities and updated its flash floods risk mapping and assessment.

.....  
<sup>14</sup> Lebanon’s national progress reports available on: <http://www.preventionweb.net/english/countries/asia/lbn/?x=6&y=5>

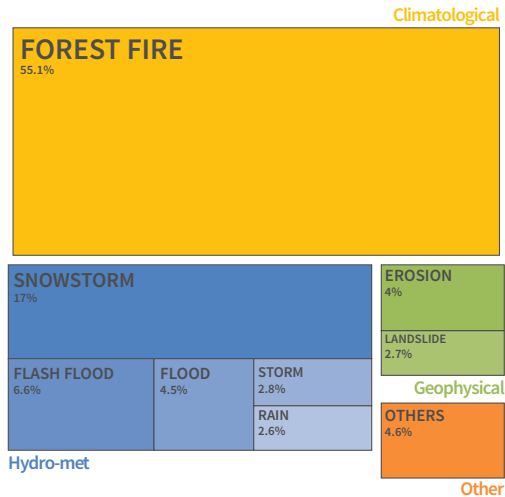
# 4.1 DISASTER LOSS

## 4.1.2 Nationally Accounted Disaster Loss (1980 to 2013)

### a. Frequency

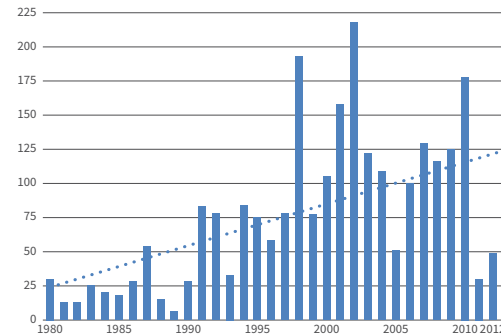
Highly localized, small-scale forest fires, snowstorms and floods account for more than 75% of the disasters recorded in Lebanon.

Disaster Frequency



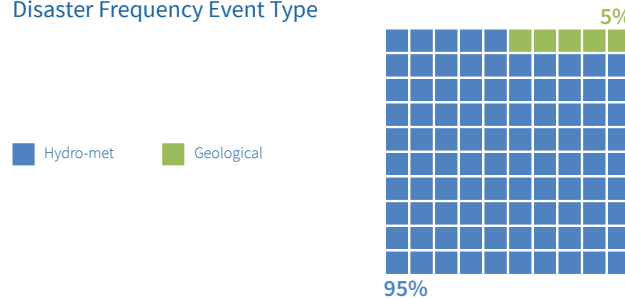
The years 1998, 2002 and 2010 were important outliers, registering up to 218 records, most of them referring to forest fires.

Disaster Frequency Time-Series Trend  
Number of Reports



Agricultural malpractices and dry weather conditions are driving forest fires in Lebanon, which are unique feature in the arid landscape of the Eastern Mediterranean.

Disaster Frequency Event Type



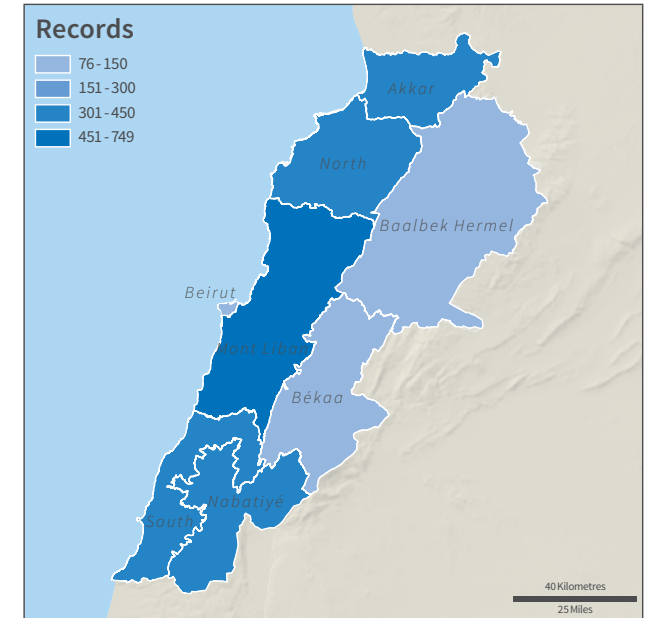
The number of records almost doubled between the decades of 1990-2000 and 2000-2010 (from 787 to 1 411). The overall trend of disaster frequency is increasing, and almost the totality of the records refer to extensive events.

Disaster Frequency Risk Type



Disasters have been more frequent in the District of Mont Liban recording 749 events.

Spatial Footprint of Disaster Frequency

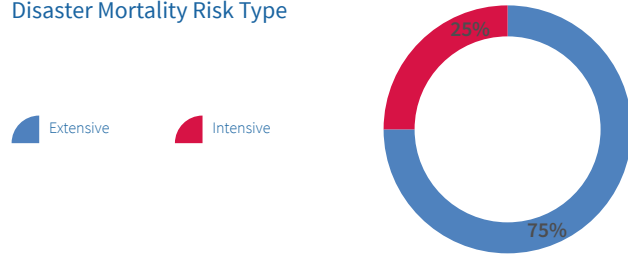


# 4.1 DISASTER LOSS

## b. Mortality

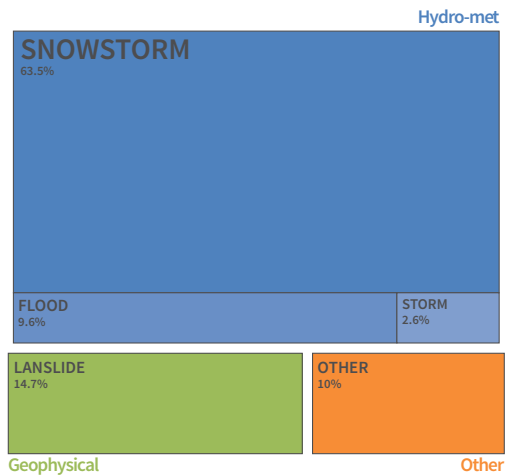
During the last three decades, disaster mortality has been low in Lebanon, with a total of 156 people killed since 1980.

Disaster Mortality Risk Type



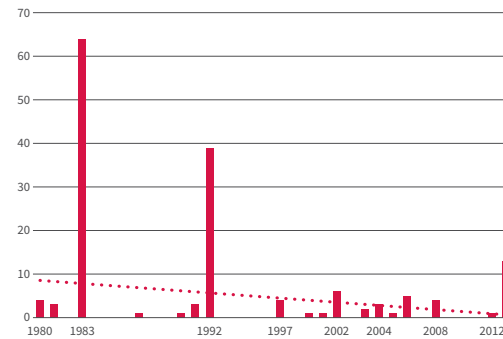
The overall mortality trend has been decreasing over the years. Mortality is mainly due to snowstorms, landslides and floods.

Disaster Mortality



One snowstorm killed 39 people (+17 missing) in Baabda, District of Mont Liban in 1983.

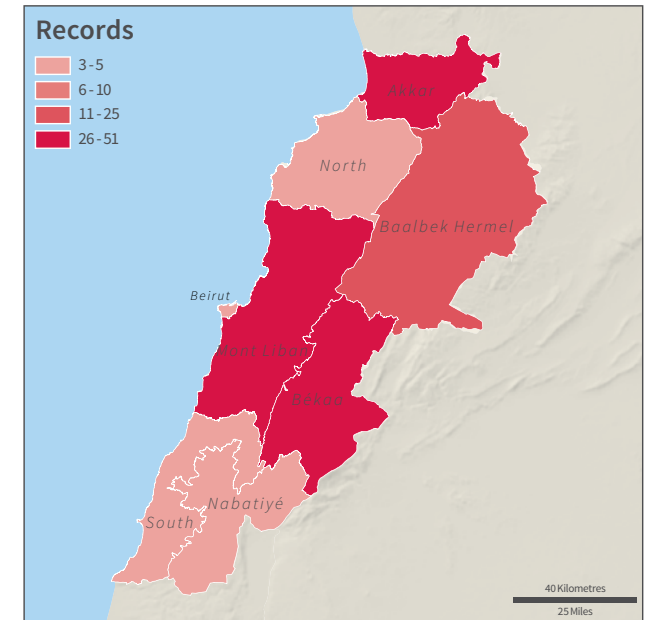
Disaster Mortality Time-Series Trend  
Number of Reports



Hundreds of travellers along the international highway linking Beirut to Damascus were trapped and a number of villages were isolated<sup>15</sup>.

In Lebanon, the snow is not uncommon. The combination of jet stream and anticyclone over Europe drives a strong current of cold air from the Arctic to overspread Middle East and can generate heavy snowfall in the region.

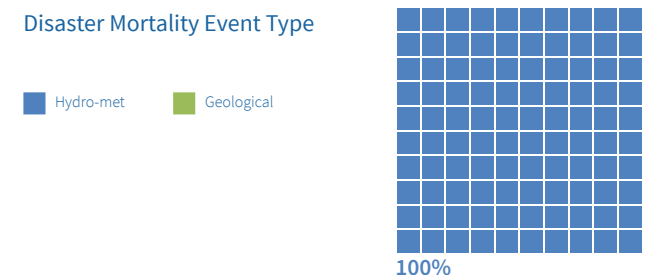
Spatial Footprint of Disaster Mortality



That same year a landslide killed 19 people in Zahle, province of Békaa.

So far, all disaster mortality registered in the national database is due to hydro-meteorological events.

Disaster Mortality Event Type



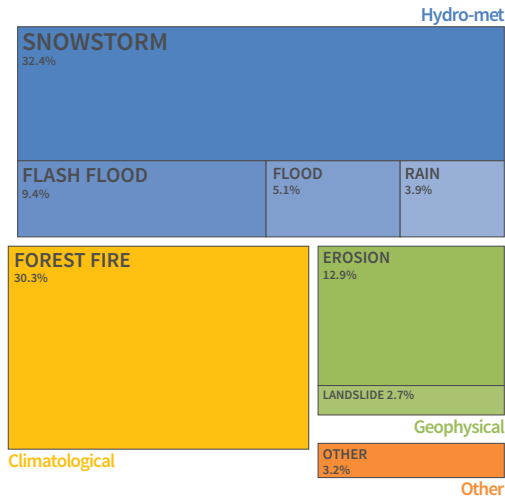
<sup>15</sup> www.upi.com/Archives/1992/02/08/Lebanon-snow-avalanche/5713697525200 and www.marines.mil/Portals/59/Publications/US%20Marines%20In%20Lebanon%201982-1984%20PCN%2019000309800\_2.pdf

# 4.1 DISASTER LOSS

## c. Economic Loss

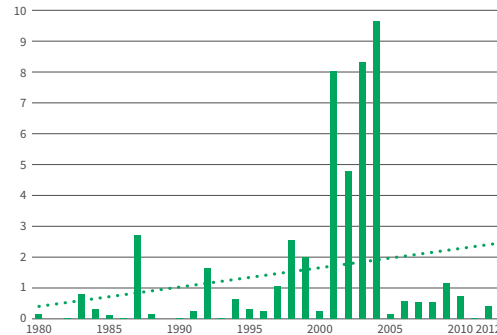
Similar to other indicators such as frequency and mortality, in terms of economic losses, disasters such as snowstorms and forest fires remain important contributors to the overall economic losses in Lebanon.

### Disaster Economic Loss



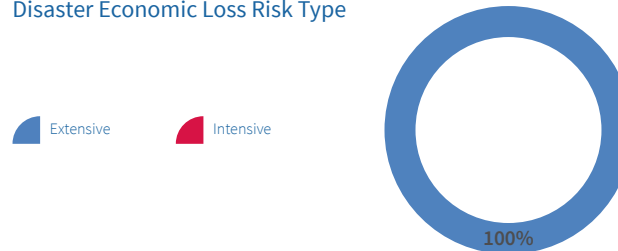
More than ¼ of the economic losses are due to snowstorms, followed by forest fires, erosion (essentially relating to heavy rain)<sup>16</sup> and floods. The overall trend of economic losses is increasing, highly influenced by the damages registered between the years 2001 and 2004.

Disaster Economic Loss Time-Series Trend  
Million US\$



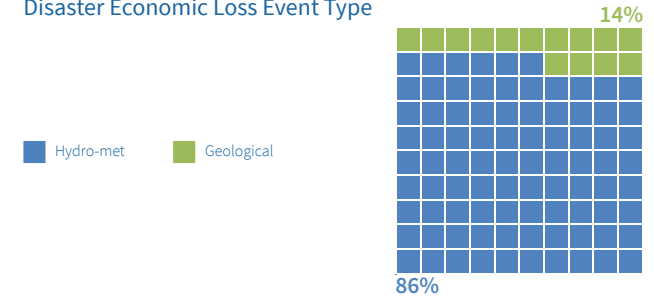
In those four years, 62% of the total economic losses were generated (30 million USD).

Disaster Economic Loss Risk Type



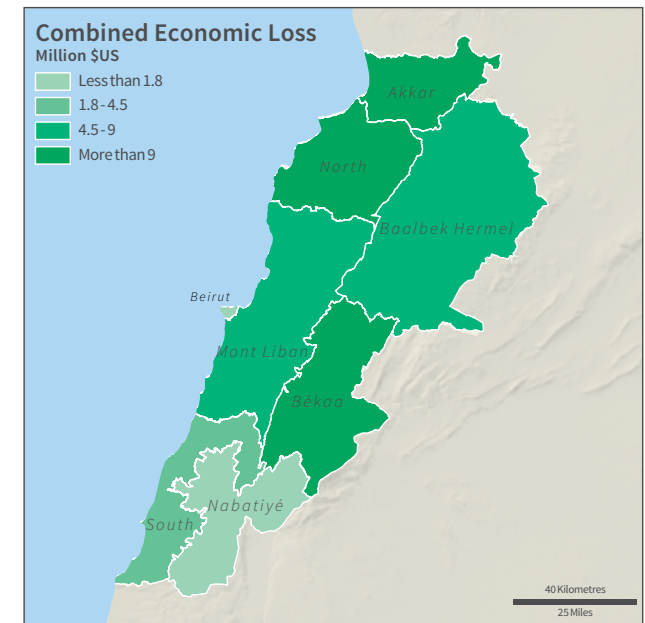
All economic losses refer to extensive events, from which 86% are from hydro-meteorological origin.

Disaster Economic Loss Event Type



Geographically speaking, the Districts of Akkar, North and Békaa generated the highest loss.

Spatial Footprint of Disaster Economic Loss



<sup>16</sup> In Lebanon's national disaster loss database the « Cause » of erosion is attributed to heavy rain.

