República de Moçambique
Ministério da Educação e
Desenvolvimento Humano

República de Moçambique
Ministério das Obras Públicas, Habitação e
Recursos Hídricos

Instituto Nacional de Gestão de
Calamidades

SAFER SCHOOLS

Developing Guidelines on School Safety and Resilient School Building Codes

SCHOOL RISK ASSESSMENT

UN-HABITAT FOR A BETTER URBAN FUTURE

EDUARDO MONDLANE UNIVERSITY
Faculty of Architecture
and Physical Planning

THE WORLD BANK

GFDRR
Global Facility for Disaster Reduction and Recovery

Title
School Risk Assessment

Scope
Safer Schools Project in Mozambique “Developing Guidelines in School Safety and Resilient School Building Codes in Mozambique”

Institutional Coordination
Ministry of Education and Human Development (MINEDH)

Institutional Partners
Ministry of Public Works, Housing and Water Resources
Ministry of State Administration and Civil Service – National Institute of Disaster Management

Executive Coordination
Eduardo Mondlane University – Faculty of Architecture and Physical Planning (UEM - FAPF)
United Nations Human Settlements Programme (UN-Habitat)

Project Financing
World Bank – Global Fund for Disaster Risk Reductions

1st Edition
Maputo, January 2015

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Acronyms and Abbreviations

CCGC	Coordination Council for Disaster Management
CTGC	Technical Council for Disaster Management
DNG	National Directorate of Geology
DPLAC	Direcção de Planificação e Cooperação
DPECs	Direcções Provinciais de Educação e Cultura
DPOPH	Province Directorate for Public Infrastructure and Housing
GFDRR	Global Facility for Disaster Reduction and Recovery
GTC or TRG	Technical Reference Group (Grupo Técnico Consultivo)
INAM	National Institute of Meteorology
INGC	National Institute of Disaster Management
MAE	Ministry of State Administration and Civil Service
MINEDH	Ministry of Education and Human Development
MOPH	Ministry of Public Works, Housing and Water Resources
UEM-FAPF	Eduardo Mondlane University – Faculty of Architecture and Physical Planning
UN-Habitat	United Nations Human Settlements Programme
UNICEF	United Nations Children Fund
SDPI	District Planning and Infrastructure Direction of the MOPH

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1. Introduction

The present study has the goal of estimating the approximate potential risk of Schools infrastructures in Mozambique due to natural hazards events, namely Cyclones, Earthquakes, Floods and Droughts through spatial representations. Overall, this risk assessment will contribute for the consolidation of a common understanding among stakeholders involved with the construction of classrooms of the problem of school vulnerability in Mozambique and shed light to the need to act to reduce risks by improving the quality of buildings. The study was developed within the framework of the of **the *Safer Schools Project: Developing Guidelines on School Safety and Resilient School Building Code*** in Mozambique, implemented by the United National Human Settlements Programme (UN-Habitat) in partnership with the Faculty of Architecture and Physical Planning of the Eduardo Mondlane University (UEM-FAPF) and the financial support of the World Bank. The Safer School's project has been delivered under the guidance and coordination of the National Institute for Disaster Management (INGC), with the Ministry of Education (MINED) as main clients and the Ministry of Public Works and Housing (MOPH) as crucial partner.

Outputs and Outcome

The present assessment will estimate risk through an approach that combines hazard mapping and vulnerability analysis based on exposure and sensitivity, as further detailed in the *Methodology* section below. The primary outputs of the present assessment are the identification of the main technical shortcomings of school buildings contributing to structural vulnerability and the identification of the proportion of schools at low, medium and high risk, as well as the districts they are located. This will be displayed through summaries (graphs and charts) and maps highlighting the spatial distribution of schools at risk due to natural hazards (Cyclones, earthquakes, Droughts and Floods.

By estimating risk, categorizing it and spatially locating it this assessment will contribute to achieving consensual technical basis for the adoption of building codes and guidelines for construction of schools, which is the main outcome of the Safer Schools Project.

Methodology

To facilitate risk estimation and allow categorization, the present study adopted an operational definition of risk that can be captured by the illustrative equation below:

RIKS *n* = HAZARD *n* + VULNERABILITY n (EXPOSURE n + SENSITIVITY n)

Risk is therefore defined as the intersection between hazard and vulnerability. For the case of school infrastructures, Vulnerability is determined by both its exposure to hazards as well as their sensitivity (i.e. technical soundness). Ideally, another variable can be added to calculate vulnerability: the Adaptation Capacity of the System, i.e. the adaptive measures adopted for the construction of school buildings, which can reduce sensitivity and therefore vulnerability. Yet, due to challenges to estimate adaptive capacity, this variable was not included in the adopted definition.

Guided by the above equation, the present risk assessment was conducted in three different phases:

a) Hazard Analysis

- Based on hazard profile of Mozambique and a vast literature review, conducted within the framework of the Safer Schools Project, the main data sources of the four prioritized hazards - Earthquakes, Cyclones, Droughts and Floods – were identified.
- Modeling of the occurrence (frequency and intensity) of earthquakes, cyclones, floods and droughts based on the information obtained from these sources.
- Production of hazard maps (for each hazard) using a Geographical Information System (GIS) platform

b) Vulnerability Assessment

- Vulnerability was assessed through two exercises: (1) Identification of Exposure and (2) Sensitivity Analysis.
- **(1) Identification of Exposure**: Identification of infrastructure (Schools) that are exposed to hazards based on the cross-referencing of the Hazard Mapping (Ref. A) and database of classrooms per district, using GIS Analysis
- **(2) Sensitivity Analysis**: sensitivity was approximated by classifying schools infrastructures according to their construction material (as per MINED classroom database). UN-Habitat has identified, based on an evaluation of 836 classrooms in seven different provinces in Mozambique, that sensitivity is highly linked to the construction material employed and main technical shortcomings were identified.

c) Risk Assessment

- Estimation of number of classrooms at risk due to natural hazards (cyclones, earthquakes, droughts and floods) by cross-referencing Hazard Analysis and Sensitivity Analysis (classroom by materials), using GIS tools.
- Summary of key figures related to classrooms at high risk of natural hazards.

The present study used GIS as the main tool to carry out the risk assessment. Although some information may be better assessed using a database or spreadsheet, the GIS presentation facilitates the use of the results for emergency management and risk reduction planning. The risk assessment have been done through spatial analiysis in ArcGIS 9.3.

Limitations of the present study

Estimating and mapping risk is highly dependent in the quality of data obtained. Due to the limited time and financial resources available, the technical team faced a few challenges, as follows:

1- Hazard modeling could be more precise due to lack of key data on hazards intensity, particularly floods; this will be perfected throughout the project;
2- Exposure: lack of precise geo-referencing of classrooms forced analysis to be conducted at district level;
3- Sensitivity analysis: the ways the intersection between exposure and type of construction material contribute for risk can be better explored and detailed, also per hazard; for instance, a criterion has to be adopted to define if a classroom built with conventional material located in a district highly exposed to floods is more at risk than a non-conventional

classroom situated in a district with low exposure (as well as for cyclone, drought and earthquake exposed areas).

2. The Risk Assessment

The present risk assessment was conducted through a 3-phased methodology: (1) Hazard Mapping, (2) Vulnerability Analysis and (3) Risk Identification/Estimation. The steps taken and results obtained in each phase are detailed in the present chapter.

2.1. Hazard Mapping

The first step of the Risk assessment consisted in identifying and representing spatially the main hazards that affect Mozambique's territory. To do so, two main steps were taken: (1) Hazard Profiling and (2) Hazard Spatial representation and categorization in Mozambique based on frequency and intensity.

Hazard Profiling

Mozambique's geographical position and structural vulnerabilities contribute for the country's placement as the third most exposed nation to risks from hazards in Africa[1]. The types of events that threaten the country's population and infrastructure are many, as illustrated in *Figure 1* below. Yet, based on extensive literature review and considering past events, four main hazards are hereby considered as the main threats to school infra-structures and were adopted for the risk assessment: **floods, droughts, cyclones and earthquakes**.

In fact, Mozambique is highly exposed to these four natural hazards due to its particular geographical location. The country has 300km of its coast located in the western boundary of one of the most active tropical cyclone basins, the Southwest Indian Ocean. The region accounts for around 10% of the world's cyclones every year and **tropical cyclones** hit Mozambique on average once a year. Its territory is involved by large river basins such as the Limpopo and the Zambezi, receiving a total of nine international rivers. Together with above average precipitation – largely a consequence of tropical depressions or cyclones-, the rivers are responsible for the **large floods** that regularly occur in the country. Mozambique has also significant chronic *drought-prone* areas in the south, where water is scarce and nutritional problems are frequent. Major **droughts** have hit the country and affected millions of people in several different occasions. Finally, **earthquakes** are also a threat, since Mozambique lies on the southern end of the African Great Rift. The estimated impact these four natural hazards have had in Mozambique is detailed in the table below.

[1] UNISDR (United Nations International Strategy for Disaster Reduction). 2009. Global Assessment Report on Disaster Risk Reduction. Geneva: UNISDR.

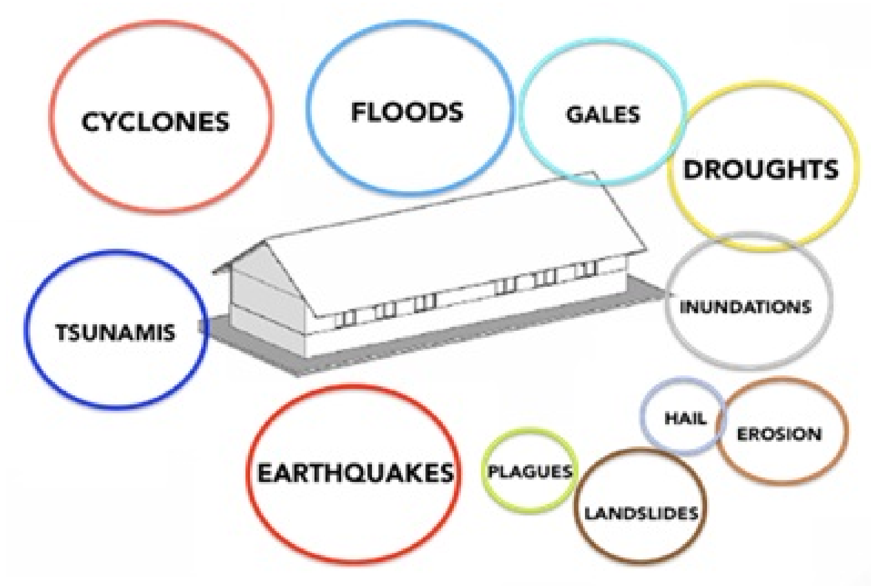


Figure 1 – Hazards that affect Mozambique

Table 1 – Summary of the impacts of natural disasters in Mozambique (1956 - 2008). Source: Adapted from INGC (2009)

Disaster Type	Number of Occurrences	People Killed	People Affected	Most vulnerable provinces
Drought	10	100,200	16,444,000	Tete, Manica, Sofala, Inhambane, Gaza, Maputo
Flood	20	1,921	9,039,251	Tete, Manica, Zambézia, Sofala, Inhambane, Gaza, Maputo
Tropical Cyclone	13	697	2,997,300	Nampula, Zambézia, Sofala, Inhambane, Gaza
Earthquake	1	10	1,44	Niassa, Zambézia, Sofala, Manica, Tete, Gaza

Spatial Representation and Categorization

The second step was to spatially represent and categorize the impacts that the four prioritized hazards have in the Mozambican territory. The identification and collection of data of hazard intensity and frequency was conducted based on existing database and consultations with a range of different stakeholders to validate the information obtained, such as National Directorate for Water (DNA), Famine Early Warning Systems Network (FEWSNET), National Geology Directorate (DNG), National Meteorology Institute (INAM), National Disaster Management Institute (INGC), Faculties of Geology, Sciences and Architecture of the Eduardo Mondlane University (UEM), among other.

