

# ELABORATION OF FLOOD RISK MAPS THROUGH A HYDROLOGICAL AND HYDRAULIC STUDY, CONNECTED TO THE EARLY ALERT SYSTEM, AND THE PRODUCTION OF COMMUNITY MAPS IN THE LICUNGO RIVER BASIN

**Project HIP 2018: ECHO/-SF/BUD/2018/91013**

**Strengthening national, district and local capacities for response to natural disasters, linking early warning with early action and promoting their scalability**

**Project led by Cruz Roja Española in collaboration with the Red Cross of Mozambique**

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Enrique Peña, Víctor Penas  
Technical Consultants CRE

**A Coruña, Spain, 12/10/2020**

# Project financed by:

European Union Civil Protection and Humanitarian Aid (ECHO)



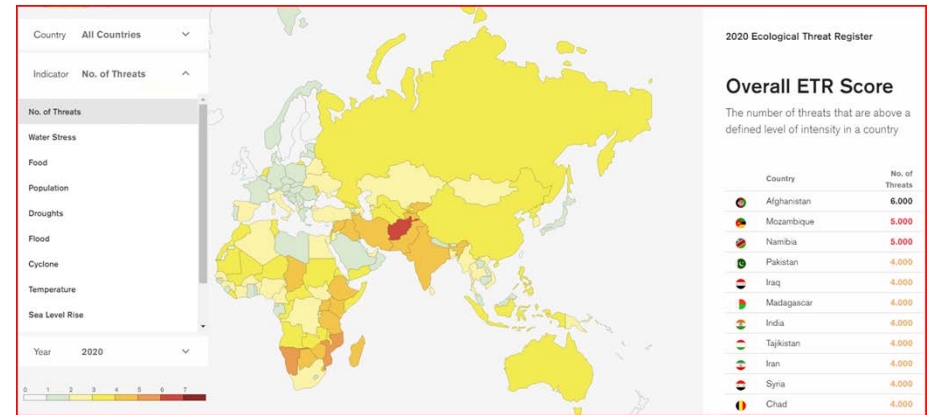
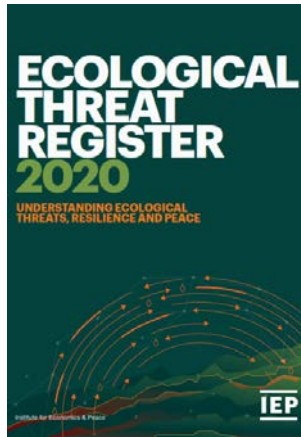
European Union  
Civil Protection and  
Humanitarian Aid

In collaboration with:



# Introduction

## Ecological Threat Register ( ETR - Sept. 2020)

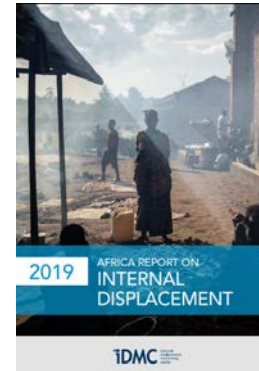


- ✓ The ETR has covered 157 countries.
- ✓ Moçambique appears as the second country with the highest risk of exposure to ecological threath
- ✓ Risk level: 5 (one of the highest scores).
- ✓ Low resilience levels. High fragility. High collapse risk.
- ✓ Low level of monitoring and data analysis networks. Fortunalety, worldwide networks, based on remote sensing, are providing very useful data.
- ✓ Among the 12 countries, all in Sub-Saarian Africa, with the highest prevalence of food insecurity.
- ✓ High population increase rate (9<sup>th</sup> in the world). Population in 2020: 31 M. Populations estimated in 2050: 65 M. Low control of security of human settlements.

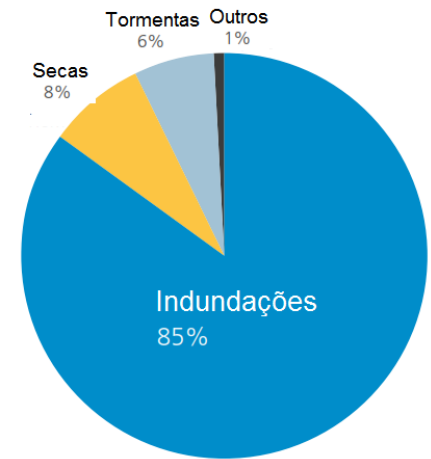
# Introduction

- ✓ Moçambique: disasters in 1990 – 2019:

| Disaster type | Nº        | %          |
|---------------|-----------|------------|
| Floods        | 40        | 48.2       |
| Storms        | 26        | 31.3       |
| Droughts      | 13        | 15.7       |
| Landslides    | 2         | 2.4        |
| Earthquakes   | 1         | 1.2        |
| Fires         | 1         | 1.2        |
| <b>Total</b>  | <b>83</b> | <b>100</b> |



% displaced(2009-2018)



\* <https://www.internal-displacement.org/africa-report>

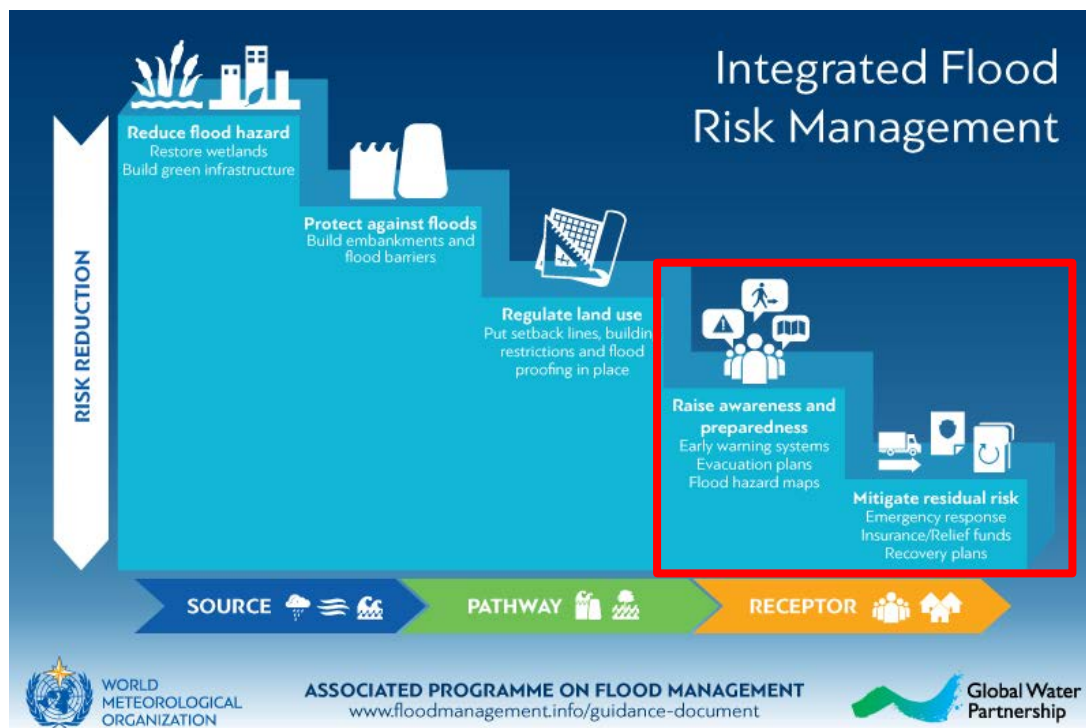
- ✓ The seventh country in the world with the highest number of displaced people in 2019
- ✓ Some 90% of the global amount of displaced people in Africa from 2009 were caused by floods or storms.