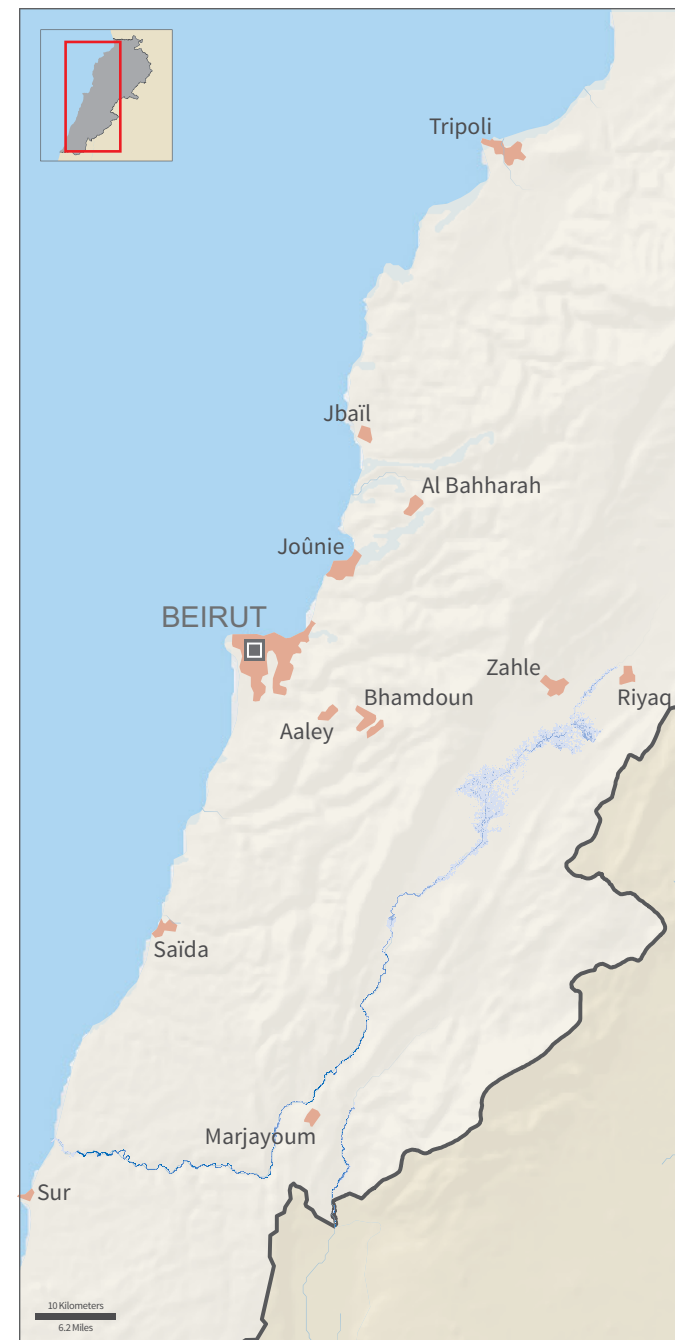


## 4.2 RIVER FLOOD HAZARD AND RISK - NAHR EL LITANI

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>17</sup> in Lebanon are presented here to show case the type of information and value of such comprehensive assessments. River flooding is not the dominant hazard in Lebanon and following results do not provide a full picture of disaster risk levels by any means.

The following map show the river flood area in Nahr el Litani basin which is one of the most flood prone basins in Lebanon. The map shows the foot print of one of the stochastic scenarios considered in the probabilistic risk assessment.

River flood area in Nahr el Litani basin



<sup>17</sup> From GAR15 Global risk assessment: [www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php](http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php)

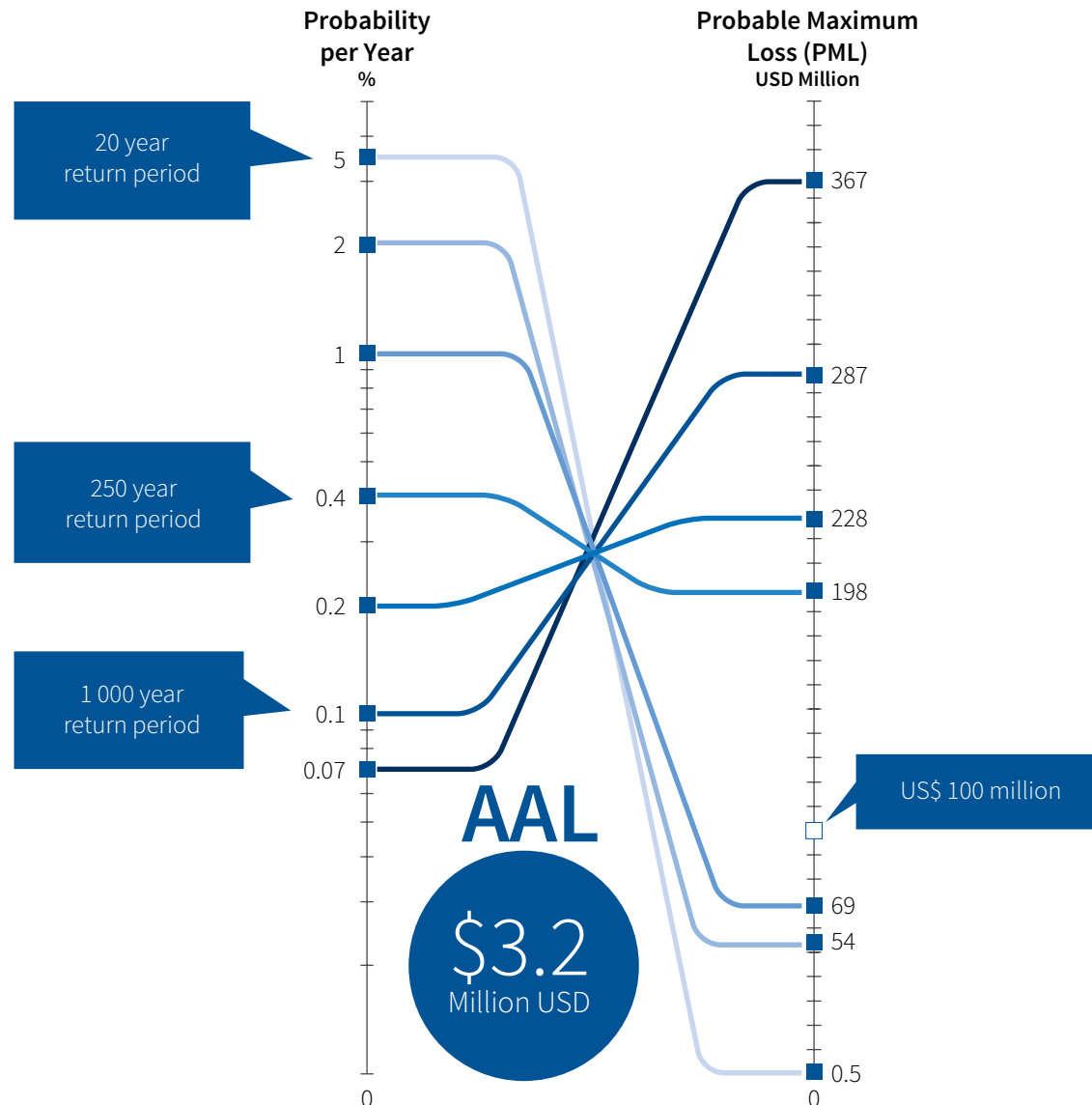
## 4.3 RIVERINE FLOOD RISK VALUES

In average on a yearly basis, floods can cause loss of less than US\$ 3 Million across the country. This value is known as Average Annual Loss (AAL) and in the case of Lebanon, it is less than 0.3% of annual public education expenditure.

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods, these loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 50 years of time span, there is 2% chance that a river flood cause more than \$ 50 Million USD.

Probable loss from river floods





# 5. MOROCCO

## National Context

Morocco, located in the extreme north west of Africa, spans from the Mediterranean Sea and Atlantic Ocean on the north and the west respectively, into large mountainous areas in the interior body, to the Sahara desert in the far south. Its total surface is 446 550 km<sup>2</sup>.



Souss Massa region, Morocco, 2005. Source: Soufiane M -flickr.com

Morocco's population is almost 34 million people living in 16 governorates<sup>18</sup>.

Morocco is a lower middle with annual GDP per Capita estimated at US\$ 3 190 in 2014.

This report and the upcoming information on Morocco are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Morocco has considerable earthquake risk which should be considered in disaster risk reduction planning.

<sup>18</sup> World Bank Development Indicators : <http://data.worldbank.org/>

## 5.1 DISASTER LOSS

### 5.1.1 Disaster Risk Reduction

Morocco is one of the Arab region's most hazard-prone countries and the economy is frequently affected by dry spells, floods, landslides and invasion by locusts. Parts of the country are also exposed to seismic risk. Cities and rural communities alike face the danger of sea-level rise and desertification as a result of climate change.

Several Ministries, Departments and Offices have developed relevant documentation related to disaster risk reduction. The Department of Environment at the Ministry of Energy, Water, Mines and Environment is the focal point institute for coordinating disaster risk reduction efforts

of the country. The Government is working on the development of a National Integrated Risk Management Strategy that is based on three essential pillars: disaster risks, commodity price risks and agricultural risks. Additional to this, sectoral policies and plans related to DRR are ongoing, and discussions around the creation of a national multi-sectorial, multi-hazard platform for DRR have started.

Morocco has reported on progress towards the implementation of Hyogo Framework for Action and submitted two national progress reports in 2013 and 2015<sup>19</sup>.

<sup>19</sup> Morocco's national progress reports available on: [www.preventionweb.net/english/countries/africa/mar](http://www.preventionweb.net/english/countries/africa/mar)

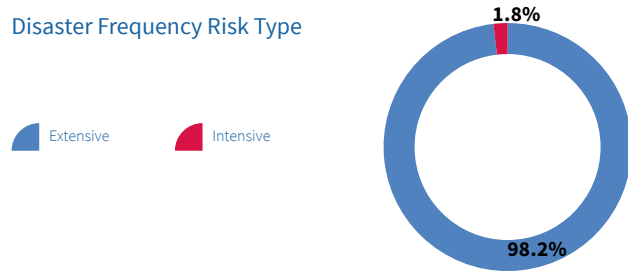
# 5.1 DISASTER LOSS

## 5.1.2 Nationally Accounted Disaster Loss (1990 to 2013)

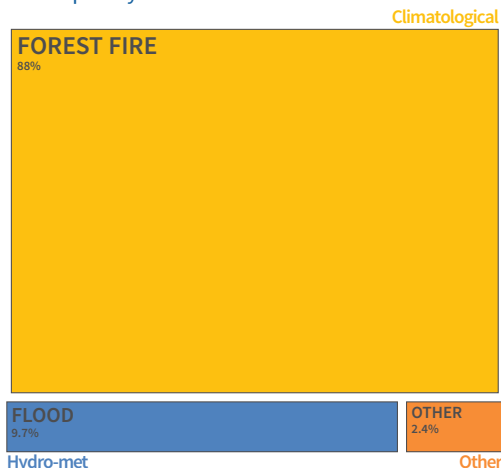
### a. Frequency

In Morocco's national disaster loss database, frequency trends are highly influenced by data availability and data entry. Therefore, only partial analysis can be done based on this dataset using the number of records as a proxy of frequency.

Disaster Frequency Risk Type

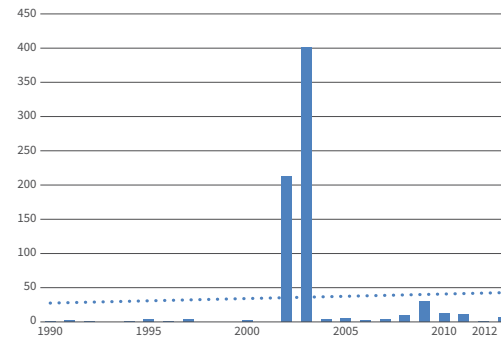


First, from all hazard types that may exist in the country, only 4 types are entered in the national Disaster Frequency



dataset: earthquake, fire, flood, and forest fire. Moreover, the time-series trend shows two outliers in 2002 and 2003 that concentrate most of the records.

Disaster Frequency Time-Series Trend  
Number of Reports

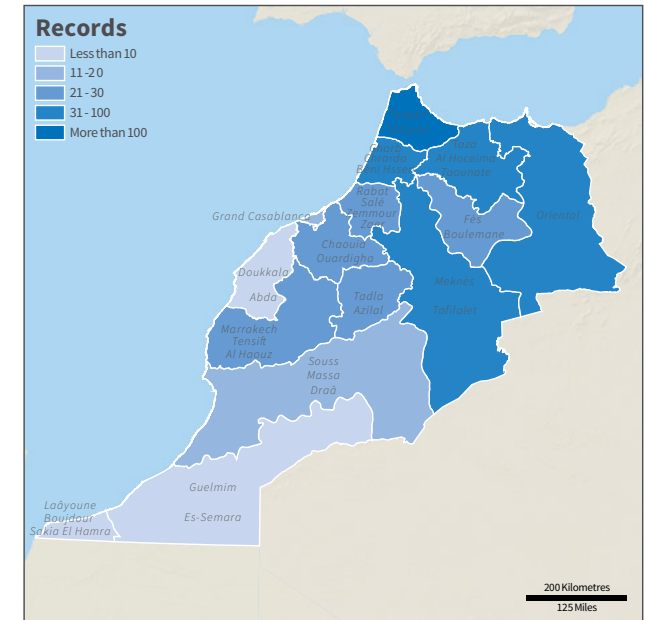


It is very likely that the high proportion of records in those two single years refer more to data availability and entry than to increased disaster frequency during that period. This makes the historical frequency trend stable, but more data input could drastically change this picture<sup>20</sup>.

The Region of Tanger Tétouan concentrates more than ¼ of all disaster frequency (227 records), followed by l Oriental (95) and Meknès Tafilalet (90). So far, the majority of the records that are registered in Morocco's database refer to hydro-meteorological events.