The data used provided (within the possibilities of availability) the spatial distribution of natural hazards concerning frequency and Intensity in the country in a period of the last 30 years. Based on the information available, possible hazard impact was classified in three categories – Low, Moderate and High (Moderate, High and Extremely High for Cyclones in particular) – taking into account frequency and intensity[2]. The maps produced are reproduced below and the data used for each one of the hazard maps is detailed in *Table 2* below.

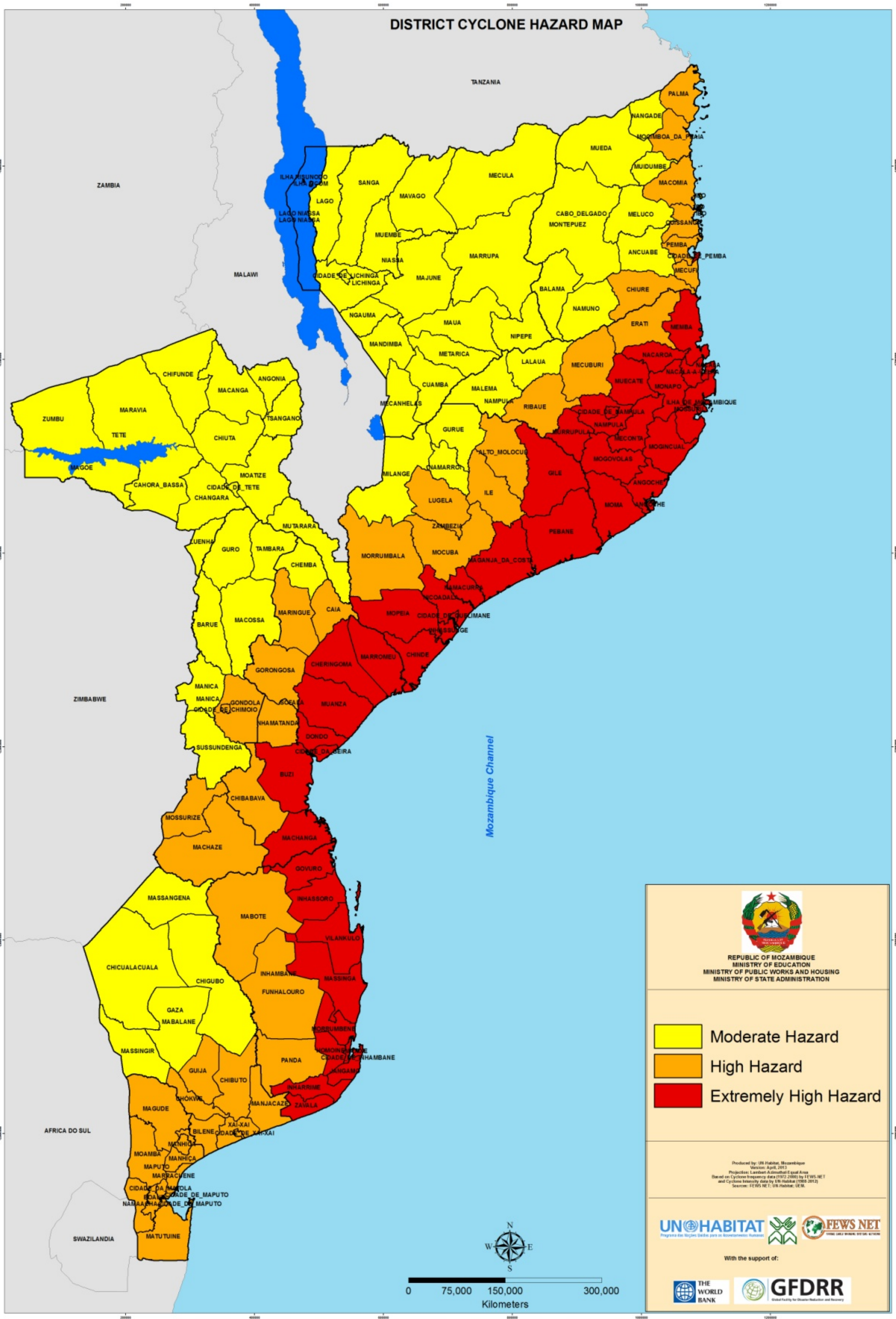
It is important to notice that, given that the database from the Ministry of Education and Human Development (MINED) regarding the typology of classrooms construction material is at District level (Ref. Subchapter 2.2 Vulnerability Analysis), the hazard mapping needed to be performed at also at District level to allow the spatial analysis of the classrooms vulnerability assessment and finally the risk mapping.

Table 2 – Data used for the production of Hazard Maps

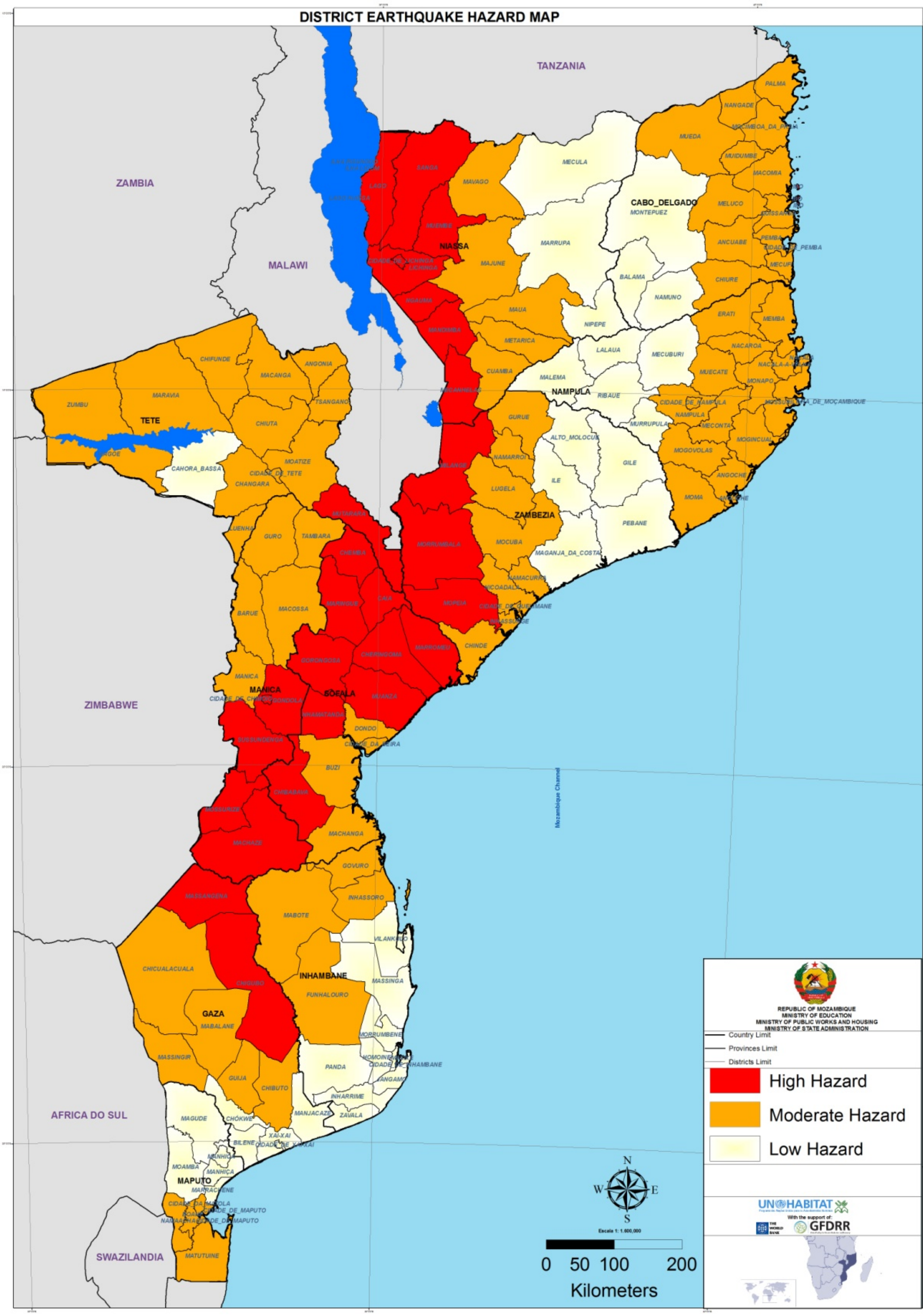
Hazard	Source of Data used for Mapping
Cyclones	The FEWSNET (1972-2000) database was used for frequency; UN-Habitat complemented with data obtained from JTWC (Joint Typhoon Warning Center) on cyclone occurrences from 1984 to 2012 as well as information on the Maximum average wind spend in cyclonic seasons and non Cyclonic seasons from national partners (Eduardo Mondlane University, Department of Physics).
Earthquakes	The Earthquake catalogue from the National Geology Directorate (1905-2007) as well as the information of the relative Peak Ground Acceleration values from the Seismic Hazard Assessment for Eastern and Southern Africa by MIDZI et all, 1999 based on the Earthquake catalogue by Turyomurugyendo (627-1994) were used to define critical zones. Information was cross-referenced with data from the Global Seismic Hazard Program (GSHAP).
Floods	The FEWSNET/UEM database was used as primary source with the flood models for the Limpopo and Zambezi basins and the information was updated and complemented with results from the Digital Elevation Model (SRTM, 90m) and with analysis of UNOSAT satellite images of floods from 2000 to 2013 for the remaining river basins covering the entire country. Database on River inundation levels from DNA was used and Interviews to confirm and reinforce data were conducted with DNA, ARA-SUL (Regional Water Administration – South) and INGC.
Droughts	The FEWSNET database (1981-2000) was used. The drought data from FEWSNET is based on Normalized Difference Vegetation Index (NDVI) obtained through the National Oceanic and Atmospheric Administration (NOAA) satellites, and processed by the Global Inventory Monitoring and Modeling Studies Group (GIMMS) at NASA. Information on Maximum Annual Average Rainfall of the last 20 years (1995-2014) from Rainfall Estimates Satellites (RFE) was used to complement the NDVI data and to categorize the drought zones in the country.

[2] A more detailed description of how the Hazard Mapping was conducted and the data used can be found in the *Hazard Mapping and Zoning* document, also produced for the Safer Schools Project.

