Landmines and Spatial Development
Appendix III
Landmine Database *

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Abstract

This Appendix describes the construction of the database recording the close to universe of landmine clearance operations in Mozambique over 1992-2015. First, we present the new dataset, giving examples, and detailing cross-validation. Second, we give descriptive and summary statistics of clearance operations, by area cleared, operator, duration, number of mines and unexploded ordnance, and categories. Third, we provide graphical illustrations and a more detailed account of clearance operations across each of Mozambique's 10 provinces.

Contents

1   Data Collection

In this section, we present the various steps involved in the landmine dataset creation. Reconstructing the universe of demining operations from 1992 to 2015 has been a complex task. As it is apparent from the history of demining, reviewed in Appendix II, the process to clear Mozambique from landmines was fraught with serious challenges; among others, lack of coordination, imperfect information on the location of minefields, as most were not laid by professional armies, little -if any- information-sharing across actors, absence of best practices before 2007 on data management, and the weak state capacity. These features rendered the reconstruction of a comprehensive database of clearance operations a complicated and often daunting task. Thankfully, the Geneva International Centre for Humanitarian Demining (GICHD), the main demining operators (e.g., HALO Trust, Humanity and Inclusion, NPA, and APOPO), and Mozambique's National Institute of Demining (IND) offered generously their expertise and resources. Many individuals, former deminers, officials of the United Nations (UN) and national authorities (IND) helped us a lot in various phases of the data collection. Figure 9 shows the conditions of the archive at the National Institute of Demining, we encountered in the beginning of our attempt to reconstruct the clearance database in 2015.

1.1   Land Release Process

Before jumping to the data creation, it is useful to describe the land release process in case of suspected by landmines contamination. Mines are usually buried within 15 centimeters of the earth's surface, which makes verification a difficult task. Even for mines laid on the ground, detection is difficult, as vegetation grows; moreover floods and rock-slides reshuffle landmines, making detection even more challenging. Gathering reliable intelligence is complicated by the fact that landmines were placed years ago by actors that are not around anymore and because in Mozambique dozens of actors used landmines (FRELIMO, RENAMO, other rebels and militias, the armed forces of South Africa, Rhodesia, and Malawi, the colonial administration, private agents).

Over time, the mine-action community has come to realize that attempting to clear all areas suspected of contamination (known as "suspected hazardous areas" - SHA) is impossible. This is because the initial classification of a SHA is usually based on word-of-mouth typically under insecure conditions. Hence, cancelling "false positive" SHA or updating their status to confirmed hazardous areas (CHA) is an essential task, typically done via non-technical surveys (NTS). NTS gather and

Figure 1: **Warehouse IND in Maputo** 2015

analyze information by visiting the area, interviewing landowners, farmers, village leaders, and (ex) military personnel. In cases of sufficient evidence of contamination, a technical survey (TS) that collects more precise information follows. Usually, a TS concludes with the clearance of the hazard(s) and the issuing of a completion report.

These practices first came into place at the end of 2001 with the issuance of the Handbook of International Mine Action Standards (IMAS), last revised on February 2016. IMAS is produced and sponsored by the United Nations Mine Action Service (UNMAS), with the support from a variety of organizations, including the Geneva International Centre for Humanitarian Demining (GICHD). It is in the absence of best practices and little coordination among demining actors that one needs to understand clearance operations in Mozambique during the $1990s$ and early/mid-$2000s$. Mozambique starts implementing best-practices in the beginning of the third phase of landmine clearance in $2007 - 2008$.

1.2 Data. IMSMA database

1.2.1 Introduction

We started our data collection accessing the Information Management System for Mine Action (IMSMA) database stored at the National Institute of Demining (IND) in Maputo. IMSMA is currently used by around 80% of mine-action programmes around the world; it is also the United Nations' preferred information management system for mine action.[1]

Thanks to GICHD and IND officials, we managed to understand the functionality of the IMSMA software and data format. The three key dimensions in the IMSMA dataset are: i) Location (the relevant administrative division); ii) Hazard (the parcel of land where the threat is identified); and iii) Activity (the operations performed on the hazard). Hazards are classified as Confirmed Hazardous Area (CHA) or as a Suspected Hazardous Area (SHA). Among the activities listed in the IMSMA, we have:

- Technical Survey Report: Technical Surveys refer to the collection and analysis of data, using appropriate technical interventions, regarding the presence, type, distribution and surroundings of mine contamination, in order to define precisely where mine contamination is present, and to support evidence-based land-release prioritization and decision making processes.

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[1]We are grateful to the Mozambican authorities and the IND director, Alberto Maverengue Augusto, for enabling access to the data.

- Impact Survey Report: These reports contain information collected by the surveyor. The purpose of these reports is to collect evidence to support decision-making about where hazards are present and where they are not. Impact survey reports are also useful to understand impacts on affected communities.

- Clearance Report: These reports are typically used to record a formal clearance task. Clearance reports store GPS information of the contaminated area and in some instances even report the exact location of mines.

- Progress Report: Report containing progress data for a reporting period, usually, the number of mines cleared, area cleared and hours worked on a given task (either attached to a hazard or activity). Progress reports do not contain GPS coordinates.

- Completion Report: These are the final reports that summarize information stored on the Progress Report and the Clearance Report. The Completion Report is the final document of clearance that serves also as a certificate for Land Release.

In the most complete entries in IMSMA database, Location, Hazard and Activity are linked. For example, one or more Confirmed Hazardous Areas (e.g., minefield A and minefield B) or Suspected Hazardous Areas are located in a given location (e.g., locality). The hazardous areas are then linked to one or more activities. SHAs are linked to Impact Surveys only; while CHAs are linked to a Technical Survey, a Progress Report, a Clearance, and a Completion Report. High-quality information also come with a polygon for both the Hazard (which represents the area affected by the CHA or the SHA) and the Activity (area on which the clearance has been performed).Figure 2 shows an example of the linkage between these three elements. The Location of this entry is Marenga village, north of Inchope on the $N1$ road that connects capital Maputo with the Central and Northern Provinces along the Indian Ocean. Panel A shows the Confirmed Hazardous Areas (in blue color) linked to this Location. We registered three Hazards with polygons delineating contamination. Attached to these Hazards are three activities for which polygons are available. Panel B shows the three activities polygons in green. But this is not the universe of activities and interventions in Marenga village. As Panel C illustrates, there are other two activities (in 2003 and in 2007 indicated black dots) for which only the centroid of the activity is available. Due to the limited information on polygons (as shown below), we perform our analysis employing centroid of intervention on Confirmed Hazardous Areas (as shown in Panel C).
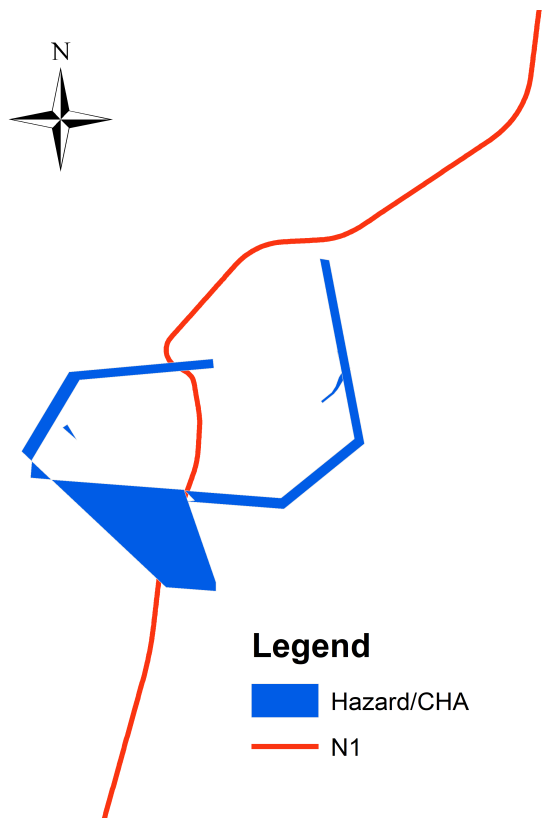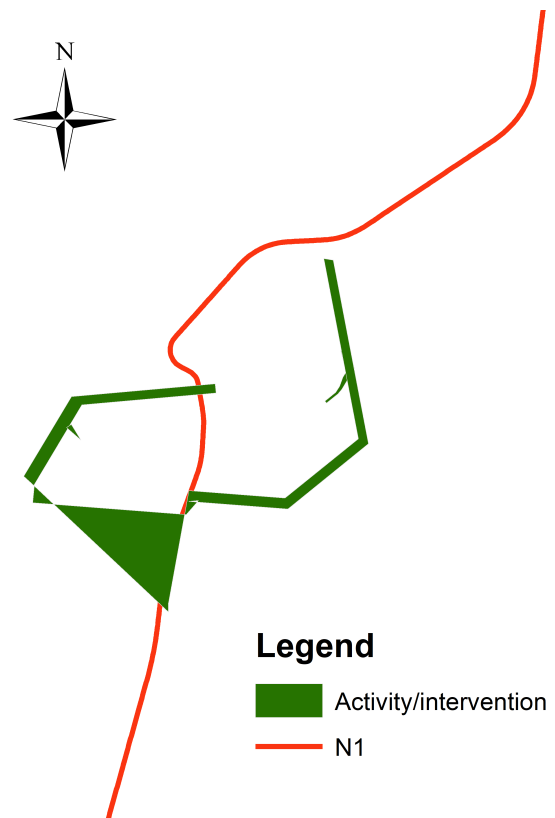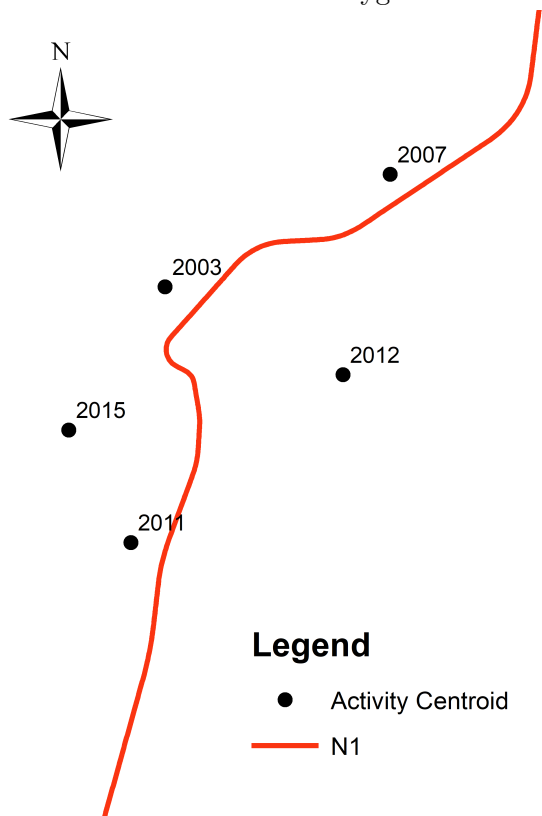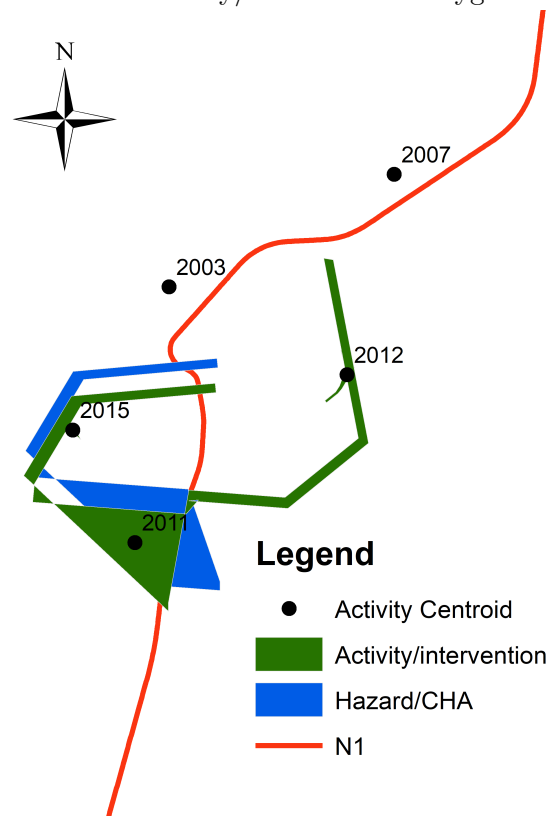
Figure 2: **Harzard and Activities: Polygons and Centroids example in Marenga village (north of Inchope)**