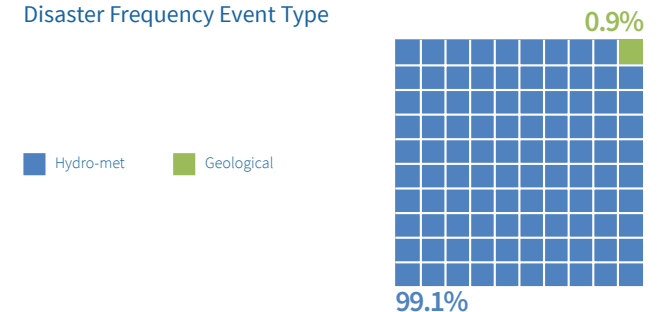
<sup>20</sup> One example of this is the report developed by the Joint Research Centre of the European commission (JRC technical reports) "Forest Fires in Europe, Middle East and North Africa, 2013", which presents an analysis on 14,205 outbreaks of fire with an average of 277 fire events per year from 1960-2012, damaging at least 158,000 hectares. Only this information could generate more than 14,200 entries in Morocco's national disaster loss database.

Spatial Footprint of Disaster Frequency



From all hazard types, 88% of the records refer to forest fires, making them the most frequent hazard affecting the country.

Disaster Frequency Event Type

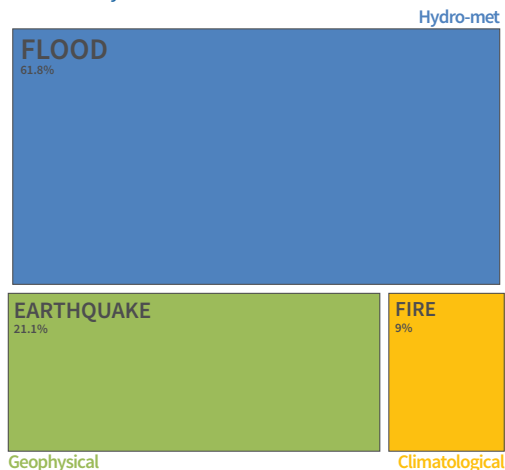


# 5.1 DISASTER LOSS

## b. Mortality

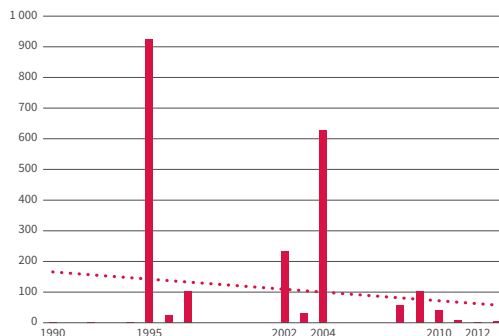
While forest fires are the most frequent disaster in Morocco, they have only contributed to 9% of the total human loss. Mortality is essentially due to floods, followed by earthquakes.

### Disaster Mortality



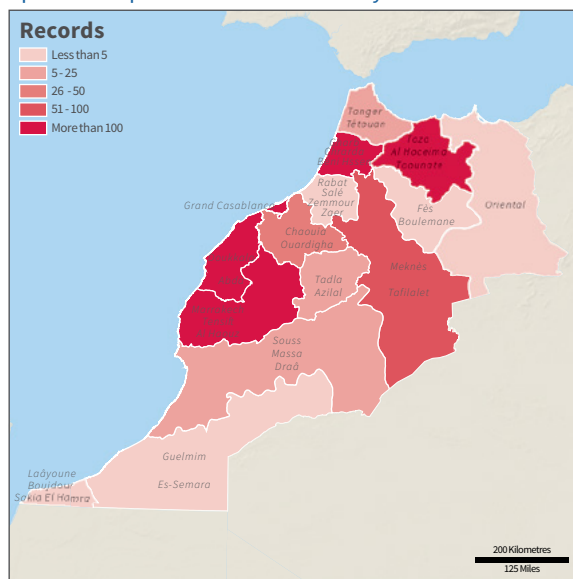
Recurrent floods have killed more than 1,300 people with some extreme events in 1995, 2002 and 2009. The complexity of tectonic active faults in Morocco have resulted in several earthquakes registered in the database with a major and intense event in 2004. The “Al Hoceima” earthquake struck near the north coast of the Mediterranean sea, with a magnitude of 6.4, killing 628 people. Despite these outliers, the mortality trend is going down. Disaster mortality is unevenly distributed in the different regions of the country.

Disaster Mortality Time-Series Trend  
Number of Reports



Marrakech Tensift Al-Haouz, Taza Al Hoceima Taounate and Grand Casablanca concentrate most of disaster mortality. In the case of Marrakech

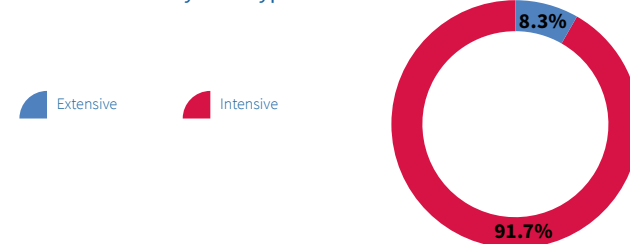
Spatial Footprint of Disaster Mortality



Tensift Al-Haouz, in the year of 1995 there are two records registering up to 880 people killed by floods in the region.

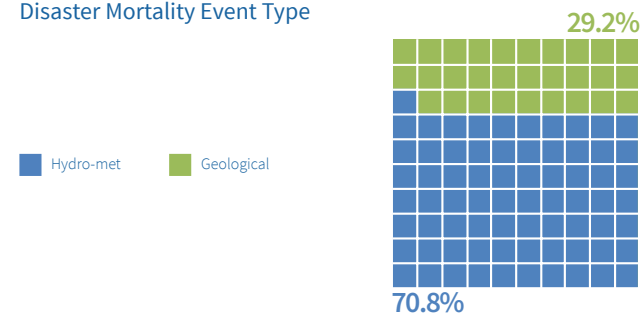
These two single records in a single year account for 40% of the overall disaster mortality.

Disaster Mortality Risk Type



This kind of disasters not only explain the fact that mortality has been caused mainly by intensive events, but also explain why hydro-meteorological events account for more than 70% of the human losses.

Disaster Mortality Event Type

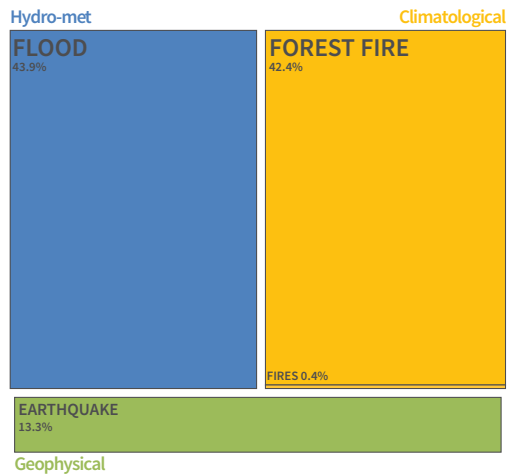


# 5.1 DISASTER LOSS

## c. Economic Loss

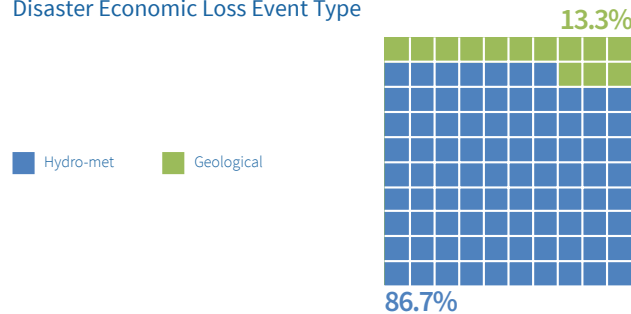
Hydro-meteorological events have generated more than 3/4 of the economic losses in Morocco. Taken together, floods (44%) and forest fires (43%) account for almost US\$ 458 million.

### Disaster Economic Loss



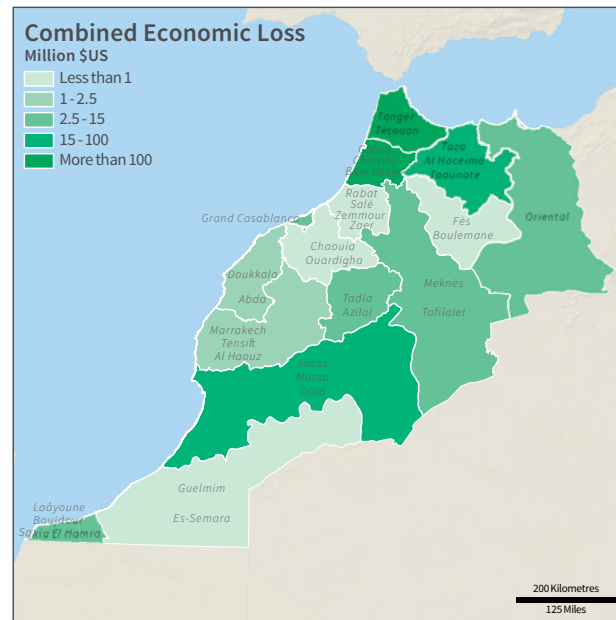
However, only 6 earthquakes have generated more than US\$ 70 million of economic losses, which is the equivalent to 13% of the total.

### Disaster Economic Loss Event Type



One single 6.4 magnitude earthquake in Al Hoceima the 24 February 2004, damaging 12 367 and destructing 1 067 houses and generated more than US\$ 68 million of losses.

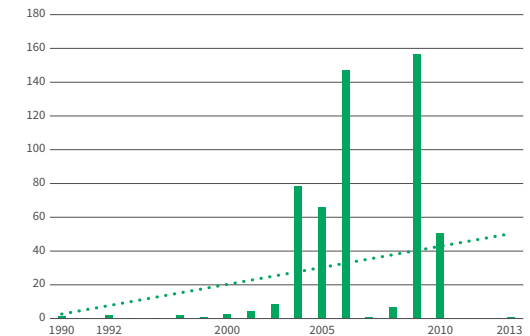
### Spatial Footprint of Disaster Economic Loss



This shows how destructive these intensive events can be.

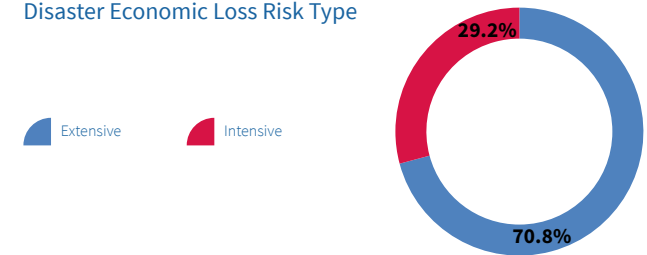
### Disaster Economic Loss Time-Series Trend

Million US\$



Despite this, intensive disasters only account for 30% of the economic loss, while the accumulation of small-scale (extensive) disasters accounts for the other 70%.

### Disaster Economic Loss Risk Type





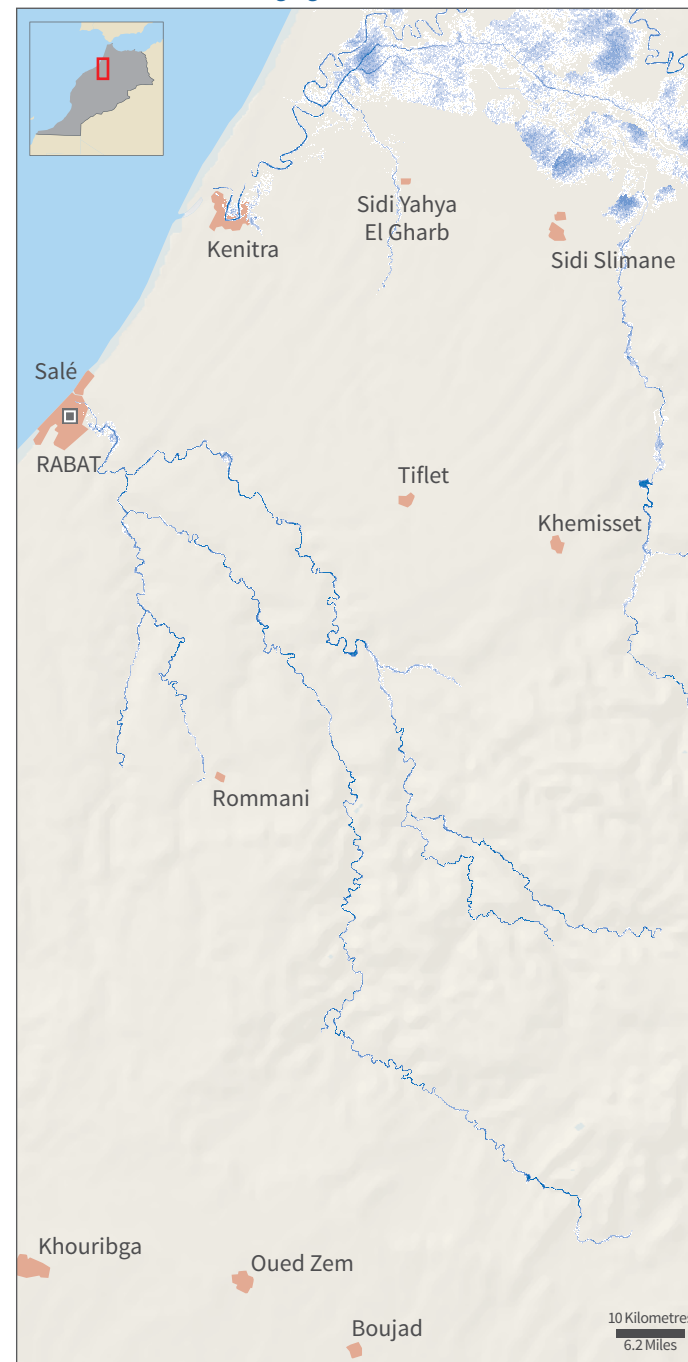
## 5.2 RIVER FLOOD HAZARD AND RISK - BOU REGREG BASIN

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>21</sup> in Morocco are presented here to show case the type of information and value of such comprehensive assessments. River flooding is one of the predominant hazard in Morocco in terms of mortality and economic losses. However, the following results do not provide a full picture of disaster risk levels by any means.

The following map shows the river flood area in Bou Regreg basin which is one of the most flood prone basins in Morocco. The map shows the foot print of one of the stochastic scenarios considered in the probabilistic risk assessment.