\* Source: The International Disaster Database <https://www.emdat.be/>

# Objectives and scope of the collaboration

- Strengthening of the capabilities in flood disaster risk management, by producing Flood Risk Maps, and training our technical counterparts in their use and production.
- Identification and dissemination of Evacuation Paths and Shelter Locations in 10 communities of Licungo River Basin.
- Flood Risk Management covers a wide range of activities. This project focus on Raising awareness and preparedness, and in the Emergency response.





# Objectives and scope of the collaboration

- The detection of potential flood areas is essential to be able to develop an Early Warning System. Hazard and Risk maps are very helpful to focus the effort in target communities.
  - Communities must be made aware of the risk, and prepared to act efficiently in the case of flooding.
  - Evacuation paths and shelter locations must be known by the communities.
- 
- In addition, communities have to be warned in the case of a potential flooding with time enough to go to the shelters. This action is not covered by the project, but it is necessary. An EWS only is useful if it works completely, from the meteorological forecast to the efficient communication to the communities.

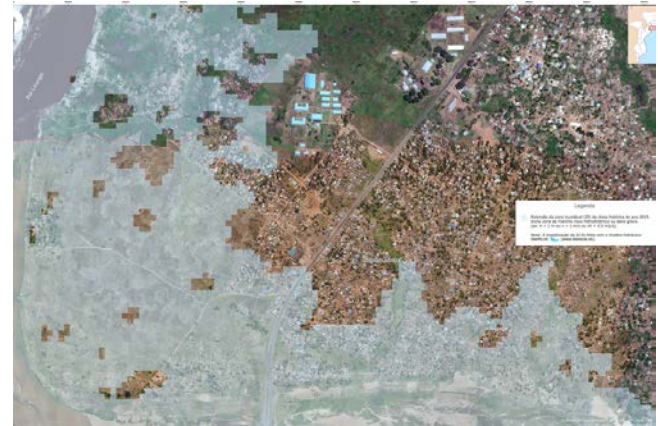


# Methodology

## ✓ Identify flood prone communities



## ✓ Evaluate flood hazard



## ✓ Propose evacuation routes and safe shelters



# Methodology

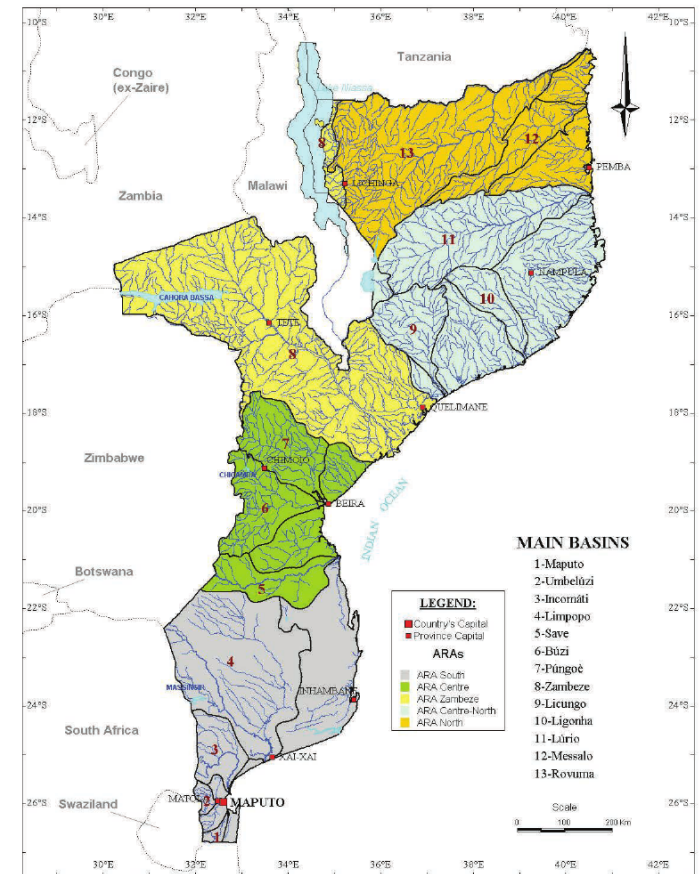
- ✓ **Freely available data.** All the data used come from freely available global data bases (ESA, NASA, JAXA satellite missions). Can be complemented with local data



- ✓ **Free softwares.** Iber and Q-GIS. Many online tutorials and courses. Both run in a single PC.



- ✓ **Scalable approach.** The approach is scalable and can be directly transposed to other catchments



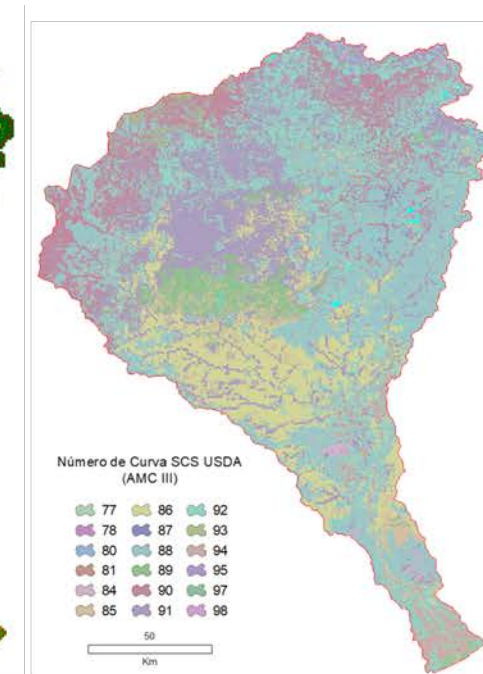
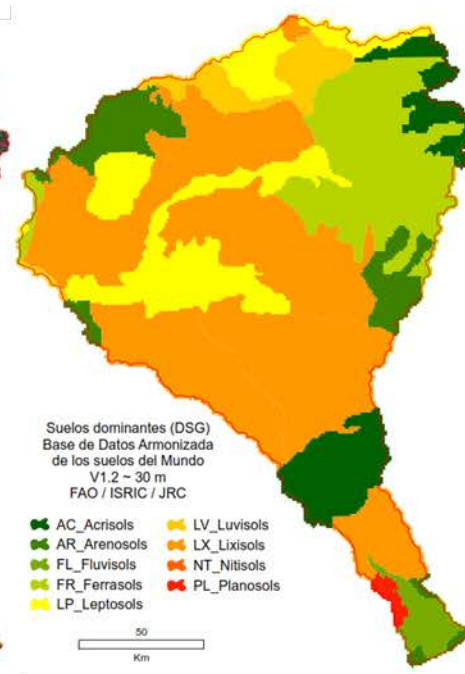
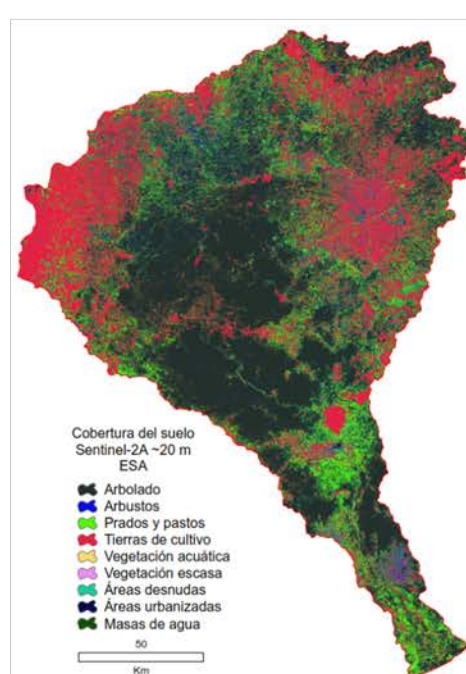
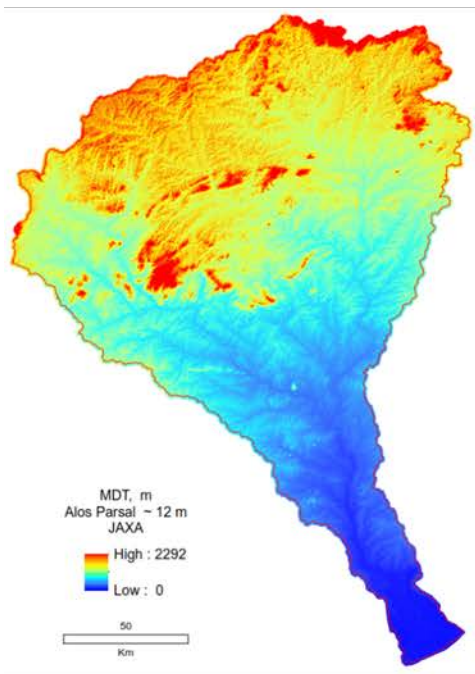
Sources: Map with title "Bacias Hidrográficas" (by Serviço Hidrográfico, 1976), DORRÉDNA, 1998