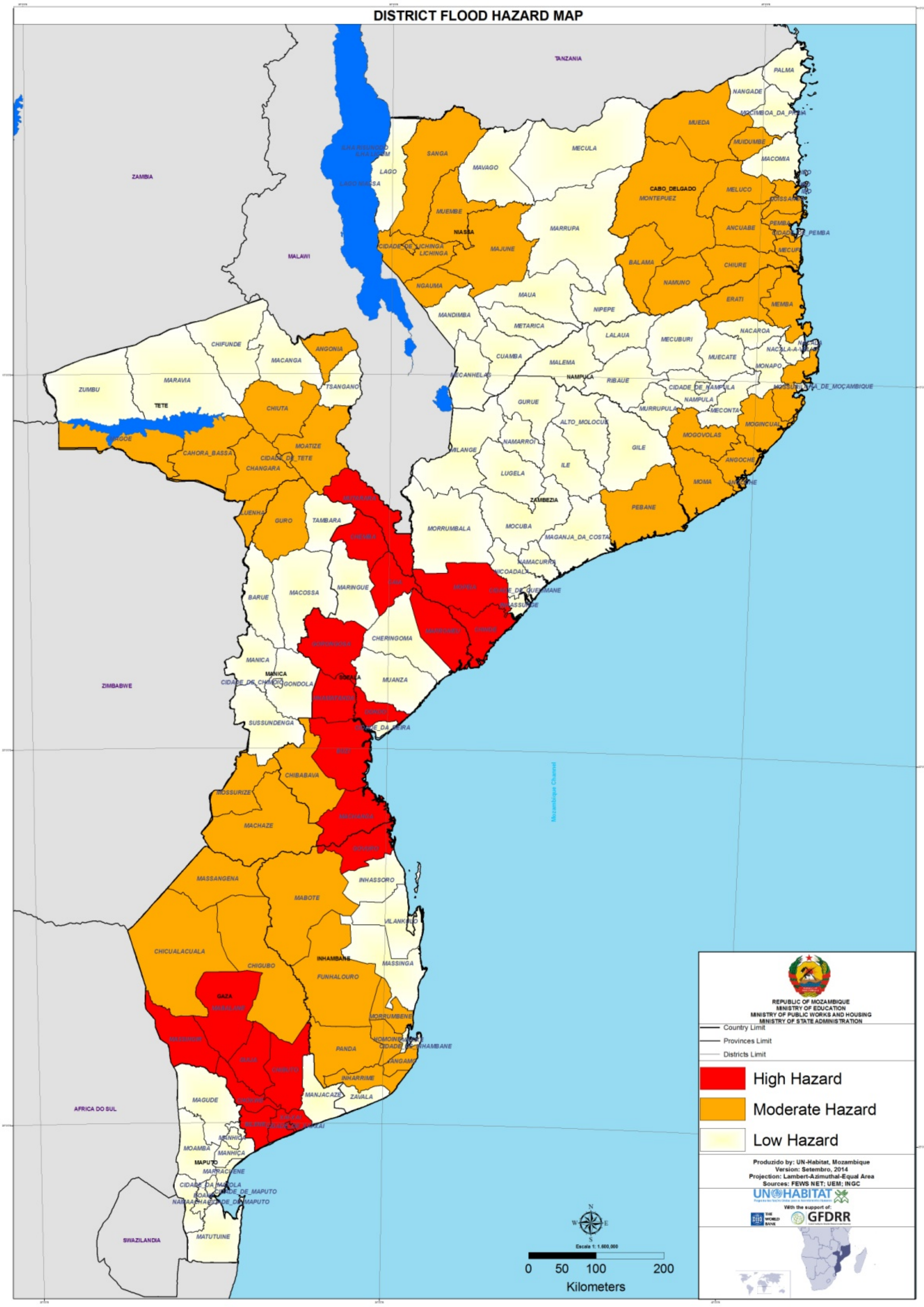
Map 1 – District Cyclone Hazard Map



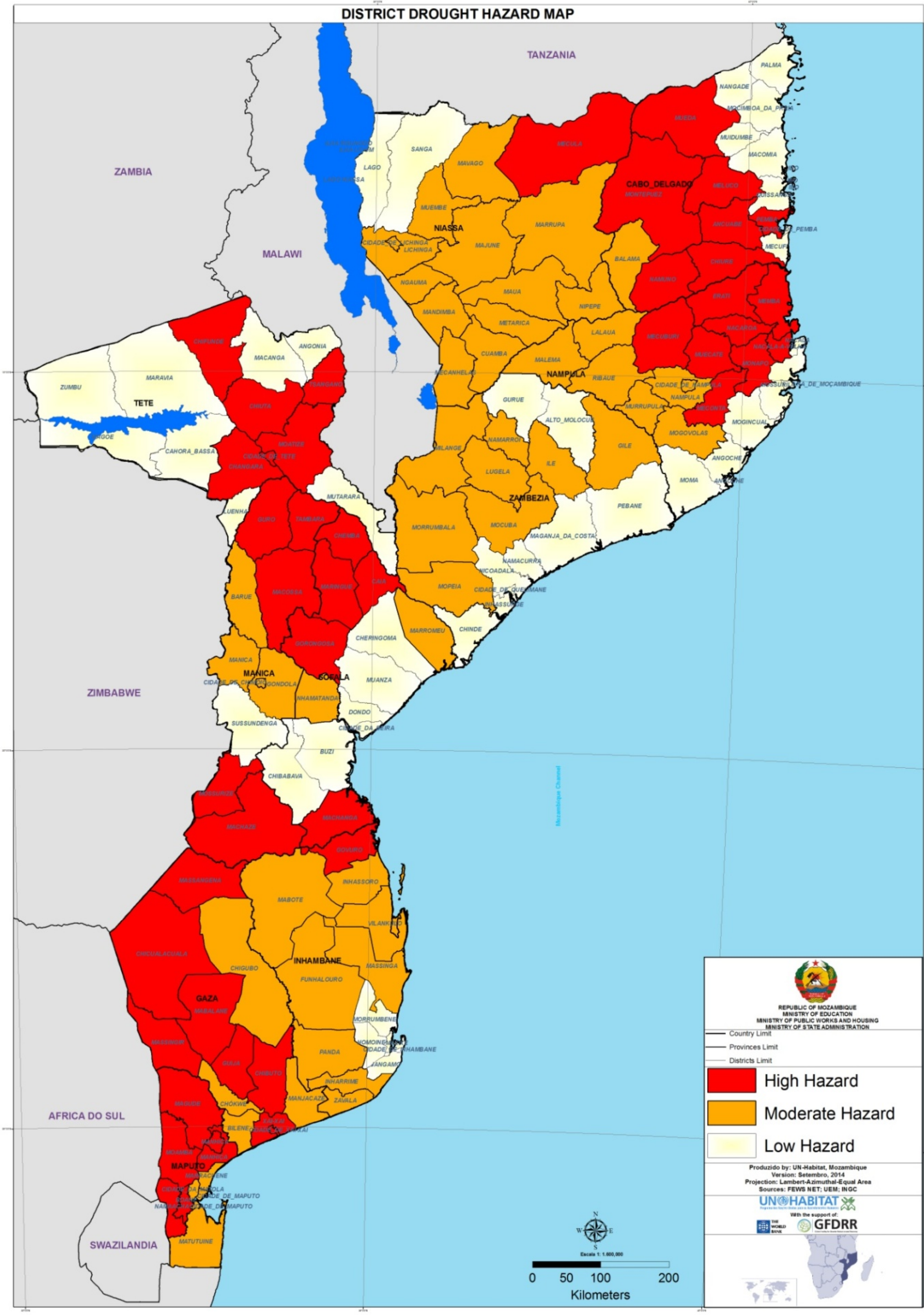
Map 2 – Earthquake District Hazard Map



Map 3 – Flood District Hazard Map



Map 4 – Drought District Hazard Map



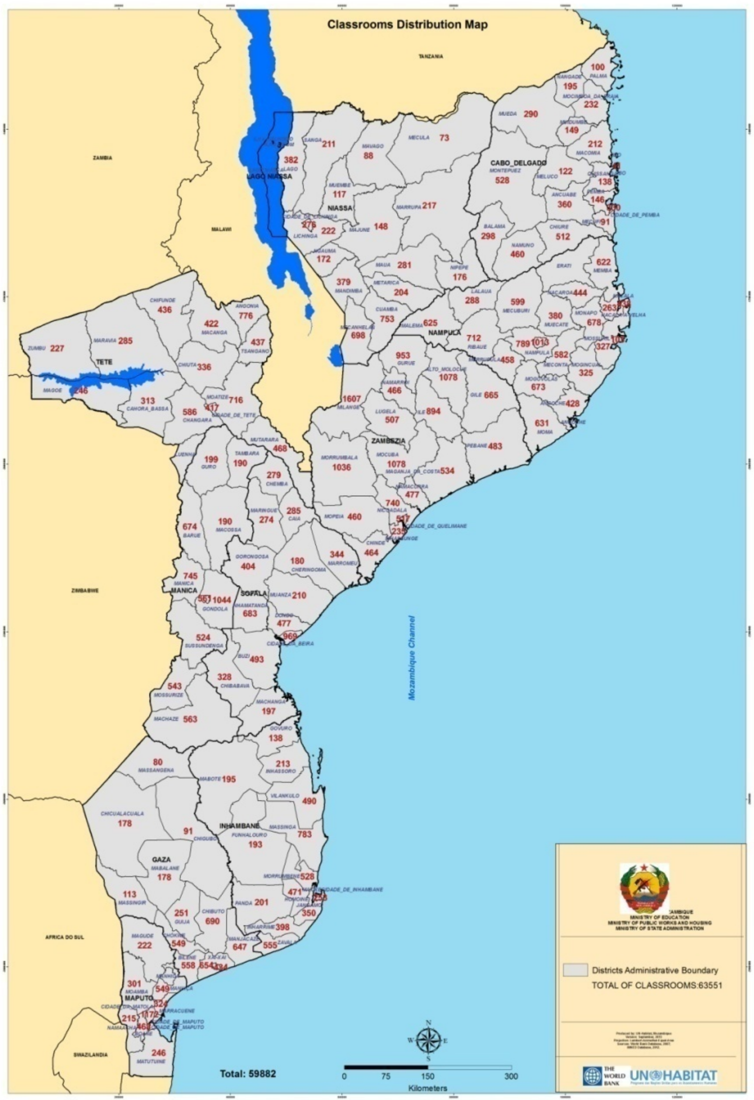
2.2. Vulnerability Analysis

In order to estimate the vulnerability of the school infrastructural network, two aspects were taken into account according to operational definition of vulnerability (Ref. Equation p.4 above): (1) Exposure of school Infrastructures to Hazard and (2) Technical Sensitivity of classroom buildings. The vulnerability analysis was carried out using the information from MINED's annual survey *3 de Março*, 2013. This database gives information on a total of 63551 classrooms across the country number corresponding to all public education levels (EP1, EP2, ESG1 AND ESG2).

Classrooms' exposure to Hazard

Employing the MINED database, the technical team used GIS tools to approximate the spatial distribution of the classroom network (63551 schools) in Mozambique. This crucial information allows cross-referencing the hazard maps with the spatial distribution of classrooms to initiate risk estimation (Ref. subchapter 2.3). The map below displays the spatial distribution of the classrooms per District in country up to 2013.