<sup>21</sup> From GAR15 Global risk assessment: <http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php>

River flood area in Bou Regreg basin



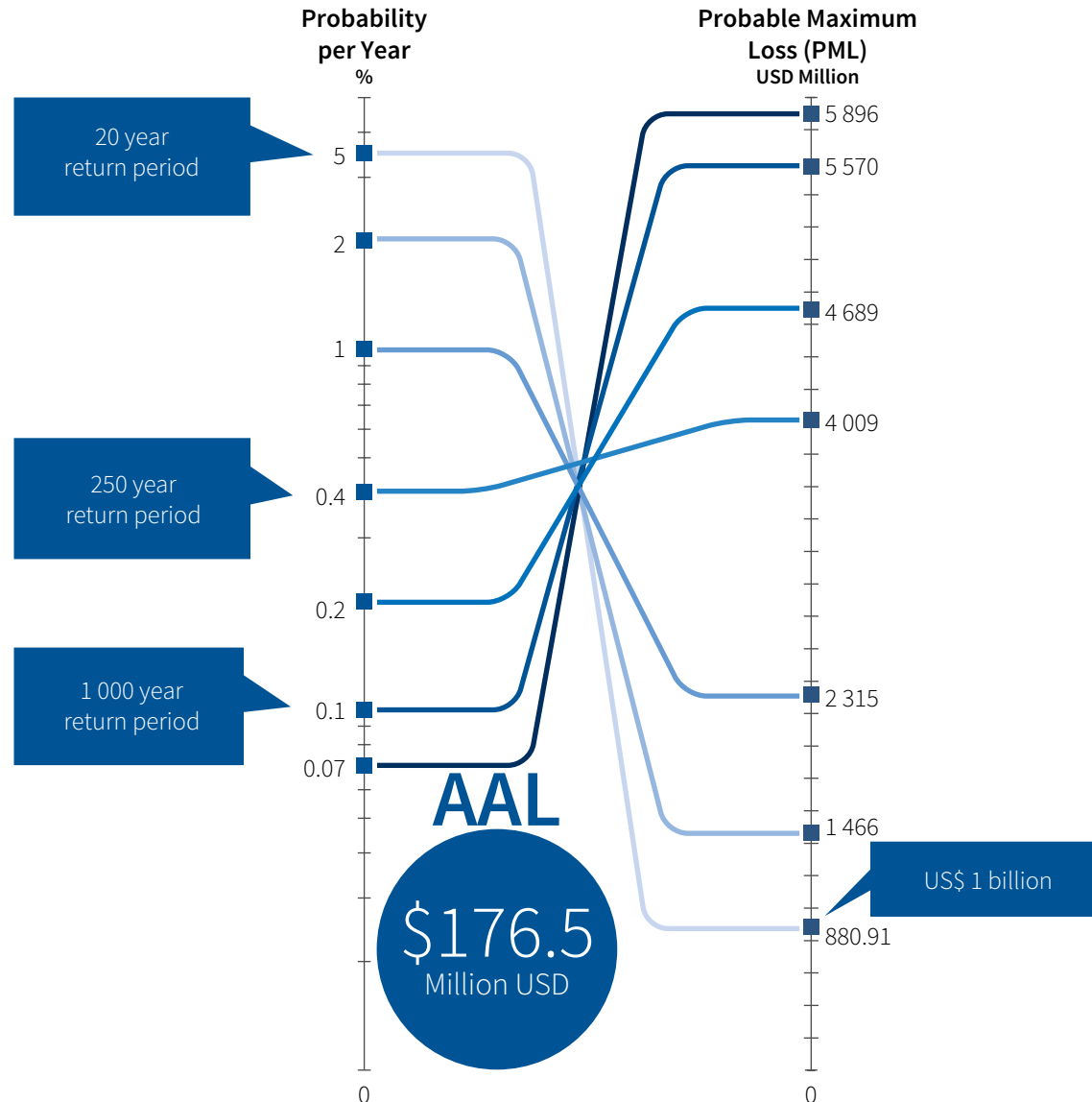
## 5.3 RIVERINE FLOOD RISK VALUES

In average on a yearly basis, floods can cause loss of about US\$ 175 Million across the country. This value is known as Average Annual Loss (AAL) and in the case of Morocco, it is more than 8% of annual public health expenditure.

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods, these loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 20 years of time span, there is 5% chance that a river flood cause US\$ 880 million.

Probable loss from river floods





# 6. PALESTINE

## National Context

The State of Palestine is situated in the Middle East and divided into two main territories: West Bank and Gaza Strip. West Bank is landlocked with surface area of 5 655 km<sup>2</sup> and a population 2,79 million people living in eleven



Jordan Valley, West Bank, Palestine, 2017. Source: Alaa Kanan.

governorates<sup>22</sup>. The Mediterranean Gaza Strip has a coastline of 40 km with surface area of 365 km<sup>2</sup> and a population of 1,76 million people living in five governorates. The Gaza Strip is the most densely populated territory in the world and could become uninhabitable by 2020 due to the ongoing de-development and years of economic blockade as the United Nations warned<sup>23</sup>.

Palestine is a lower middle income state with annual GDP per Capita estimated at US\$ 2 965 in 2014<sup>24</sup>, while data from the Palestinian Central Bureau of Statistics in 2013 shows that GDP per Capita in West Bank is US\$ 2 051 and drops to almost half in Gaza Strip with GDP per Capita estimated at US\$ 1 103.

This report and the upcoming information on Palestine are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Palestine has significant earthquake risk which should be considered in disaster risk reduction planning.

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<sup>22</sup> Palestinian Central Bureau of Statistics [www.pcbs.gov.ps/Portals/\\_Rainbow/StatInd/StatisticalMainIndicators\\_E.htm](http://www.pcbs.gov.ps/Portals/_Rainbow/StatInd/StatisticalMainIndicators_E.htm)

<sup>23</sup> UNRWA Report "Gaza in 2020: A liveable place?" [www.unrwa.org/userfiles/file/publications/gaza/Gaza%20in%202020.pdf](http://www.unrwa.org/userfiles/file/publications/gaza/Gaza%20in%202020.pdf)

<sup>24</sup> World Bank Development Indicators : <http://data.worldbank.org>

## 6.1 DISASTER LOSS

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### 6.1.1 Disaster Risk Reduction

Palestine is exposed to multiple natural hazards, including earthquakes, flooding, droughts, and landslides and in recent years has also seen extreme heat and cold waves. High population rates within unplanned urbanization, fragile economic and political context, lack of institutional mechanisms for multi-sectorial and multi-hazard disaster risk reduction system, all increase the vulnerable conditions thus creating a significant risk of high impact disasters.

There has been an emphasis on emergency response through the civil defence mechanism, which does not address the full spectrum of risks that could give rise to a national emergency. Law number 3 is the main current law governing disaster issues, and it is modelled after similar 1960s civil defence laws developed after the Cuba crises when the main threat was war; other disasters, like natural disasters, were added on at later stage. This law from 1998 creates a good foundation for preparedness and response from a civil defence perspective, however, the law does not give a comprehensive, whole-of government approach to a broader disaster risk management framework system. In 2013, and based on the recommendation of the UN Special Representative of the Secretary-

General for Disaster Risk Reduction, the President of Palestine established a multi-stakeholder DRR committee tasked to review institutional and legal frameworks , including coordination mechanisms, to strengthen risk management and preparedness.

A UN Disaster Assistance and Coordination (UNDAC) team conducted a disaster preparedness mission in 2014 and concluded that the Law 3 on civil defence is too limited in scope for broad risk management. UNDAC recommendations recognized that there is a strong sense of community support in Palestine and that there are many good practices at the local level that should be carried forward in strengthening

national disaster risk management, yet a national mechanism needs to be created through a multi-level and multi-stakeholder approach supported by a reform of the institutional and operational set-up. Given the special circumstances of Palestine, it is important to maintain a strong culture of preparedness and response to deal with disaster and crisis situations.

Palestine has consistently reported on progress towards the implementation of Hyogo Framework for Action since 2009 and submitted three biennial reports since then <sup>25</sup>.



Floods in Gaza, Palestine, 2011.  
Source: Alhasan Sweirju/Oxfam-flickr.com

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<sup>25</sup> Palestine's national progress reports available on: [www.preventionweb.net/english/countries/asia/pse/](http://www.preventionweb.net/english/countries/asia/pse/)

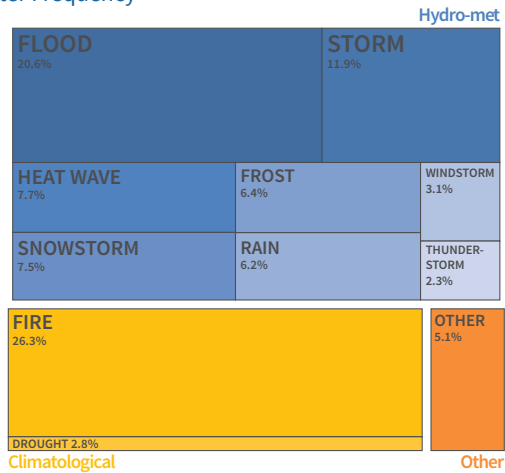
# 7.1 DISASTER LOSS

## 6.1.2 Nationally Accounted Disaster Loss (1980 to 2013)

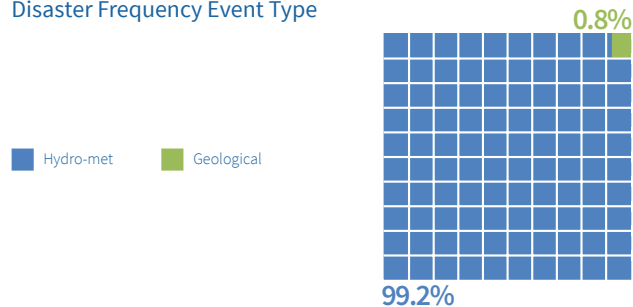
### a. Frequency

From a total of 388 records, 385 (99.23%) refer to hydro-meteorological events, from which fires and floods remain prominent hazards (102 and 80 records respectively).

Disaster Frequency

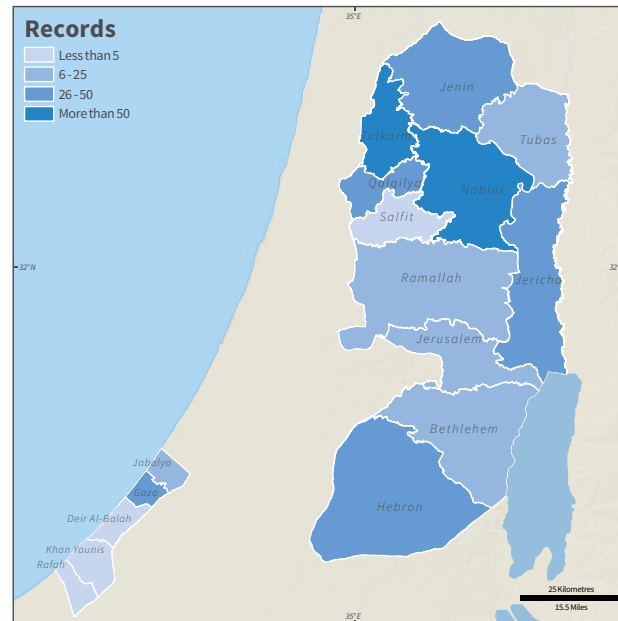


Disaster Frequency Event Type



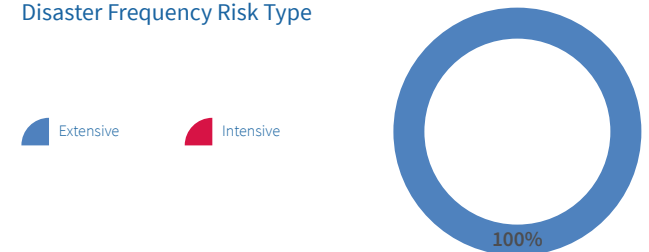
Geographically speaking, the Districts of Tulkarm and Nablus have experienced the highest numbers of records, respectfully 51 and 55.

Spatial Footprint of Disaster Frequency



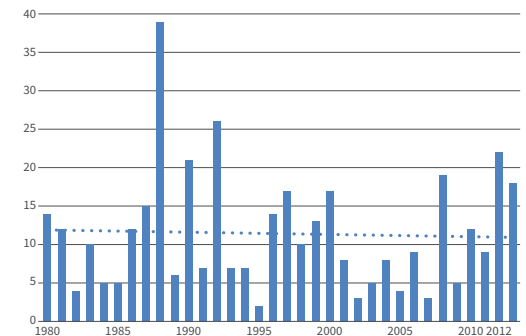
Frequency is quite variable, with no important outliers with the exception of 1988 in which 39 events were registered, while the yearly average is 11 records.

Disaster Frequency Risk Type



The trend of disaster frequency remains quite stable with a slightly downwards trend. All records refer to extensive disasters.

Disaster Frequency Time-Series Trend Number of Reports

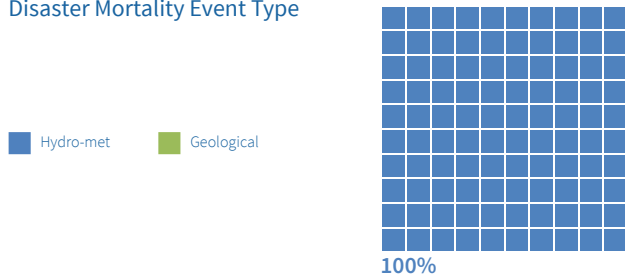


# 6.1 DISASTER LOSS

## b. Mortality

45 people have been killed by disasters in the State of Palestine, all of them due to hydro-meteorological events.

Disaster Mortality Event Type



Taken together, rain and floods have killed 31 persons, which represent almost 69 % of the total mortality.

Disaster Mortality

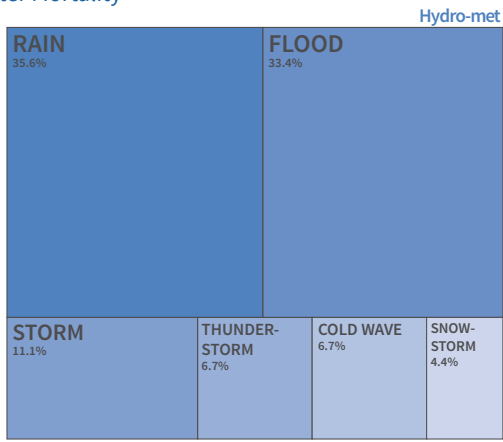
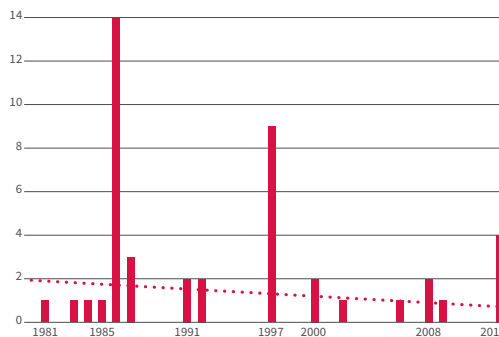


FIGURE 2.22  
Climatological

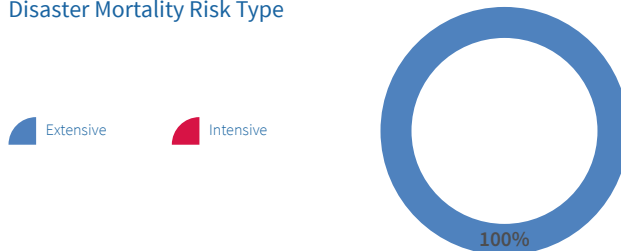
Mortality is trending down. However, two important outliers can be seen, in the year of 1986 where the state suffered of heavy rain killing 14 people.