by JNF de Costa, 20-8-1999



# Input data for hydrological and hydraulic analysis with Iber

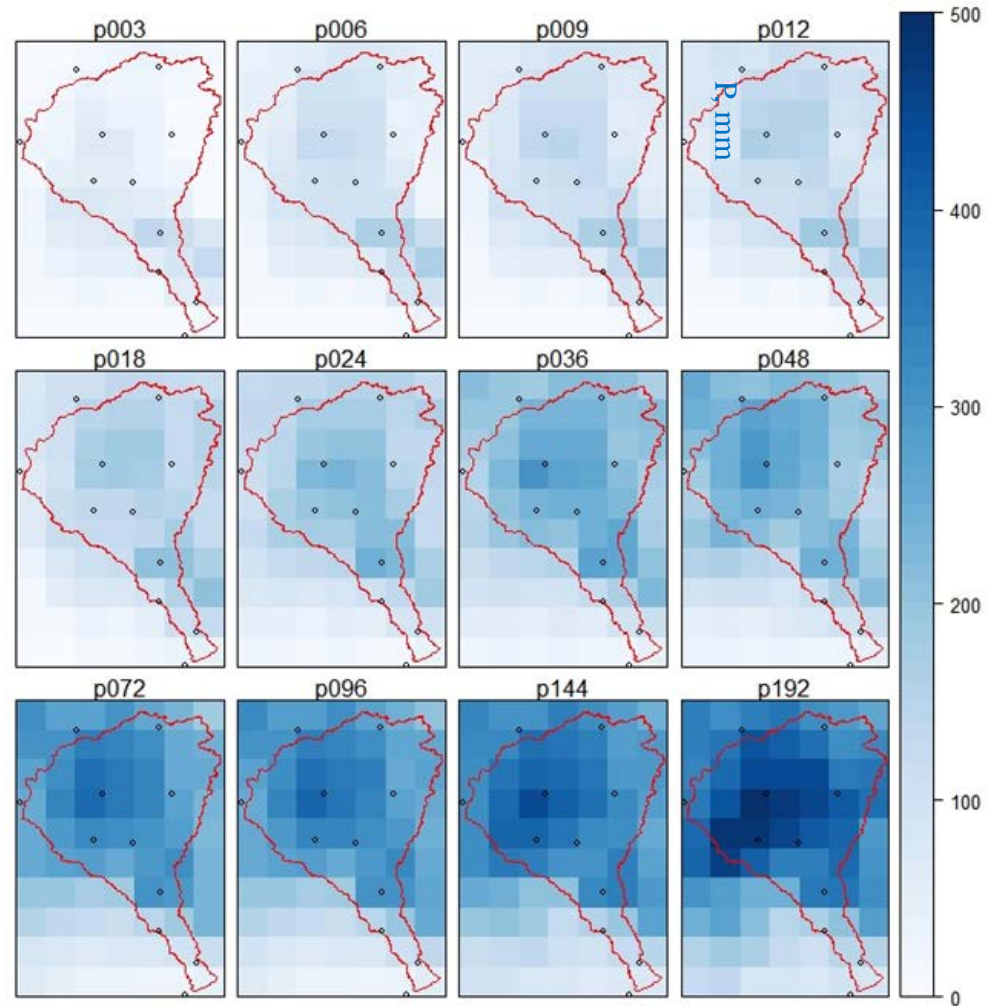
- ✓ **Digital terrain model.** Alos Parsal RTC from the ASF (15 – 30 m)
- ✓ **Land cover distribution.** Sentinel-2A data from the GlobCover project ESA (20 m)
- ✓ **Soil Types.** World Harmonized Soil Database from the FAO (30 m)
- ✓ **Rainfall.** TRMM (25km 3h) and GPM (10km 30min) missions from NASA



# Input data for hydrological and hydraulic analysis with Iber

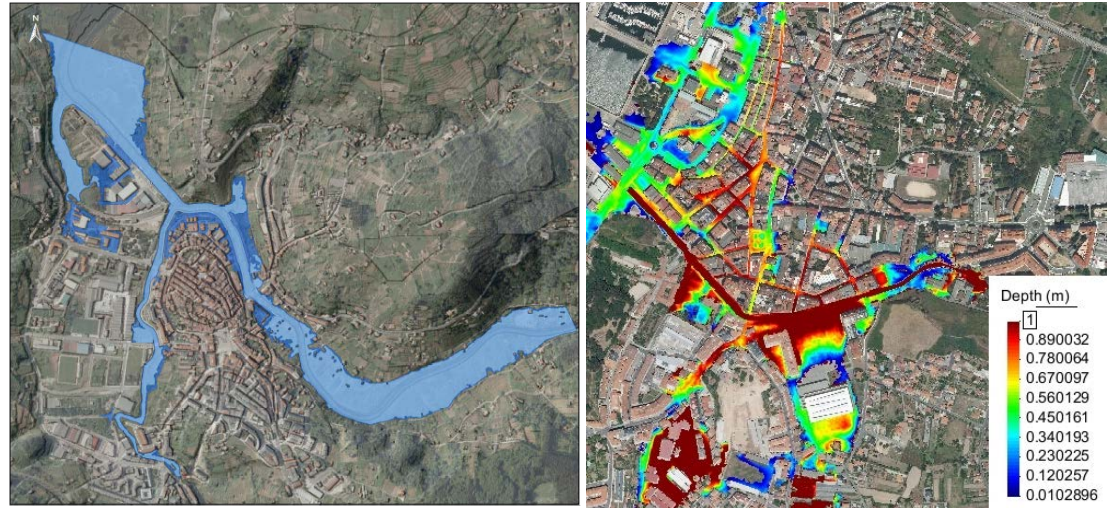
- ✓ Analysis based on the flood of the year 2015 in the Licungo basin

Spatial and temporal distribution of rainfall during the **Chedza Tropical Depression** in the Licungo basin (January 2015)

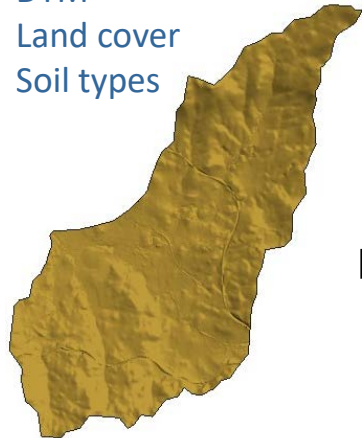




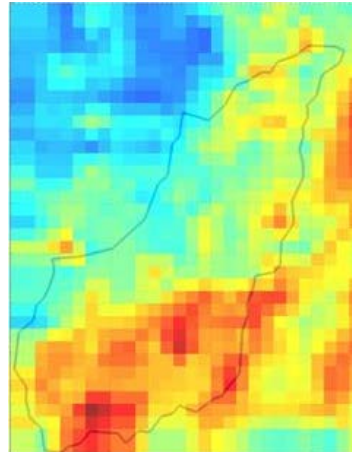
# Results of the hydrologic/hydraulic simulations