There are two IMSMA databases for Mozambique. The first stores information on demining activities from January 2008 to October 2015. According to IND officials and the GICHD experts, this dataset is reliable, as it was assembled following best practices. The second dataset, called "Legacy Dataset", contains information on landmine clearance from 1993 to 2007. The original pre-2008 dataset was lost; sp the available dataset is a copy of the original data. On top of this problematic issue, while data from 2001 to 2007 were originally collected by the IND, the data between 1993 and 2000 were migrated from different data storage systems depending on the individual operators and are evidently of lower quality.

1.2.2 IMSMA post 2008

The post-2008 IMSMA dataset includes $3,374$ entries. The quality of the dataset allows us to identify $3,148$ demining interventions and 226 Suspected Hazardous Areas that were deemed "false positives" and got cancelled. Each intervention is linked to a hazard and a location: the $3,148$ interventions are distributed over $2,853$ Confirmed Hazardous Areas. All $3,148$ activities are based on Completion Reports, summarizing relevant information from the Progress and Clearance reports (e.g., Start date, End date, Operator identity, Area Cleared, Number of items cleared, etc.). Despite the high quality of the post-2008 database, only $1,026$ (32% of the total) interventions have information on the polygon of the contaminated area. Below we discuss the validation of the post-2008 dataset.

1.2.3 IMSMA pre 2008

We took several steps to improve the quality and coverage of the "Legacy dataset". The raw IMSMA data record $16,343$ entries. There were three patterns/ways of data storage:

- $5,668$ activities that were not linked to a hazard, but only to a location.

- $8,346$ activities that were linked to a hazard and an associated location.

- $2,329$ hazards with the corresponding location, to which no activities are reported.

As a first step and to avoid redundancies, we linked each activity to a hazard and a location. To this end, we created for each entry an identifier using information on the activity code, operator identity, and location. We then used this identifier to match each activity to either another activity or a hazard or both. This allows us to match information contained in a Progress Report regarding the

timing of interventions and the number of landmines cleared. We end up assigning information from 7, 458 Progress Reports to 2, 468 Clearance and Completion reports. The resulting pre-2008 dataset includes 8, 885 activities/hazards.

The second step involved the identification of Confirmed Hazardous Areas (CHA) and Suspected Hazardous Areas (SHA). Specifically, we proceeded as follows:

- We drop all operations before 1998 that erroneously coded as having been done by Handicap International (Humanity and Inclusion). We drop them, as HI started its operations in the country as early as 1998. This leads to the exclusion of 566 entries. We also dropped an intervention from ADP, whose timing of end of operation was 2009 (well after ADP ceased activities).

- We went through each entry in the Impact Surveys identifying two categories: i) SHAs which were cancelled according to level-1 (Mozambique-wide) surveys (namely the 1994 SHAMAN HALO Trust and the 2001 MLIS); overall there are 1, 511 cancelled SHAs. ii) Impact surveys in locations that subsequently clearance operations took place. Overall there 1962 entries. We dropped them as we were able to track them through the subsequent reports of demining activities.

- Using the "Baseline Assessment" Survey of HALO Trust in 2007 − 2008, we dropped SHAs that did not result in a CHA in the post-2008 period. These are classified as "cancelled" SHA. This led to the exclusion of 45 entries.

- We also deleted (duplicate) entries that have the same operator, GPS coordinates, and timing of interventions. We dropped 758 duplicate observations.

Figure 3 (right panel) portrays the spatial distribution of cancelled suspected hazardous areas (SHA). These are areas that were initially thought of being contaminated, but eventually no clearance operations were carried. For comparability, the figure also portrays the distribution of all CHA.

After these steps, we are left with a dataset of 3, 083 CHA from 1993 − 2008.

1.3   Additions and Validation from Original Data

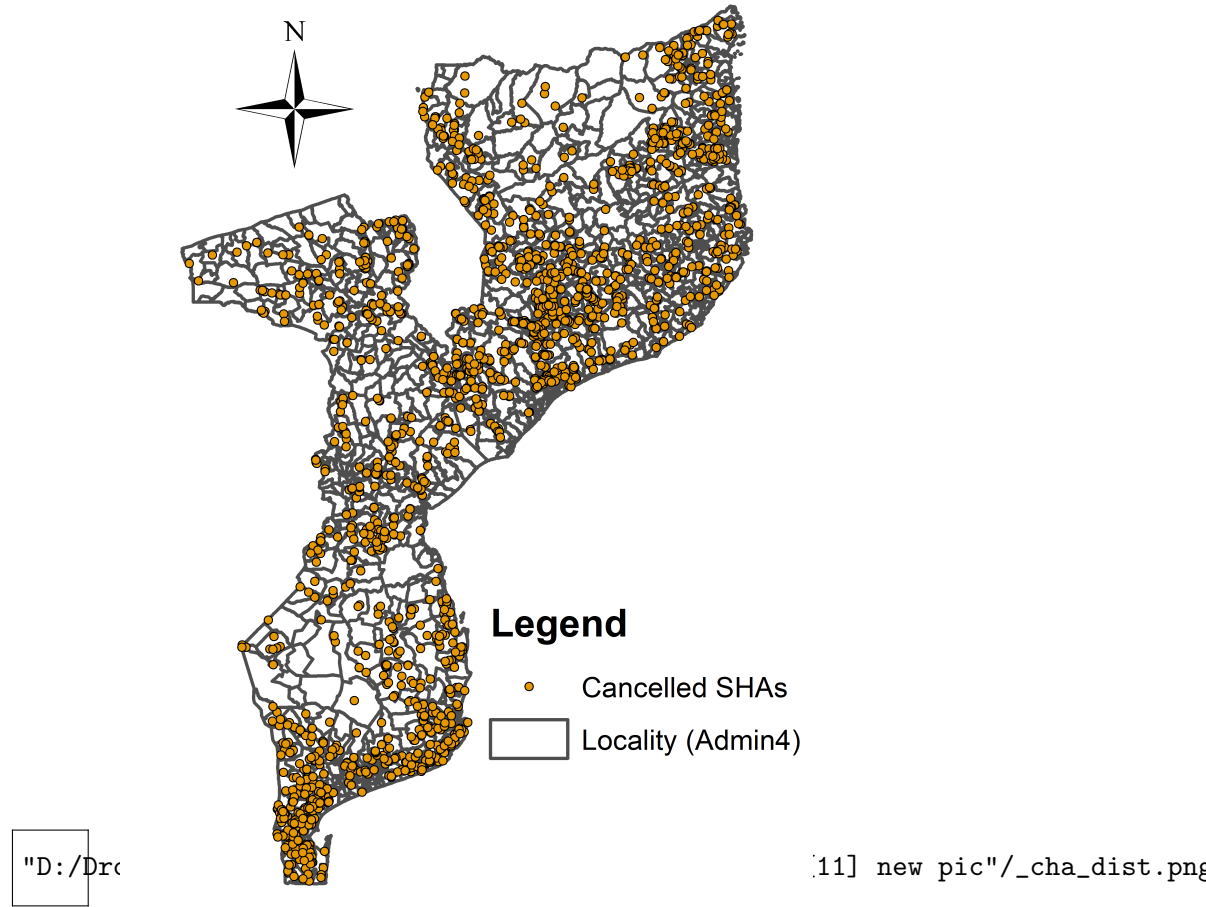After processing the IMSMA dataset (both post and pre 2008), we are left with 6, 231 interventions.