Disaster Mortality Time-Series Trend  
Number of Reports



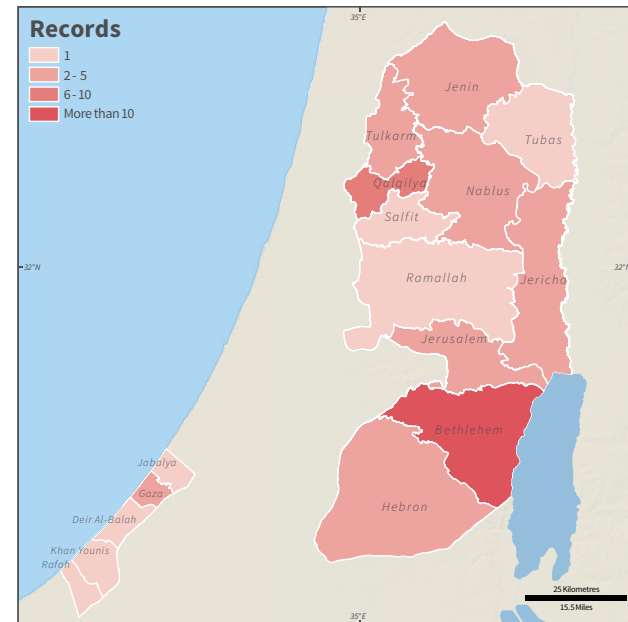
A severe flood in 1997 where 9 people were reported dead.

Disaster Mortality Risk Type



The District concentrating the highest mortality due to disasters is Bethlehem (15 people).

Spatial Footprint of Disaster Mortality

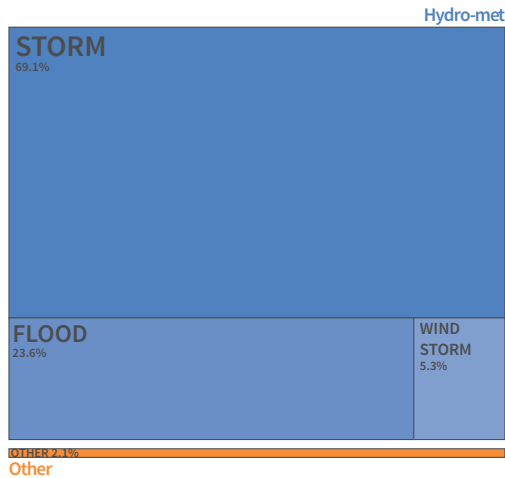


# 6.1 DISASTER LOSS

## c. Economic Loss

The State of Palestine accounts for an estimation of more than US\$ 11.5 million of losses. These losses have been triggered by two main hazards: storms (almost US\$ 8 million) and floods (US\$ 2.7 million), which taken together represent 92% of the total.

### Disaster Economic Loss



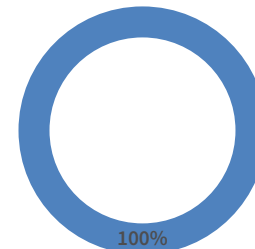
Economic losses are almost equally distributed in Gaza (US\$ 5.2 million) and the West Bank (6.3 million USD). Tubas and Rafah are the two most affected Districts in terms of economic losses.

### Spatial Footprint of Disaster Economic Loss



2013 is the main outlier in the historical trend, which can be explained by some intense floods and storms which generated important physical damage, essentially to housing (more than 50 destroyed and more than 300 damaged in that single year).

### Disaster Economic Loss Risk Type

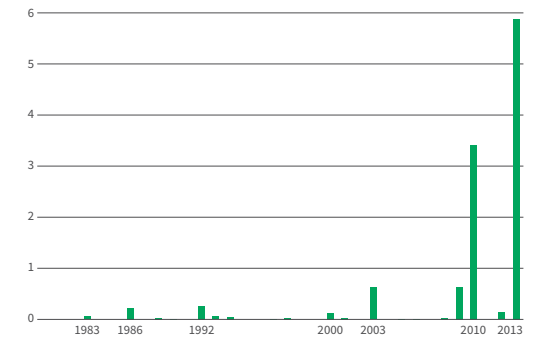


Another outlier is 2010, when important agricultural losses were reported in Gaza due to a storm in December that year.

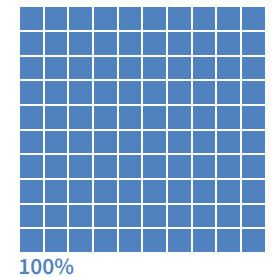
So far, no losses from geological events are reported.

### Disaster Economic Loss Time-Series Trend

Million US\$



### Disaster Economic Loss Event Type





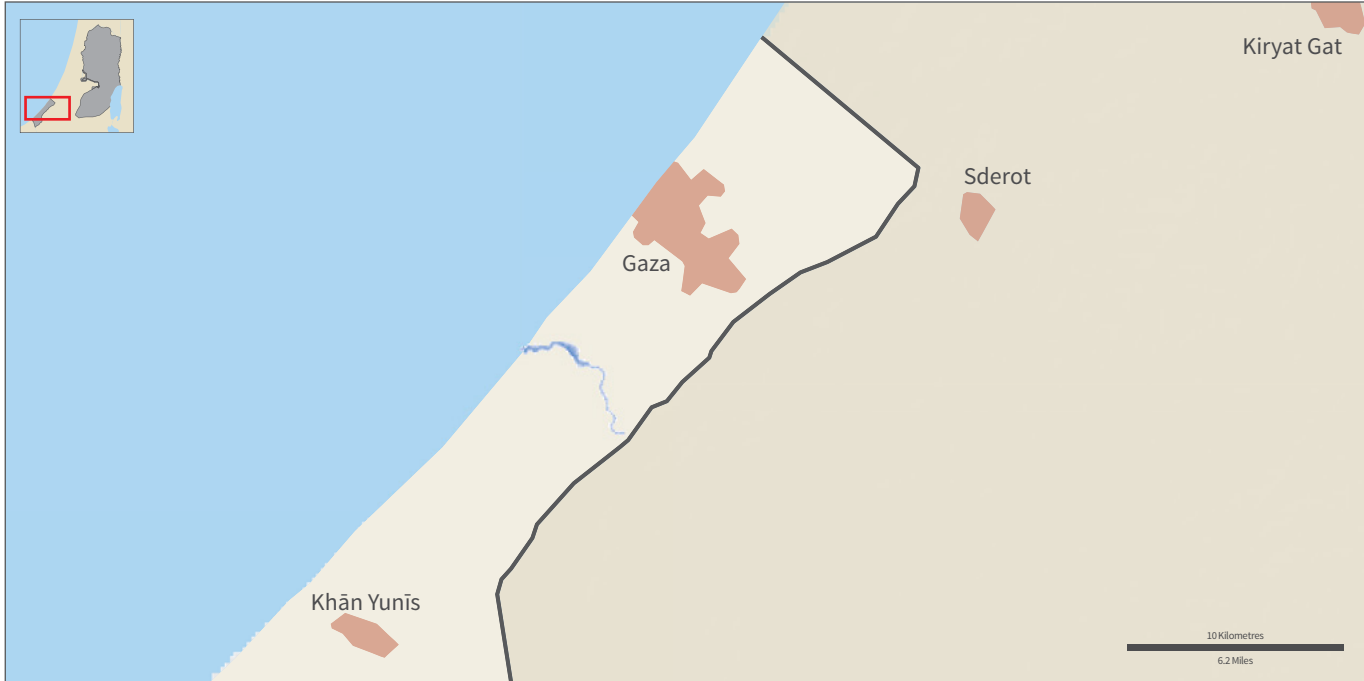
## 6.2 RIVER FLOOD HAZARD AND RISK - WADI GAZA

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>26</sup> in the State of Palestine are presented here to show case the type of information and value of such comprehensive assessments. River flooding, and all type of floods, are the main killer hazard in State of Palestine and

generating ¼ of the economic loss. However, the following results do not provide a full picture of disaster risk levels by any means.

The map below show the river flood area in Wadi Gaza basin which is one of the most flood prone basins in the State of Palestine. The map shows the foot print of one of the stochastic scenarios considered in the probabilistic risk assessment.

River flood area in Wadi Gaza basin



<sup>26</sup> From GAR15 Global risk assessment: <http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php>

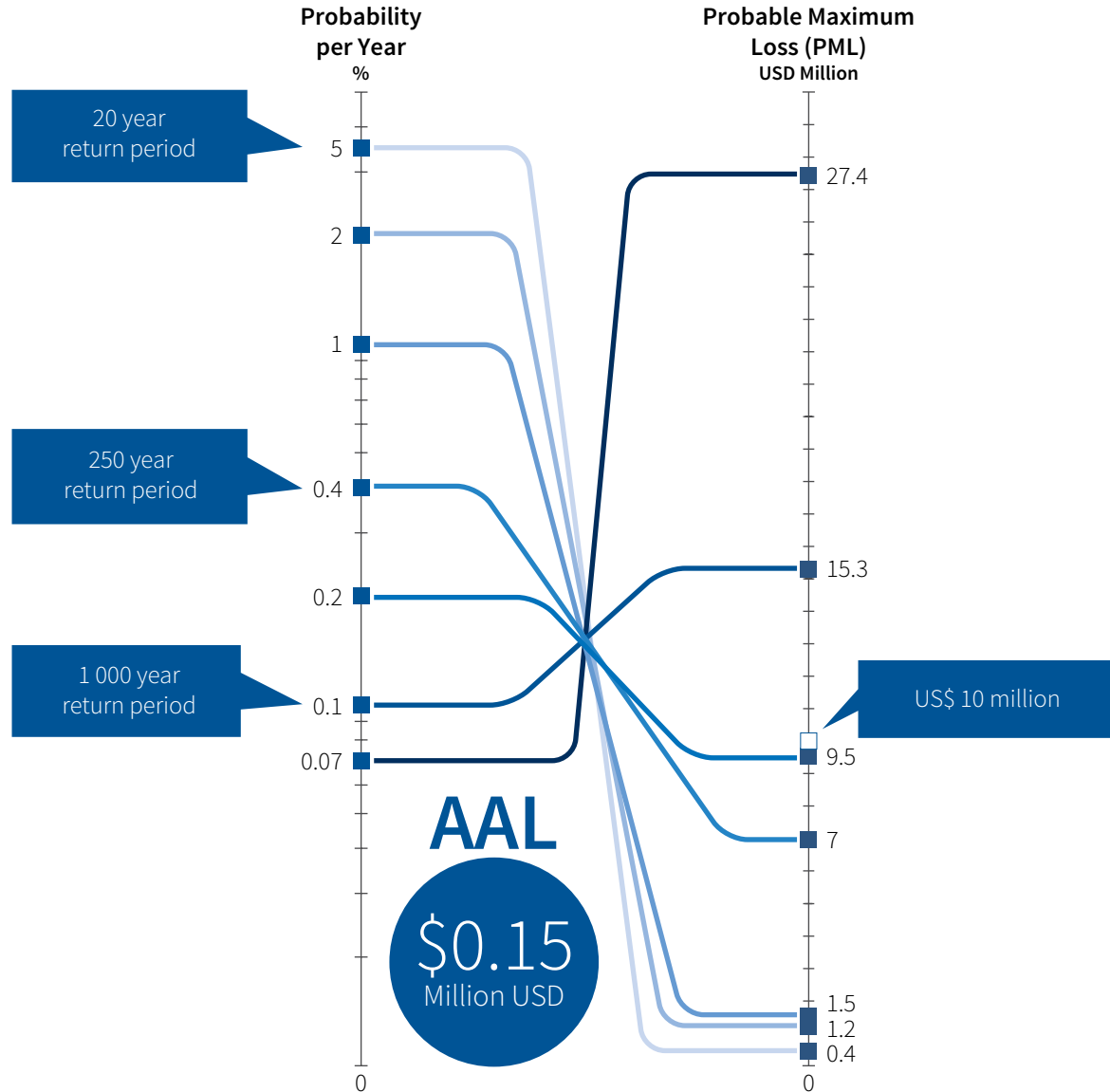
## 6.3 RIVERINE FLOOD RISK VALUES

In average on a yearly basis, floods can cause loss of less than \$150 000 USD across the country. This value is known as Average Annual Loss (AAL) and in the case of State of Palestine, it is less than 0.01% of capital investment, which means the measurement of the total investment by the private and public sectors in a given year, using the metric of Gross Fixed Capital Formation (GFCF).

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods, these loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 50 years of time span, there is 2% chance that a river flood cause more than US\$ 1.2 million.

Probable loss from river floods





# 7. TUNISIA

## National Context

Tunisia is the northernmost country in Africa. Its total surface is 163 610 km<sup>2</sup>. Geographically, Tunisia contains the eastern end of the Atlas Mountains and the northern reaches of the Sahara desert. Much of the rest of the country's land is fertile soil. Tunisia's coastline stretches to 1 300 km on the Mediterranean



Matmata, Tunisia, 2014. Source: Nanou El -flickr.com

Sea and the country is bordered by Algeria on the West and Libya in the South. Tunisia is an upper middle income country with GDP per capita estimated at US\$ 4 420 in 2014. The country is divided administratively into 24 governorates with a population of almost 11 million<sup>27</sup> people.

This report and the upcoming information on Tunisia are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Tunisia has considerable earthquake risk which should be considered in disaster risk reduction planning.

<sup>27</sup> World Bank Development Indicators : <http://data.worldbank.org>

## 7.1 DISASTER LOSS

### 7.1.1 Disaster Risk Reduction

Tunisia is at risk of different hazards, including earthquakes, snowstorms, sandstorms, flooding and drought. In 1991, the country created a specific legislation aiming at the reduction of risks from natural and man-made hazards. Since then, several revisions, additions and sectorial policies and laws have been developed in order to tackle the underlying drivers of risk such as increasing urbanization, climate change and land use.