Map 5 – Classrooms Distribution Map in 2013



Sensitivity Analysis

The sensitivity of the classrooms in Mozambique was estimated essentially based on the types of construction materials used. The database provided by the MINED and used to spatially distribute the classroom network (see p. 13 above) included information regarding type of material of construction (Cement, Brick, -wattle and daub, *Maticado*, others; Ref. Annex). The different materials used were grouped in 2 main types of classrooms so to facilitate methodology: **(1) Conventional Classrooms**, which are the ones build with cement and bricks, and **(2) Non-Conventional Classrooms**, which are the ones built with local materials such as *maticado, pau-a-pique (*wattle and daub) and others. It was found that from the 63551 classrooms, 35705 (56%) are conventional and the remaining 27846 (43%) are non conventional.

The employment of the type of construction material as the main criterion to define sensibility is grounded on (and supported by) an assessment of approximately 830 classrooms conducted by UN-Habitat in 2012 and 2013 in 7 different provinces in the country (Maputo, Gaza, Inhambane, Sofala, Zambezia, Manica and Nampula).

Although three types of classrooms can be identified if one considers the construction material criterion (Ref. Figure 7 below), the "Mixed" category was grouped into the non-conventional one due to database limitations. Nevertheless, this has not significantly harmed analysis: as a general conclusion of the assessment, it can be affirmed that **conventional classrooms are usually less sensitive to hazards than non-conventional or mixed classrooms.** This conclusion is based on the assumption that the network of classrooms in Mozambique follows the same pattern as the 830 classrooms assessed, as a general rule.

Conventional | Mixed | Non-Conventional

Figure 2 – Typology of Classrooms based on Construction Material

In fact, during the field assessment carried out by UN-Habitat, the main common shortcomings identified among the analyzed building are linked to four areas that are often highly overlooked by local builders and communities that use local material for classrooms: (1) **quality of execution, (2) quality of the material used, (3) the non-consideration of the orientation of the wind and (4) negligence of anticyclone construction techniques.** These technical limitations are summarized and illustrated below.

Table 3 – Recurrent technical failings identified in assessed school buildings

1. Overall **low quality of execution** by building firms or local constructors and low respect of existing norms	
2. Very **low quality of the materials** used	
3. Inconsistent **orientation of buildings against winds**	

4. Non-appliance of the basic of anticyclone construction techniques (Doors and windows that cannot be closed, wrong slopes, etc.)

Furthermore, UN-Habitat's assessment considered in a more detailed manner a set of components of classroom buildings that directly influence the sensibility of schools, contributing to increase or decrease the vulnerability of schools and consequently affecting risk. This components are listed below:

1. ***Location of the building or deployment*** - Orientation of buildings, physical characteristics of the land.
2. ***Foundation or base of the building*** - Elevation pavement, pavement quality.
3. ***Structure of Building and Walls*** - Distancing between the pillars, material type closure (blocks, bricks, poles, maticado, etc) and condition, dimensions of the structure- this construction materials were further organized to classify the classrooms in 2 typologies that could allow a comprehensive risk assessment: Conventional and Non Conventional Classrooms.
4. ***Structure of coverage*** - type structure, conservation and treatment of roof structure, linking the various elements of the roof structure and strengthening of linkages.
5. ***Coverage*** - Storage conditions of coverage, thickness of the cover plate, fixing of roofing sheets.
6. ***Windows, Doors and Openings*** - Existence of Frames in vain, frames quality, accessories and operationalization of the frames.
7. ***Capture System and Water Storage*** - Existence of a system to capture and store rainwater, operationalization of these systems and the elements that comprise these systems as cover, gutter and tanks.

As expected, the seven components analyzed have shown to be less technically sound (and more sensitive to hazards) in non-conventional classrooms as a general rule, largely due to lack of technical capacity and observance of techniques and norms that can improve resistance to hazards.

Therefore, based on the conclusion - supported by the Classroom Assessment, as detailed above- that conventional schools are overall less sensible to hazards, sensitivity was couple with exposure by identifying the geographical distribution (limited to district level) of each type of classroom according to their construction material. The maps below display the spatial distribution of the conventional and non conventional classroom per District in Country.

Map 6 – Conventional Classrooms Distribution Map in 2013

Map 7 – Non-conventional Classrooms Distribution Map

2.3. Assessing Risk

Based on the hazard mapping and the vulnerability analysis of classrooms and its respective results, it is possible to estimate risk due to natural hazards of classrooms in Mozambique according to risk categories, notwithstanding the methodological limitations pointed in the introductory chapter and along the sections of this document.

The key outputs of the present risk assessment are as follows:

(a) Numbers of classrooms in each risk state (Extremely High, High, Moderate and Low) for conventional and non conventional classrooms and by hazards;

(b) Maps showing the geographical distribution of classrooms at risk (conventional and non conventional), at different ranks;

(c) Maps displaying the Districts at high risk of 1 or more natural hazards- ***schools (classrooms) at such Districts must be a priority for planning and response purposes.***

As explained above, to be able to conduct the risk estimation and conclude the risk assessment, the classroom database provided by the MINED was exported to a GIS environment and contains key fields or useful attributes (construction material typology and geographical location). The information was readily incorporated with other GIS themes/layers (such as hazard layers of cyclones, floods, droughts and earthquakes) to provide a basis for further data manipulation and spatial analysis. The resultant spatial modeling of the data provides a basis for the school risk/hazard analysis.

Therefore, the results obtained take into account the geographic location of the school relative to a certain hazard level as well as the type of material classrooms are built of. It is important to clarify that ultimately risk was estimated separately for classrooms built with conventional materials and for the ones built with non-conventional material.

Important:

In order to analyze risk of both classrooms types jointly in a technically accurate manner, there is a need to develop a sound methodology to understand how the quality of the construction (sensitivity) actually intersects with exposure to hazards, identifying criteria to estimate vulnerability more precisely; this would allow this study to estimate with more accuracy if, for instance, a non-conventional classroom in a district moderately exposed to cyclones is at higher risk than a convention classroom in a district highly exposed to cyclones.

While the relation between sensitivity and exposure needs to be further developed, this study has assumed that, as a ***general rule*** *based on the field assessment conducted with 836 classrooms (see above), conventional classrooms are* ***less sensitive*** *and therefore* ***less vulnerable*** *than non-conventional classrooms. For this reason, it can be affirmed that* ***non-conventional classrooms are overall more at risk than conventional schools****. Yet, exposure still plays an important role, as it can be seen in the maps in the following pages.*

The process of School risk assessment presented in this study may also be visualized as a series of GIS themes, each representing a layer of data. This required the acquisition of data in a GIS format that would include:

(a) infrastructure (classrooms) maps to establish location and various properties of each asset,

(b) Natural hazard information, comprising hazard areas (Extremely High, High, Low to Moderate and Low):

- Cyclones
- Earthquakes
- Floods
- Droughts

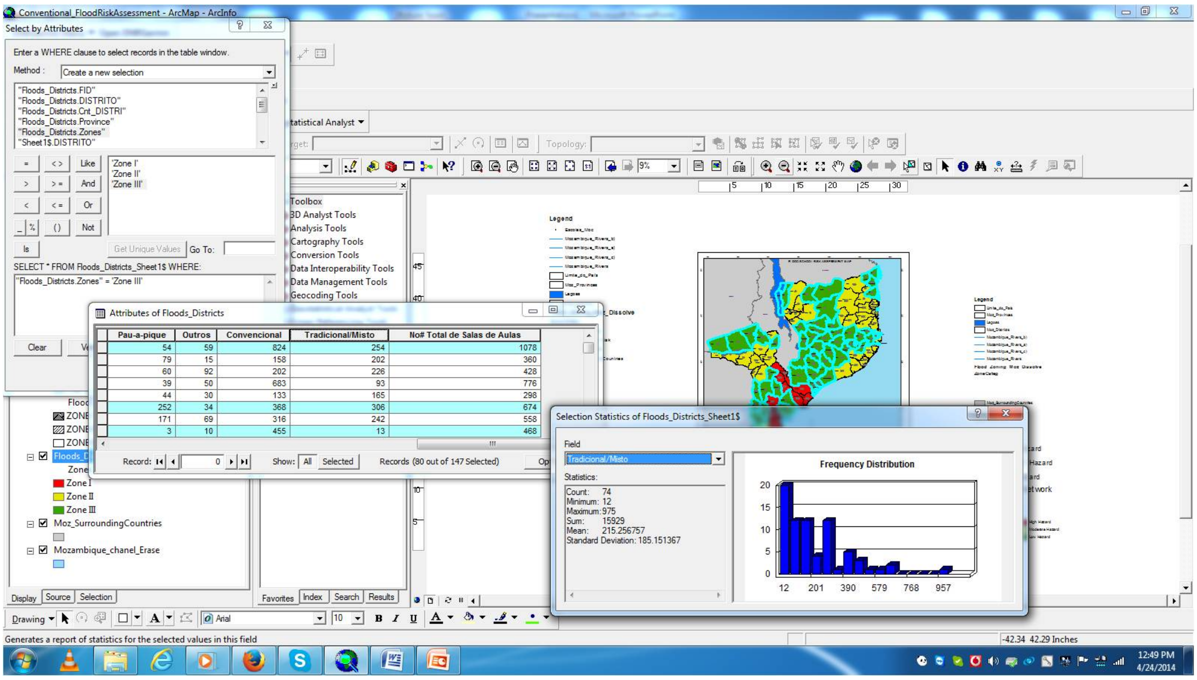


Figure 3 – Spatial Analysis on Classrooms Distribution at Risk of Natural Hazards

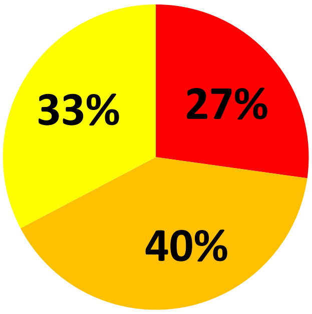
The results of the risk assessment are presented by Maps and are also accompanying charts and tables so that the information can be readily used by stakeholders.

Results on Risk Assessment

The number of classrooms – and their location – and their exposure to risk will be displayed separately for Cyclones, Earthquakes, Floods and Droughts. Under each one of the hazards, results will be presented through maps and charts separately for (1) Conventional Schools and (2) Non-conventional schools.

