Participatory Community Mapping Hazards & Vulnerability

Methodology

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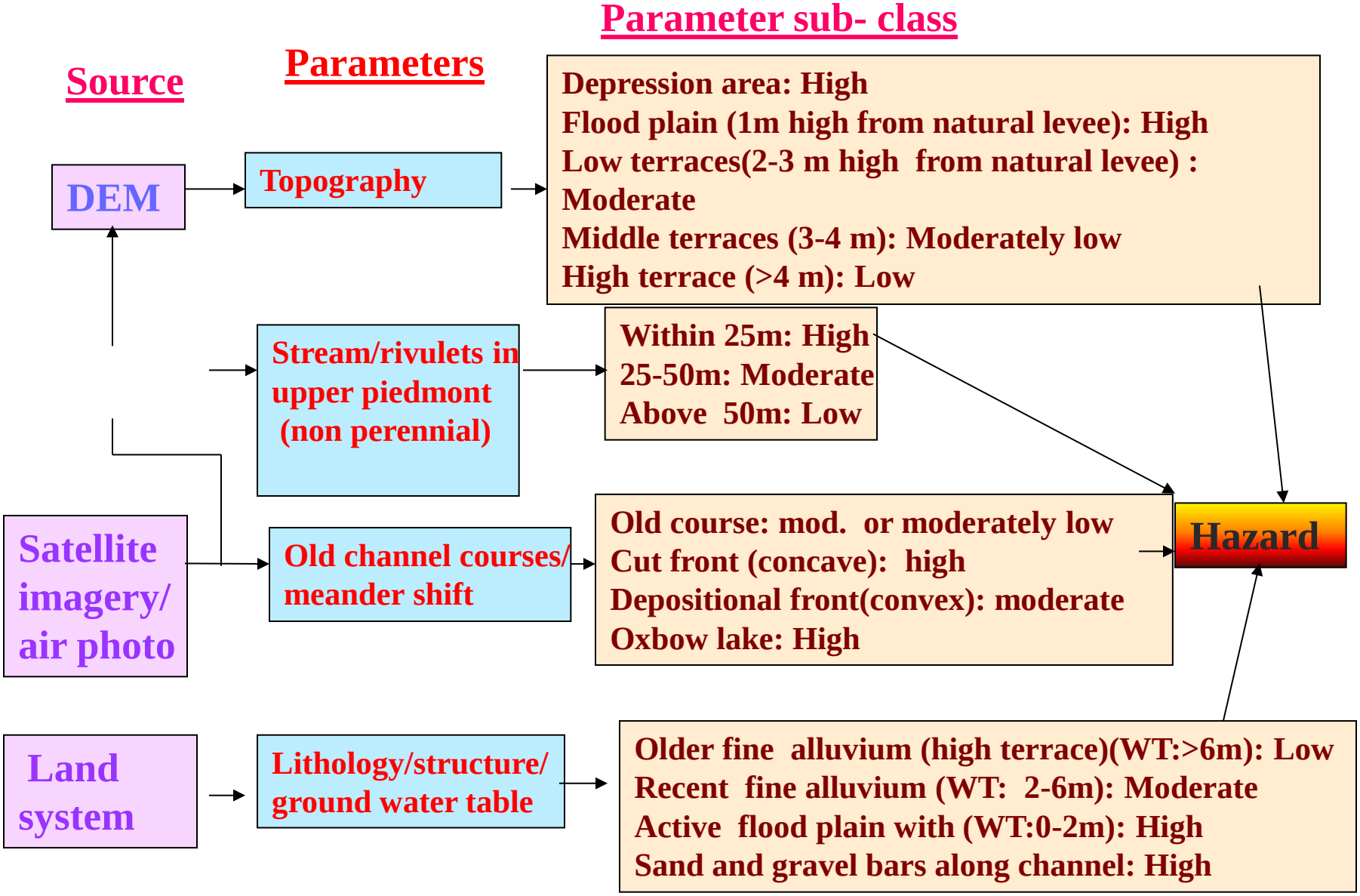
Methodological strategies and approaches in Mapping Flood Hazard

- **Geomorphological approach using time series topographical maps, air photographs, satellite images with intensive field verification**

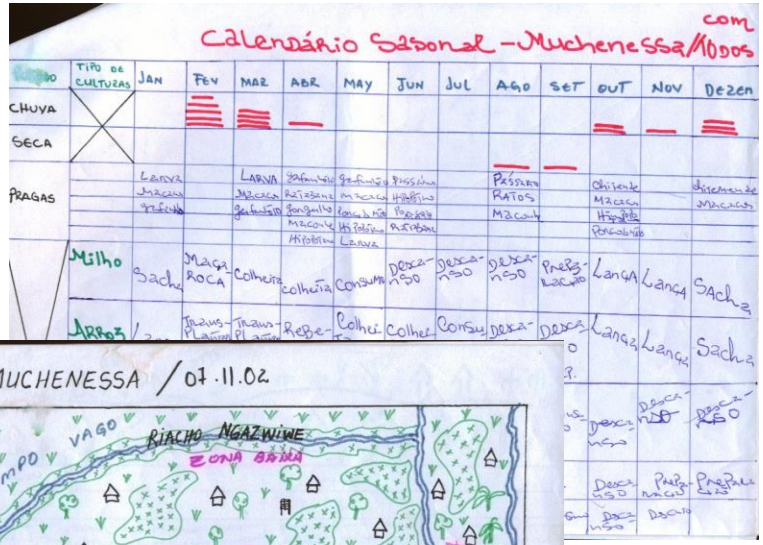
- **Community flood hazard mapping involving local communities based on their experiences**

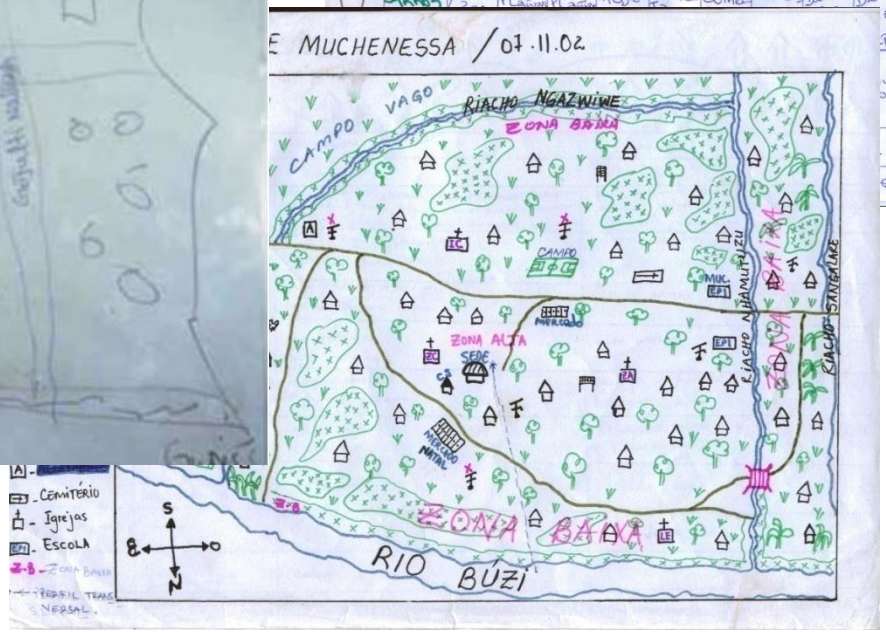

Source
Parameters
Parameter sub- class
DEM
Topography
Depression area: High
Flood plain (1m high from natural levee): High
Low terraces(2-3 m high from natural levee) : Moderate
Middle terraces (3-4 m): Moderately low
High terrace (>4 m): Low
Stream/rivulets in upper piedmont (non perennial)
Within 25m: High
25-50m: Moderate
Above 50m: Low
Satellite imagery/ air photo
Old channel courses/ meander shift
Old course: mod. or moderately low
Cut front (concave): high
Depositional front(convex): moderate
Oxbow lake: High
Hazard
Land system
Lithology/structure/ ground water table
Older fine alluvium (high terrace)(WT:>6m): Low
Recent fine alluvium (WT: 2-6m): Moderate
Active flood plain with (WT:0-2m): High
Sand and gravel bars along channel: High

Vulnerability/Hazard mapping at the community level

- **Get an understanding of vulnerabilities to hazards in villages**
- **Facilitate and enhance the process of vulnerability reduction at the community level**
  - Integration of PRA practices
- **Provide maps for enhanced decision making**
- **Identify indicators for the specific area of interest to allow further investigation about the spatial characteristic of vulnerability**
- **Helps to identify resources in the community**

PRA
Community Mapping



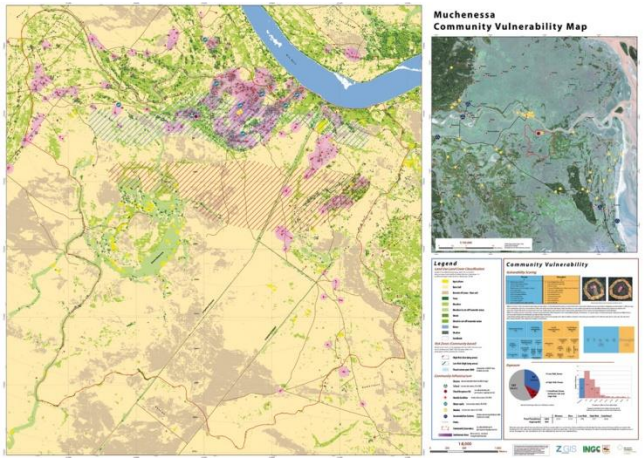


Results

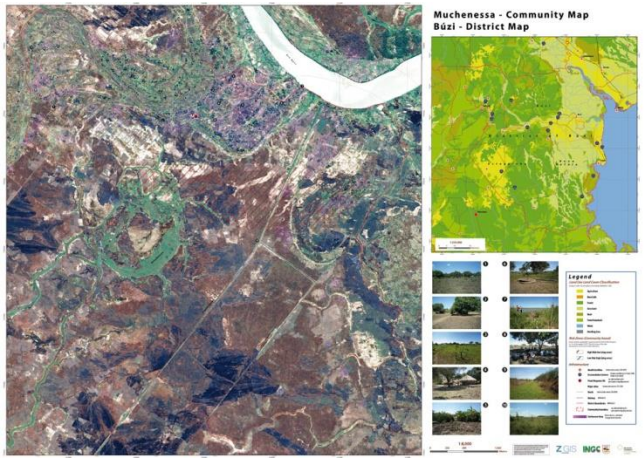
Manual


India
(2 communities)
Bangladesh
(1 community)
Malawi
(2 communities)
Madagascar
(1 community)
Mozambique
(4 communities)
Training Activities