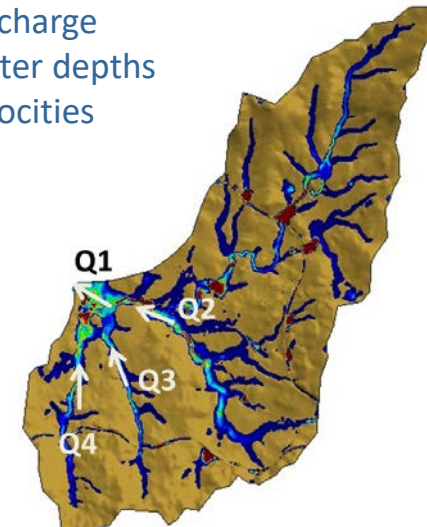
DTM  
Land cover  
Soil types



Rainfall

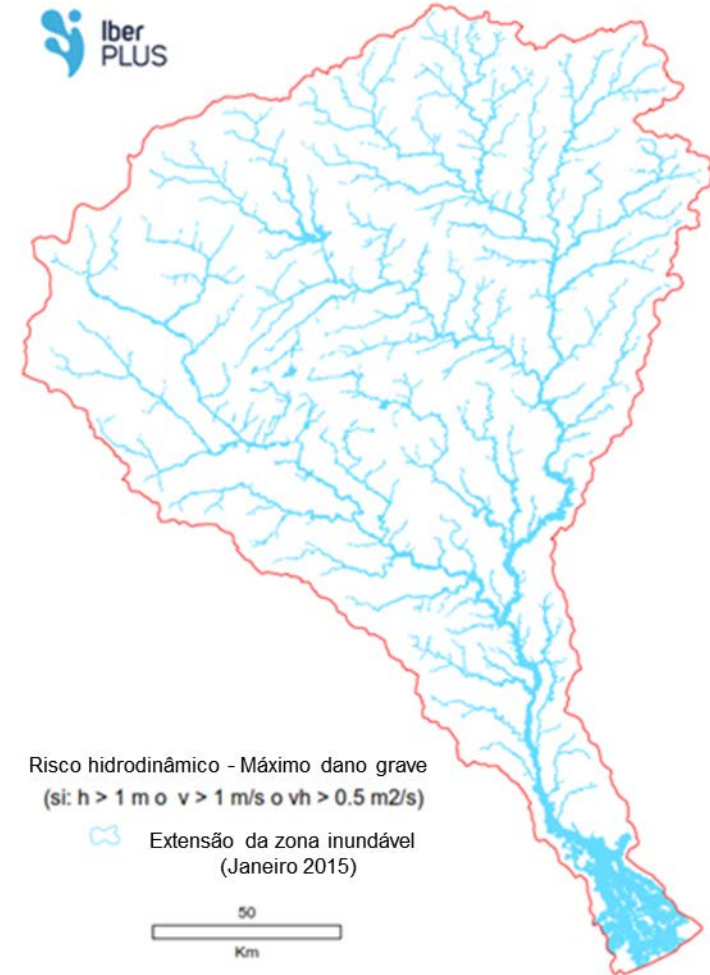
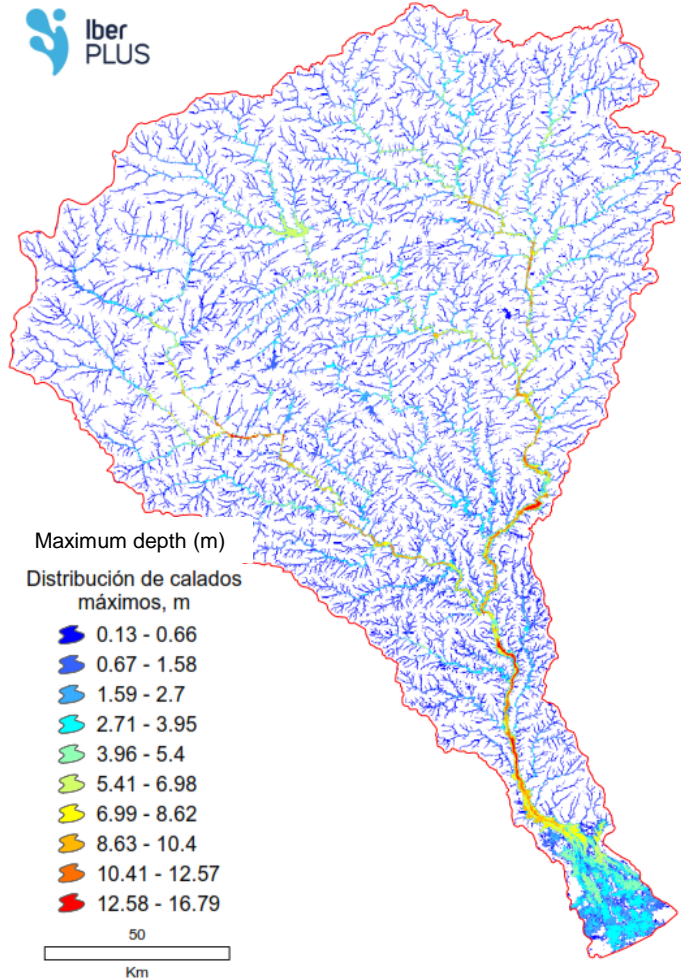