Since 2011, more attention has been given to disaster risk reduction including thorough process to strengthen disaster risk management capacities, systems and planning processes. Tunisia started to report on progress towards the implementation of Hyogo Framework for Action in 2011 and has submitted 2 national reports since then<sup>28</sup>. In 2012, Tunisia launched its national multi-stakeholder platform for disaster risk reduction bringing together all stakeholders from central government, national institutions, civil society and local NGOs, scientific community and interregional bodies.

Tunisia's new Constitution adopted in 2014 established a Commission for Sustainable

Development and the Rights of Future Generations, which provides a conceptual framework for disaster risk reduction and includes access to healthy environment taking into account the vulnerability to climate change. In the transitional phase to institutionalize all new mandates under the Constitution, Tunisian authorities are working towards creating synergies, coordination and decentralization of roles and responsibilities of all stakeholders working on disaster risk reduction.

<sup>28</sup> Tunisia's national progress reports available on: [www.preventionweb.net/english/countries/africa/tun/](http://www.preventionweb.net/english/countries/africa/tun/)

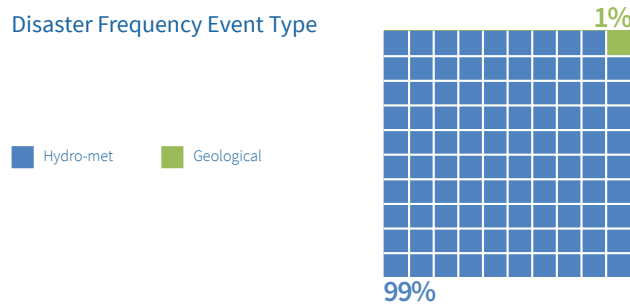
# 7.1 DISASTER LOSS

## 7.1.2 Nationally Accounted Disaster Loss (1982 to 2013)

### a. Frequency

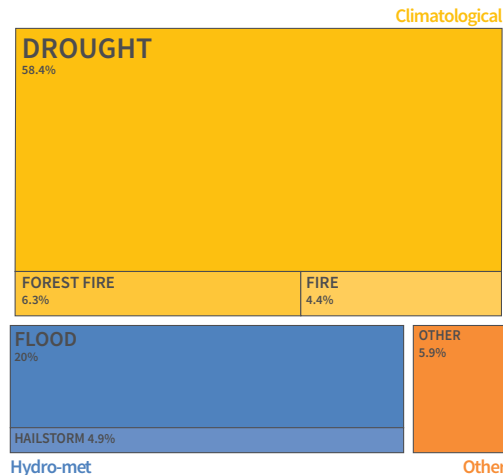
99% of the records in Tunisia database are of hydro-meteorological origin.

Disaster Frequency Event Type



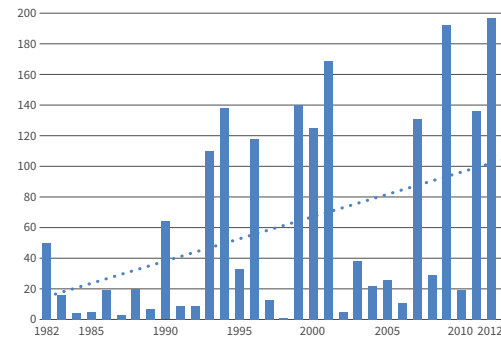
The majority of them refer to drought (1121 records), followed by floods (384).

Disaster Frequency



As hydro-meteorological hazards are dependent on climate variability, their frequency is equally variable as can be seen in the time-series trend.

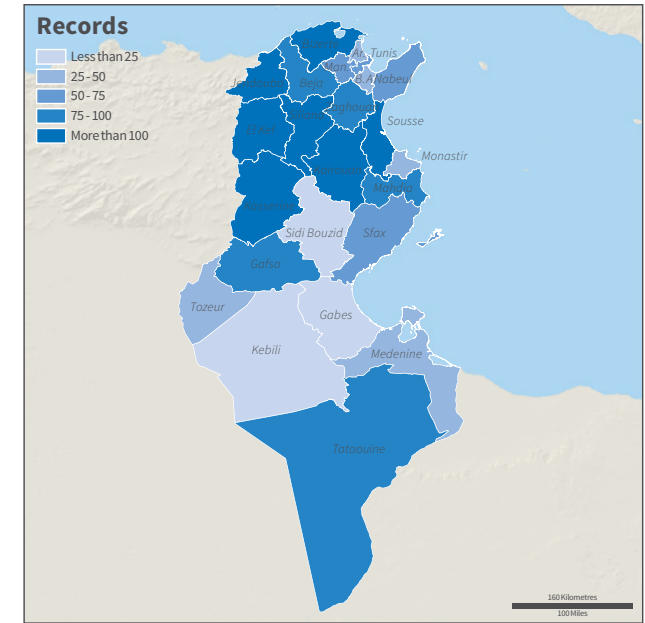
Disaster Frequency Time-Series Trend  
Number of Reports



No important outliers can be seen, but some years have more than 170 records, while the annual average is 60.

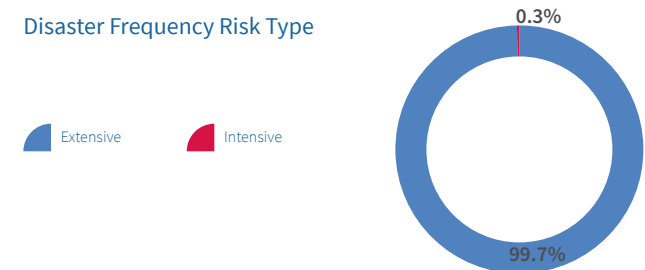
Disasters have been more frequent in the Governorates of Kairouan and El Kef registering respectfully 165 and 158 events.

Spatial Footprint of Disaster Frequency



Country data also reveals that Tunisia has been essentially hit by small-scale and frequent events rather than intensive events<sup>29</sup>.

Disaster Frequency Risk Type



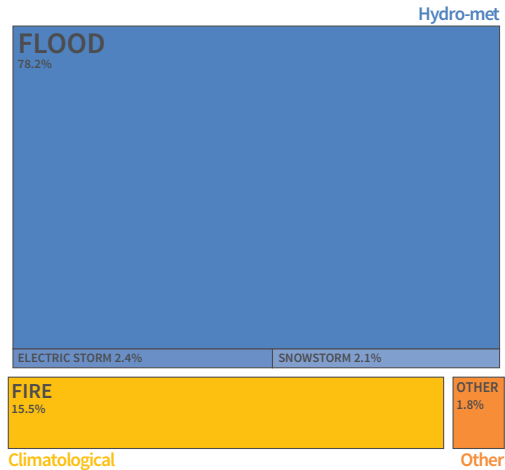
<sup>29</sup> However, it is still important to remind that the number of records are a proxy of frequency. In some cases, such as the floods that hit the province of Sfax in September 1982, some 8 datacards registered damages for that same event. Taken together, they represent a single, intensive event.

# 7.1 DISASTER LOSS

## b. Mortality

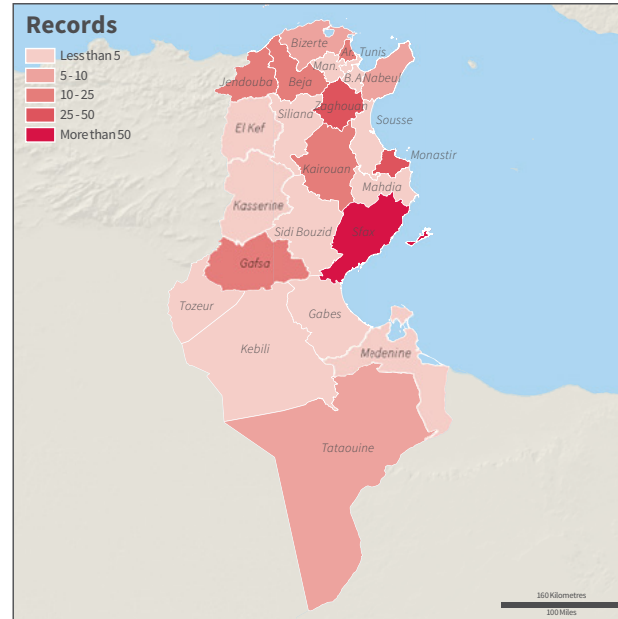
From a total of 330 persons killed by disasters, 258 have been killed by floods.

### Disaster Mortality



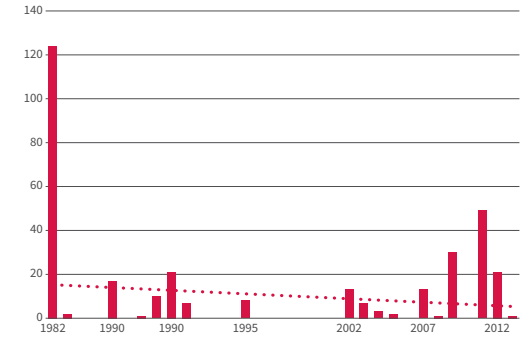
The Governorates of Sfax concentrates most of disaster mortality, which can be explained by the intense flooding that hit different municipalities of the province in September 1982, killing more than 93 people.

Spatial Footprint of Disaster Mortality



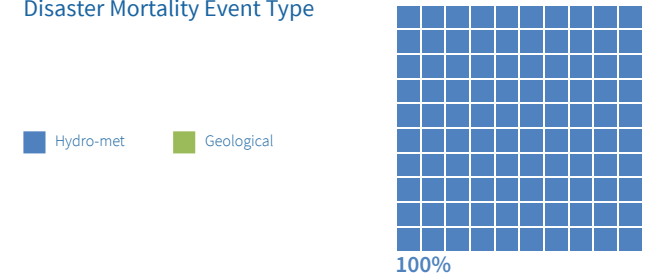
This makes 1982 an important outlier in the historical mortality trend line.

Disaster Mortality Time-Series Trend  
Number of Reports



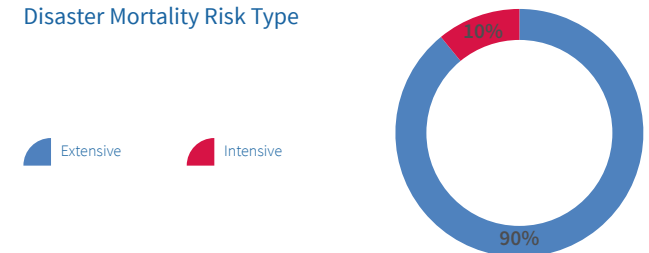
So far, all disaster mortality has been caused by hydro-meteorological disasters.

Disaster Mortality Event Type



A downwards trend can be seen, but numbers have increased in the last years compared to the beginning of the 2000-2010 decade.

Disaster Mortality Risk Type

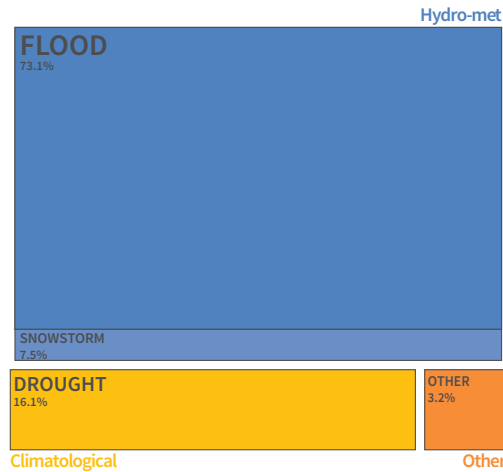


# 7.1 DISASTER LOSS

## c. Economic Losses

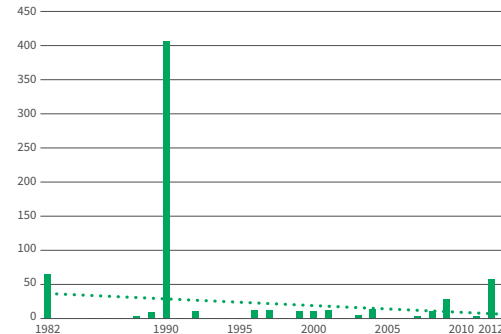
Floods are the main contributor to the economic losses in Tunisia (US\$ 500 million of losses, 73% of the total).

Disaster Economic Loss



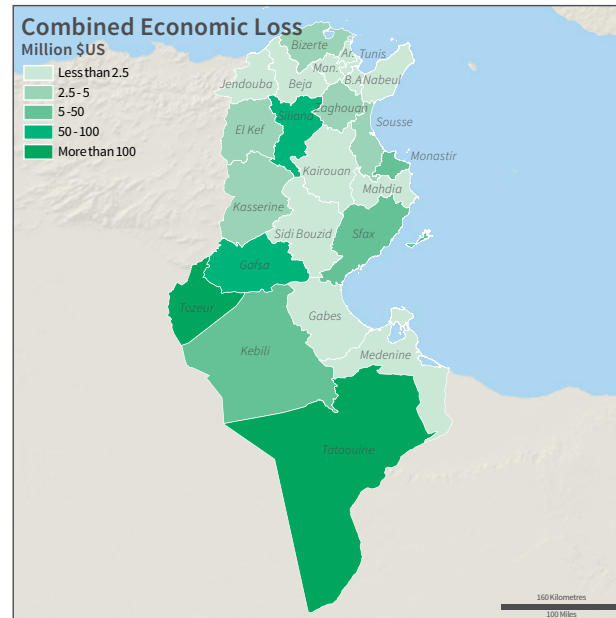
Severe floods hit the Governorates of Tozeur in 1990, implying high physical damage (but no deaths reported).

Disaster Economic Loss Time-Series Trend  
Million US\$



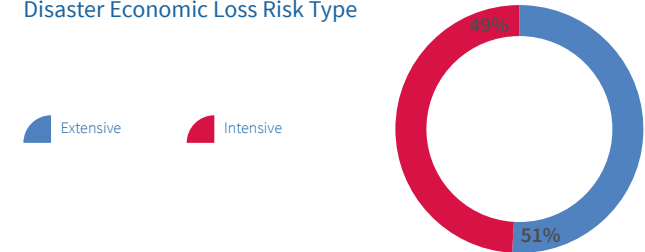
This disastrous year explains not only 1990 as outlier in the economic losses, but also the concentration of losses in Tozeur province compared to others (49%).