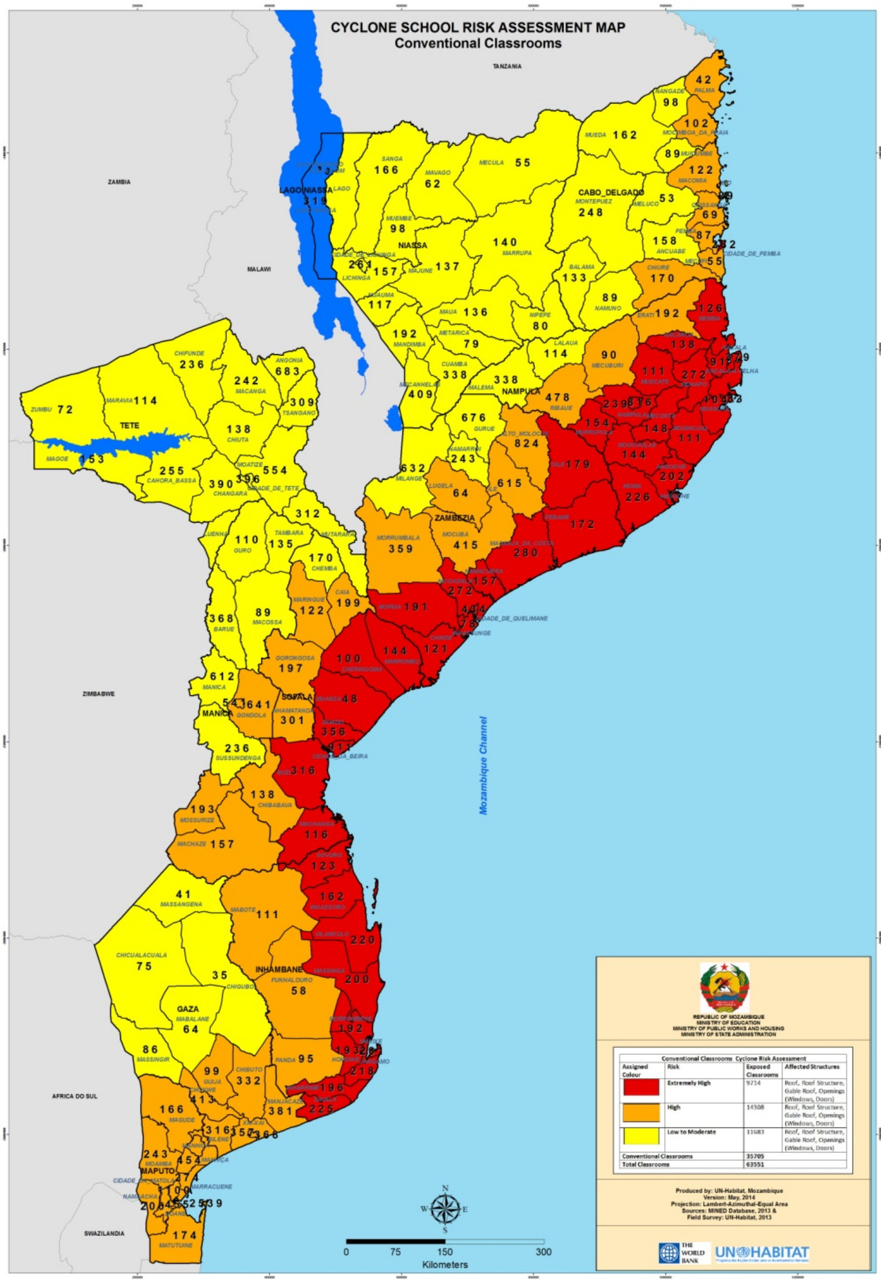
1. *CYCLONES*

a) Conventional Classrooms Cyclone Risk Assessment

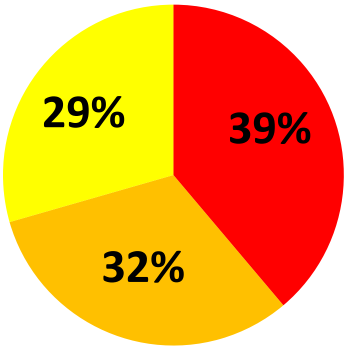


Risk Level	No of Classrooms
High	9714
Moderate	14308
Low	11683
Total	**35705**

Map 8 – Conventional Classrooms Cyclone Risk Assessment Map

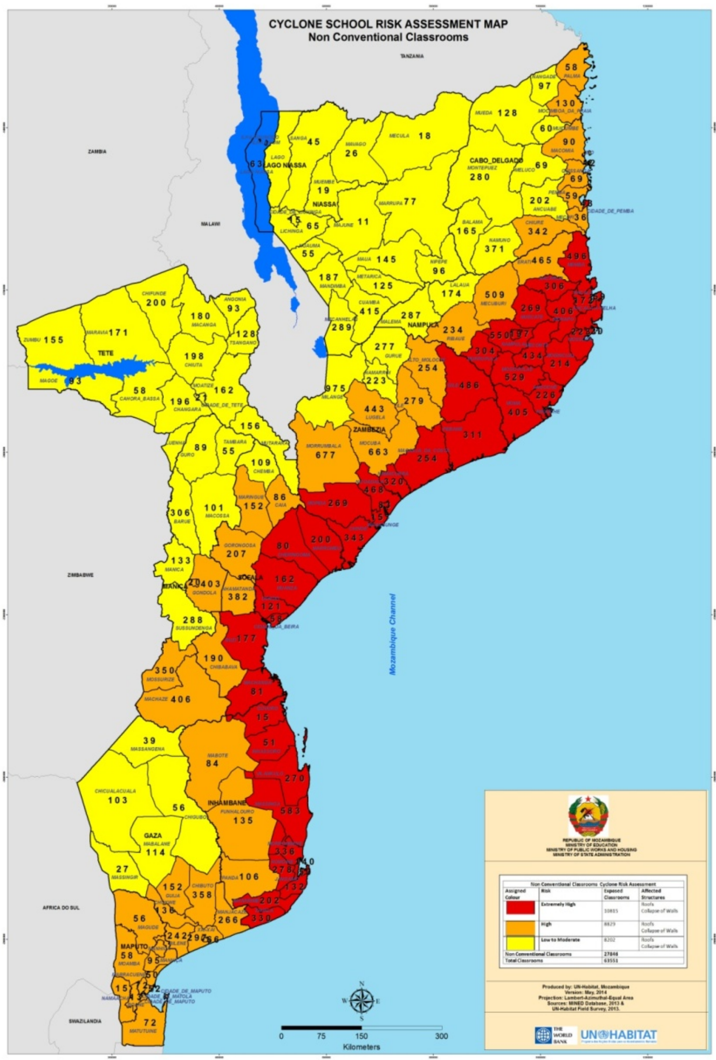


b) Non Conventional Classrooms Cyclone Risk Assessment



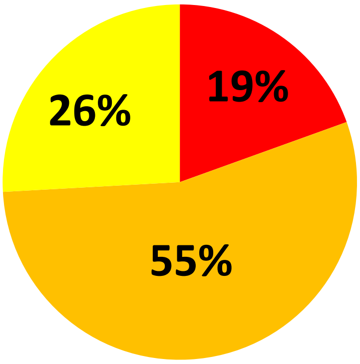
Risk Level	No of Classrooms
High	10815
Moderate	8829
Low	8202
Total	**27846**