Figure 3: **Panel A: Location of CHAs   Panel B : Cancelled SHAs across Localities**

We then collected, processed, and digitized data from the Halo Trust, Humanity and Inclusion (HI), the Norwegian People's Aid (NPA), and APOPO, using these organizations' internal records. All these data are at the Completion Report level.

- **HALO Trust**. We accessed the two original datasets (in Microsoft Access format) from HALO Trust. The first contains all operations performed by HALO in the Northern provinces before 2007 (see Figure 4). The second dataset stores all activities of HALO Trust in the Center-South of the country, post-2008.

  - **North Operations HALO Trust dataset**. We cross-checked the IMSMA entries with the HALO trust original data. As HALO Trust data and IMSMA followed different labeling criteria, we used ArcGIS to perform the following selection criteria. We impose a buffer of 1000m radius and erased those GPS location that overlap with a HALO Trust interventions
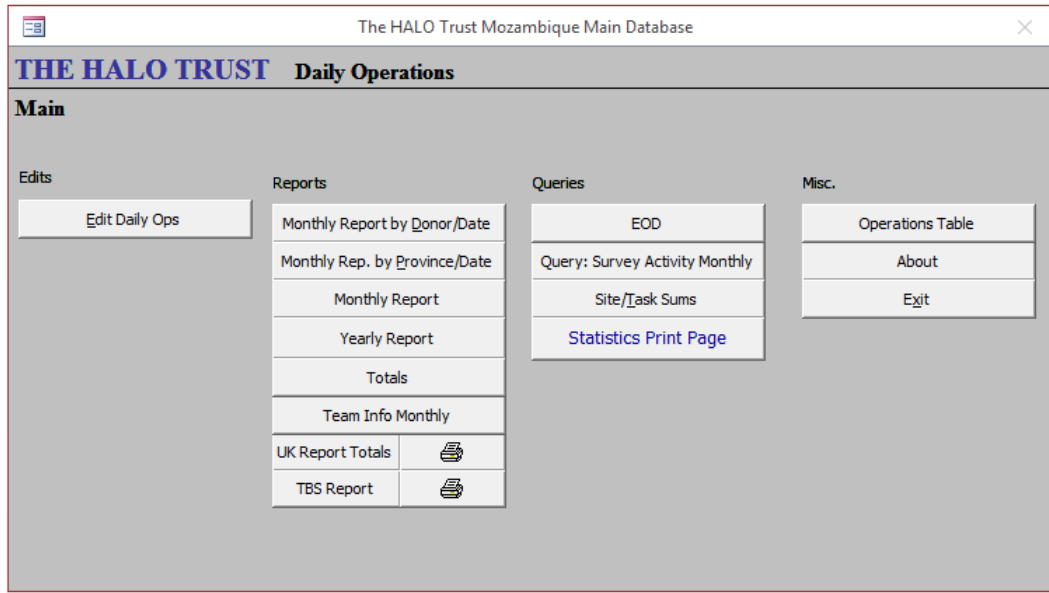
10

Figure 4: **HALO Trust Dataset of Northern Operations 1994-2007.**

from the IMSMA dataset. We retrieve 827 interventions that were not present in the IMSMA dataset, increasing the coverage of HALO Trust by 39% in the pre-2008 period.

– **Post-2008 HALO Trust Dataset.** Regarding the post-2008 IMSMA database, using the original HALO Trust data we validated all $1,623$ HALO Trust activities. Reassuringly for the post-2008 IND data all HALO Trust interventions were properly recorded.

- **Handicap International (Humanity and Inclusion)**. From HI we received MS Excel files containing summaries of operations for various years starting in 2002. Unfortunately, Handicap International does not have report/data at the hazard/intervention level for its $1998 - 2002$ operations. We accessed information for the universe of HI operations for 2002, 2003, 2006, 2007, 2009, and from 2010 to 2015. We are thus able to validate around **627** HI operations (49% of the total interventions). For the pre-2002 period, we worked with Aderito Ismael, one of HI experts who worked at the time in Central Mozambique and we checked the pre-2002 entries in the IMSMA dataset.

- **Norwegian People's Aid**. With the help of NPA directors, we visited the NPA warehouse in Tete, centre-West Mozambique, and accessed all reports covering the $1993 - 2000$ period. Figure 5 shows the summary of total operations performed by NPA until 2000. We went over 70 clearance reports. The IND's dataset did not have an entry for 27 interventions that were

thus stored as new data. 43 interventions matched the IND database and thus allowed us to validate the accuracy of NPA data in the IMSMA database. We also accessed 53 original reports for the years $2003 - 2005$. We end up adding 12 new interventions and validated the remaining 41. We did the same for original reports covering the 2013 to 2015. We validated all 43 NPA's interventions for this period. Overall we increased NPA coverage by 20%.

- **UN Accelerated Demining Program (ADP).** We reached out and interviewed deminers and a field supervisor working with ADP in the mid 1990s. We retrieved 41 interventions from the ADP covering the period $1994 - 2000$. We added 35 interventions from the ADP program that were not present in the IMSMA database. We validated that the remaining 6 interventions were accurately stored in the IMSMA database.

- **GTZ/Mine-Tech**. We accessed information on the operations performed by GTZ/Minetech from Dr. Ulrich Weyl with funding from the German Development Agency. Using Dr. Weyl personal archive, we were able to validate all the 64 interventions of Mine-Tech for the period $1997 - 1999$ and 10 interventions of Armor SCS. Figure 6 illustrate an example of such a report.

- **"Baseline Assessment" Survey** $2007 - 2008$. We identified 251 Confirmed Hazardous Areas listed in the "Baseline Assessment" Survey of HALO Trust in $2007 - 2008$ that were not stored in the pre-2008 dataset. To identify these CHAs, we impose a buffer of 1000m radius and erased those GPS locations that overlap with a pre-2008 IMSMA intervention from the "Baseline Assessment" Survey.

- **RONCO** We accessed a report commissioned by USAID mapping 24 interventions covering 1994 and 1995 (see Figure 7). These interventions, mostly on roads in the central provinces of Sofala and Zambezia, were not stored by the Mozambican authorities and were therefore missing from the IMSMA database. All such interventions are on roads in the province of Sofala and Zambezia.

- **UNOMOZ/UNOHAC** We accessed the United Nations Archives in New York City and digitized information of the UN mission in the country (UNOMOZ and UNOHAC) in the period surrounding the Peace Accord of 1992 and the National Elections of 1994. Adding interventions for the early period was important, as the IMSMA database does not contain any information

MINECLEARANCE TASKS

Figure 5: **NPA Original Summary of Operations, 1993-2000**

CPD/GTZ/IHD/MARRP DEMINING PROJECT

FINAL REPORT: IHD OPERATION PHASE 2: DEMINING:
SAMBAZOKA VILLAGE: MACHAZE DISTRICT:
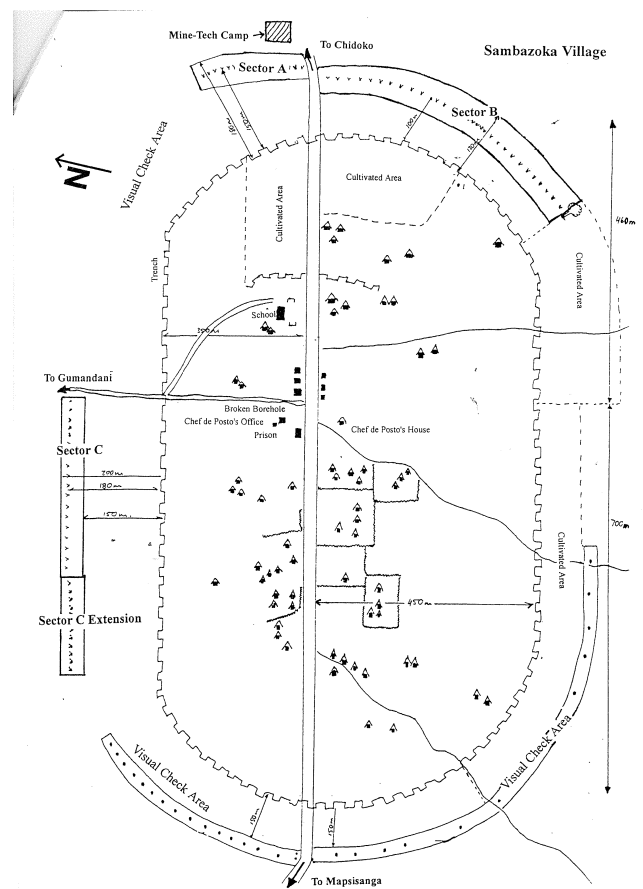MANICA PROVINCE: MOCAMBIQUE.