Discharge  
Water depths  
Velocities



# Results of the hydrologic/hydraulic simulations

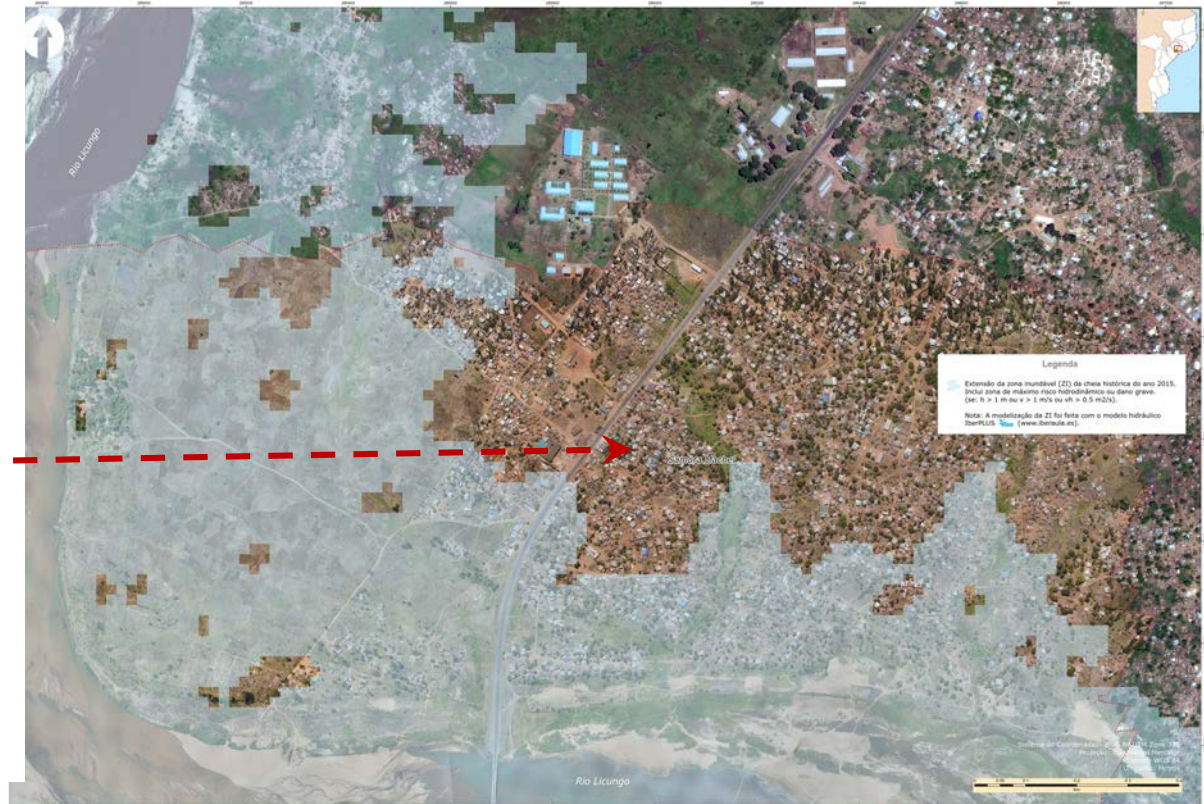
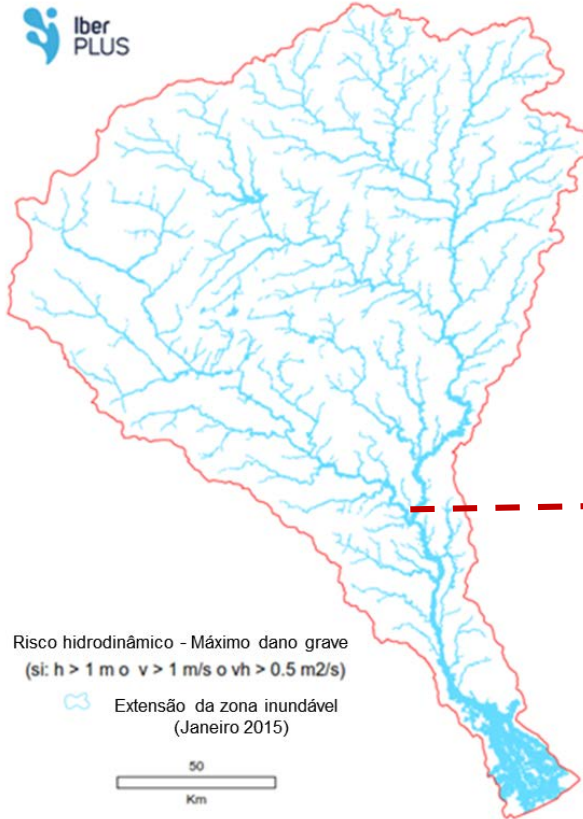
January 2015





# Results of the hydrologic/hydraulic simulations

## Comunidade Samora Machel

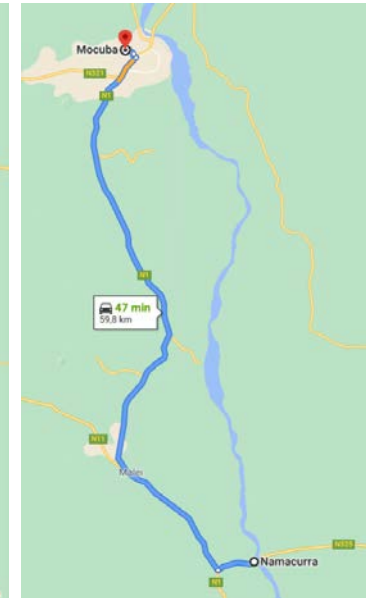


Moçambique Zambézia Mocuba - Comunidade de Samora Machel  
Extensão da zona inundável da cheia histórica do ano 2015.

Cruz Roja Española INGC

# Results of the hydrologic/hydraulic simulations

Some of the damage caused in the Samora Machel community





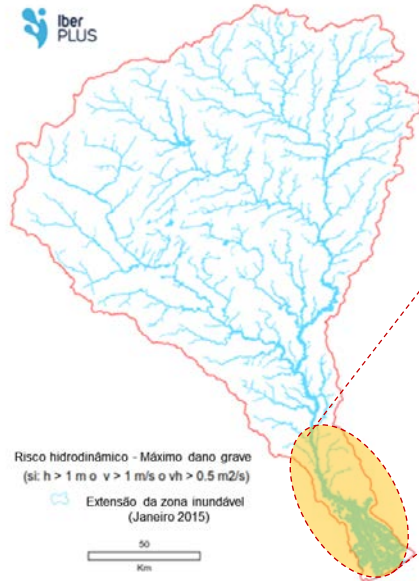
# Results of the hydrologic/hydraulic simulations

Satellite images before and after the January 2015 flood

27/02/2014



Iber PLUS



17/01/2015



# Results of the hydrologic/hydraulic simulations



102.2



104.0



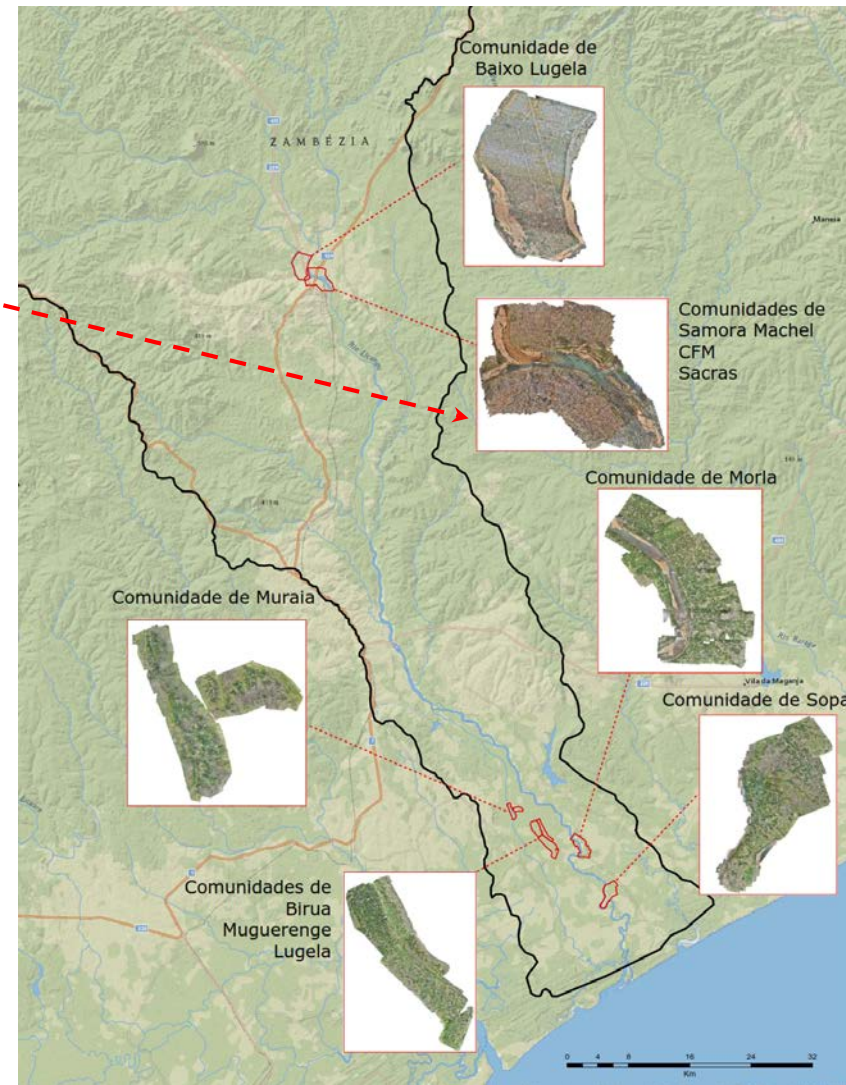


# Thematic maps

## Thematic maps for each settlement

- 01\_MAPAS\_JPG\_CFM\_MOCUBA
- 02\_MAPAS\_JPG\_SAMORA\_MACHEL\_MOCUBA
- 03\_MAPAS\_JPG\_SACRAS\_MOCUBA
- 04\_MAPAS\_JPG\_BAIXO LUGELA\_LUGELA
- 05\_MAPAS\_JPG\_MORLA\_MAGANJA\_DA\_COSTA
- 06\_MAPAS\_JPG\_SOPA\_MAGANJA\_DA\_COSTA
- 07\_MAPAS\_JPG\_MUGUERENGE\_NAMACURRA
- 08\_MAPAS\_JPG\_BIRUA\_NAMACURRA
- 09\_MAPAS\_JPG\_LUGELA\_NAMACURRA
- 10\_MAPAS\_JPG\_MURAIA\_NAMACURRA