Spatial Footprint of Disaster Economic Loss

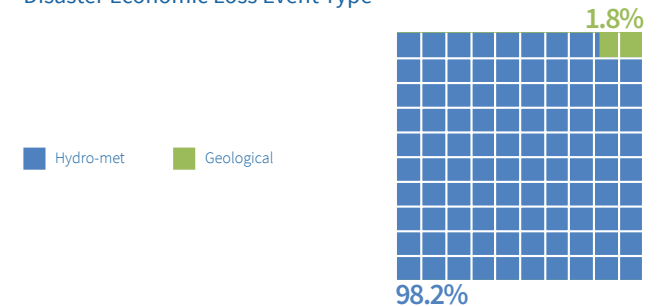


Drought and snowstorms represent an important share of the overall economic losses, adding to the prominence of hydro-meteorological events compared to geological (98% vs. 2%).

Disaster Economic Loss Risk Type



Disaster Economic Loss Event Type





## 7.2 RIVER FLOOD HAZARD AND RISK - OUED MAJARDA

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>30</sup> in Tunisia are presented here to showcase the type of information and value of such comprehensive assessments. River flooding is one of the predominant hazards in

Tunisia in terms of mortality and economic losses. However, the following results do not provide a full picture of disaster risk levels by any means.

The map below show the river flood area in Oued Majardah basin which is one of the most flood prone basins in Tunisia. The map shows the foot print of one of the stochastic scenarios considered in the probabilistic risk assessment.

River flood area in Oued Majardah basin



<sup>30</sup> From GAR15 Global risk assessment: [www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php](http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php)

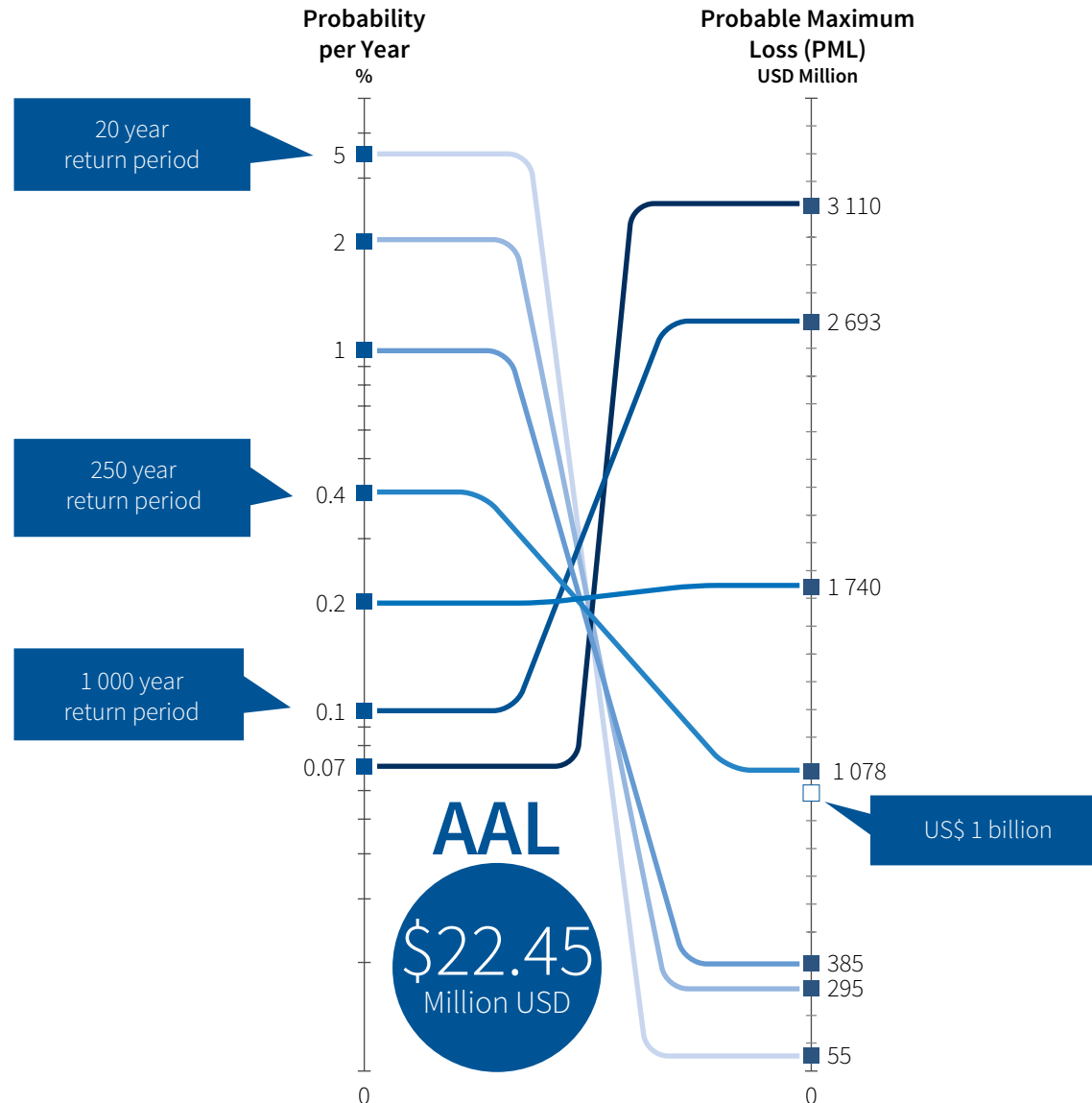
## 7.3 RIVERINE FLOOD RISK VALUES

In average on a yearly basis, floods can cause loss of about US\$ 22 million across the country. This value is known as Average Annual Loss (AAL) and in the case of Tunisia, it is 3% of annual public health expenditure.

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods. These loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 50 years of time span, there is 2% chance that a river flood cause US\$ 295 million USD.

Probable loss from river floods





# 8. YEMEN

## National Context

Yemen is situated in the south-west of the Arabian Peninsula with a total surface area of 527 970km<sup>2</sup>. Yemen is bordered by Saudi Arabia to the north and Oman to the east, with a 2 000 km coastal line by the Red Sea on the west



Al Ramaa Mountain, Yemen, 2015. Source: Ihab Jnad.

and the Arabian Sea on the south. Its unique topography and largely arid weather makes Yemen highly susceptible to desertification and floods. Yemen is a lower middle income country with GDP per capita estimated at US\$1 408 in 2013<sup>31</sup>. The country is divided administratively into 19 governorates with an overall population of more than 26 million people.

This report and the upcoming information on Yemen are focused on hydro-meteorological hazards and based on information gathered from nationally accounted disaster loss database which do not cover a very long time period of history. This has two implications: (i) extreme events that may have happened before or after the time frame of the data collection are not accounted for, (ii) hazards with less frequency of occurrence such as earthquake and tsunami are not presented here, although scientific evidence and risk assessments show that Yemen has considerable earthquake risk which should be considered in disaster risk reduction planning.

<sup>31</sup> World Bank Development Indicators : <http://data.worldbank.org>

## 8.1 DISASTER LOSS

### 8.1.1 Disaster Risk Reduction

Yemen is a disaster prone country that faces a number of natural hazards every year. Over the last two decades, Yemen has become increasingly vulnerable to natural hazard related disasters due to high population growth, poorly controlled urbanization, unplanned and unregulated urban development, and lack of environmental controls. Increased concentration of physical assets and vulnerable population in high-risk areas are leading to increased exposure to adverse natural events.

The Supreme Council for Civil Defence is the first national body for multi-sectoral disaster management and response under the Ministry of Interior. In 2004 the Ministry of Water and Environment established the General Directorate of Environmental Emergencies as the first

governmental institution identified to act on risk reduction aspects such as natural and man-made risks identification, mapping early warning systems, etc.

Yemen has consistently reported on progress towards the implementation of Hyogo Framework for Action since the national reporting biennial cycle started in 2007<sup>32</sup>. Environmental protection legislation incorporating disaster risk reduction has been passed, but with major challenges in implementation and enforcement due to the partly limited resources and capacities. In addition there are ongoing awareness raising campaigns related to disaster losses and environmental protection, especially in view of severe flooding and extreme events experienced by the country in recent years.

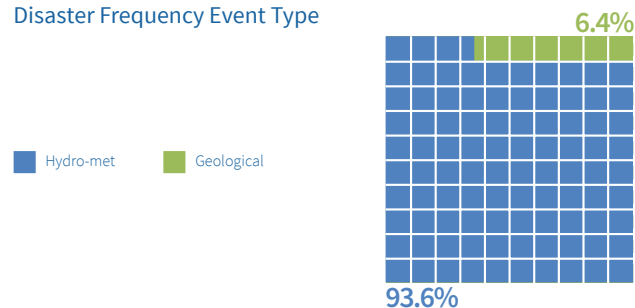
.....  
<sup>32</sup> Yemen's national progress reports available on: [www.preventionweb.net/english/countries/asia/yem/?x=15&y=3](http://www.preventionweb.net/english/countries/asia/yem/?x=15&y=3)

# 8.1 DISASTER LOSS

## 8.1.2 Nationally Accounted Disaster Loss (1971 to 2013)

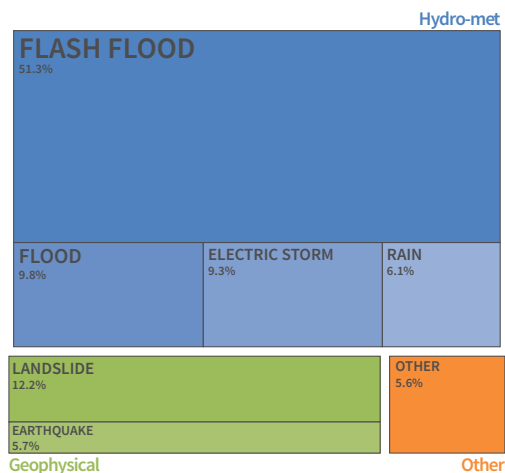
### a. Frequency

Disaster Frequency Event Type



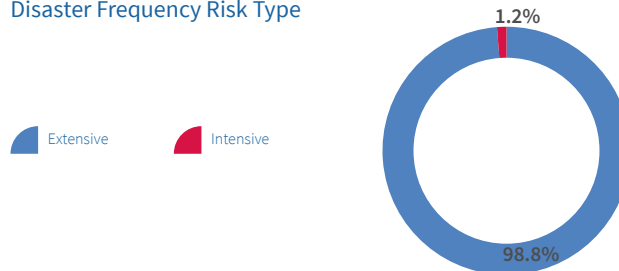
Most of the records registered in Yemen database refer to hydro-meteorological events.

Disaster Frequency



Almost 95% (1533 records) refer to weather related hazards. Half of the records (51%, 840) refer to flash flood, followed by landslides (12%, 199 records).

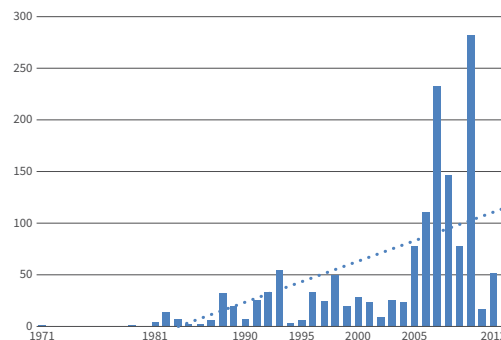
Disaster Frequency Risk Type



Loss records refer to geological hazards with almost 100 records generated by several quakes.

The timeline shows drastic increase in frequency of hydro-meteorological events since 2005 with

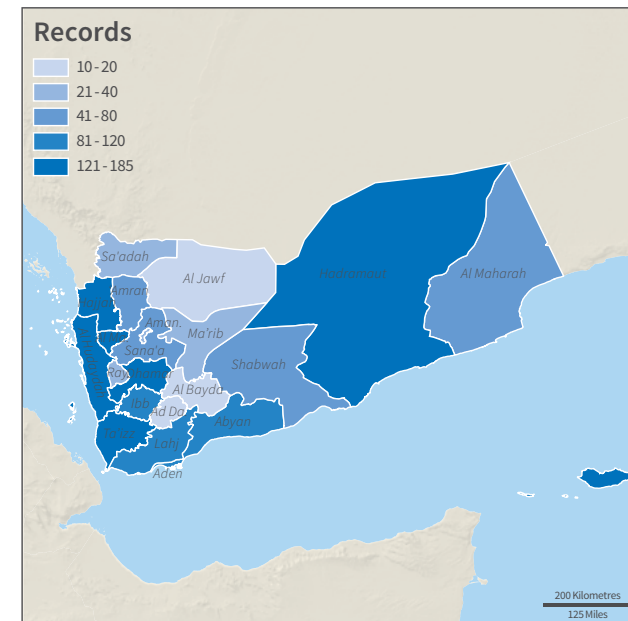
Disaster Frequency Time-Series Trend Number of Reports



important outliers in 2007 and 2010, where several disasters (mainly related to flash flood) hit the country.

Disasters have been more frequent in the Governorates of Ta'izz recounting 184 events.

Spatial Footprint of Disaster Frequency

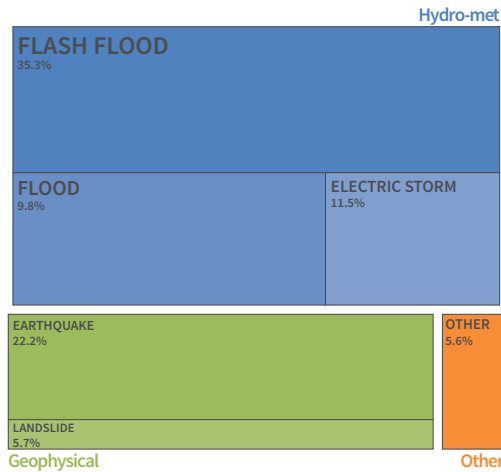


# 8.1 DISASTER LOSS

## b. Mortality

Flash flood is not only the most frequent, but the deadliest disaster.

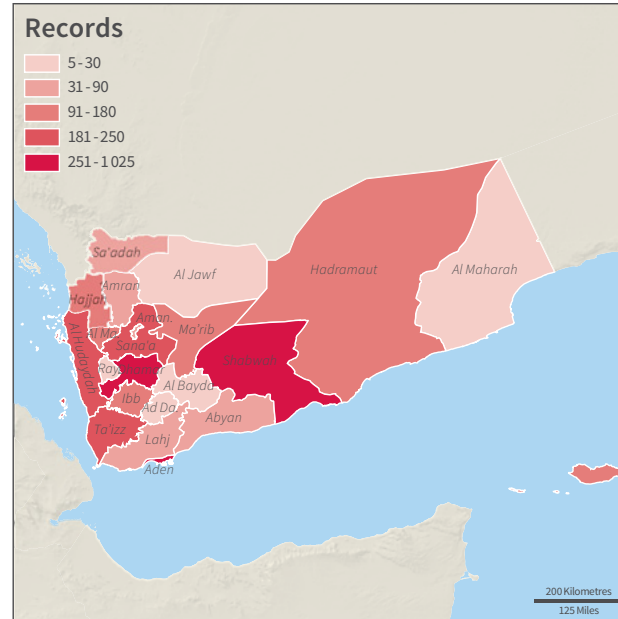
Disaster Mortality



During the last three decades, 3 201 people have died due to weather related hazards.