Community Maps
2 maps per community



Vulnerability Map

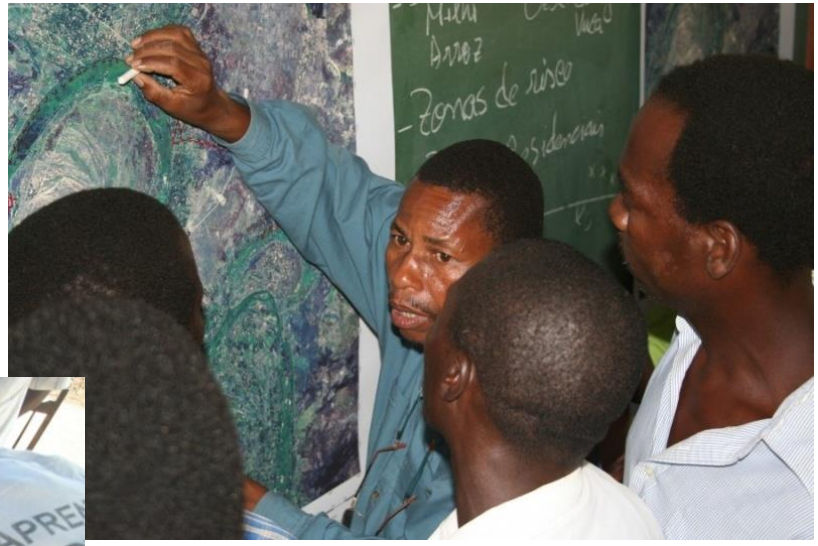


Satellite Map & District Map

Methods

- **Participatory Mapping Exercises**

- **Vunerability identification and weighting (scoring)**



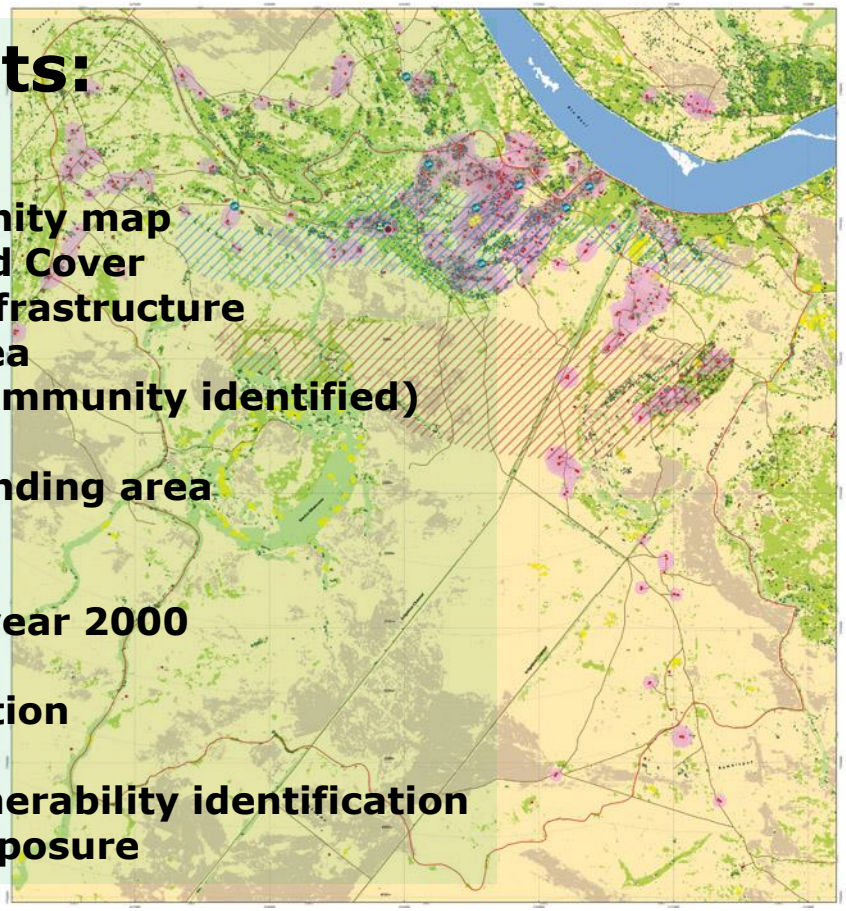
Vulnerability Map

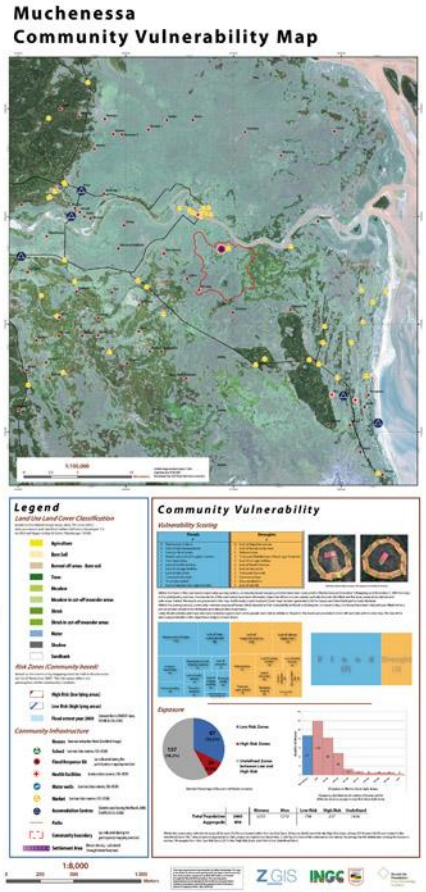
Map elements:

- Main map: Community map
  - Land Use/Land Cover
  - Community Infrastructure
  - Settlement area
  - Risk Zones (community identified)

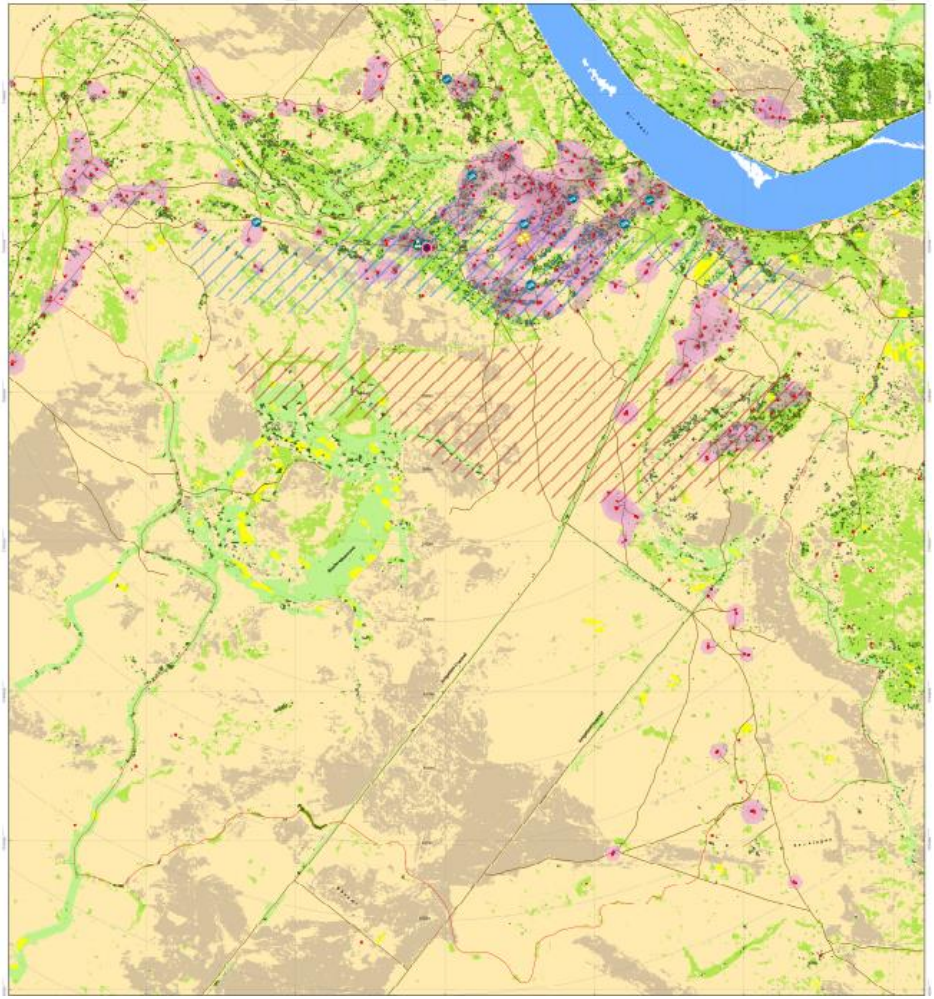
- Small map: Surrounding area
  - Satellite Map
  - Infrastructure
  - Flood extend year 2000

- Additional information
  - Legend
  - Results of vulnerability identification
  - Analysis on exposure





Vulnerability Map
Community map: elements



Land Use Land Cover Classification

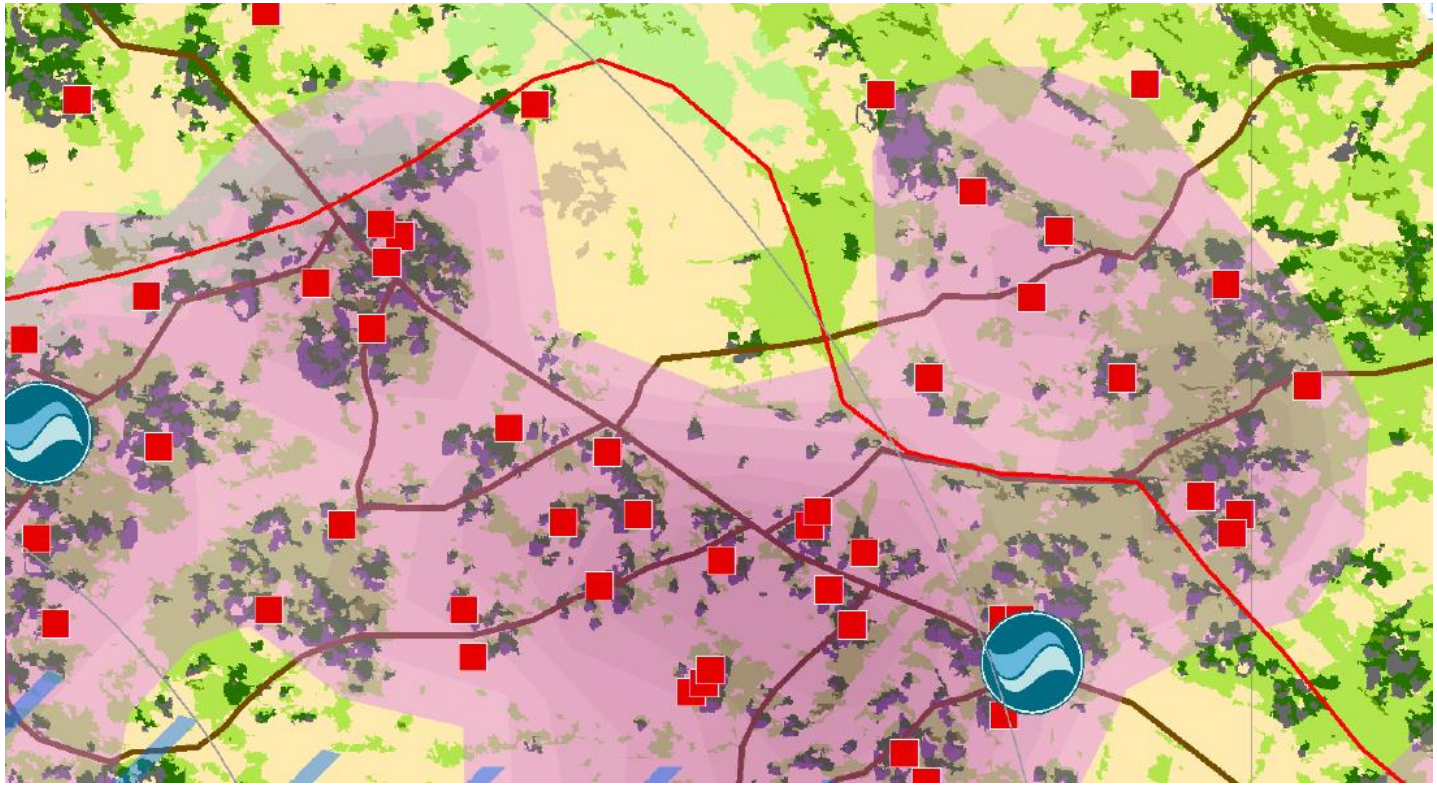
based on Quickbird Image (acqu. date 7th June 2005);
data processed and classified within Definiens Developer 7.0
by Michael Hagenlocher & Stefan Kienberger (2008)

- Agriculture
- Bare Soil
- Burned off areas - Bare soil
- Trees
- Meadow
- Meadow in cut-off meander areas
- Shrub
- Shrub in cut-off meander areas
- Water
- Shadow
- Sandbank

Vulnerability Map
Community map: elements

Houses (manual extraction from Quickbird image)

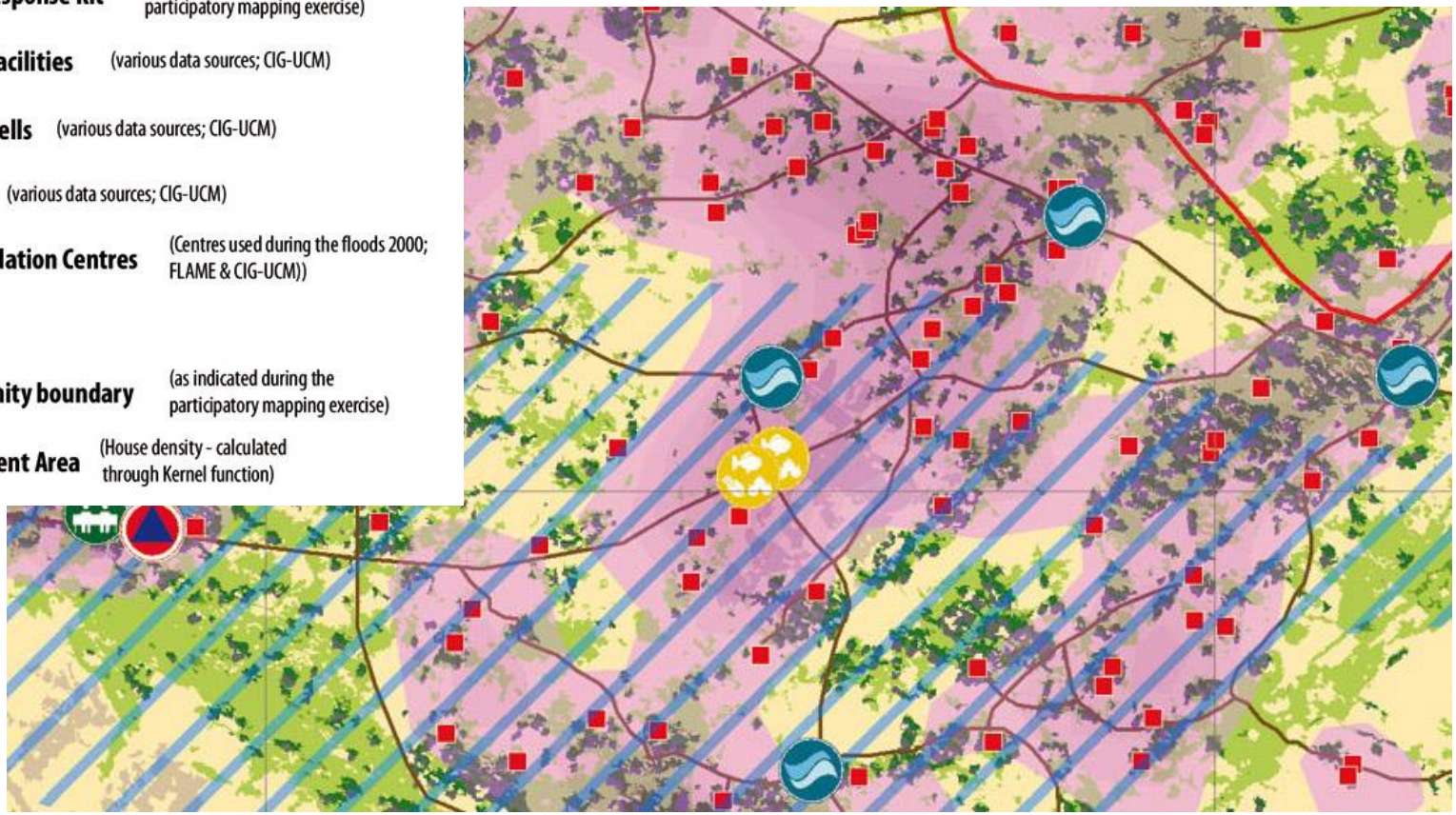
3 4 5 6 7 8 9 **Settlement Area** (House density - calculated through Kernel function)