- ✓ Each settlement has its own folder with its own thematic maps



# Results at Samora Machel

## Types of maps

### Folder:

02\_MAPAS\_JPG\_SAMORA\_MACHEL\_MOCUBA

### Content:

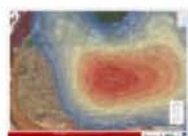
|   |                  |             |          |
|---|------------------|-------------|----------|
|  01_MAPA_ORTOFOTO_SAMORA_MACHEL.jpg                              | 26/09/2020 13:02 | Imagen JPEG | 3,716 KB |
|  02_MAPA_ZONA_INUNDÁVEL_SAMORA_MACHEL.jpg                        | 28/09/2020 12:57 | Imagen JPEG | 3,144 KB |
|  03_MAPA_DENSIDADE_SAMORA_MACHEL.jpg                             | 26/09/2020 16:32 | Imagen JPEG | 2,826 KB |
|  04_A_MAPA_PROPOSTA_ROTAS DE EVACUAÇÃO_SAMORA_MACHEL.jpg         | 24/09/2020 18:24 | Imagen JPEG | 3,563 KB |
|  04_B_MAPA_PROPOSTA_ROTAS DE EVACUAÇÃO_SAMORA_MACHEL.jpg         | 24/09/2020 18:27 | Imagen JPEG | 3,505 KB |
|  04_C_MAPA_PROPOSTA_ROTAS DE EVACUAÇÃO_SAMORA_MACHEL.jpg         | 30/09/2020 12:42 | Imagen JPEG | 2,898 KB |
|  05_MAPA_PROPOSTA_UBICAÇÃO_SINAIS_DE_EVACUAÇÃO_SAMORA_MACHEL.jpg | 24/09/2020 18:19 | Imagen JPEG | 3,557 KB |
|  06_MAPA_PROPOSTA_UBICAÇÃO_SINAIS_ZPI_SAMORA_MACHEL.jpg          | 24/09/2020 18:16 | Imagen JPEG | 3,632 KB |



01\_MAPA\_ORTOFOTO\_SAMORA\_MACHEL.jpg



02\_MAPA\_ZONA\_INUNDÁVEL\_SAMORA\_MACHEL.jpg



03\_MAPA\_DENSIDADE\_SAMORA\_MACHEL.jpg



04\_A\_MAPA\_PROPOSTA\_ROTAS DE EVACUAÇÃO\_S...



04\_B\_MAPA\_PROPOSTA\_ROTAS DE EVACUAÇÃO\_S...



04\_C\_MAPA\_PROPOSTA\_ROTAS DE EVACUAÇÃO\_S...



05\_MAPA\_PROPOSTA\_UBICAÇÃO\_SINAIS\_DE\_EVACUAÇÃO...



06\_MAPA\_PROPOSTA\_UBICAÇÃO\_SINAIS\_ZPI\_SAMORA...



# Results at Samora Machel

## 01 - Background map based on orthophotos

- ✓ Identify the most relevant infrastructures (churches, mosques, health centers, schools) and complete it with simple schematic symbols
- ✓ The location of houses, roads, bridges, graveyards, water wells was digitalised and used to evaluate the number of homes and people affected by a flood and to design safe evacuation routes

01\_MAPA\_ORTOFOTO\_SAMORA\_MACHEL.jpg



Mozambique Zambesia Mocuba - Comunidade de Samora Machel  
Ortofotos da comunidade de Samora Machel

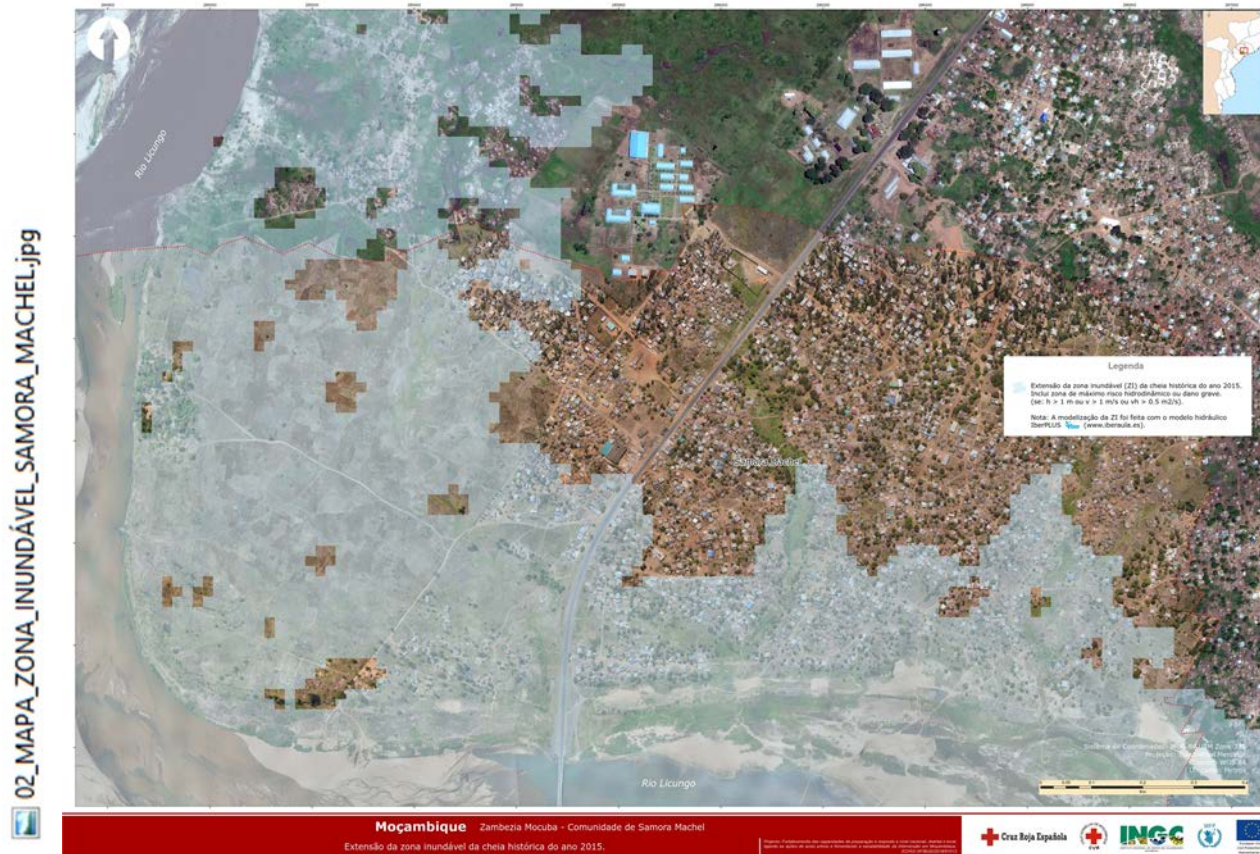


# Results at Samora Machel

## 02 - Map of the flood extension (January 2015)

The includes the area of maximum hydrodynamic risk or serious damage.  
(if:  $h > 1$  m or  $v > 1$  m/s or  $vh > 0.5$  m<sup>2</sup>/s).