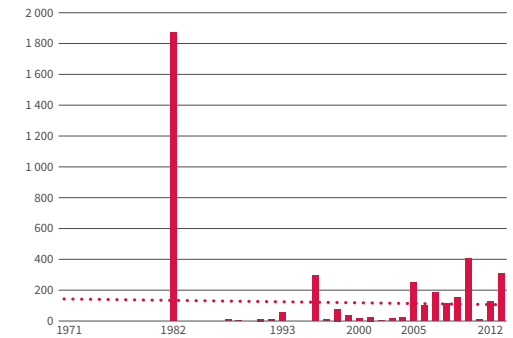
25% of disaster mortality in the country has been in the Governorate of Dhamar, which was mainly due to an earthquake that hit the province on 16th December 1982.

Spatial Footprint of Disaster Mortality



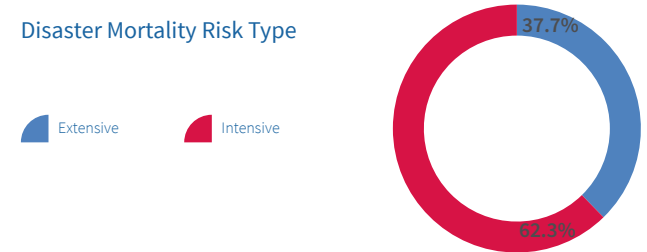
Other Governorates such as Shabwah and Aden have high numbers of human loss (724 and 579 people killed respectively) mainly due to severe hydro-meteorological events. Despite the occurrence of disasters such as the 1982 earthquake and other important events that generated high numbers of human loss, mortality has trended down in Yemen.

Disaster Mortality Time-Series Trend Number of Reports

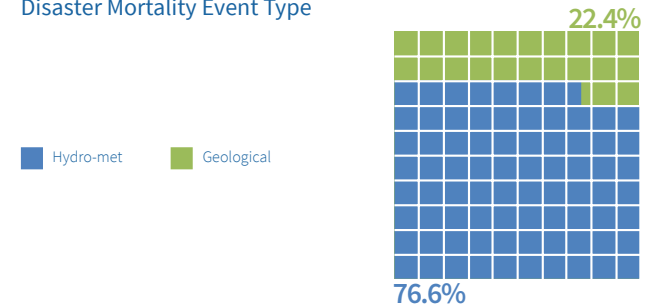


Mortality is due to intensive disasters (2 571 people killed, 53% of total mortality in past three decades), and extensive disasters have killed 1 915 people.

Disaster Mortality Risk Type



Disaster Mortality Event Type

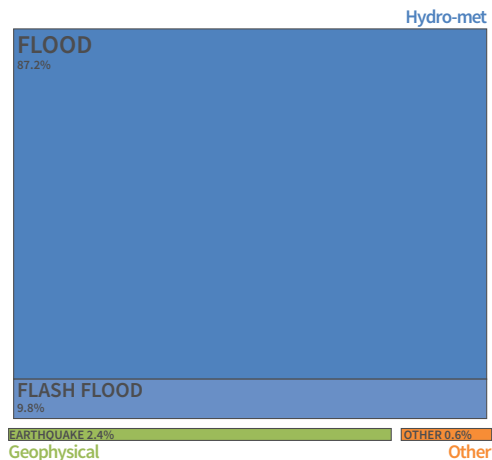


# 8.1 DISASTER LOSS

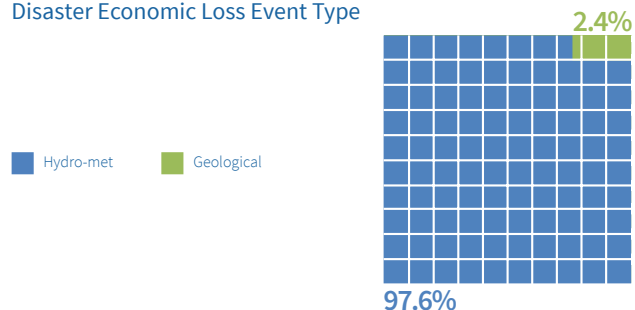
## c. Economic Losses

Floods and flash floods combined account for the majority of the economic losses (97%, almost US\$ 3 billion).

Disaster Economic Loss

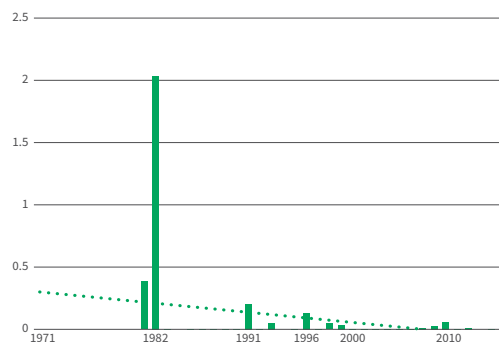


Disaster Economic Loss Event Type



Two major floods, in 1981 (US\$ 162 million) and 1982 (US\$ 975 million), were important contributors of these total numbers.

Disaster Economic Loss Time-Series Trend  
Million US\$

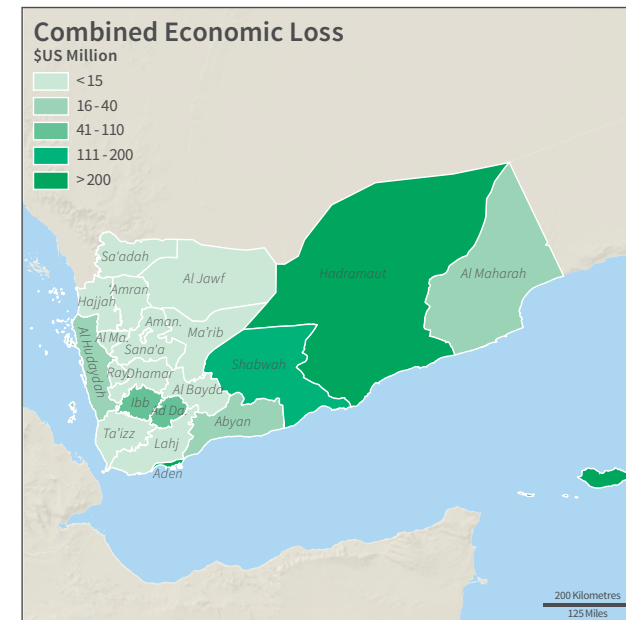


Disaster Economic Loss Risk Type



The Governorate of Aden concentrates most of the economic losses (81%), which are mainly due to flooding that hit the Municipality of Dar Sad in different years; from these, the 29 March 1982 floods were highly damaging. This single event explains the outlier in the time-series trend.

Spatial Footprint of Disaster Economic Loss





## 8.2 RIVER FLOOD HAZARD AND RISK - WADI AL MASILAH

Hazard and risk assessments, using probabilistic methodologies, provide a more comprehensive view of risk as they consider all the events that may occur (see methodology section). Some hazard and risk results on river flooding<sup>33</sup> in Yemen are presented here to showcase the type of information and value of such comprehensive assessments. River flooding, and all type of floods in general, are the predominant hazard in Yemen regarding

frequency, mortality and economic loss. However, the following results do not provide a full picture of disaster risk levels by any means.

The map below show the river flood area in Wadi Al Masilah basin which is one of the most flood prone basins in Yemen. The map shows the footprint of one of the stochastic scenarios considered in the probabilistic risk assessment.

River flood area in Wadi Al Masilah basin



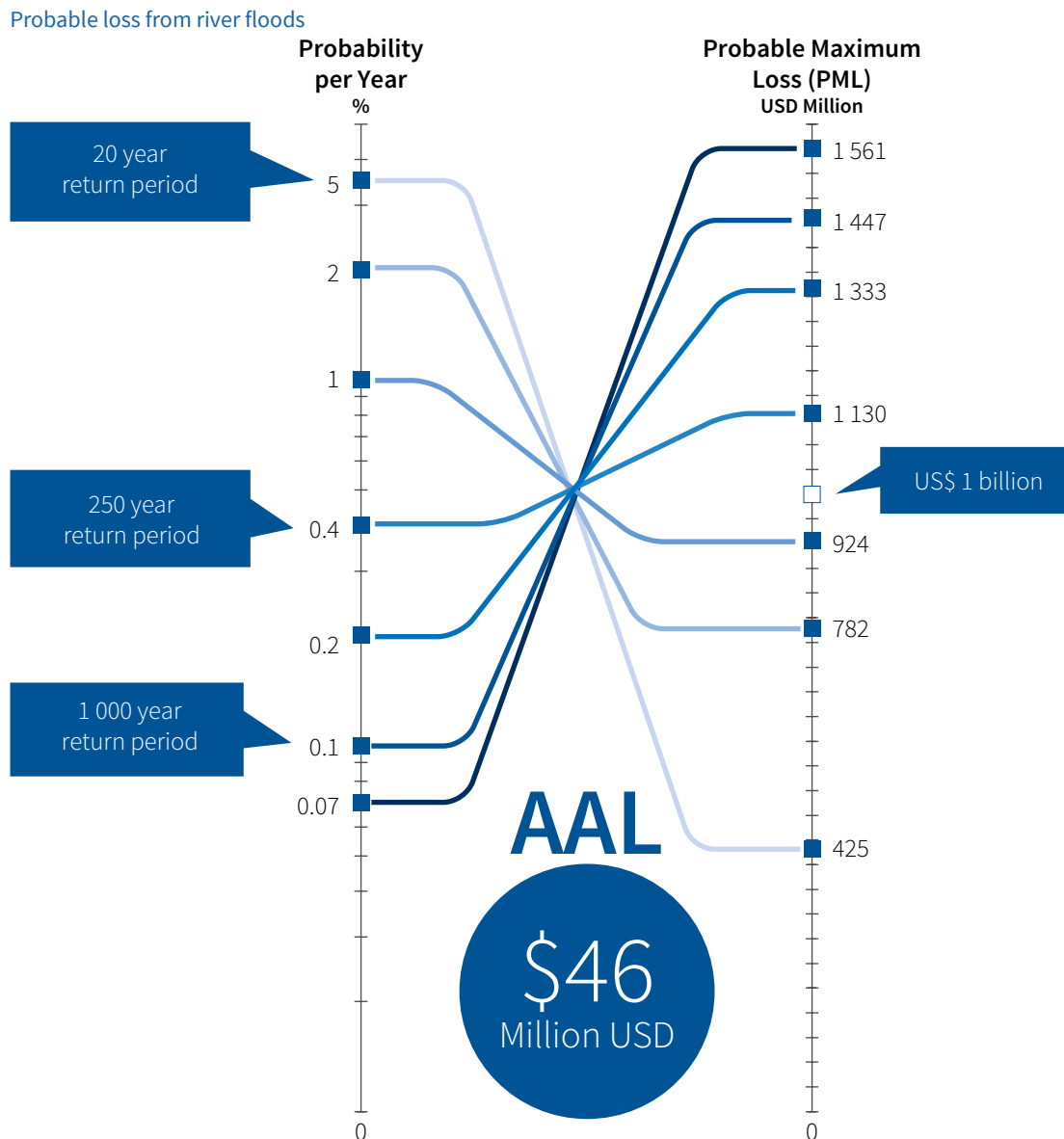
<sup>33</sup> From GAR15 Global risk assessment: [www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php](http://www.preventionweb.net/english/hyogo/gar/2015/en/home/data.php)

## 8.3 RIVERINE FLOOD RISK VALUES

In average, on a yearly basis, floods can cause loss of about US\$ 46 million across the country. This value is known as Average Annual Loss (AAL) and in the case of Yemen, it is equal to 11% of annual public health expenditure.

The following figure shows the probable loss from river floods with different probabilities per year or in other terminology loss values with different return periods. These loss values are known as Probable Maximum Loss (PML) at various return periods.

The loss values can also be interpreted as probable loss in a certain period of time. For example, in any 20 years of time span, there is 5% chance that a river flood cause US\$ 425 million.



# 10. POLICY RECOMMENDATIONS

The Sendai framework for disaster risk reduction (2015-2030) calls for enhancing access to risk information as a target and improving understanding risk as the first priority for action.

An essential step for design, financing, and implementation of any disaster risk reduction policy and investment is to have historical loss, damage, and risk information as well as understanding the characteristics of risk such as underlying risk drivers such as vulnerability of various asset types exposed or vulnerability due to climate change as assessed in RICCAR. Comprehensive understanding of risk is complex but it is critical to make informed decisions for disaster risk reduction policy and planning.

There are three main recommendations for moving towards improved understanding of risk for use in disaster risk reduction:

## 1. Invest in high quality risk information

This is important for historical loss databases, which requires ongoing data collection across the country, and for hazard and risk assessments which requires high quality data from scientific and governmental entities on hazard,

exposure, and vulnerability data (e.g. RICCAR methodology on vulnerability assessment). Conducting probabilistic hazard and risk assessment at local level, especially with future projections of climate change impacts developed by RICCAR and urbanization, is costly but essential for making effective decisions for investment in policies, plans, and infrastructure that will save economies and lives.

## 2. Share risk data and information

The value of investment in data and information becomes magnified when more stakeholders have access to it. Historical loss database and other risk data and information should be shared with as wide as possible in an understandable and easy to access format, ideally open to public. Online website with data sharing tools are great for this purpose, but also public awareness campaigns are a great way to reach out to the general public. These data on disaster risks and frequencies can be used to verify the future climate change projections in the Arab region using RICCAR (e.g. extreme climate indices that can be

used as measures for floods, droughts, heat waves, sandstorms, etc.).

## 3. Build capacity to understand and use risk information in disaster risk reduction

Risk information can lead to reduction of risk only if it is used by decision makers among stakeholders in various public and private sectors. Education and training in understanding the risk information and how each element of risk information can be used for making a wise decision for designing effective policy and plans is essential to facilitate use of risk information in DRR. The flood risk analysis conducted in this report It is important to note that these results are based on regional outputs, and thus further analysis at the country level is required in order to provide more accurate projections risk maps, in addition to the use of hydrological modelling in the flood risk analysis which is a more powerful tool to assess potential future flood risk in this context for various climate change scenarios developed under RICCAR.