Vulnerability Map
Community map: elements

Community Infrastructure

- **Houses** (manual extraction from Quickbird image)
- **School** (various data sources; CIG-UCM)
- **Flood Response Kit** (as indicated during the participatory mapping exercise)
- **Health facilities** (various data sources; CIG-UCM)
- **Water wells** (various data sources; CIG-UCM)
- **Market** (various data sources; CIG-UCM)
- **Accomodation Centres** (Centres used during the floods 2000; FLAME & CIG-UCM))
- **Paths**
- **Community boundary** (as indicated during the participatory mapping exercise)
- 2 3 4 5 6 7 8 9 **Settlement Area** (House density - calculated through Kernel function)



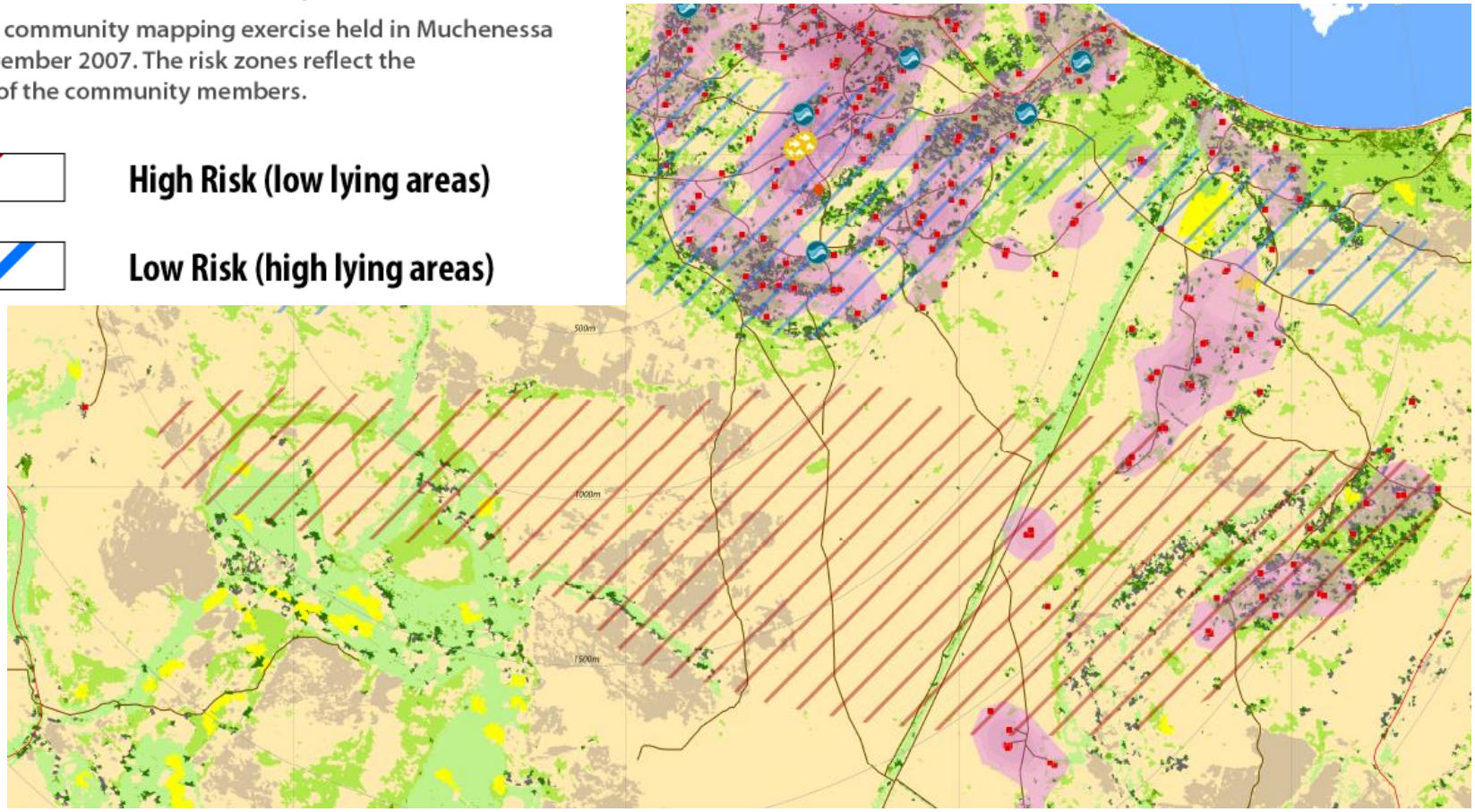
Vulnerability Map – Community map: elements

Risk Zones (Community based)

based on the community mapping exercise held in Muchenessa on 1st of November 2007. The risk zones reflect the pereception of the community members.

High Risk (low lying areas)

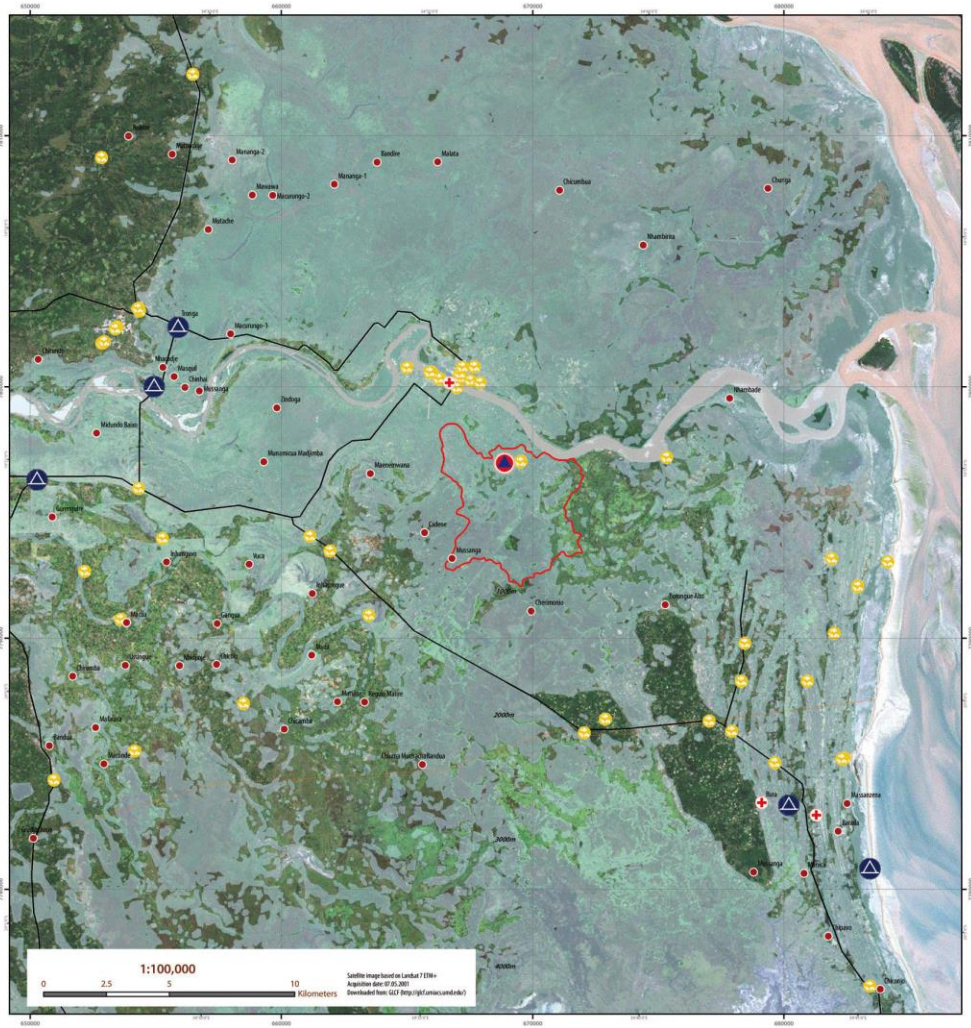
Low Risk (high lying areas)



Vulnerability Map – Surrounding area: map elements

Small map: Surrounding area

- **Community location**
- **Previous flood extend**
- **Health facilities**
- **Markets**
- **Streets**
- **Major villages**



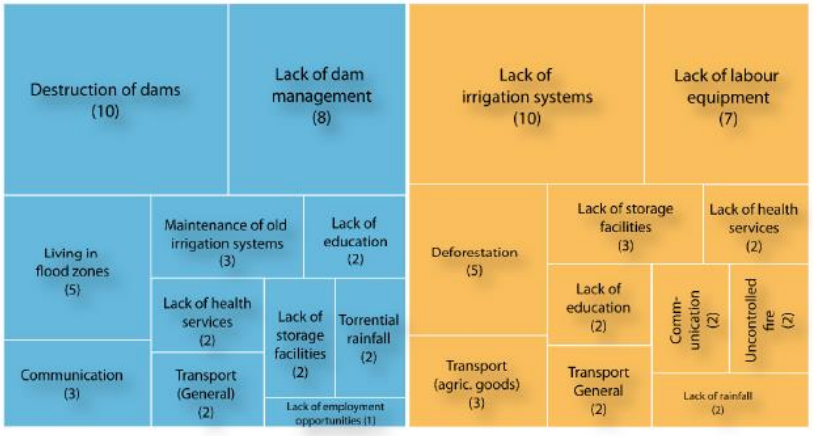
Vulnerability Map
Vulnerability identification

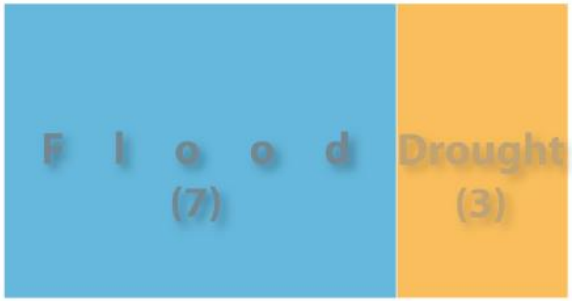
Vulnerability Scoring

Floods		Droughts	
7		3	
10	Destruction of dams	10	Lack of irrigation system
8	Lack of dam management	7	Lack of labour equipment
5	Living in flood zones	5	Deforestation
3	Maintenance of old irrigation system	3	Transport (Distribution of food; agri. Products)
3	Communication	3	Lack of storage facilities
2	Lack of Health Services	2	Lack of Health Services
2	Lack of storage facilities	2	Lack of education
2	Lack of education	2	Transport (General)
2	Transport (General)	2	Communication
2	Torrential rainfall	2	Uncontrolled fire
1	Lack of employment opportunities	2	Lack of rainfall

Distribution of points/weights according to their importance perceived by the community

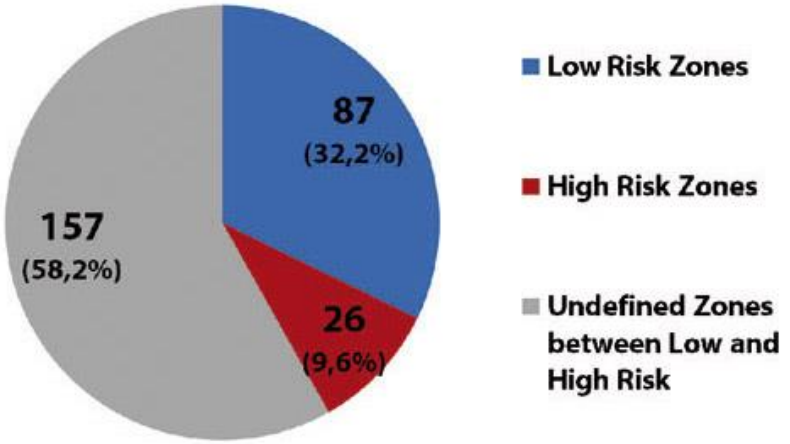
Within the frame of the community based early warning system, community based mapping activities have been conducted in Muchenessa on November 1 (Mapping) and November 2, 2007 (Scoring). In the participatory exercise, the boundaries of the community have been delineated, important infrastructures named, agricultural zones identified and the areas prone to inundation and safer areas marked. The results are presented in the map. Additionally a Land Use/Land Cover map has been generated and the houses and identifiable paths/roads digitized.
Within the scoring exercise, community members expressed factors which determine their vulnerability to floods and droughts. In a second step, the factors have been weigted/quantified within a pre-set amount of points (n=40; beans) according to their importance.
Lastly, floods and droughts have also been evaluated against each other; people were able to distribute 10 points. The results are presented on the left hand side within a tree map. The size of the area is proportionally to the importance (weight) of each factor.