Map 9 – Traditional Classrooms Cyclone Risk Assessment Map



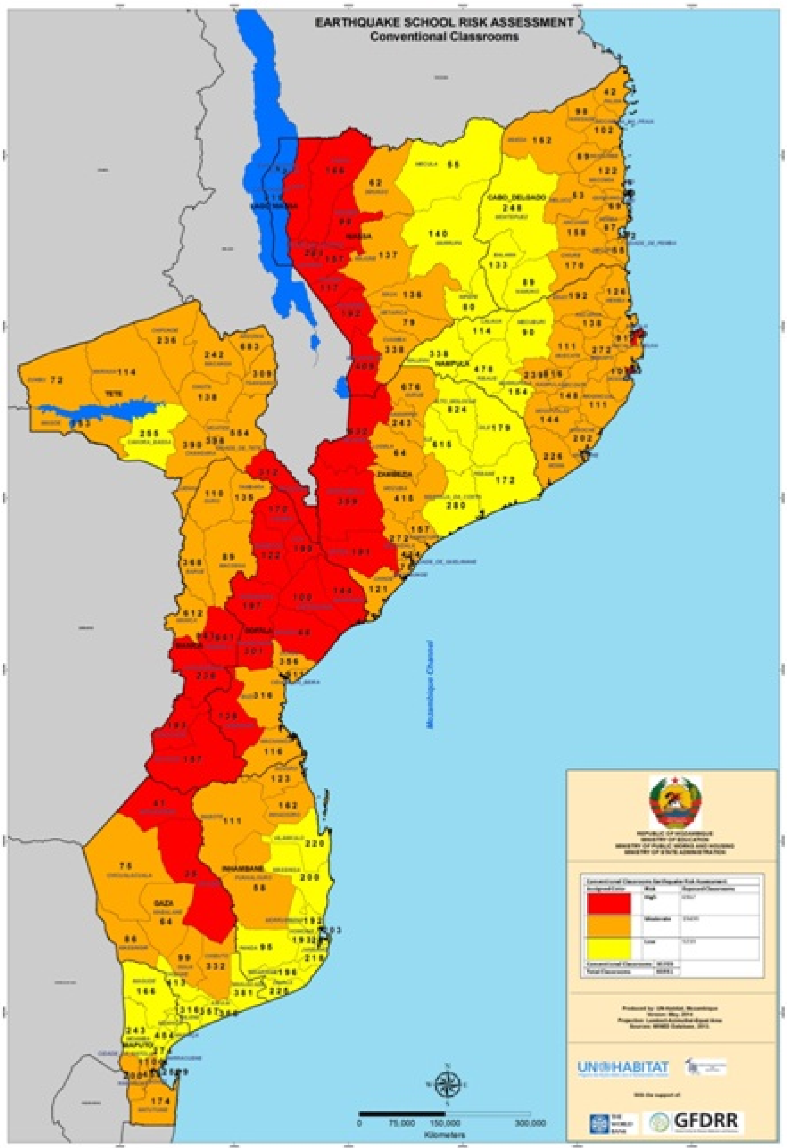
2. *EARTHQUAKES*

a) Conventional Classrooms Earthquake Risk Assessment

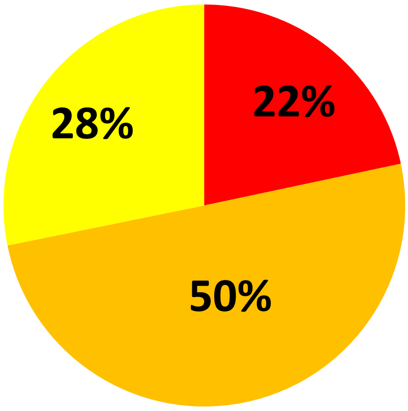


Risk Level	No of Classrooms
High	6967
Moderate	19499
Low	9239
Total	**35705**

Map 10 – Conventional Classrooms Earthquake Risk Assessment Map

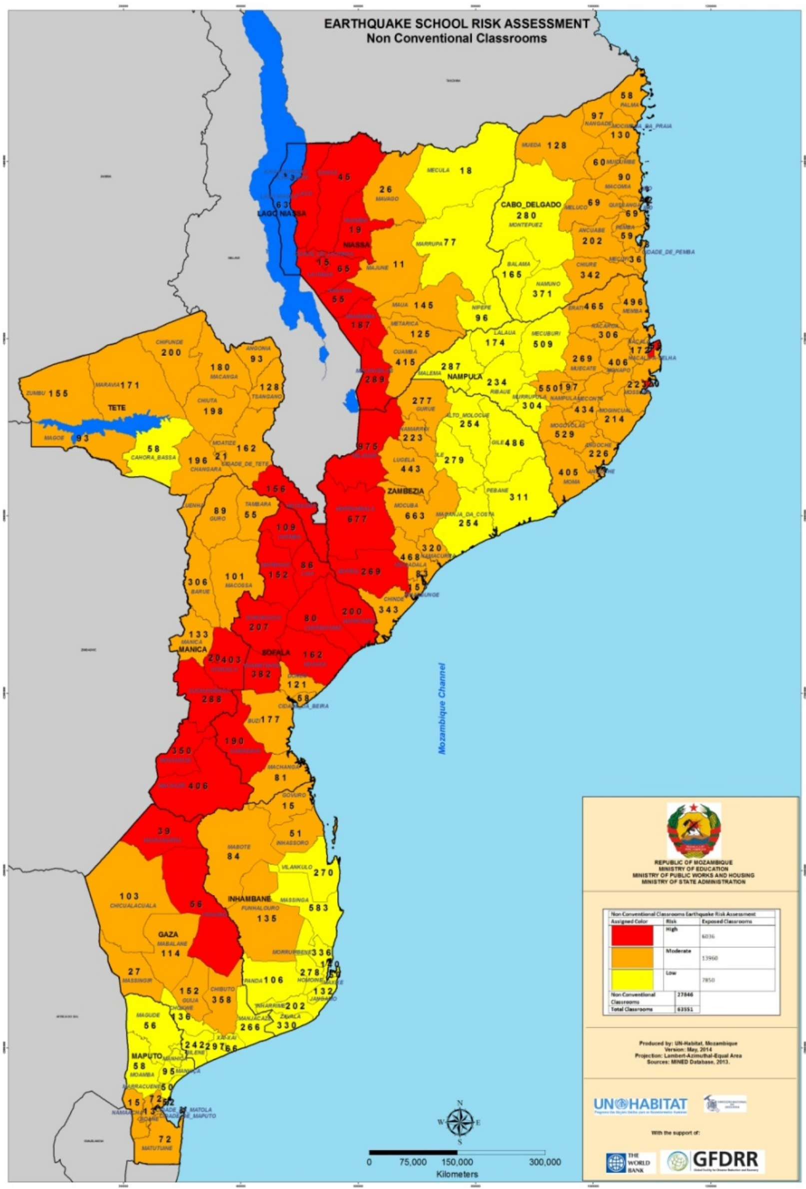


b) Non Conventional Classrooms Earthquake Risk Assessment



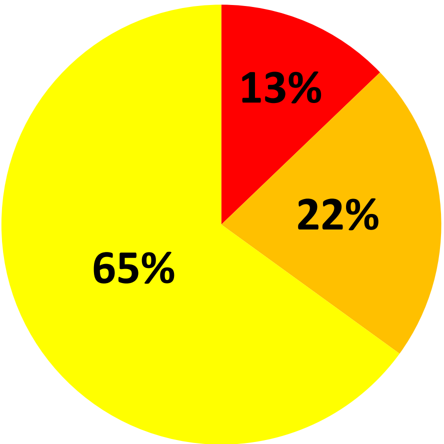
Risk Level	No of Classrooms
High	6036
Moderate	13960
Low	7850
Total	**27846**

Map 11 – Non Conventional Classrooms Earthquake Risk Assessment Map



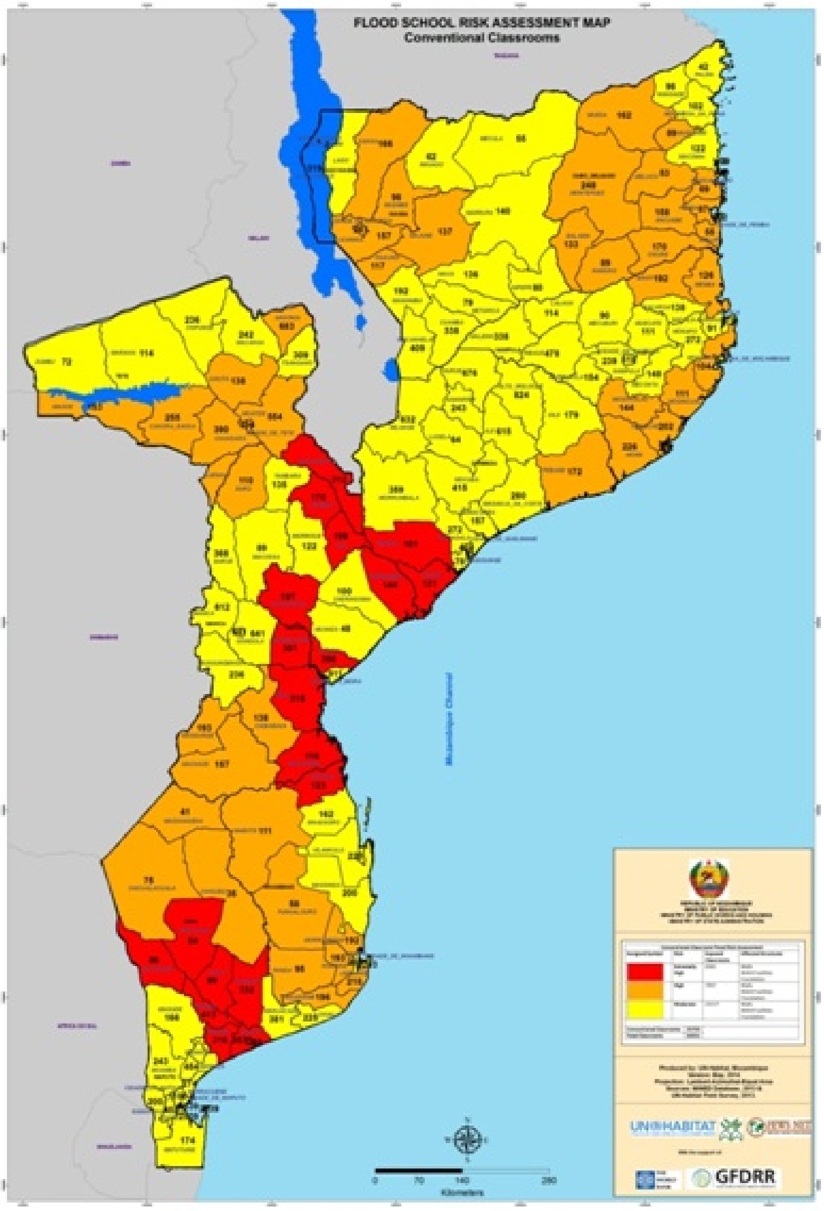
3. FLOODS

a) Conventional Classrooms Flood Risk Assessment

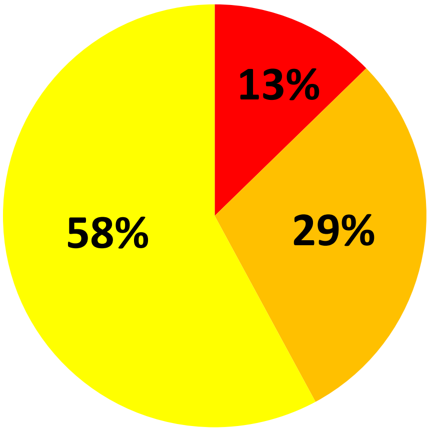


Risk Level	No of Classrooms
High	4581
Moderate	7907
Low	23217
Total	**35705**

Map 12 – Conventional Classrooms Flood Risk Assessment Map

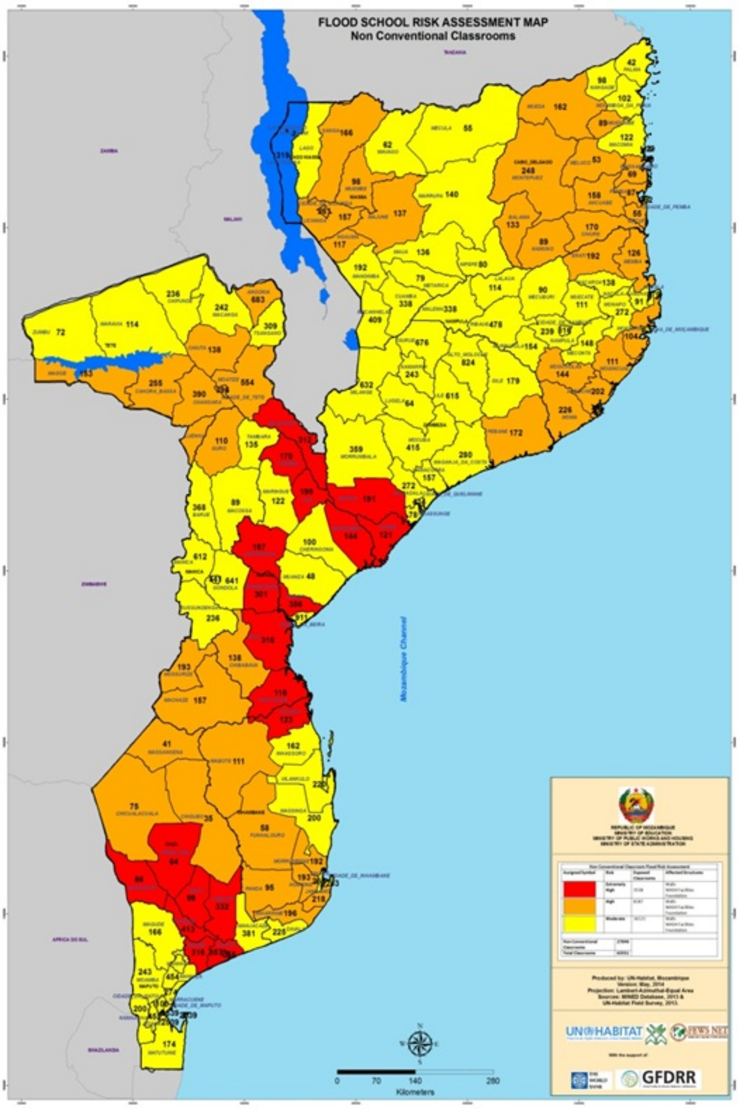


b) Non conventional Classrooms Flood Risk Assessment



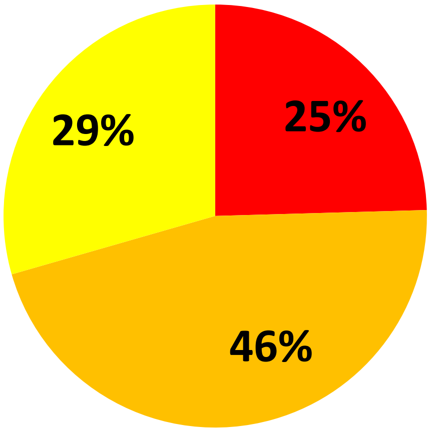
Risk Level	No of Classrooms
High	3538
Moderate	8187
Low	16121
Total	**27846**