September 1997

(D207)

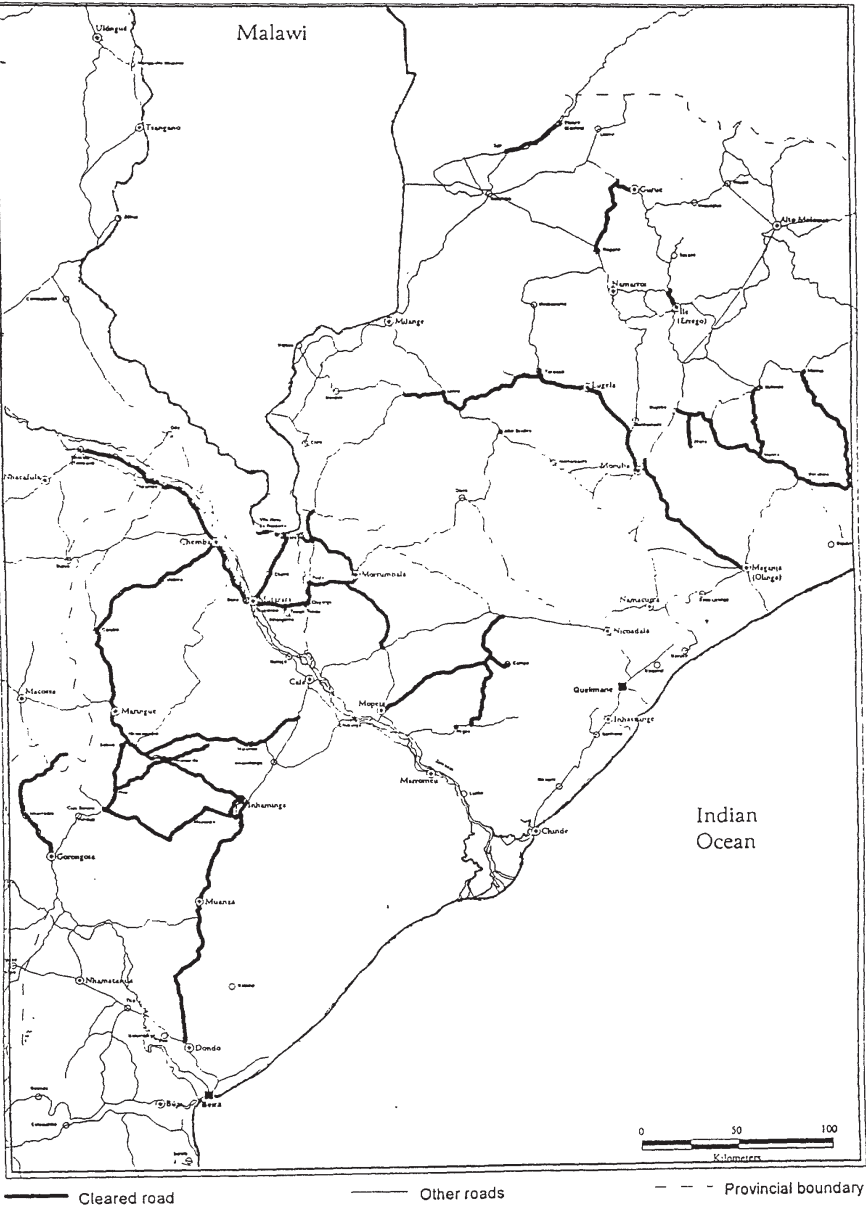Figure 6: **GTZ-Mine-Tech report of Sambazoka operation**
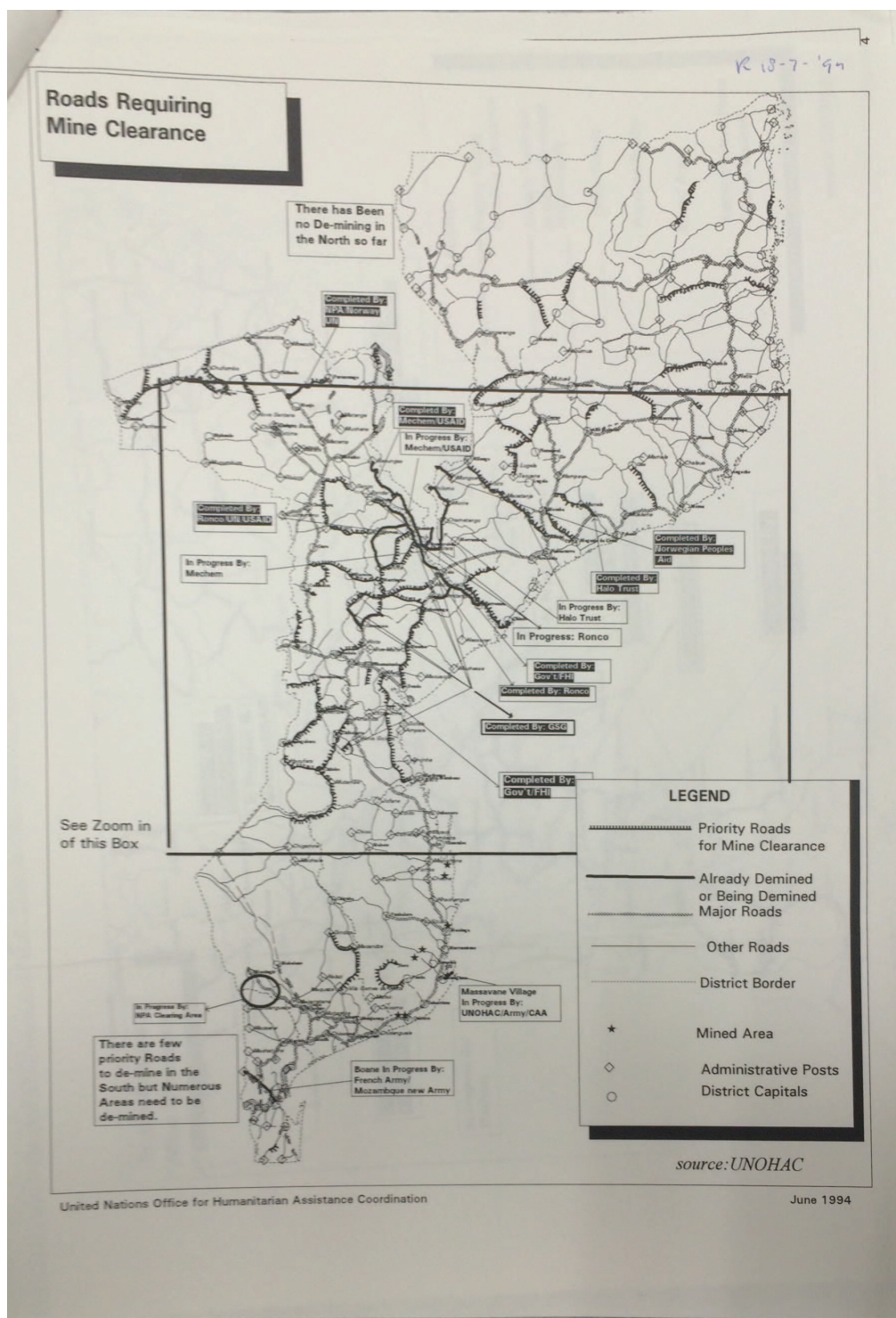
Figure 7: **RONCO Map**

related to the ONUMOZ mission. Figure 8 reports the original map we retrieved from the archives. From these archives, we retrieve the following:

- **Lornho GSG**. We add 16 interventions contained in the ONUMOZ archives in $1992-1994$.

- **GSG/Lornho & MECHEM**. We add 12 interventions in 1994.

- **RONCO**. We add 2 interventions from RONCO under the ONUMOZ archives. These interventions are subsequent to those recorded by the USAID report.

- **Norwegian People's Aid**. We retrieve information on 2 interventions by NPA from the ONUMOZ archives. We then validated these two interventions from the NPA archives in Tete.

- **Khron Mechanical Mine Clearance**. We also checked the presence of Khron interventions using the original information provided by former Khron's employees on their 3 interventions in Mozambique (Sabie ring; Moamba ring; Boane ring). All the three interventions are recorded in the IMSMA dataset, under the ADP interventions which has been subcontracting clearance to Khron.

1.4 Validation from Secondary Sources

We performed further validation checks using secondary sources. We devoted particular attention to small operators at the beginning of the Mine Action process in the 1990s. When available, we consulted the websites of commercial firms (e.g. Mechem and MgM). We also retrieved information from the 1999 and the 2002 Landmines Monitor report of Human Rights Watch. We checked and validated the following interventions for the following operators:

- **Mine-Tech** operations on roads clearance in support of UN between 1994 and 1995 (operations inside the UN Project Caminho).

- **Armor Special Clearance Services (SCS)** operations on villages in Sofala and Manica provinces.

- **Mechem and LORNHO** activities for Project Caminho. Moreover, we validated (i) an intervention on Massangir dam in 1999; and (ii) Mechem road clearance operations in 2001

Roads Requiring Mine Clearance

There has Been no De-mining in the North so far

Completed By: NPA Norway UN

Completed By: Mechem/USAID

In Progress By: Mechem/USAID

Completed By: Ronco UN USAID

In Progress By: Mechem

Completed By: Norwegian Peoples Aid

Completed By: Halo Trust

In Progress By: Halo Trust

In Progress: Ronco

Completed By: Gov't FHI

Completed By: Ronco

Completed By: GSG

Completed By: Gov't FHI

See Zoom in of this Box

In Progress By: NPA Clearing Area

Massavane Village In Progress By: UNOHAC/Army/CAA

There are few priority Roads to de-mine in the South but Numerous Areas need to be de-mined.

Boane In Progress By: French Army/ Mozambque new Army

LEGEND

Priority Roads for Mine Clearance

Already Demined or Being Demined Major Roads

Other Roads

District Border

★   Mined Area

◇   Administrative Posts

○   District Capitals

source: UNOHAC

United Nations Office for Humanitarian Assistance Coordination   June 1994

Figure 8: **UNOHAC "Project Caminho" Map**

- **Empresa Mocambiacana de Desminagem, Lda (EMD)** interventions in 2001 in Inhambane province.

- **Menschen gegen Minen (MgM)** operations in 2000 and 2001 in Chokwe and Guija district, Gaza province

- **Mozambique Mine Action (MMA)** road clearance operations in 2001 in Inhambane province.

- **RONCO** roads demining operation in 1994 under the USAID contract. Moreover, we validated its operation in 2001 in Sofala and Maputo provinces.

2 Summary Statistics

This section presents summary statistics of our final dataset. We report statistics on operators, data sources, area cleared, items removed, and timing of interventions. We then present details on the GIS and report-based classification of each intervention.

2.1 Operators

Our dataset contains information on 42 demining operators. In Table 1 we report the year of the first and last operation for each actor and the total number of interventions. Among these operators, two main groups can be identified: i) humanitarian NGOs and ii) commercial firms. The first group comprises HALO Trust (United Kingdom), Handicap International (France), Norwegian People's Aid (Norway), APOPO (Belgium), and several Mozambican organizations (Afrovita, Associacion de Sapadores Mozambicanos, FADM, CODEG, Necochaminas). In the group of commercial firms belong the rest of small operators like RONCO (US), Mozambican Mine Action (MMA), Bactec International, Empresa Mocambicana de Desminagem, JV Desminagem, Mine Kills, MgM, and Mine Tech.