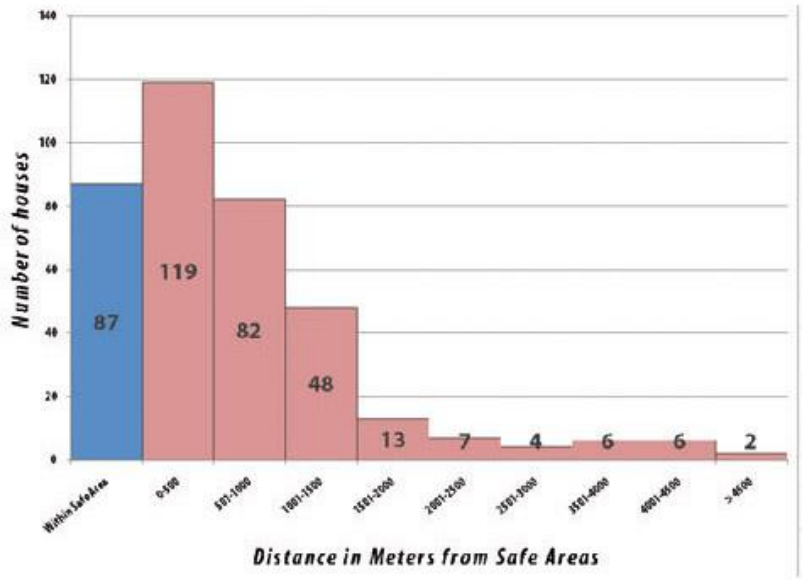


Vulnerability Map
Exposure Analysis

Exposure



Number/Percentage of houses in different risk zones

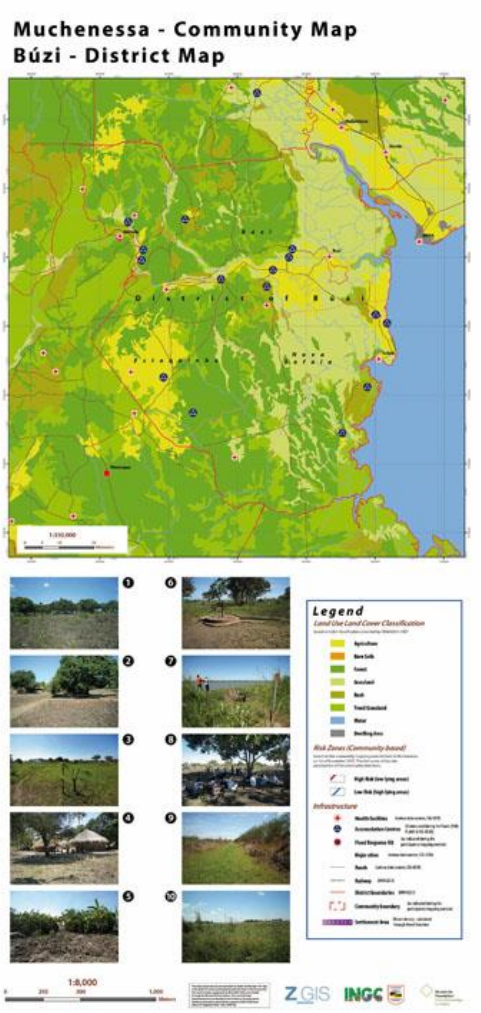


Frequency distribution of number of houses within different distance ranges to Low Risk Zone (Safe Area)

		Women	Men	Low Risk	High Risk	Undefined
Total Population	2465	*1255*	*1210*	*794*	*237*	*1434*
Aggregado	494					

Within the community defined risk zones, 87 houses (32,2%) are located within the Low Risk Zone. 26 houses (9,6%) are wihin the High Risk Zone, wheras 157 houses (58,2%) are located in the Undefined Zone'. The total amount of population is 2465 people (as reported on November, 2 2007 by the head of the community (see table)). Assuming that the distribution among the houses is normal, 794 people live in the 'Low Risk Zone', 237 in the 'High Risk Zone' and 1434 in the 'Undefined Zone'.

Satellite Map



Satellite Map
Community map: elements

Risk Zones (Community based)

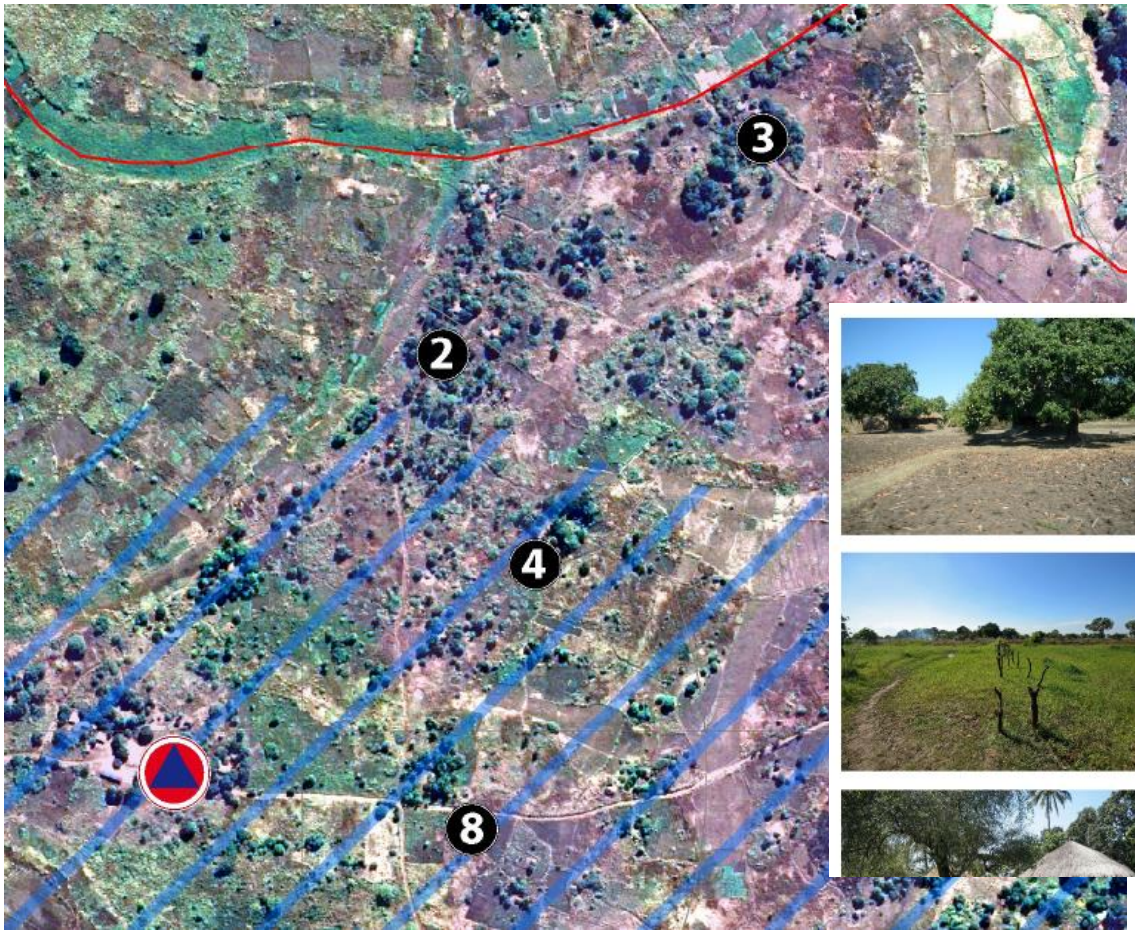
based on the community mapping exercise held in Muchenessa on 1st of November 2007. The risk zones reflect the pereception of the community members.

- High Risk (low lying areas)
- Low Risk (high lying areas)

Infrastructure

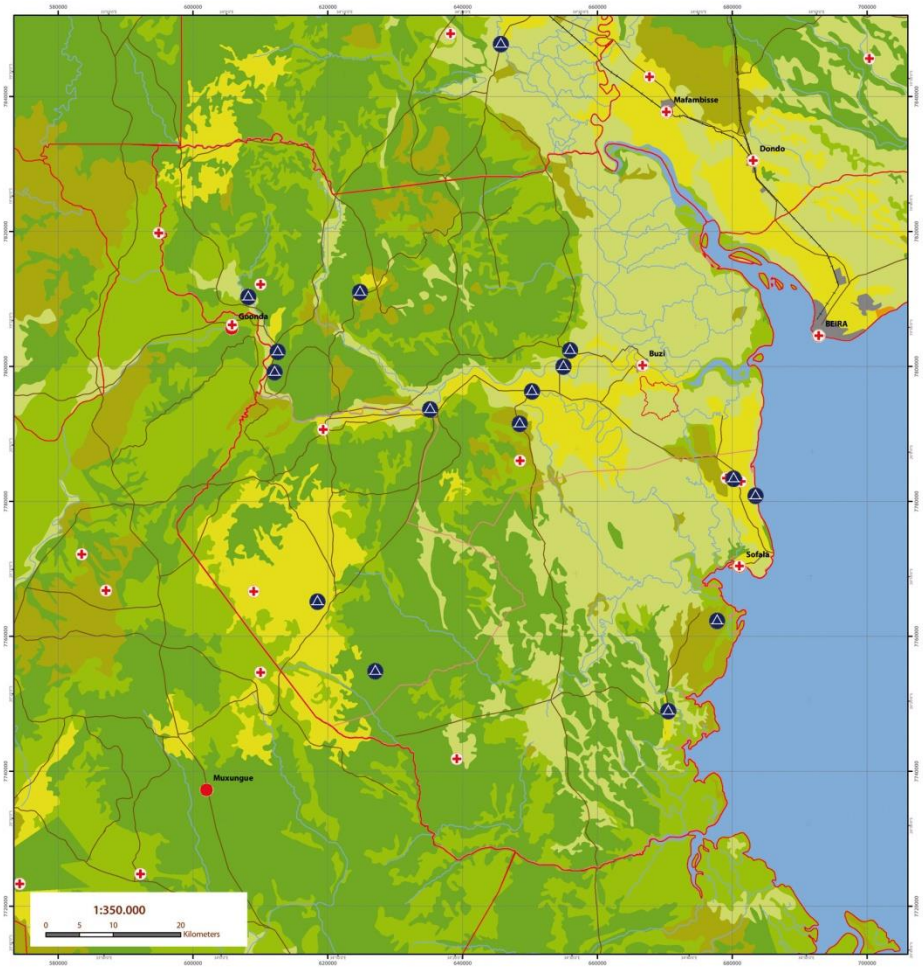
- Health facilities (various data sources; CIG-UCM)
- Major cities (various data sources; CIG-UCM)
- Roads (various data sources; CIG-UCM)
- Railway (DINAGECA)
- District boundaries (DINAGECA)
- Community boundary (as indicated during the participatory mapping exercise)
- 3 4 5 6 7 8 9 Settlement Area (House density - calculated through Kernel function)

Satellite Map
Community map: elements



Georeferenced photos of characteristic community spots

Satellite Map
District Map



Legend

Land Use Land Cover Classification

based on LULC classification provided by DINAGECA 1997

- Agriculture
- Bare Soils
- Forest
- Grassland
- Bush
- Treed Grassland
- Water
- Dwelling Area

Infrastructure

- Accomodation Centres (Centres used during the floods 2000; FLAME & CIG-UCM))
- Flood Response Kit (as indicated during the participatory mapping exercise)
- Health facilities (various data sources; CIG-UCM)
- Major cities (various data sources; CIG-UCM)
- Roads (various data sources; CIG-UCM)
- Railway (DINAGECA)
- District boundaries (DINAGECA)
- Community boundary (as indicated during the participatory mapping exercise)
- Settlement Area (House density - calculated through Kernel function)

Methodology

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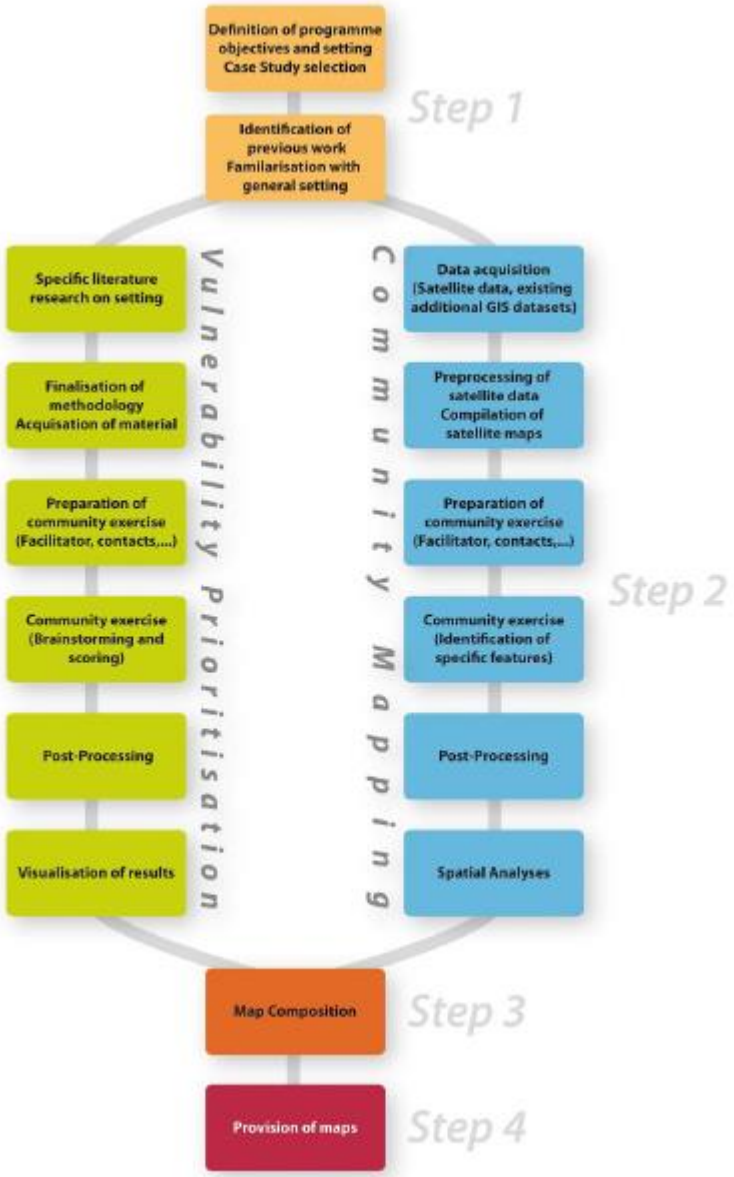
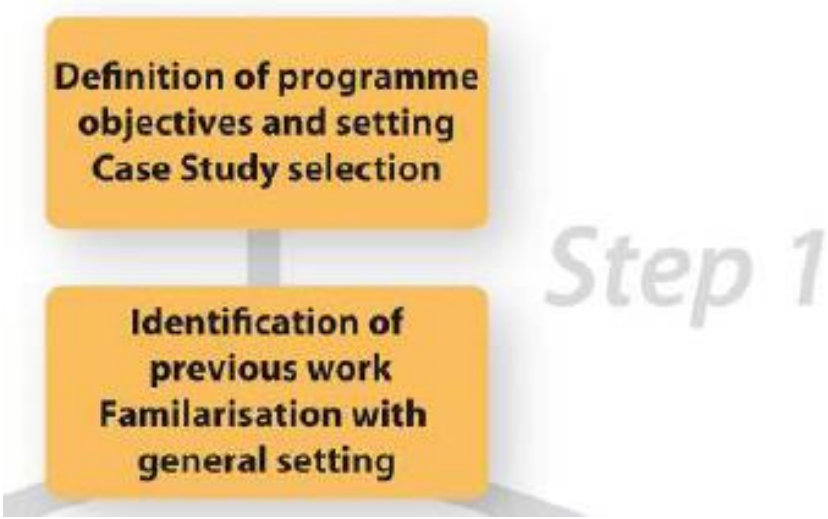
Workflow