Map 13 – Non Conventional Classrooms Flood Risk Assessment Map



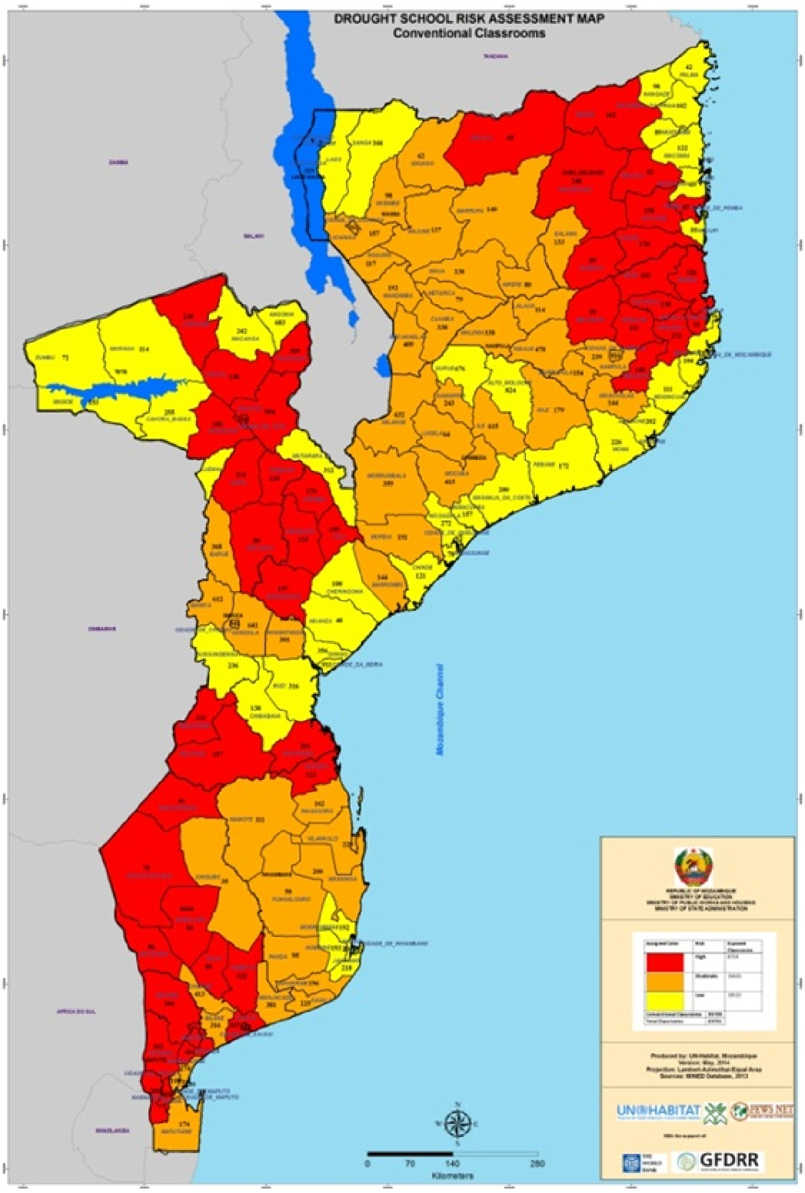
4. DROUGHTS

a) Conventional Classrooms Drought Risk Assessment

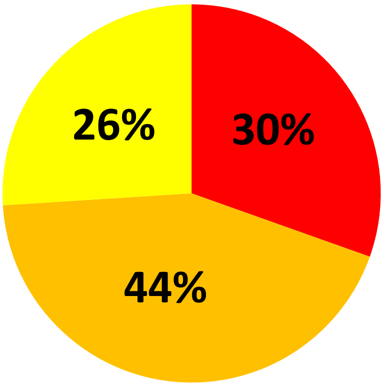


Risk Level	No of Classrooms
High	8764
Moderate	16426
Low	10515
Total	**35705**

Map 14 – Conventional Classrooms Drought Risk Assessment Map

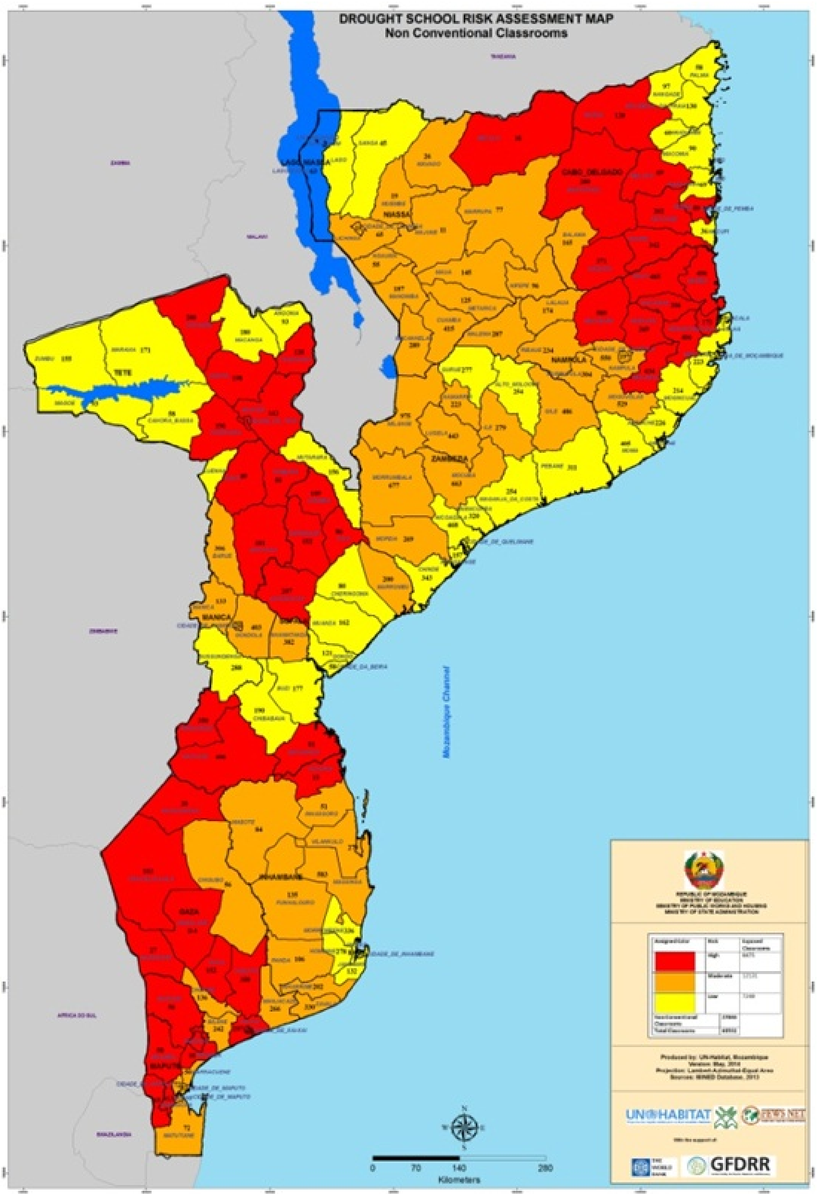


b) Non conventional Classrooms Drought Risk Assessment



Risk Level	No of Classrooms
High	8475
Moderate	12131
Low	7240
Total	**27846**

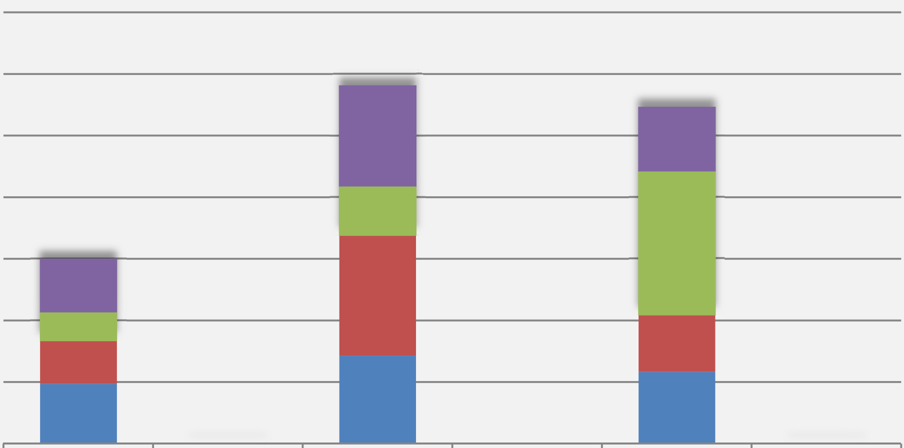
Map 15 – Non conventional Classrooms Drought Risk Assessment Map



3. Key Findings

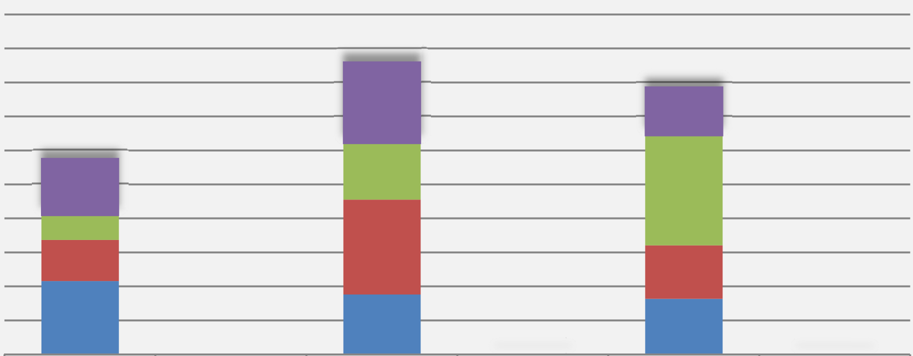
For easier reference and comparison, the graphs below display the different levels of risk per hazard grouped, separately for Conventional and Non-Conventional Classrooms.

Chart 1 – Conventional Classrooms Risk Assessment



	High Risk	%	Moderate Risk	%	Low Risk	%
Droughts	8764	13.8	16426	25.8	10515	16.5
Floods	4581	7.2	7907	12.4	23217	36.5
Earthquaques	6967	11.0	19499	30.7	9239	14.5
Cyclones	9714	15.3	14308	22.5	11683	18.4

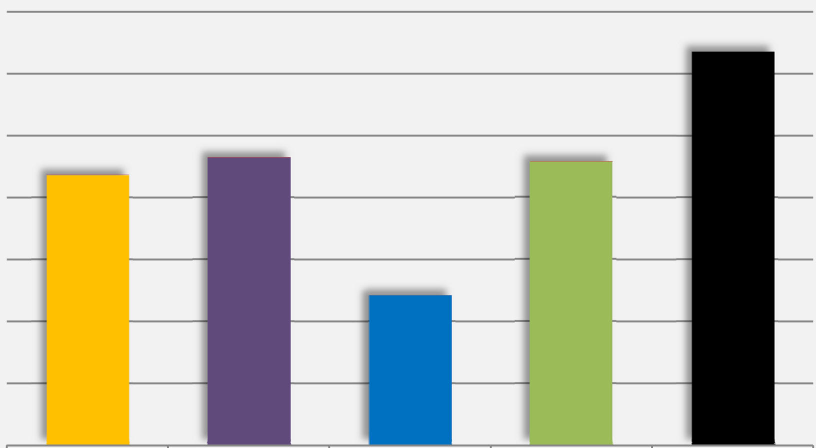
Chart 2 – Non Conventional Classrooms Risk Assessment



	High Risk	%	Moderate Risk	%	Low Risk	%
Droughts	8475	13.3	12131	19.1	7240	11.4
Floods	3538	5.6	8187	12.9	16121	25.4
Earthquaques	6036	9.5	13960	22.0	7850	12.4
Cyclones	10815	17.0	8829	13.9	8202	12.9

In Summary, this studied identified that, from a universe of 63551 classrooms, 43666 (68%) are at risk[3] of Cyclones, 46462 (73.1%) are at risk of Earthquakes, 24213 (38.1%) are at risk of Floods and finally, 45796 (72.1%) are at risk of Droughts.