Figure 9 reports the distribution of interventions by operator. In terms of demining tasks performed, the key player is HALO Trust accounting for 50% of the total demining activities in the country. Handicap International (Humanity and Inclusion) and APOPO were responsible for 19.14% and 14.83% of interventions, respectively. The percentage of operations conducted by the UN Accelerated Demining Program (ADP) is 7.1% and NPA completed around 3.4% of clearance interventions. We further provide a disaggregation of the distribution of interventions by operator for each of the

three demining periods of Mine Action: $1992 - 1999$, $2000 - 2007$, and $2008 - 2015$. The three pie charts in Figure 10 offer the tabulations. In line with the history of demining, sketched in Appendix II, the first period is characterized by a tripartite division between HALO Trust, NPA, and ADP in the Northern, Central, and Southern provinces, respectively. RONCO and Mine-Tech are important players in the mid 1990s. In the two subsequent periods, HALO Trust emerges as the leading actor in the demining process coupled with the increase of HI role (from the second period) and APOPO after 2008.

The activities of the various operators exhibit sizable spatial variation. We offer a visualization of the spatial evolution of demining operation for each of the main operators in Figure 11 (HALO Trust), Figure 12 (HI), Figure 13 (NPA), Figure 14 (APOPO), and Figure 15 (ADP).

Table 1: **Number and Timing of Intervention by Operator**

| Operator	Number of Interventions	Percentage Number of Interventions	First Year	Last Year
ADP	527	7.100	1994	2006
AFROVITA	8	0.108	2001	2006
APOPO	384	5.173	2008	2015
ARMOR SCS	10	0.134	1997	2001
Associaçao de Sapadores Moçambicanos	16	0.216	2004	2006
BACTEC MOÇAMBIQUE	23	0.310	2004	2010
BICKMUTI LDA	9	0.121	2013	2014
CGTVA	2	0.027	1999	1999
CIDC	1	0.013	2006	2006
CODEG-Desminagem	1	0.013	2006	2006
DAG, Lda	3	0.040	2013	2013
Desminagem e Agricultura	36	0.485	2007	2013
ECOMS	1	0.013	2004	2004
EMD	81	1.091	1999	2014
FADM	63	0.849	2003	2014
GPC	6	0.081	1996	2001
GSG (Lorhno)	4	0.054	1993	1994
HALO Trust	3738	50.357	1994	2015
Handicap International	1421	19.143	1998	2015
IND	50	0.674	2001	2015
JV Desminagem	33	0.445	2004	2009
LIS 07	251	3.381	2001	2007
Lornho/RO/Mechem	6	0.081	1994	1994
MECHEM	67	0.903	1997	2006
MF Investimentos Lda	10	0.135	2009	2012
MGM	47	0.633	2000	2006
MINE-TECH	116	1.563	1997	2006
MMA	84	1.132	2001	2012
MMS, LDA	5	0.067	2011	2012
MONECHECHA-Lda	18	0.242	2010	2014
MOPROTECTOR Ltda	28	0.377	2010	2014
Mamacoma	17	0.229	2011	2012
Mechem	2	0.027	1994	1994
Mine Kills Lda	21	0.283	2007	2014
NECOCHAMINAS	6	0.081	2002	2006
NPA	252	3.395	1993	2015
Not Specified	13	0.175	2001	2006
REASeuro	9	0.121	2005	2006
RONCO	50	0.674	1994	2006
Scorpion-Desminagem	3	0.040	2011	2011
VAB DESMINAGEM	1	0.013	2013	2013
Total	7423	100		
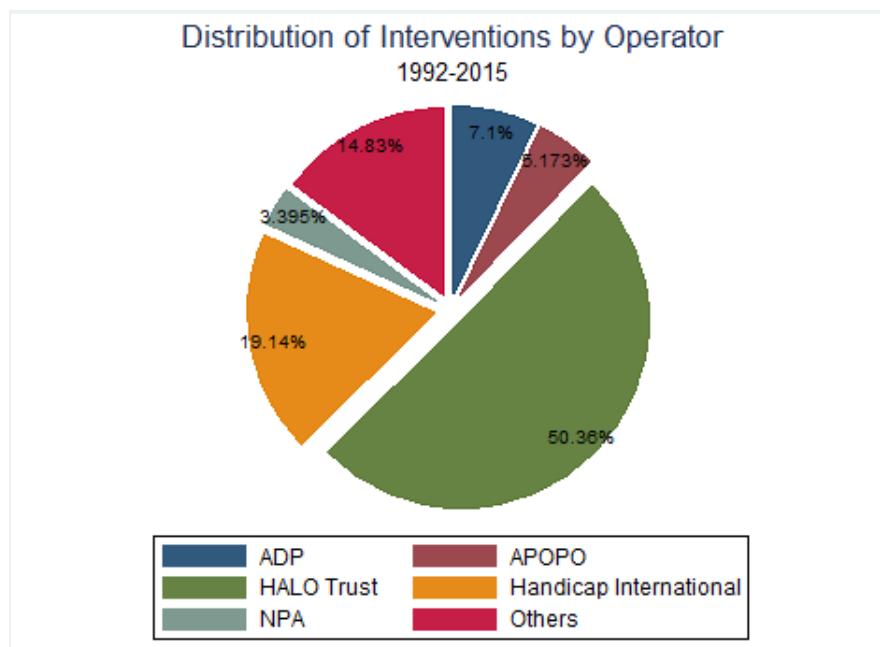
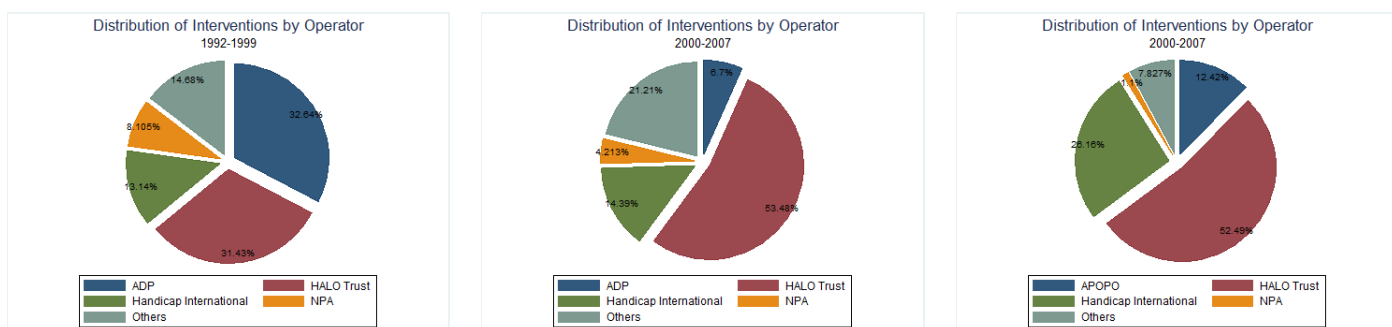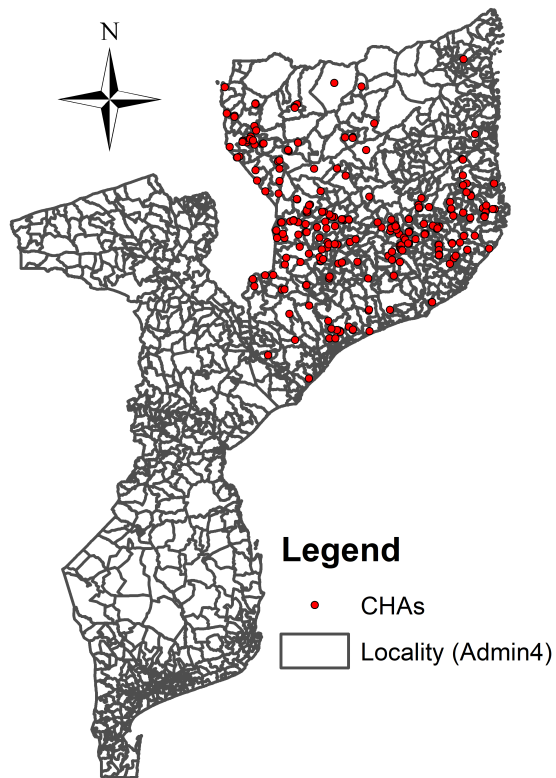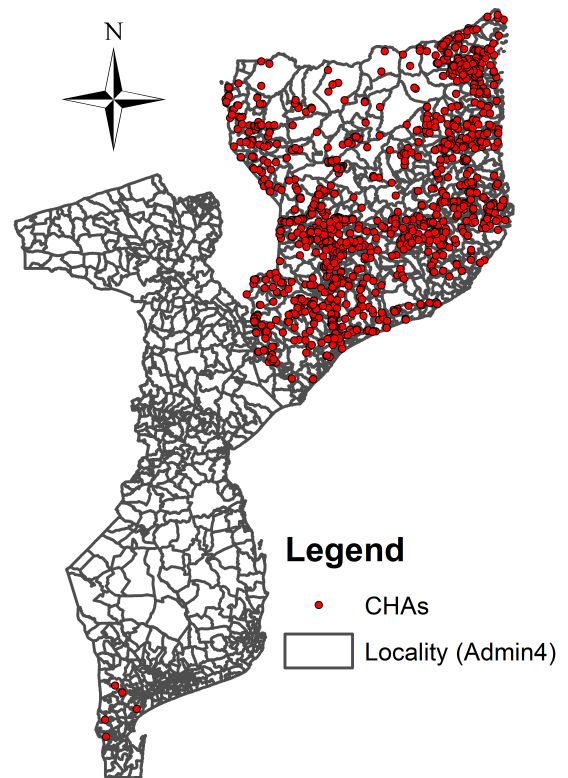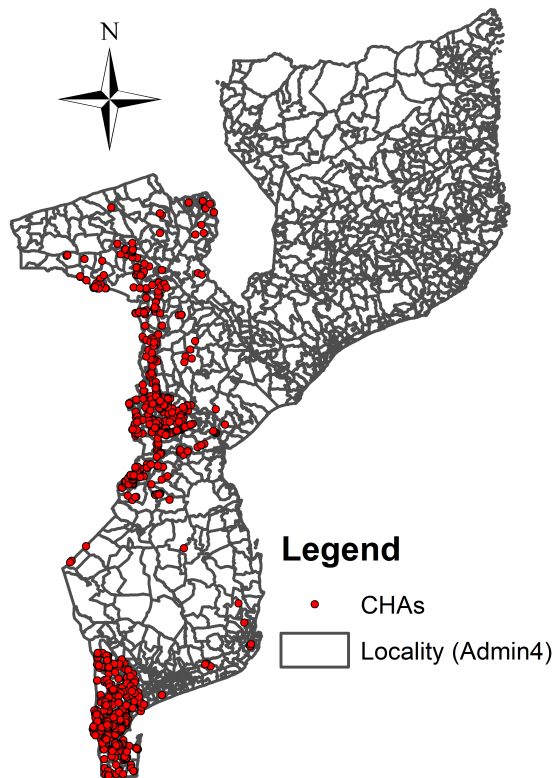Figure 9: **Distribution of Interventions by Main Operators**