Definition of programme objectives and setting Case Study selection
Step 1
Identification of previous work Familarisation with general setting
Specific literature research on setting
Finalisation of methodology Acquisation of material
Preparation of community exercise (Facilitator, contacts,...)
Community exercise (Brainstorming and scoring)
Post-Processing
Visualisation of results
Vulnerability Prioritisation
Community Mapping
Data acquisition (Satellite data, existing additional GIS datasets)
Preprocessing of satellite data Compilation of satellite maps
Preparation of community exercise (Facilitator, contacts,...)
Community exercise (Identification of specific features)
Post-Processing
Spatial Analyses
Step 2
Map Composition
Step 3
Provision of maps
Step 4

Step 1: Setting the project agenda and project design



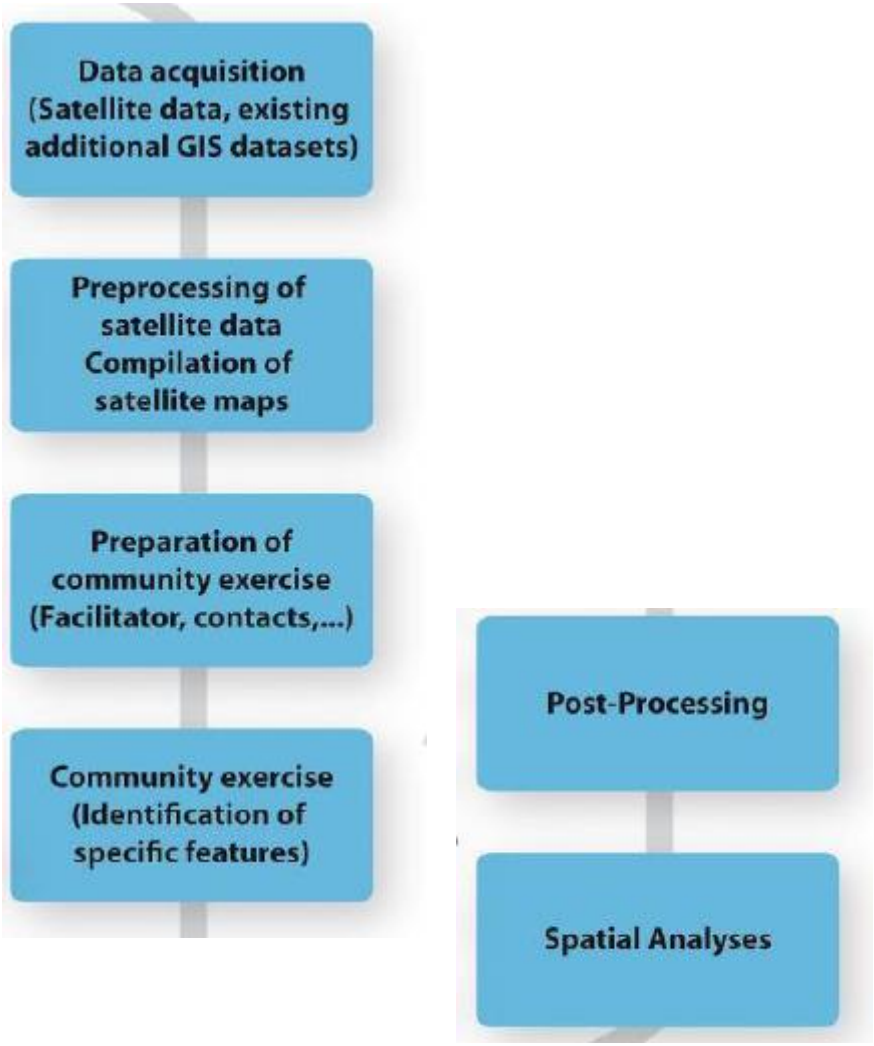
Step 1: Setting the project agenda and project design

- **Integrated in an overall disaster risk reduction strategy with a long-term perspective**
- **Maps have to be accepted as an appropriate decision support tool**
- **Requires specialised technical training and managerial support**
- **Level of community participation maximised**
- **Definition of the case study area has to be a transparent**

Step 1: Setting the project agenda and project design

- **Identify previous work in disaster risk management**
- **Adapt the project design accordingly to the experience of community members**
- **Familiarise yourself with the general setting**

Step 2: Community Mapping



Step 2: Data acquisition

- **Data through various sources**
- **High resolution satellite imagery or aerial photographs or UAV data (validation in accuracy)**
- **Identification of gaps and new data has to be acquired**
- **Use of Virtual Globes (e.g. Google Earth) and OSM data of help**

Step 2: Preprocessing

- **Check georeferencing**
- **Composition of a satellite map**
  - RGB combination
  - Scale, reference grid
  - acquisition date of the image, the reference system and the cartographer
  - additional space (for notes and the legend)
- **Plotting of 2 A0 maps**
- **If required, additional plots of special interest areas**

(Blank) Satellite map prepared for community exercise

High resolution satellite image (e.g. Quickbird)

Reference grid

Space for notes and legend

Scale bar and number

Additional information (e.g. data source etc.)

Step 2

Step 2: Preparation of exercise

- **Identification of stakeholders/key informants**
- **Identification of local facilitator and translator**
- **Establish contact to the community and identify a date and time**
- **Contact to and permission of officials**
- **Introduce facilitator into the method**

Step 2: Community Mapping

- **Welcome and introduction**
- **Decide on a place to conduct the exercise**
- **Prepare and affix the two maps**
- **Instructions should be given by the facilitator**
- **Establishment of a good rapport between facilitator and community members**

Step 2: Community Mapping

Step 2: Community Mapping

- **Community members should orientate themselves**
- **Identify and mark the required features:**
  - Community boundary
  - Neighbouring communities
  - Risk Zones (Community members need to identify on the basis of experiences on earlier floods)
  - Agricultural Zones
  - Special infrastructure of the community
  - Settlement areas
  - Naming of areas and natural features

Step 2: Community Mapping

Step 2: Community Mapping

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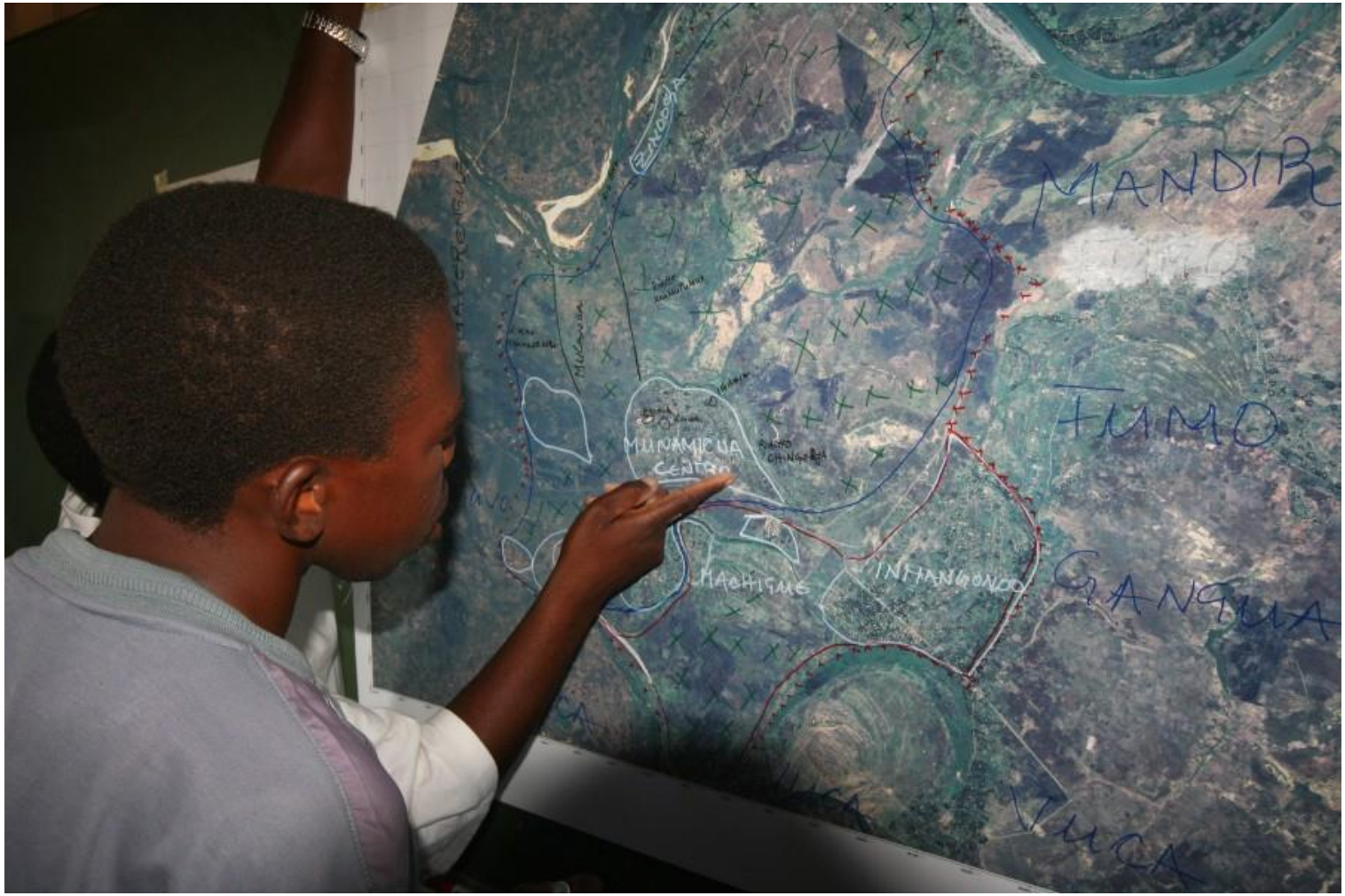
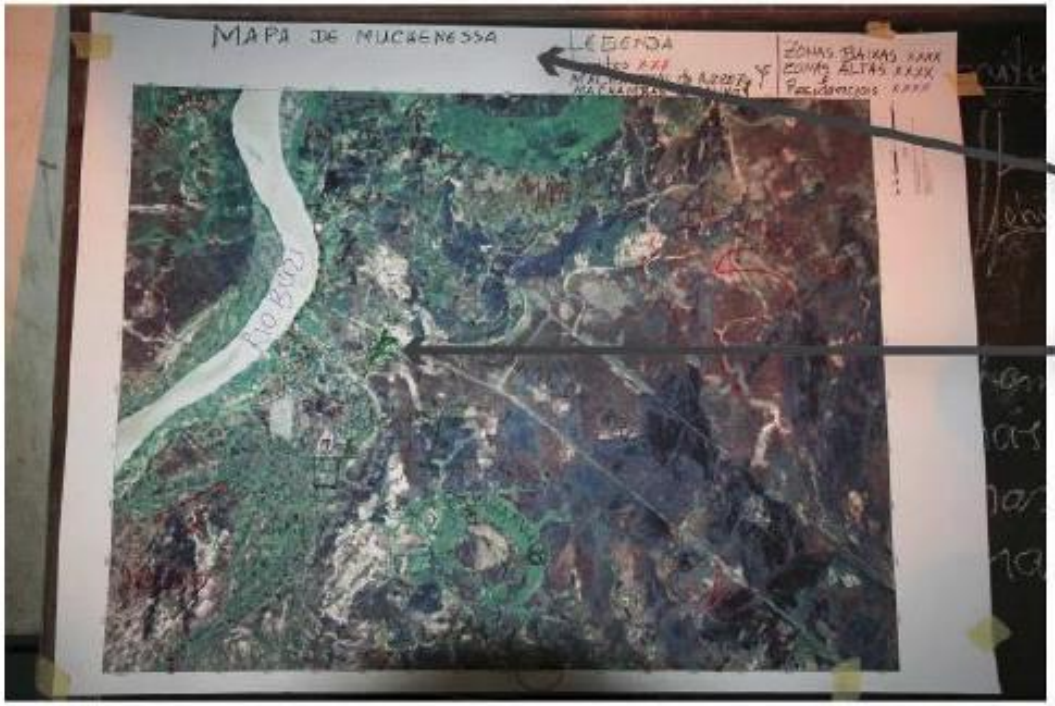
Step 2: Community Mapping



