

Cyclone Resilience of Traditional Wooden Houses in Madagascar

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RC3 Project

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Tropical cyclones in Madagascar

SEASON	CYCLONE	DATES	CATEGORY (MF)	SUSTAINED WIND SPEED				
2019-2020	Belna	2nd December '19 - 11 December '19	Tropical Cyclone	10-min: 155 km/h				
2018-2019	No tropical cy	yclones made landfall i	n Madagascar					
2017-2018	Ava	27th December '17 - 9th January '18	Tropical Cyclone	10-min: 155 km/h				
2016-2017	Enawo	2nd March '17 - 9th March '17	Intense Tropical Cyclone	10-min: 205 km/h				
2015-2016	No tropical cy	yclones made landfall in Madagascar						
2014-2015	No tropical cy	o tropical cyclones made landfall in Madagascar						
2013-2014	Hellen	26th March '14 - 5th April '14	Very Intense Tropical Cyclone	10-min: 230 km/h				
2012-2013	Haruna	18th Feburary '13 - 24th February '13	Tropical Cyclone	10-min: 150 km/h				
2011-2012	Giovanna	7th February '12 - 22nd February '12	Intense Tropical Cyclone	10-min: 195 km/h				
2010-2011	Bingiza	9th Feburary '11 - 19th '11 Feburary	Tropical Cyclone	10-min: 155 km/h				



Characteristics and track of cyclone Enawo 2017



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- The built environment and specifically traditional wooden houses in coastal regions are particularly affected by cyclones.
- Traditional wooden houses make more than 85% of the housing stock.

Objectives

- To characterize the exposure of Madagascar to cyclonic winds under current climate and climate change conditions;
- To develop a tool to assess the structural capacity of traditional houses to resist cyclone wind loads;
- To assess the current and future capacity of Malagasy society to respond and adapt to the impacts of cyclones;
- To engage with NGOs and other stakeholders to coproduce adaptative measures that would increase the resilience of traditional houses.



Exposure of Madagascar to cyclonic winds

Results of the ERA5 validation Station 5 (Antalaha)



Locations of weather stations throughout Madagascar





- ERA5 validation:
 - Gives a good simulation of the current and recent past climate
 - Good correlation for maximum and minimum temperatures and precipitation
 - Wind speeds: consistently underestimated, especially for wind gusts and extreme events
- Issues with the data comparison
 - Errors in some of the observed data
 - ERA5 outputs are averaged over a large area so do not represent local spatial variations

Vulnerability of population and traditional houses

Vulnerability of population and houses to cyclones in Madagascar

Cyclones damage data collection	Review construction guidelines
Ratio of affected population Ratio of affected houses	Identification of cyclone-induced damage patterns

Identify weak links in the wooden houses construction process





Vulnerability of population and traditional houses



Fierenana

Ampitabe

Beforona

Vodiriana

Lakato

BRICKAVILLE

Ranomafana

OVohibinany

Andevoranto

O Vatomandry

Maintinandry

Loss

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Vulnerability of population and traditional houses



- Data analysed for 12 cyclones during the last two decades
- Analysis of available data indicates that high vulnerability are most concentrated in the front coastal regions crossing the cyclone track

Construction Guidelines vs Practices















Identification of cyclone-induced damage patterns





Tilip

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Foundation failure (embedement) No lateral bracing system Weak cladding walls to the vertical members (columns) connections Ridge beam fractured Weak column-joist beam connections Weak rafter-to-joist beams connections weak purlins-to-rafter connections Weak roof secondary elements-to-purlins (or rafters) connections Weak roof sheets-to-secondary roof elements connections

Adaptive Capacity - Determinants

Objectives	Methods
Identify the determinants and indicators of adaptive capacity relevant to the study	Literature review
Characterize the adaptive capacity of the study areas (coastal versus highlands)	Survey (REBEC project)



Study field	Determinants/elements/factors of adaptive capacity							Source					
	Economic wealth	Technology	Information and skills	Infra- structure	Institutions	Equity							*(1)
Climate change	Income	Technology	Knowledge		Institutions		Health	Social capital	Education				*(2)
	Financial capital		Information		Governance			social capital	human resources				*(3)
Tropical cyclone	Economic well-being			Infra- structure	Governance		Health		Education				*(4-5-6)
Island com- munities	Economic resources	Technology	Information	Infra- structure				Social capital	Human capital	Natural resources	Collective actions	Cognitive elements	*(7)
Less developed countries	Income				Political power		health		Education				*(8)
(1) IPCC (2001), (2) IPCC (2007), (3) Brooks and Adger (2004) (4) Sharma and Patwardhan (2008), (5) Sharma, Patwardhan and Patt (2013), (6) Nguyen et al. (2019) (7) Warrick et al., (2017) (8) Lemos et al. (2013)													

Adaptive Capacity - Results

Determinants	Indicators	Source: of data
	Number of people in employment	Survey
Economic wealth	Number of people having diversified income- generating activities	Survey
	Number of people earning a daily income above the poverty line (\$1.90)	Survey
Governance an d policy	Number of people following guidelines to build their house	Survey
Tachnical skills	Number of people applying house- strengthening techniques before cyclones	
	Number of people who built their own houses	Survey
	Number of people with access to cyclone information from the government	Survey
Knowledge and Information	Number of people who received technical training	Survey
Human	Inverse of the demographic dependency ratio	
resources	Literacy rate of individuals aged 15 and over	Census data

-Highlands -Coastal





What next ?

- 1. The characterisation of cyclonic winds under climate change conditions
- 2. Fieldworks to conduct experimental tests to characterise as traditional wooden construction as practiced (tests on connections, members, soil,)
- 3. Fieldworks for data collection, including new determinants and indicators, with household survey for three regions of Madagascar (1 Highland, 2 Coastal)