Figure 10: **Distribution of Interventions by Main Operators and Periods**
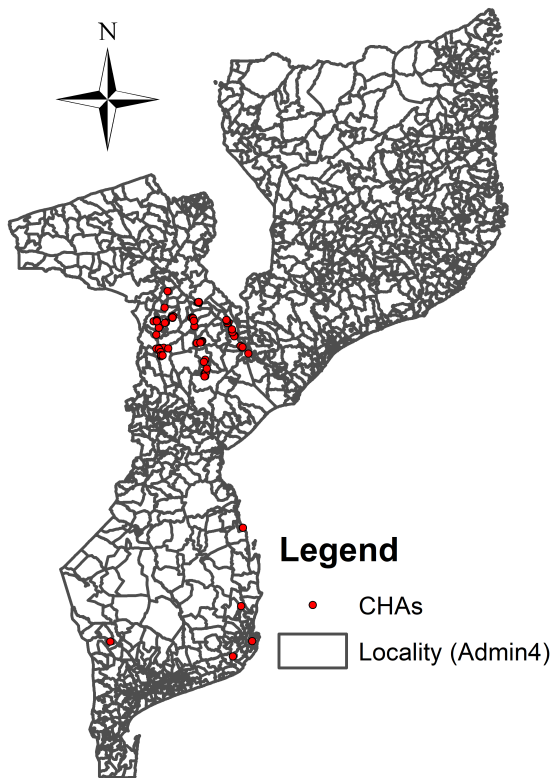
HALO Trust $1992 - 1999$
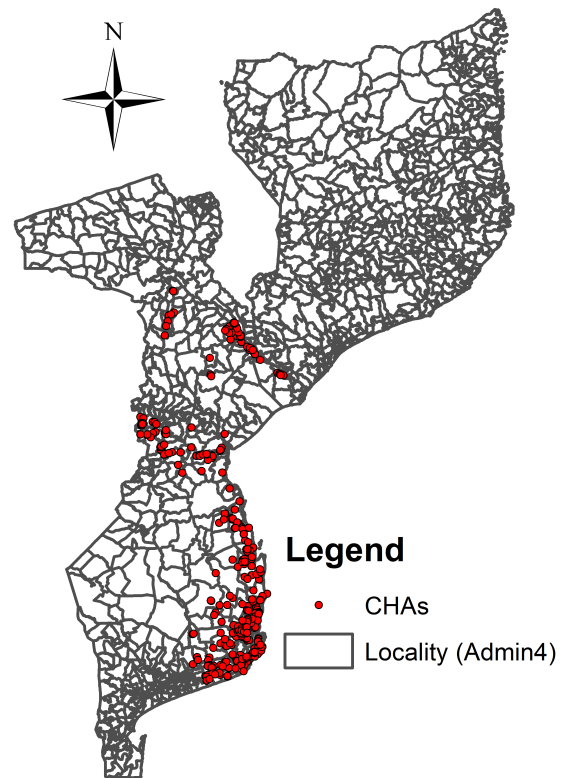
HALO Trust $2000 - 2007$
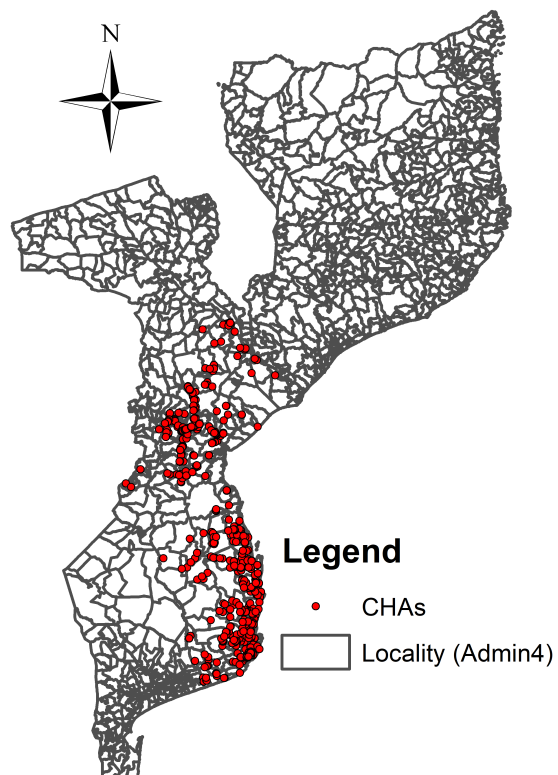
HALO Trust $2008 - 2015$

Figure 11: **HALO Trust Interventions by Period**
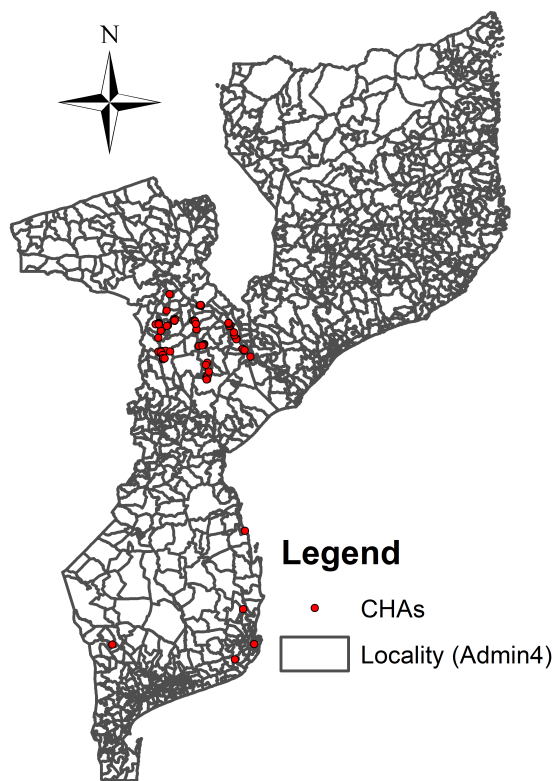
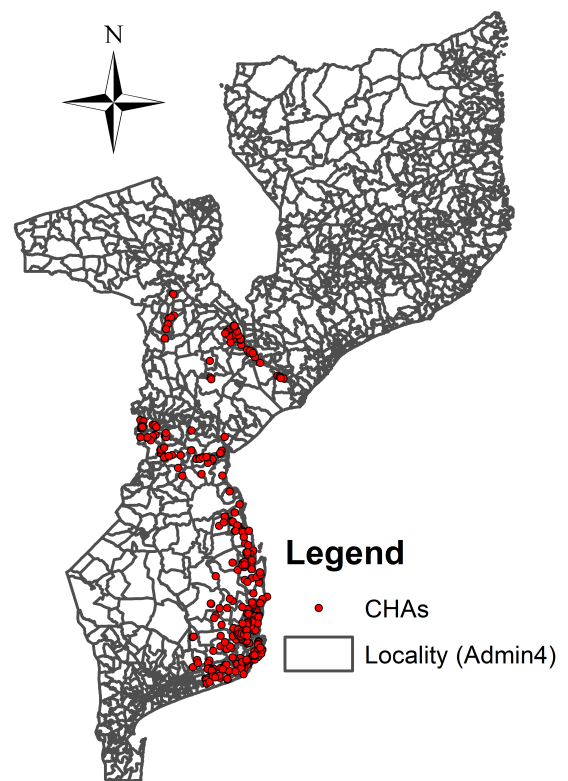Handicap International 1992 − 1999

Handicap International 2000 − 2007
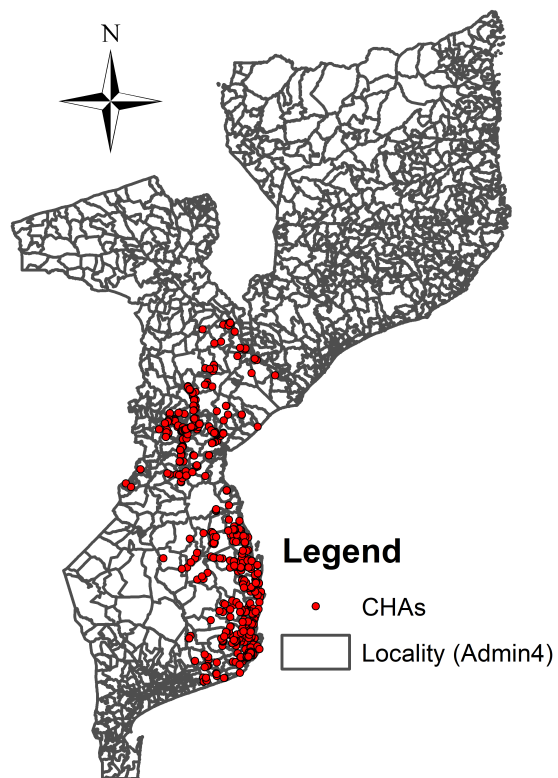
Handicap International 2008 − 2015