Step 2: Community Mapping



Satellite map after the community exercise

Legend, map name and date

Identified features marked on the map

Note: The map was turned around by the participants into the 'real' location

Step 2

Step 2: Community Mapping

- **Ask if the map is complete**
- **Some of the community members should be asked to transfer the results to the second map**
- **Facilitator and the implementer should conclude the exercise with a short summary on what has been achieved**
- **OPTIONAL STEP: GPS survey) with georeferenced photos)**

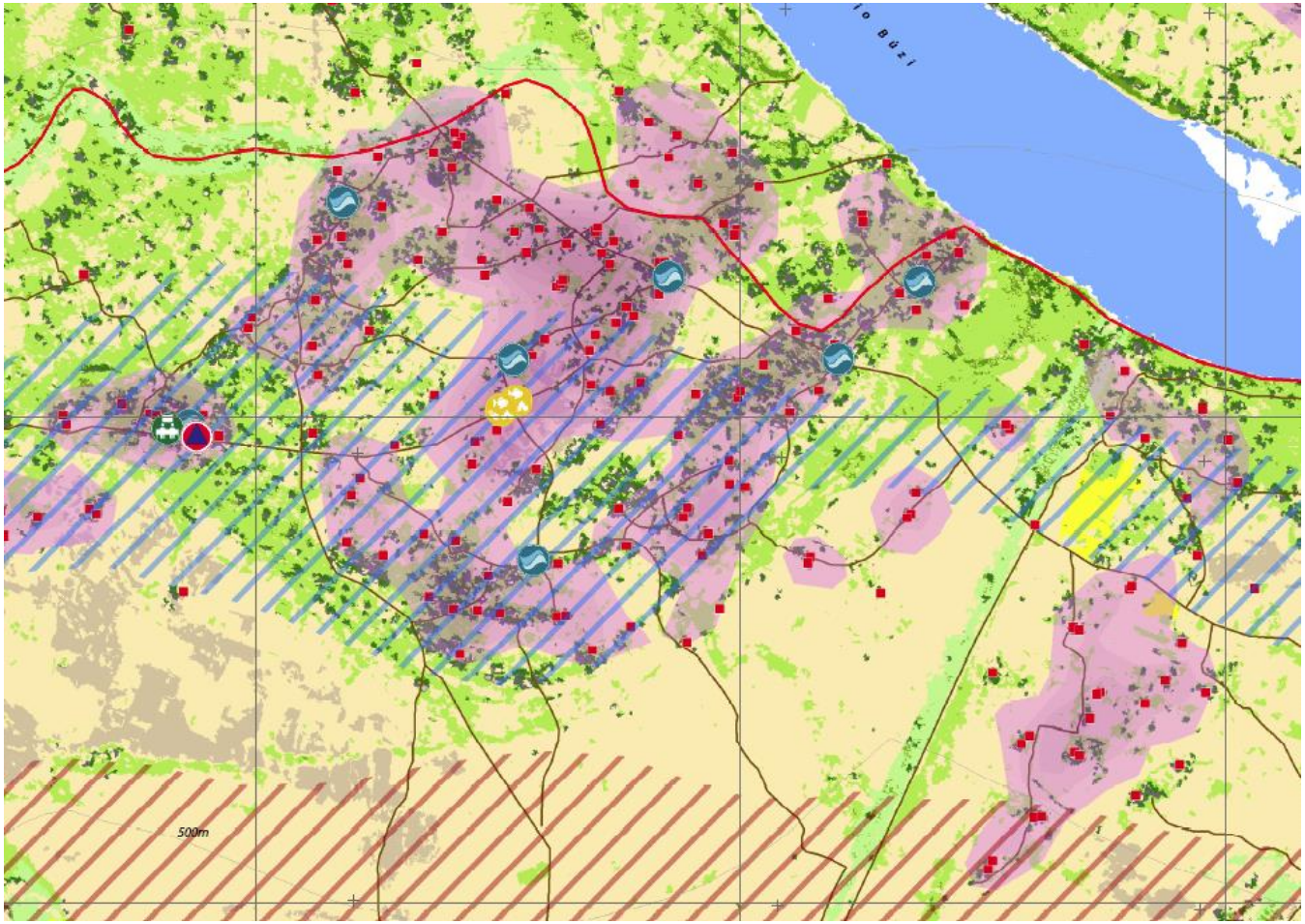
Step 2: Post-Processing

- **Identified features of the community have to be integrated (digitised) in a GIS environment**
- **Evaluate correctness**
- **Acquire additional data if necessary and possible**
- **Georeferencing of photos**

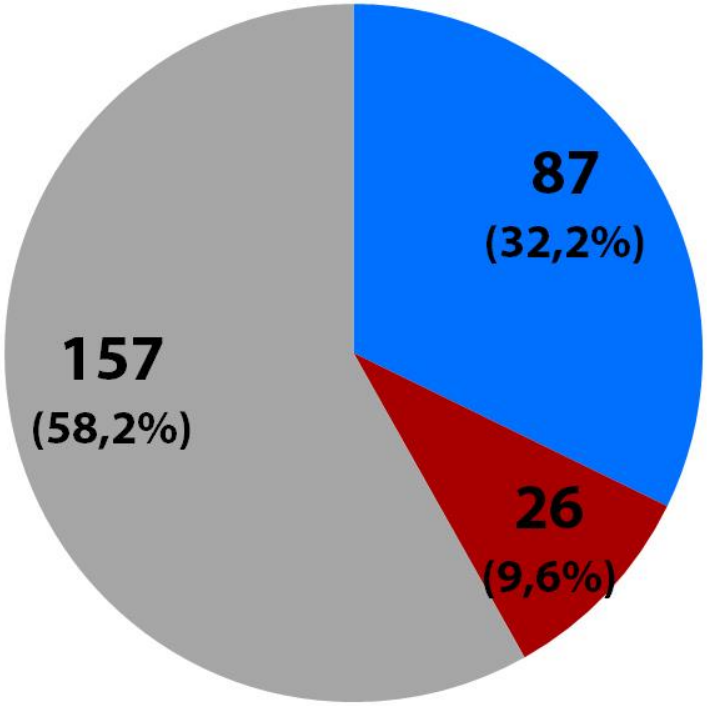
Step 2: Spatial analysis

- **Distance analysis**
- **Spatial queries**
- **Buffer zones**
- **Density analysis**
- **Land Use/Land Cover classification**

Step 2: Community Mapping



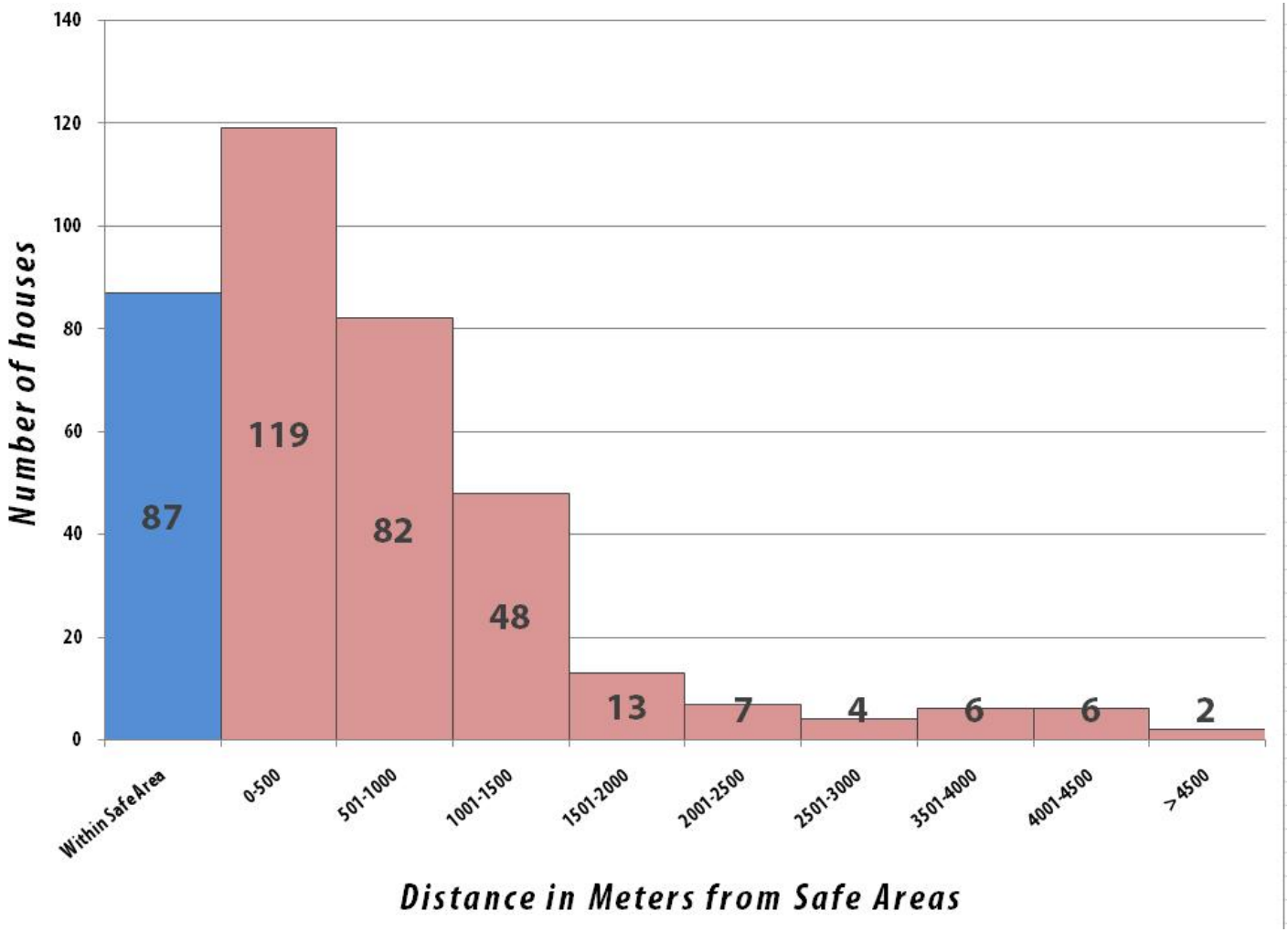
Step 2: Community Mapping



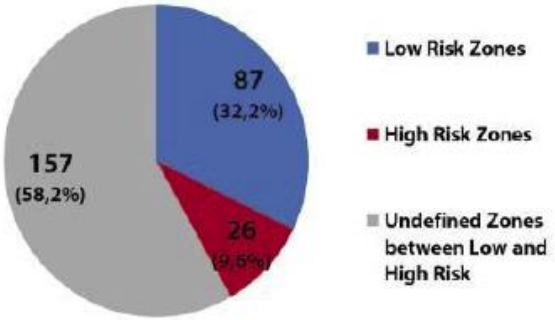
- Low Risk Zones
- High Risk Zones
- Undefined Zones between Low and High Risk

		Women	Men	Low Risk	High Risk	Undefined
Total Population	2465	*1255*	*1210*	*794*	*237*	*1434*
Aggregado	494					