Thematic community maps

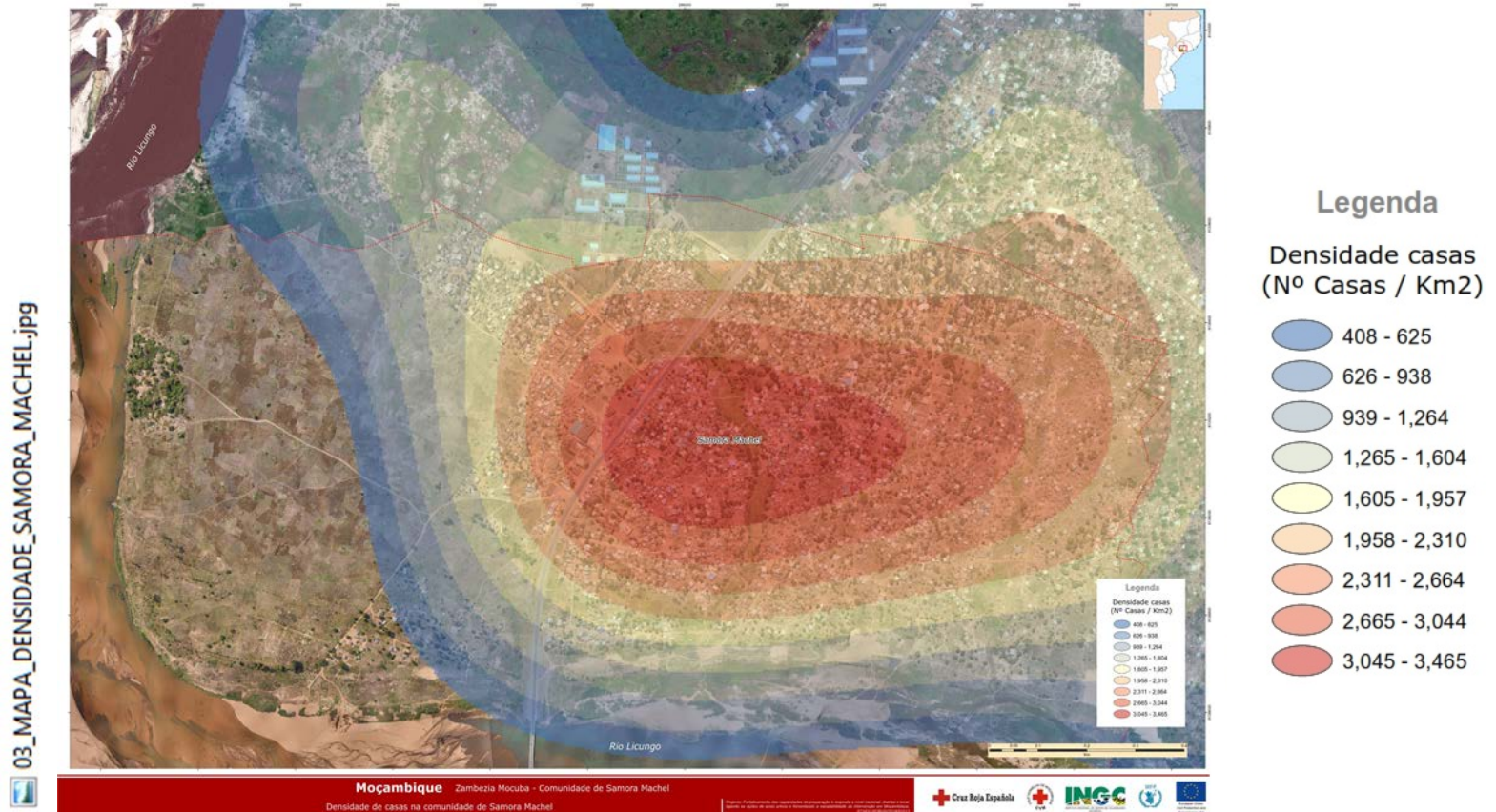




# Results at Samora Machel

## 03 - Map of density of houses (houses/km<sup>2</sup>)

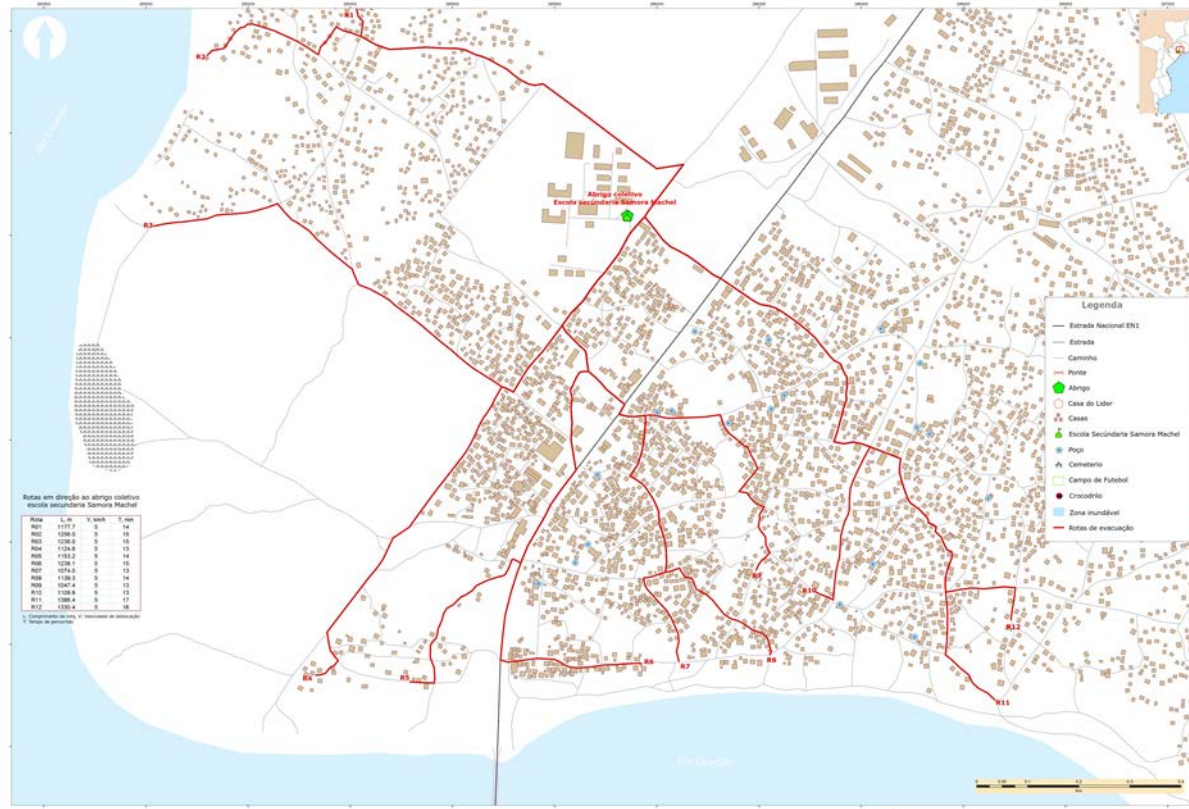
- ✓ Allows the identification of the areas with the highest concentration of population
- ✓ In general, the highest density of houses occurs in the safest zones, while the most exposed areas have a lower concentration of people



# Results at Samora Machel

## 04 - Map of the proposed evacuation routes

04\_B\_MAPA\_PROPOSTA\_ROTAS DE EVACUAÇÃO\_SAMORA\_MACHEL.jpg



Rotas em direção ao abrigo coletivo escola secundaria Samora Machel

| Rota | L, m   | V, km/h | T, min |
|------|--------|---------|--------|
| R01  | 1177.7 | 5       | 14     |
| R02  | 1256.0 | 5       | 15     |
| R03  | 1236.0 | 5       | 15     |
| R04  | 1124.6 | 5       | 13     |
| R05  | 1153.2 | 5       | 14     |
| R06  | 1238.1 | 5       | 15     |
| R07  | 1074.0 | 5       | 13     |
| R08  | 1139.3 | 5       | 14     |
| R09  | 1047.4 | 5       | 13     |
| R10  | 1109.8 | 5       | 13     |
| R11  | 1386.4 | 5       | 17     |
| R12  | 1330.4 | 5       | 16     |