Chart 3 – Number of Classrooms Exposed to Risk



	Cyclones	Earthquaques	Floods	Droughts	Total
%	68.7	73.1	38.1	72.1	
Nr. Classrooms	43666	46462	24213	45796	63551

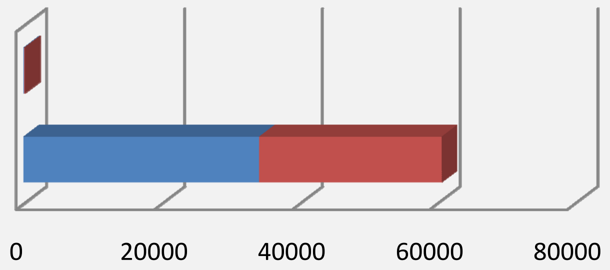
Finally, a map displaying all classrooms – regardless of sensitivity - located in districts highly exposed to at least one hazard is presented[4].As depicted in the map below, a large number of districts - 136 - are highly exposed to at least one hazard. Based on this information, it was possible to estimate that 60653 (i.e. 95% of the total) classrooms of both conventional and non-conventional materials are located in districts that are highly exposed to at least one of four hazards. Further detailing the analysis, it is possible to identify that the proportion of classrooms in highly exposed districts is similar if separated by material: 26564 out of 27846 non-conventional classrooms (i.e. 95.4%) and 34089 out of 35705 conventional classrooms (i.e. 95.5%) (Ref. Figure below)

[3] "At risk" here is considered as classrooms situated in districts considered of high or moderate risk.

[4] Although this final map considers vulnerability as an approximation of exposure, without effectively considering sensitivity due to methodological limitations in the database, the technical team believes that it is important to identify the number of schools in highly exposed districts to illustrate the dimension that the vulnerability of the classroom network may reach

Map 16 – District at High Risk of a least 1 or more natural hazard

Chart 4 – Classrooms at High Risk of 1 or more natural Hazards



	Nr. Classrooms	%
Conventional	34089	95.5
Unconventional	26564	95.4

The Risk assessment presented in this study has a considerable uncertainty and loss estimates should be derived using probability distributions so that the uncertainty is explicitly presented. Based on the construction materials at district level it was found that in both conventional and unconventional classrooms the most vulnerable components are the basic components of the school building including the walls and structures, Structure of Coverage and Coverage, and within these three the roof structure and the very coverage are more vulnerable. Regarding the walls and building structures, schools performed in unconventional materials have mostly an advanced state of disrepair or poor quality of execution that increase the level of vulnerability of these schools and consequently, the risk.

Regarding water catchment and storage for system was notorious those schools mostly do not exhibit this works and if is there its inoperable or poor.

Annex

Levantamento Estatístico – 03 de Março

Número de Escolas e Salas de Aula por tipo de material de construção.

Ano	2013

		Escolas	Salas por tipo de material de construção				
Provincia	Distrito		Cimento	Tijolo	Maticado	Pau-a-pique	Outros
Cabo Delgado	Ancuabe	58	149	9	108	79	15
	Balama	62	131	2	91	44	30
	Chiúre	125	159	11	196	113	33
	Cidade de Pemba	25	276	6	3	19	26
	Ibo	10	29	0	2	3	7
	Macomia	47	114	8	33	32	25
	Mecúfi	20	55	0	15	18	3
	Meluco	31	53	0	34	25	10
	Mocímboa da Praia	52	97	5	22	108	0
	Montepuez	107	248	0	116	121	43
	Mueda	63	124	38	29	90	9
	Muidumbe	27	89	0	9	48	3
	Namuno	132	80	9	303	57	11
	Nangade	44	43	55	44	48	5
	Palma	33	35	7	23	35	0
	Pemba - Metuge	30	87	0	21	30	8
	Quissanga	38	69	0	29	35	5
Cabo Delgado Total		904	1838	150	1078	905	233
Gaza	Bilene - Macia	90	314	2	2	171	69
	Chibuto	120	324	8	82	139	137
	Chicualacuala	47	71	4	50	53	0
	Chigubo	31	35	0	39	14	3
	Chokwe	89	398	15	48	57	31
	Cidade de Xai-Xai	37	335	33	5	22	39
	Guijá	47	87	12	81	16	55
	Mabalane	47	60	4	78	18	18
	Manjacaze - Dingane	116	380	1	3	84	179
	Massangena	21	35	6	9	26	4
	Massingir	31	86	0	14	6	7
	Xai-Xai distrito	83	342	15	14	240	43
Gaza Total		759	2467	100	425	846	585
Inhambane	Cidade da Maxixe	33	279	2	3	68	69

	Cidade de Inhambane	28	203	0	0	31	19
	Funhalouro	39	58	0	2	75	58
	Govuro	28	122	1	0	3	12
	Homoíne	79	193	0	0	30	248
	Inharrime	66	196	0	6	109	87
	Inhassoro	45	162	0	1	24	26
	Jangamo	51	200	18	1	73	58
	Mabote	35	107	4	22	42	20
	Massinga	117	200	0	0	259	324
	Morrumbene	83	183	9	1	156	179
	Panda	44	95	0	3	16	87
	Vilankulo	77	219	1	5	93	172
	Zavala	85	225	0	0	19	311
Inhambane Total		810	2442	35	44	998	1670
Manica	Bárué	87	255	113	20	252	34
	Cidade de Chimoio	49	457	84	3	11	6
	Gondola	150	517	124	26	255	122
	Guro	36	76	34	5	74	10
	Machaze	98	147	10	26	263	117
	Macossa	22	72	17	7	86	8
	Manica	118	522	90	15	66	52
	Mossurize	94	133	60	145	153	52
	Sussundenga	92	203	33	31	226	31
	Tambara	37	118	17	6	44	5
Manica Total		783	2500	582	284	1430	437
Maputo	Boane	55	427	28	0	3	10
	Cidade da Matola	93	1083	17	0	0	72
	Magude	60	140	26	23	14	19
	Manhiça	93	426	28	0	29	66
	Marracuene	47	263	11	0	6	44
	Matutuíne	56	174	0	8	16	48
	Moamba	70	235	8	1	24	33
	Namaacha	39	200	0	1	7	7
Maputo Total		513	2948	118	33	99	299
Nampula	Angoche	107	185	17	74	60	92
	Cidade de Nampula	83	776	40	30	94	73
	Ilha de Moçambique	14	77	6	4	8	8
	Lalaua	65	87	27	80	84	10
	Malema	117	93	245	97	123	67
	Meconta	98	115	33	160	122	152
	Mecubúri	118	90	0	214	271	24
	Memba	132	89	37	250	153	93
	Mogincual	81	110	1	39	175	0
	Mogovolas	139	125	19	153	272	104

	Moma	142	217	9	138	208	59
	Monapo	126	183	89	84	109	213
	Mossuril	88	89	15	131	66	26
	Muecate	80	99	12	120	121	28
	Murrupula	116	78	76	154	117	33
	Nacala - Porto	49	309	70	14	4	41
	Nacala - Velha	63	73	18	100	31	41
	Nacarôa	76	95	43	138	137	31
	Namapa - Eráti	149	103	89	159	81	225
	Nampula - Distrito	129	173	66	201	189	160
	Ribaué	126	104	374	152	16	66
Nampula Total		2098	3270	1286	2492	2441	1546
Niassa	Cidade de Lichinga	37	220	41	0	0	15
	Cuamba	169	231	107	143	220	52
	Lago	97	166	153	4	40	19
	Lichinga - Distrito	67	123	34	0	32	33
	Majune	41	106	31	2	7	2
	Mandimba	86	111	81	36	76	75
	Marrupa	53	119	21	18	49	10
	Maúa	78	94	42	37	101	7
	Mavago	18	55	7	10	13	3
	Mecanhelas	191	171	238	87	131	71
	Mecula	28	47	8	2	10	6
	Metarica	68	39	40	24	98	3
	Muembe	24	69	29	0	13	6
	N'Gauma	59	24	93	2	22	31
	Nipepe	54	60	20	37	43	16
	Sanga	51	134	32	11	30	4
Niassa Total		1121	1769	977	413	885	353
Sofala	Búzi	103	280	36	109	24	44
	Caia	55	169	30	11	39	36
	Chemba	65	140	30	30	47	32
	Cheringoma	42	93	7	13	22	45
	Chibabava	78	133	5	96	38	56
	Cidade da Beira	87	902	9	4	6	48
	Dondo	58	352	4	28	34	59
	Gorongosa	78	170	27	56	70	81
	Machanga	39	114	2	47	3	31
	Maríngue	61	106	16	23	76	53
	Marromeu	60	134	10	54	101	45
	Muanza	44	45	3	99	51	12
	Nhamatanda	103	260	41	253	68	61
Sofala Total		873	2898	220	823	579	603
Tete	Angónia	179	202	481	4	39	50
	Cahora Bassa	58	173	82	3	47	8

	Changara	122	255	135	6	165	25
	Chifunde	71	67	169	41	81	78
	Chiúta	62	74	64	25	135	38
	Cidade de Tete	36	364	32	0	5	16
	Macanga	73	106	136	35	95	50
	Mágoé	49	85	68	3	44	46
	Marávia	65	71	43	26	111	34
	Moatize	128	327	227	9	119	34
	Mutarara	90	172	140	22	37	97
	Tsangano	87	106	203	6	68	54
	Zumbo	58	41	31	30	103	22
Tete Total		1078	2043	1811	210	1049	552
Zambézia	Alto Molócué	227	209	615	141	54	59
	Chinde	122	110	11	206	27	110
	Cidade de Quelimane	41	391	43	8	75	0
	Gilé	151	135	44	268	93	125
	Gurué	201	279	397	127	108	42
	Ile	228	132	483	90	46	143
	Inhassungue	62	76	2	85	20	52
	Lugela	160	36	28	389	7	47
	Maganja da Costa	148	183	97	194	55	5
	Milange	424	285	347	508	197	270
	Mocuba	214	253	162	315	114	234
	Mopeia	144	165	26	165	41	63
	Morrumbala	233	260	99	515	162	0
	Namacurra	124	151	6	216	39	65
	Namarroi	109	113	130	121	35	67
	Nicoadala	156	238	34	292	87	89
	Pebane	152	136	36	142	80	89
Zambézia Total		2896	3152	2560	3782	1240	1460
Cidade de Maputo	Municipal de Nhlamankulo (DU 2)	23	284	0	0	0	0
	Municipal Ka Mavota (DU 4)	42	542	23	0	0	10
	Municipal KaMaxakeni (DU 3)	27	325	0	0	0	8
	Municipal KaMfumo (DU 1)	67	772	0	0	2	29
	Municipal KaMubukwana (DU 5)	45	593	0	0	3	0
Cidade de Maputo Total		204	2516	23	0	5	47
Grand Total		**12039**	**27843**	**7862**	**9584**	**10477**	**7785**