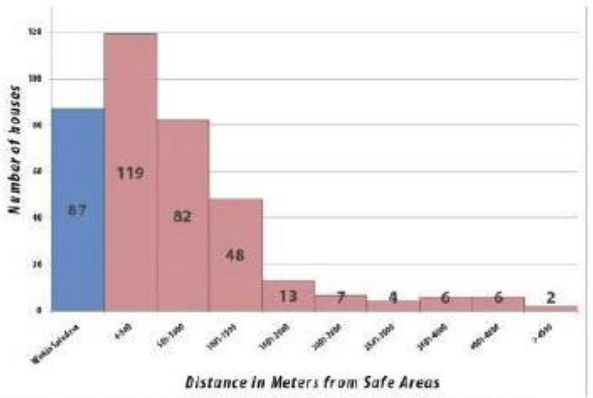
Step 2: Community Mapping



Step 2: Community Mapping

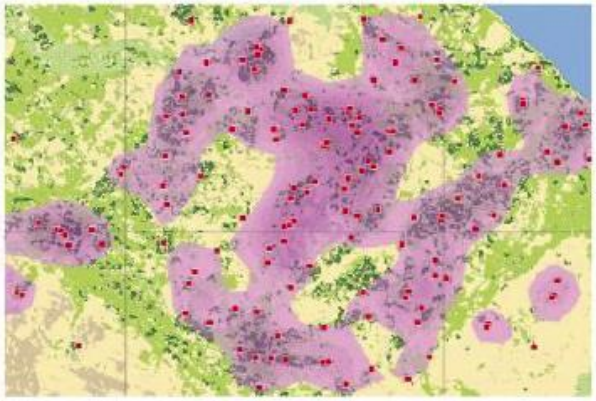


Percentage and number of houses within different risk zones

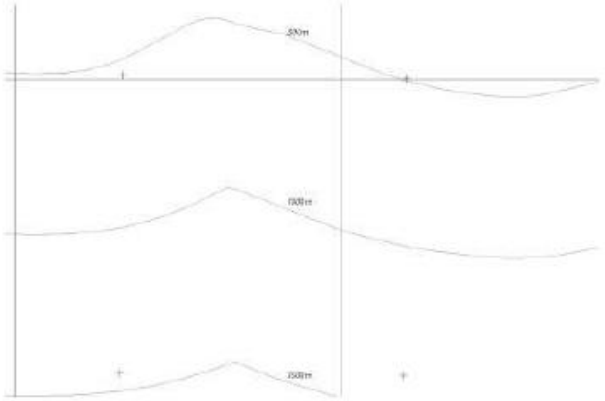


Histogram of houses within different distance ranges to safe areas

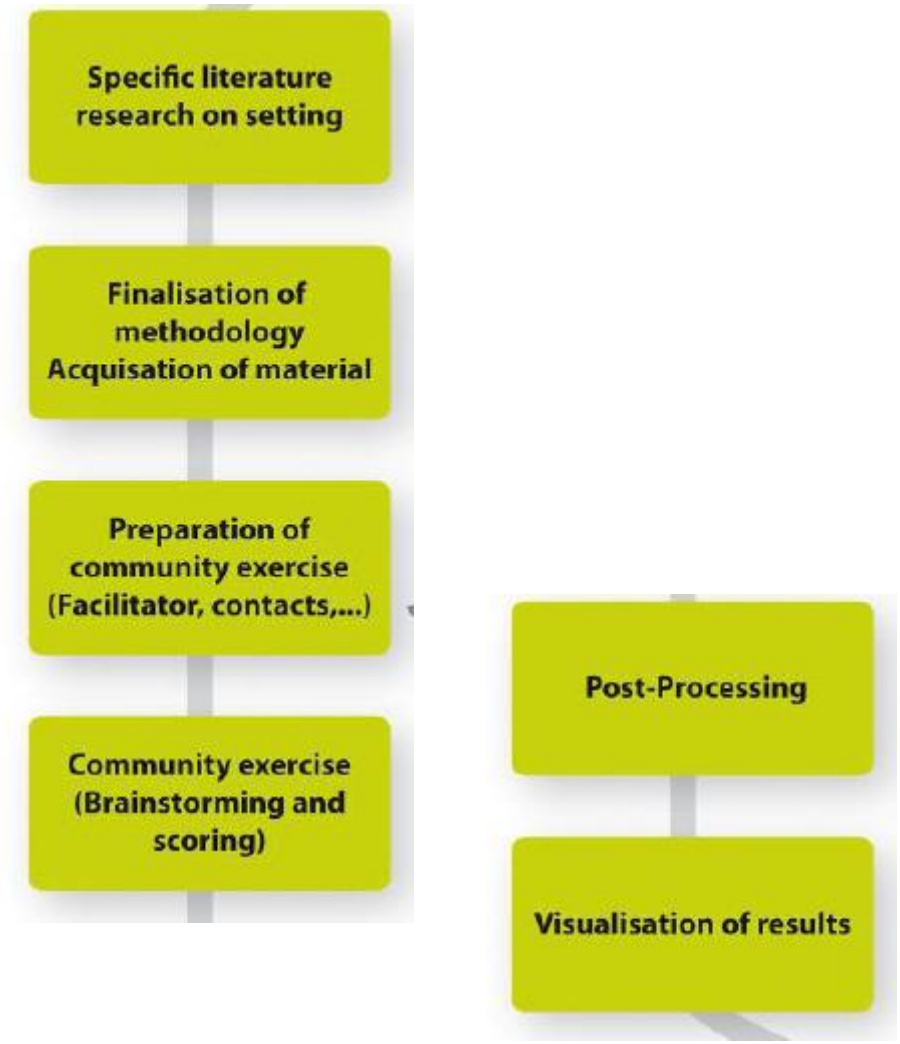
Settlement density and Land Use/Land Cover Mapping



Buffer zones showing distance to safe areas



Step 2: Community based vulnerability prioritisation



Step 2: Literature research and setting

- **Get an understanding of the specific case study**
- **Get an understanding of the concept of vulnerability and find a specific definition which suits the project context**
- **Identify the most important hazards**
  - **Which perceptions apply?**

Step 2: Finalisation of methodology and material

- **Apply a methodology which is suitable and fits the objectives of the aim of the project**
- **In this case the method of brainstorming and scoring has been applied. The method links to the approach of a Delphi exercise**
- **Acquire necessary material and documents which are required to conduct the exercise**

Step 2: Preparation

- **Identification of local facilitator and translator**
- **Establish contact to the community/stakeholders**
- **Within a preparatory meeting, the facilitator should be introduced into the process and background information provided**

Step 2: Community exercise

- **Welcome and introduction to the head of the community**
- **Decide on a place to conduct the exercise**
- **Advisable to affix the map close to the venue**
- **Facilitator specifically explains the exercise and starts it, asking the community members the specific question to be investigated**

Step 2: Community exercise

- **Feedback of the community members (brainstorming) should be noted on moderation cards and placed on the ground**
- **Facilitator should be independent**
- **Discuss specific issues in detail if required**
- **After the collection of the factors the facilitator should summarise the results and ask the community members if something has not been mentioned**

Step 2: Community exercise

- **In the last step the different factors should be quantified**
- **A predefined amount of beans should be used to weight/score the collected issues accordingly to their importance**
  - Facilitator guides this exercise
  - Should not influence the distribution of the beans/points
  - Assure that everybody contributes
- **Approval by community and final summary through facilitator**

Step 2: Community exercise

Step 2: Community exercise

Step 2: Community exercise

Step 2: Community exercise

Step 2: Post-Processing

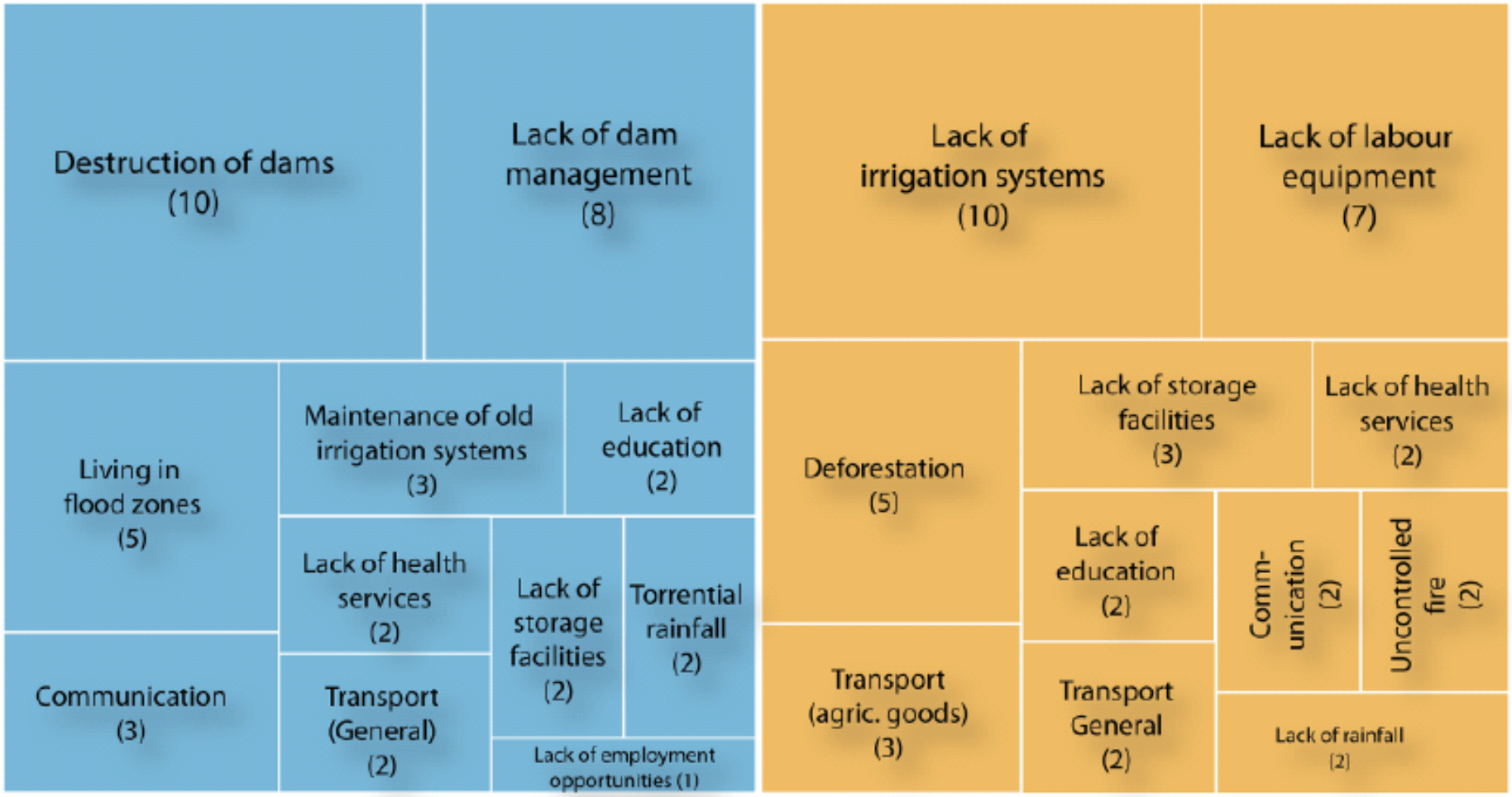
- **Translate and collect the issues within a spreadsheet**
- **Ranking and different statistics**
- **Might be necessary to group similar factors/contributions**
- **Results can be used to identify the different perceptions among the communities and identify gaps in the selection of priorities**

Inharongue				Muchenessa				Munamicua			
Drought	7	Flood	3	Drought	3	Flood	7	Drought	7	Flood	3
Lack of Health Services	6	Lack of Health Services	6	Lack of Health Services	2	Lack of Health Services	2	Lack of Health Services	2	Lack of Health Services	3
Lack of storage facilities	3	Lack of storage facilities	4	Lack of storage facilities	3	Lack of storage facilities	2	Lack of storage facilities	2	Lack of storage facilities	4
Lack of education	4	Lack of education	4	Lack of education	2	Lack of education	2			Lack of education	1
		Transport (General)	2	Transport (General)	2	Transport (General)	2	Transport (General)	7	Transport (General)	1
						Lack of employment opportunities	1	Lack of employment opportunities	3	Lack of employment opportunities	1
				Communication	2	Communication	3				
								Violation of laws	3	Violation of laws	6
								Transportable roads	1	Transportable roads	1
								Ignorance	1	Ignorance	1
Lack of irrigation system	10			Lack of irrigation system	10			Lack of irrigation system	9		
Uncontrolled fire	3			Uncontrolled fire	2			Uncontrolled fire	4		
Lack of rainfall	2			Lack of rainfall	2			Lack of rainfall	5		
				Deforestation	5			Deforestation	1		
Transport (Distribution of food; agri. Products)	3			Transport (Distribution of food; agri. Products)	3						
Drought resistant crops	6										
Lack of agricultural associations	3										
				Lack of labour equipment	7						
								Access	1		
								Lack of food reserves	1		
		Destruction of dams	4			Destruction of dams	10			Destruction of dams	10
		Lack of dam management	3			Lack of dam management	8			Lack of dam management	7
		Torrential rainfall	4			Torrential rainfall	2			Torrential rainfall	2
		Living in flood zones	6			Living in flood zones	5			Living in flood zones	1
		Lack of Search & Rescue equipment	4							Lack of search&rescue equipment	1
						Maintenance of old irrigation system	3			Maintenance of old irrigiation system	1
		Early Warning System	3								

Drought	Inharongue	Muchenessa	Munamicua	Average	Stand Dev.	Number
Lack of Health Services	6	2	2	3.333333333	1.885618083	3
Lack of storage facilities	3	3	2	2.666666667	0.471404521	3
Lack of education	4	2		3	1	2
Transport (General)		2	7	4.5	2.5	2
Lack of employment opportunities		3		3	0	1
Communication		2		2	0	1
Violation of laws			3	3	0	1
Transportable roads			1	1	0	1
Ignorance			1	1	0	1
Lack of irrigation system	10	10	9	9.666666667	0.471404521	3
Uncontrolled fire	3	2	4	3	0.816496581	3
Lack of rainfall	2	2	5	3	1.414213562	3
Deforestation		5	1	3	2	2
Transport (Distribution of food; agri. products)	3	3		3	0	2
Drought resistant crops	6			6	0	1
Lack of agricultural associations	3			3	0	1
Lack of labour equipment		7		7	0	1
Access			1	1	0	1
Lack of food reserves			1	1	0	1

Step 2: Visualisation

- **Visualistion of tree maps or tag clouds**
  - A treemap is a visualisation of hierarchical data with nested rectangles. The size of the rectangles displays the weight of the representing factor
  - Tag cloud: Size of font represents frequency
- **This type of visualisation allows the easy capturing of the structure and the weight of the different factors**


Destruction of dams (10)
Lack of dam management (8)
Living in flood zones (5)
Maintenance of old irrigation systems (3)
Lack of education (2)
Lack of health services (2)
Lack of storage facilities (2)
Torrential rainfall (2)
Communication (3)
Transport (General) (2)
Lack of employment opportunities (1)
Lack of irrigation systems (10)
Lack of labour equipment (7)
Deforestation (5)
Lack of storage facilities (3)
Lack of health services (2)
Lack of education (2)
Comm-unication (2)
Uncontrolled fire (2)
Transport (agric. goods) (3)
Transport General (2)
Lack of rainfall (2)