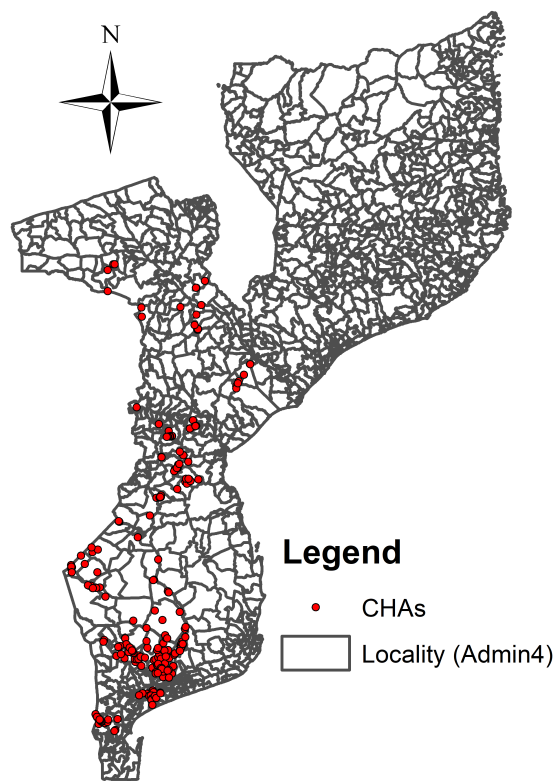Figure 12: **Handicap International Interventions by Period**
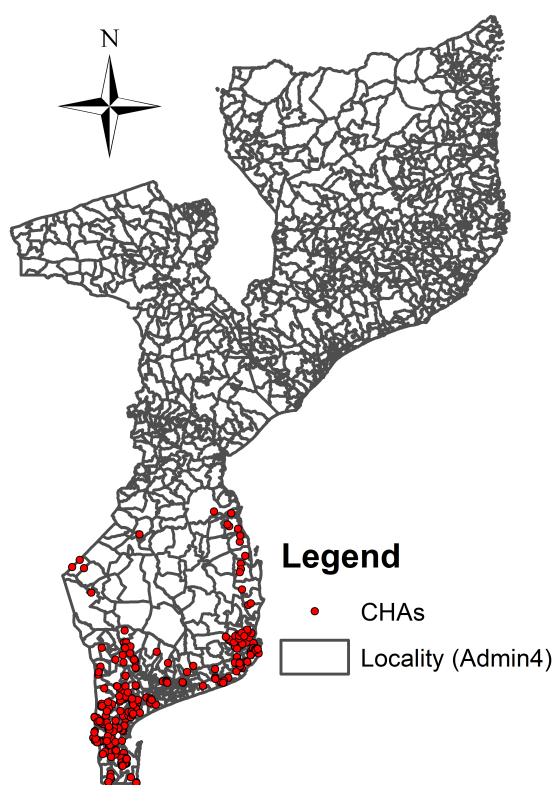
NPA 1992 − 1999

NPA 2000 − 2007

NPA 2008 − 2015

Figure 13: **Norwegian People's Aid Interventions by Period**

N

Legend

• CHAs

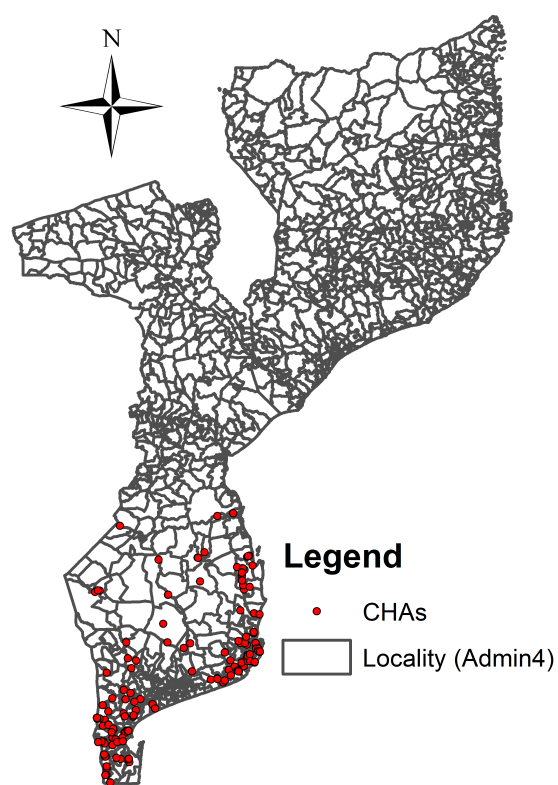☐ Locality (Admin4)

APOPO 2008 − 2015

Figure 14: **APOPO Interventions by Period**

ADP 1992 − 1999   ADP 2000 − 2007

Figure 15: **UN Accelerated Demining Program Interventions by Period**

2.2 Duration of Interventions

Another dimension regards the timing of interventions and its duration. Officials at the National Institute of Demining and the various NGOs alerted us that this information is of decent- but far from perfect quality. For each intervention, we have information on the starting and ending date. In Table 2 we break down the duration for each intervention. Around 92% of interventions were concluded in less than one year. The average intervention in this subsample lasts for 51 days. Around 3.62% of operations were concluded one year after the starting date. An additional 3.46% of intervention finished between 2 and 4 years after the start of the demining activities. Less than 1% of operation lasted more than 5 years, with a delay of 8 years in concluding the operations for 6 interventions. The longest intervention lasted 12 years in Macomia (Cabo Delgado), starting in August 1993 and concluding in November 2005. We further disaggregate the duration at the daily frequency. IND officials and deminers alerted us on non-negligible noise on the exact date and timing of intervention, though they argued that the reported year should be fine. These statistics should be, however, interpreted cautiously. The average time from start to finish of a demining intervention is 123.2 days; the median is just 8 days, as 41.6% of all interventions started and finished on the same day.

Table 2: **Duration at Intervention Level**

Years of Duration at Intervention Level	Freq.	Percent	Cum.
0	6,564	92	92
1	258	3.62	95.61
2	159	2.23	97.84
3	61	0.85	98.7
4	27	0.38	99.07
5	47	0.66	99.73
6	5	0.07	99.8
7	9	0.13	99.93
8	4	0.06	99.99
12	1	0.01	100
Total	7242	100.00	

2.3 Area of Interventions

We have information on the area of interventions as well as how many items (landmines and UXOs) that got cleared. Regarding the area of interventions, we have information on the cleared square meters for 4,202 interventions (56% of the universe of interventions). The average is 64949 square meter (a square with a side of 250m); while the median is 2500 square meter. The largest minefield we have

measures $45,870,000$ square meters (a square with a side of $6,7km$) and it is located in Gurue district in Zambezia. Another large minefield ($7,422,200$ square meter) was cleared by EDM in 2006 on a road in Namacurra village (Zambezia province). APOPO in 2009 cleared the largest minefield ($1,704,225$ square meter) in the post-2008 period on the Maputo-Komatipoort corridor (Tsokate locality in Gaza province).

2.4   Items Removed

Regarding the items removed, we have information for the number of landmines and UXOs removed/destroyed for around 80% of the sample. In this sample, we have $1,787$ interventions in which the clearance process led to no items found; while $4,252$ led to the discovery of at least one landmine or UXOs. The average number of landmines is 41.22 with a standard deviation of 769.86; while the average number of Unexploded Ordnances is 577.61 with a standard deviation of $5,569.7$. The largest number of landmines was found in Nametil (Cabo Delgado) in 2000 by HALO Trust. The minefield contained $29,729$ landmines ($28,773$ Anti-Personnel mines and 955 Anti-Group mines). The most contaminated minefields in the post-2008 period were demined by HALO Trust in 2014 in Magoe district (Tete) at the border with Zimbabwe. Figure 16 depicts the two polygons for Khahira Luia and N'Soluwamuthu minefields; HALO Trust cleared $14,608$ and $11,656$ landmines, respectively.

High quality data stores information on both the country of production and the model of landmines. Panel A of Figure 17 illustrates the distribution of landmines by country of production for the period $2008-2015$. In line with the history of the Civil War (see Appendix I), the majority of landmines were produced in Soviet Union 44.23% which was supporting the FRELIMO side. A sizable percentage of landmines (36.49%) were South African made, one of the main supporter of the RENAMO cause. Non negligible is the contamination due to the War of Independence: 1 every 10 landmines found between 2008 and 2015 was produced in Portugal. The same pattern is reflected by the most frequent landmine models deminers cleared. The Soviet MAPS landmines accounts for 35.91% of the landmines found in the post-2008; while the South African R2M2 model accounts for 25.2% of the cases.
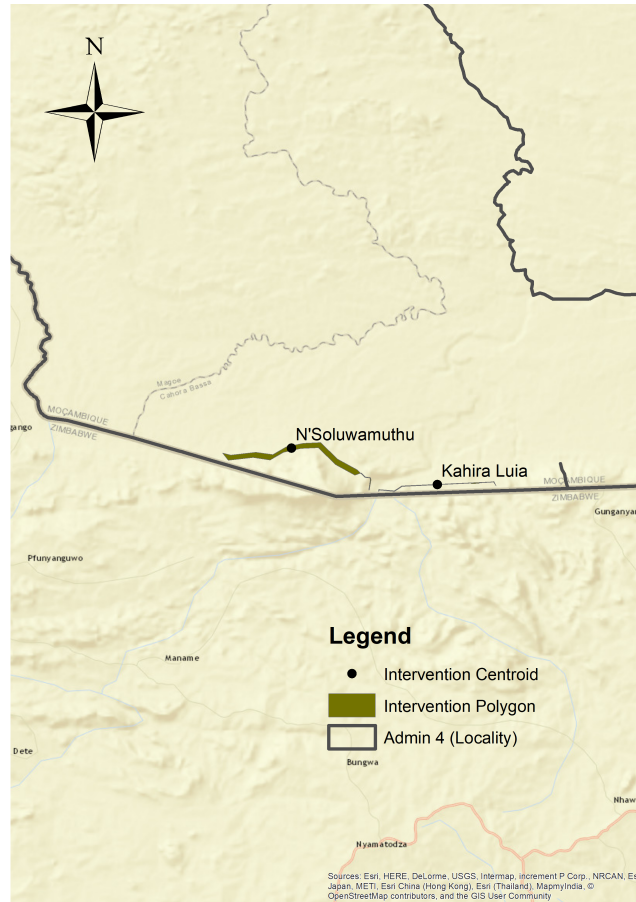
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Figure 16: **Khahira Luia and N'Soluwamuthu minefields (Tete province at the border with Zimbabwe)**

2.5 Heterogeneity Categories.

2.6 Report Based Categories

A characteristic of high quality reports is to contain a short description or a classification regarding the affected area of minefield. We are able to construct non-mutually exclusive categories for $4,497$ interventions (60% of the total sample). To construct a report based classification we extracted information from the following fields of the original data:

- Type of Cleared Area: Contains further information on the actual area type that got demined.