L: Length of route,  
V: Average speed of a person's displacement  
T: Travel time

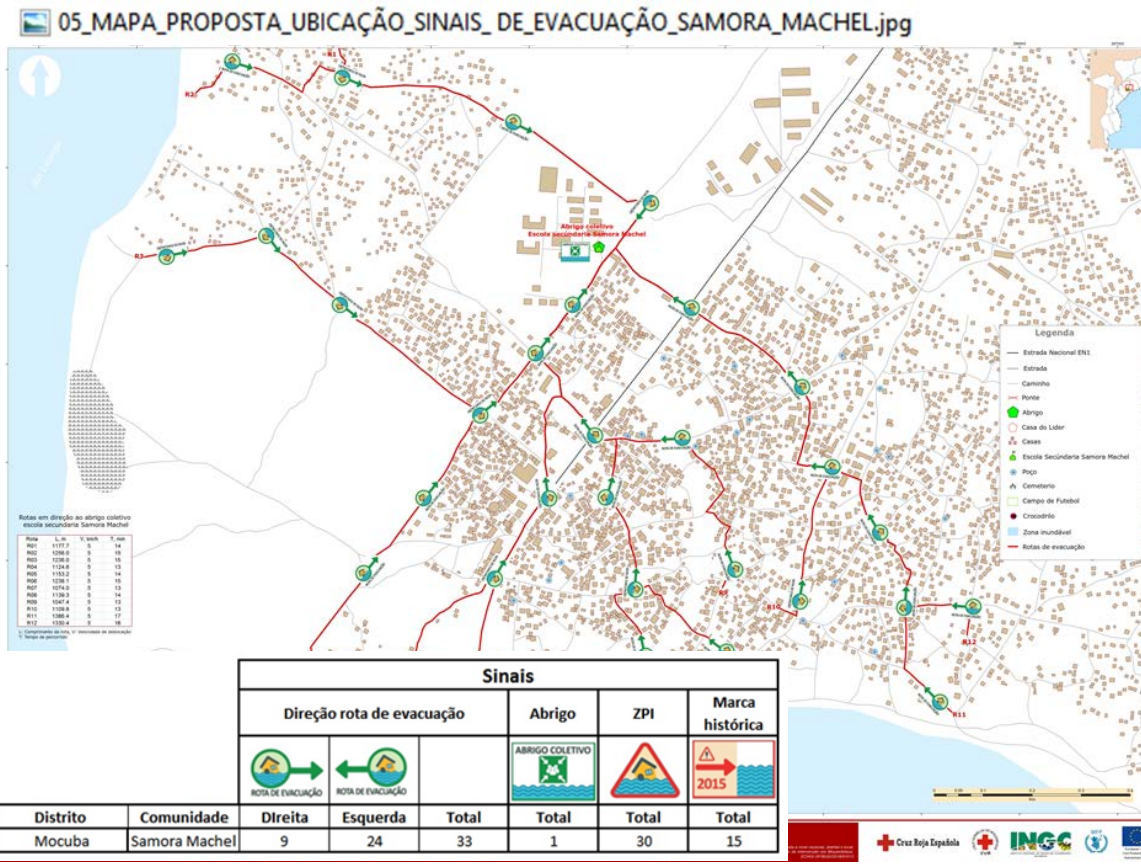
Thematic community maps



# Results at Samora Machel

## 05 - Map with the proposed location of the flood signs showing the evacuation routes and the collective shelters

- ✓ This is just a proposal to help the technicians to find the most appropriate location

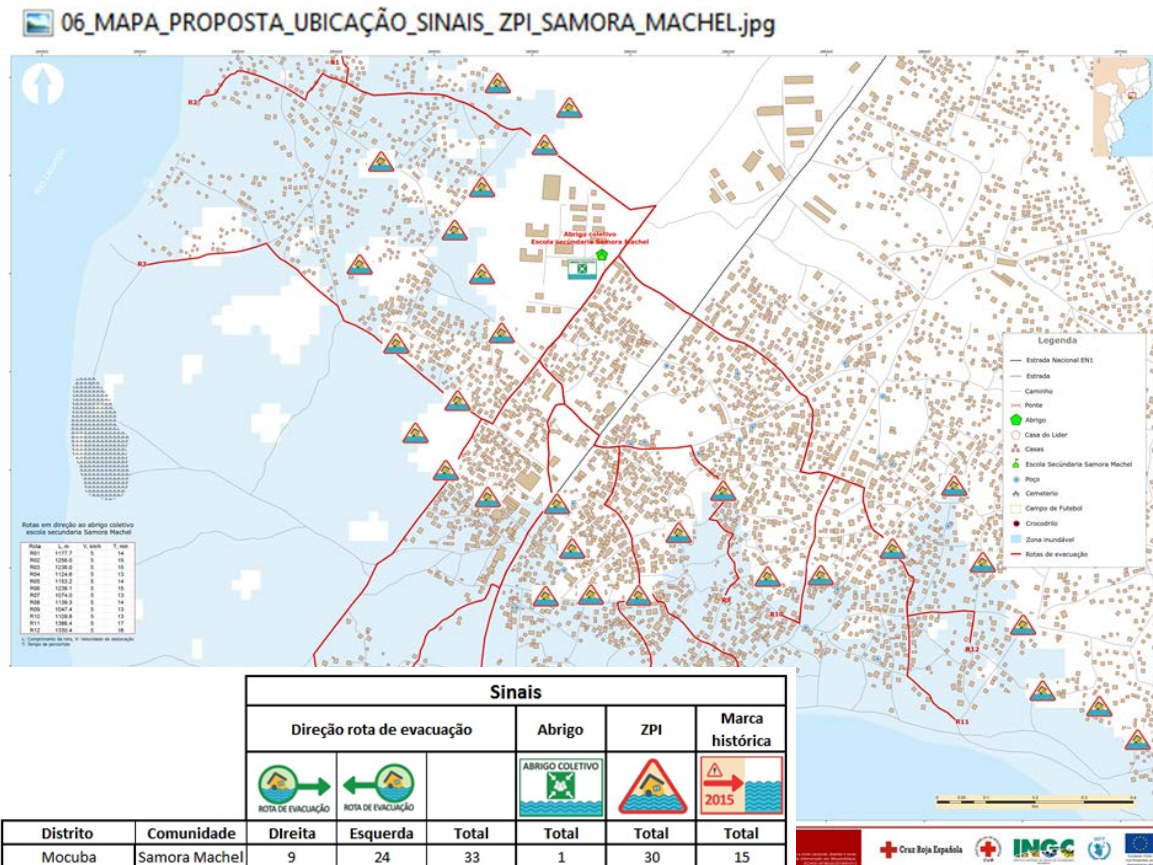


# Results at Samora Machel

## 06 - Map with the proposed location of the flood signs to delimitate the flood risk areas

- ✓ We propose to locate these flood signs in the limits of the flood risk area

Thematic community maps





# Proposed flood signs

Collective shelter



Flood hazard area



2015 flood level



Evacuation routes



# Risk Maps training with CLGRC technicians

At the beginning of October 2020 the technicians of the CLGRC of the 10 communities concerned by this project were trained, with a series of online meetings



In the coming weeks, the technicians will be working within the communities on the location and placement of the flood signs



Despite COVID-19, we will continue to work on flood risk management in the vulnerable communities of the Licungo River basin.

Let's be optimistic !