Floods:

Lack of Health Services, Lack of storage facilities, Lack of education, Transport (General), Lack of employment opportunities, Communication, Destruction of dams, Lack of dam management, Torrential rainfall, Living in flood zones, Maintenance of old irrigation system,

Droughts:

Lack of Health Services, Lack of storage facilities, Lack of education, Transport (General), Communication, Lack of irrigation system, Uncontrolled fire, Lack of rainfall, Deforestation, Transport (Distribution of food; agri. Products), Lack of labour equipment,

Tag cloud: frequency of terms in the manual and toolbox

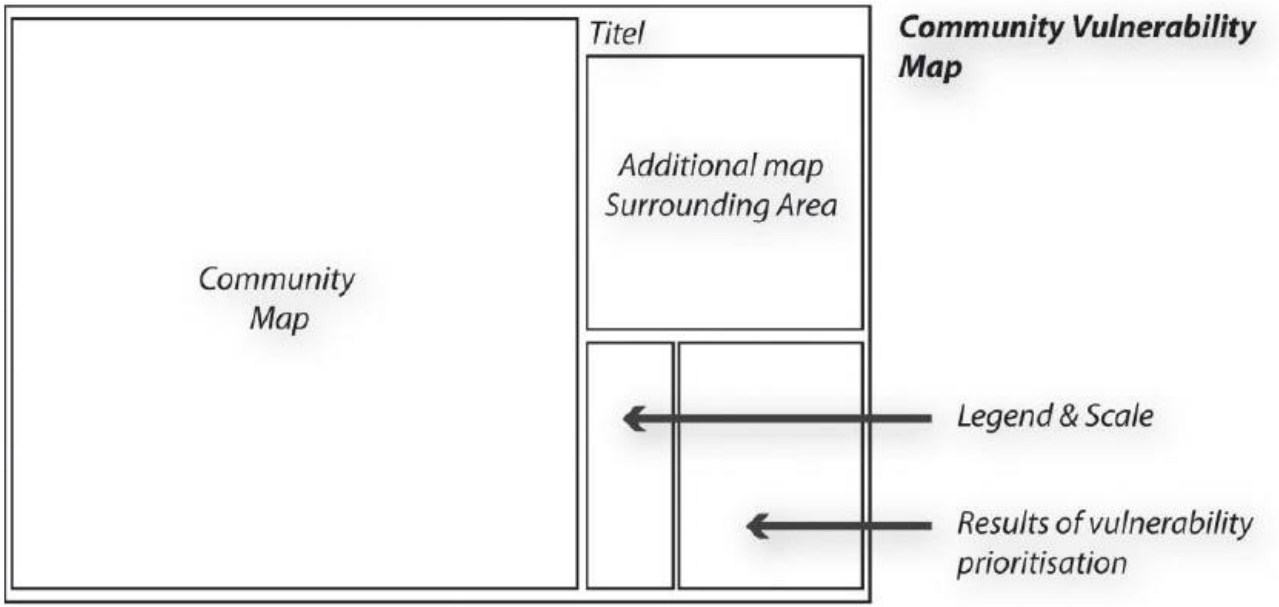
→ www.wordle.net

Step 3: Map composition

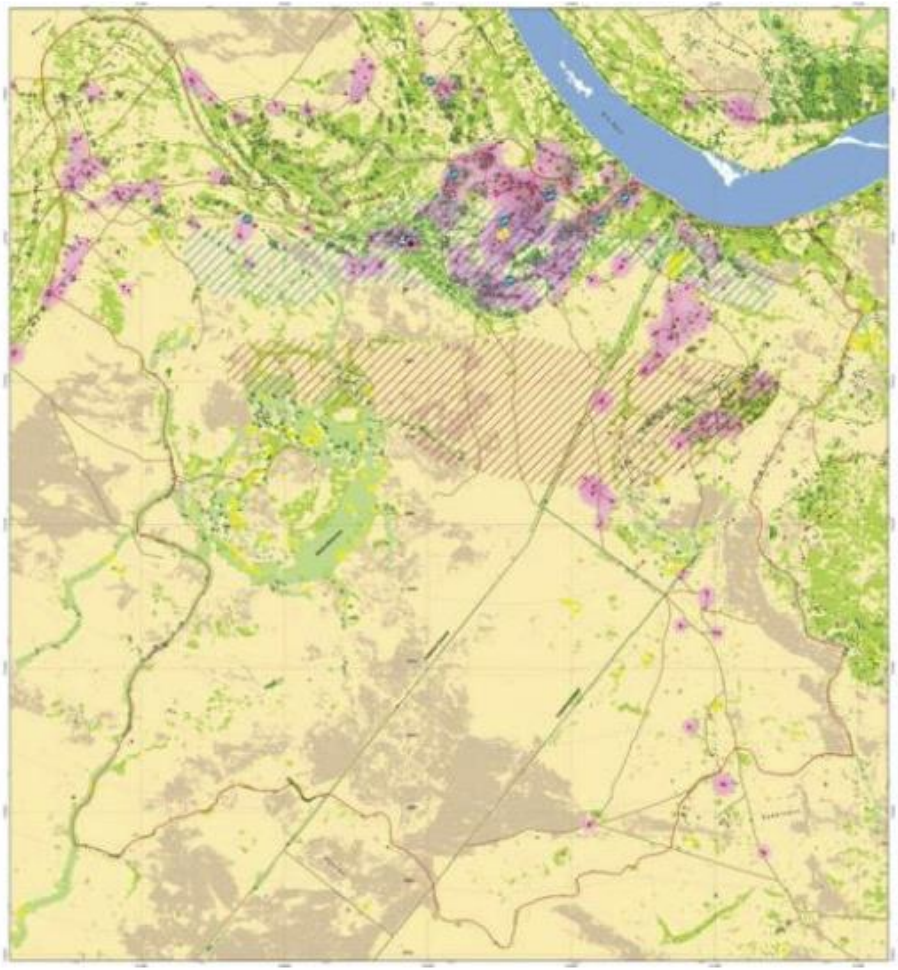
- **Maps as reflections of the perceptions of different stakeholders: Policy relevant results**
- **Vulnerability flood map of the area**
- **Vulnerability/Hazard map of communities**

Step 3: Map composition

Map Composition

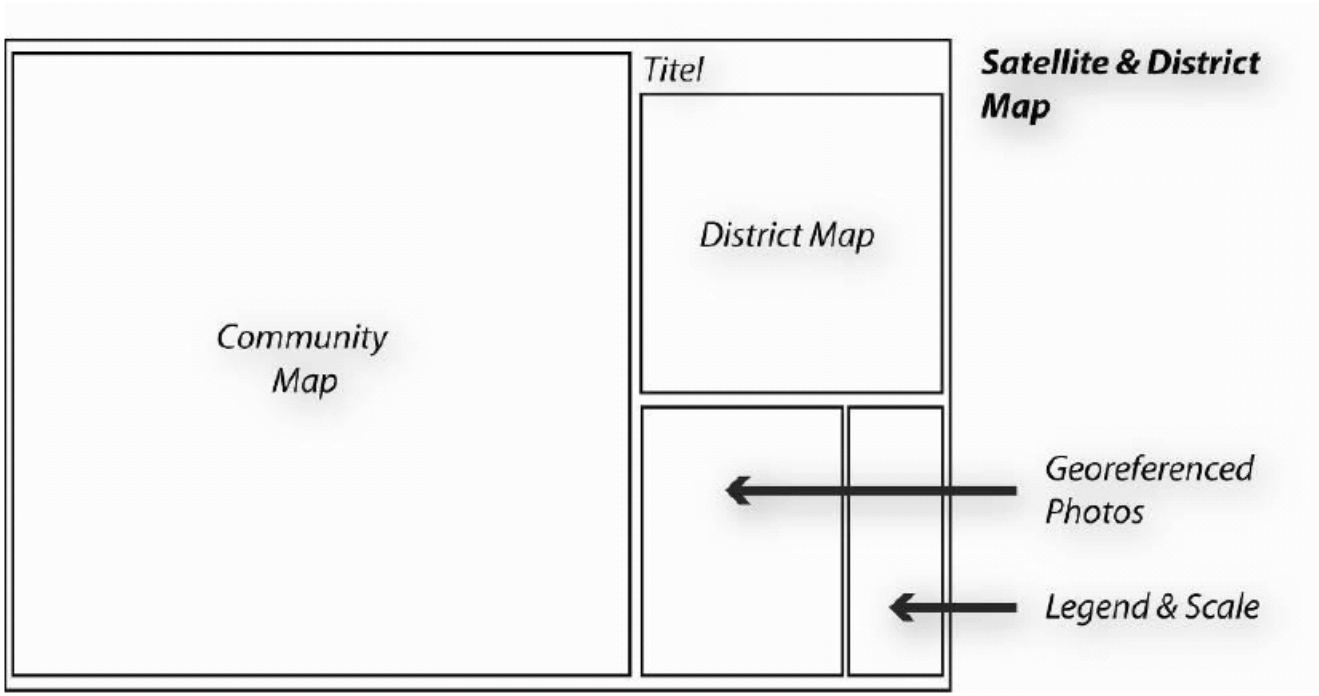


Step 3: Map composition

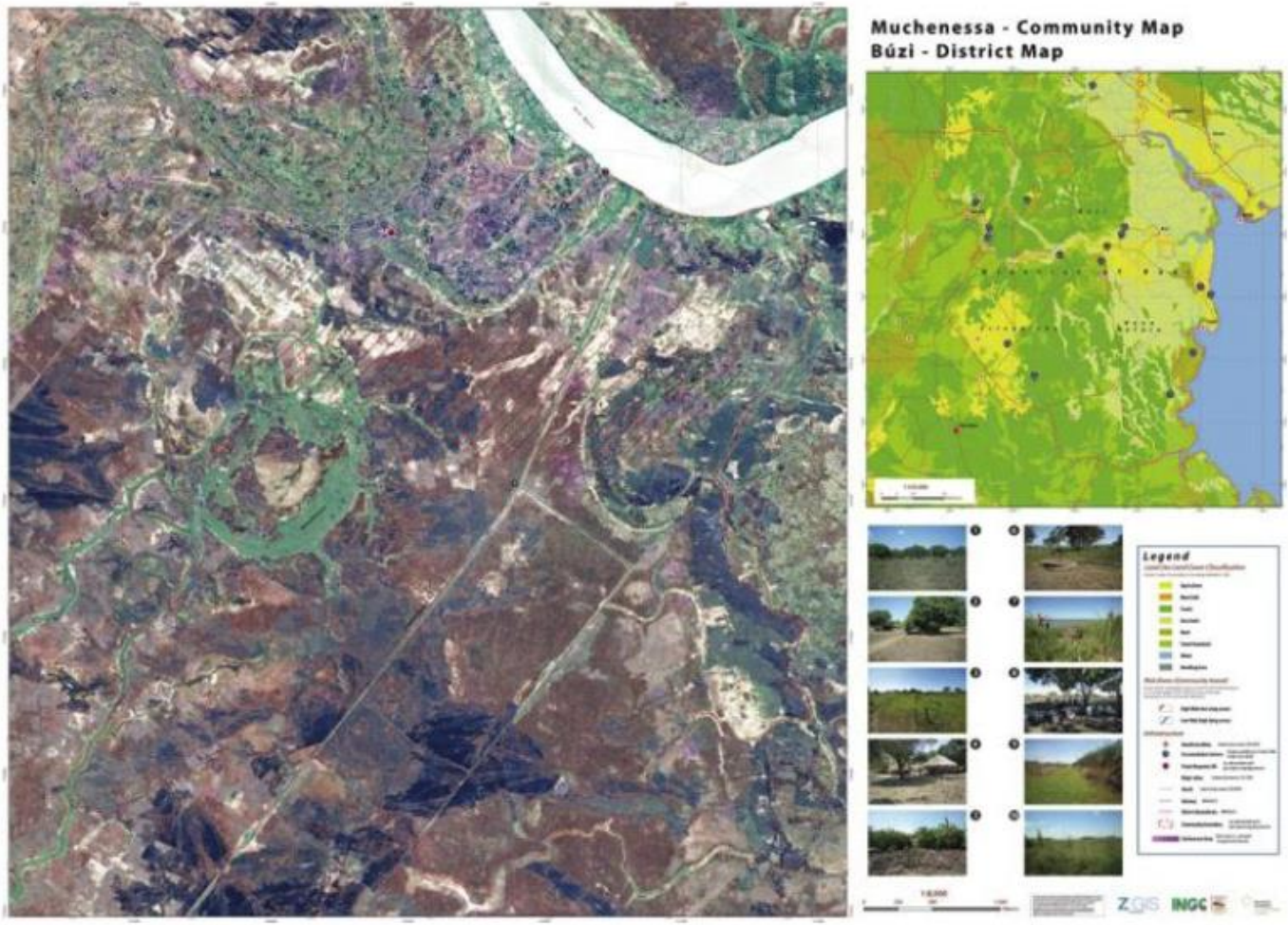


Step 3: Map composition

Map Composition



Step 3: Map composition



Step 4: Provision of maps – Education and future planning

- **Results have to be provided to the community members**
- **It never can be assured that a map is 100% correct (updates)**
- **Involve the possibility for feedback loops, continuous updates and the strengthening of capacities at all levels**
- **Independent centres of expertise & knowledge can support the long-term integration and success of the integration of spatial decision support tools**

Step 4: Provision of maps – Education and future planning