- Area Enumeration: Containing a classification by the deminers on the type of area affected by the hazard.

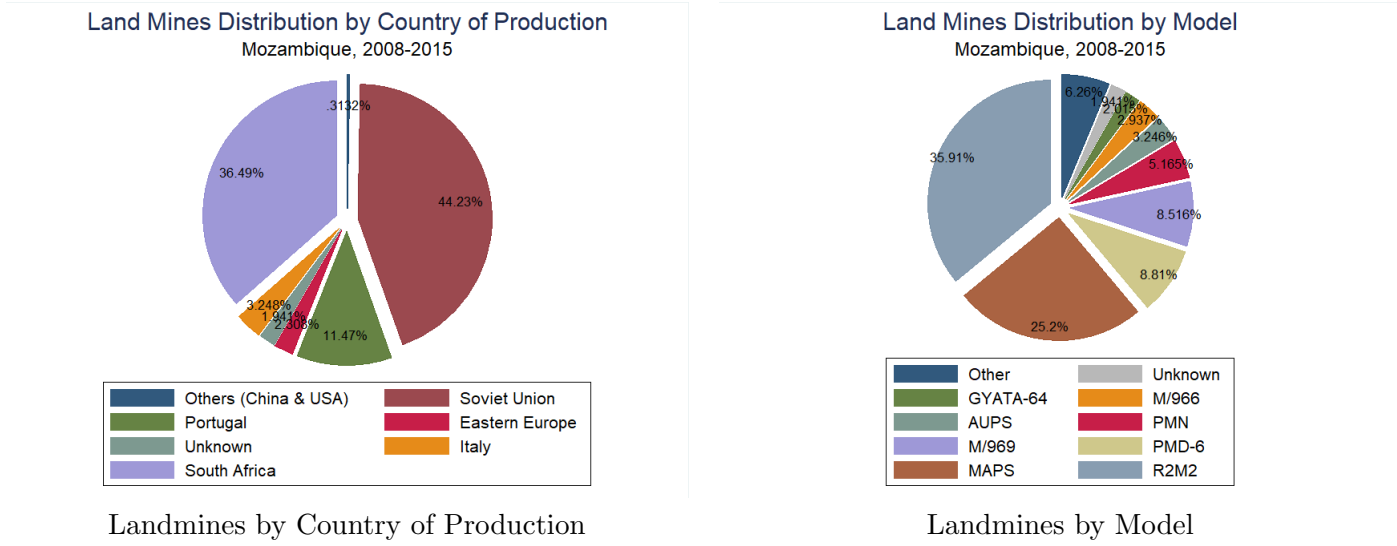- Hazard Name: The name of the site.

Landmines by Country of Production

Landmines by Model

Figure 17: **Distribution of Landmines by Model and Country of Production.**

- Hazard Description: This contains a description compiled by the deminers of the activity performed as well as information on the site conditions.

First, we employed ready-to-use categorization following the one conducted by deminers and practitioners. Type of Demined Area and Area Enumeration store the following categories: footpath, farmland, village, school, house, road, forest, water supply, military infrastructure, coast, river, pasture, public infrastructure, residential area. From these two categories, we retrieve information from 916 out of 4497 interventions. In case of disagreement in the classification (when both are present), we assign the Type of Area Demined as this represent the place in which the demining intervention was performed.

Second, we apply a semantic search algorithm based on the name of the hazard. Following the practitioners categorization, we selected keywords to be assigned to the corresponding categories. For example, a hazard named like "Frelimo Barrack" is assigned to Military; while a hazard titled "Lichinga Road" is assigned to Road categories.

Third, we manually imputed multiple categories for those interventions that have a description of the activities performed. In some instances the information has to do with the performance of the clearance e.g. "Demining is Proceeding well" or "The minefield was fully demined". In other cases, irrelevant information for the classification are stored e.g., "Mined Area". Notice that the these two procedures combined increased the number of report based categories to 3581 (79.6%) out of 4, 497. Not all the Hazard Description contents are useful for classification; as such we cannot retrieve

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meaningful information for 700 cases. For $2,131$ interventions (47.4%) we derive the categorization from the name only; and for 1450 interventions (32.2%) we use the detailed description.

Forth, we further aggregated the different categories for the 4497 interventions into 13 non-mutually exclusive report-based categories: i) Road, Railway, Bridge; ii) Border; iii) Protection Ring & Residential; iv) Public Infrastructure; v) Military; vi) River; vii) water supply; viii) Electricity Pylons; ix) Footpath; x) Forest/Bush; xi) Farm; and xii) Not Classified. To better clarify the contents of the report based categories we report few examples for the some of these categories.

2.6.1 Example of Road Category

- "The risk is not so high because even though it is suspected, the people are using the road as footpath. They acknowledge that only AT mines are suspected. Vehicles are not using the section of suspected road. There is alternative from the tour. The road from Mararanhe to Chissenguane was used as a main one from Buzi to Mushungue EN1 by big bus before civil war. Chissenguane village was occupied by Renamo's troops. They mined the road from Mararanhe to interdict Frelimo troop's movement on the road attacking them. According to the informants that information was supplied by old Renamos soldiers to local leaders. The certainty existing threat is because of the AT mine detonated on the road Estaquinha-Chissenguane in 2006 after vehicles moved on it several times. Locals would like the road to be renovated after clearance." Chissingana Locality in Sofala Province

- The road between Namarroi and Molumbo in NEIGHBOURING Milange District had long been closed due to the threat of mines. Halo employed LIRV to verify the road as clear and thus reopened this important inter-district highway bringing improved mobility, trade and all the attendant socio-economic benefits. Regone Locality in Zambezia Province.

- "The minefield is a turn in the Nacaroa-Mossuril track, 2km before Namipiza bridge, near Intete primary school and follow the road to Intete village."

2.6.2 Example of Border Category

- "The minefield is all the same of ejacamba the system of mining and types of mines. It is also the same direction to Pundanhar and was mined by the Portuguese to hinder the Frelimo who were staying in Tanzania during the war time." Nangade sede, Nagade District, Cabo Delgado

province

- "The minefield starts from Mtitimila village where barbed wire started at 40m wide and 21km long. This goes to Pundanhar direction and was mined by the portuguese to hinder the Frelimo soldiers who were hiding themselves in Tanzania and were crossing Rovuma river to fight with the colonies." Nangade sede, Nagade District, Cabo Delgado province

- "Along the border with Zimbabwe there are mines to prevent rape.." (Translated from Portuguese) Ressano Garcia town, Moamba district, Maputo province

2.6.3 Example of Protection Ring & Residential Category

- "All the entrances of the village are surrounded by AP mines, which are now identified as PMN and PMD-6 by a resident, on both sides of the small bridge. of the population. Information provided by the local Military Command" Maguiguana locality, Manhica district, Maputo province

- "the mined area starts from west part of Buzi river all the way to east region in a circle of 7 Kms around the village." Buzi town, Buzi district, Sofala province

- "Ring that protects the village." (Translated from Portuguese) Nalazi village, Guija district, Gaza Province

- "North to West area around the Hospital Town." Murrupula town, Murrupula district, Nampula province

- "the area is situated close to the church, within meters of the local population and there fields." Intaria locality, Macanhelas district, Niassa province.

2.6.4 Example of Military Category

- "This is an old frelimo base that served as a defense line for the village. They laid mines around the base in defense against the enemy attack from behind. The minefield runs from south to north with a distance of 50-100m from the base. It is limited to Northeast by cultivated field. " Ex Frelimo base. Marromeu municipality in Sofala Province" (Translated from Portuguese).

- "Additional information: In this place is the former command of the FPLM near the local Dumbanengue (market) of Sitila." (Translated from Portuguese) Sitila in Inhambane Province

- "The community sates that this minefield prevents them from moving freely in the area. The community is concerned that the local children born after war won't fear the area and might enter and have accident. Older resident avoid this area but if cleared would like to use it for farmland. Vuca centro dos antigos combatentes was a center or place inhabited by ex Frelimo liberation war troops. This ex-military center was once severely attacked by Renamo and for this reason a good re-enforcement of troops was sent by the government and all the population from the surrounding villages including Vuca was gathered together in the military center for protection. In order to deter Renamo troops, Frelimo soldiers laid mines in the south side of the center. The vast area between the center buildings and the suspect area was used for agriculture in order to produce food for the people living in the center during the war. Three accidents occurred during the war involving two children and a man who all died. This area is needed by the local for housing, chopping of sticks and wood for cooking and expansion of their cultivations." Centro de Antingos combatentes. Maimelane municipality in Inhambane Province

- "The mined area is a semi-circle where once there was a position of the 26th battle of the 2nd Mapai brigade, part of the village of Chipilimo that connects to the Dindijiva lagoon field." Mavue Sede in Gaza Province (Translated from Portuguese)

- "The mined area surrounds the barracks directly behind the Marrupa-Majune road." Marrupa Barracks. Marrupa Sede in Niassa

2.6.5 Cross-Tabulation of Report-Based and GIS-based Categories

Finally, we illustrate the relationship between the report-based classification and the GIS-based one. We highlighted in bold the element of the matrix that belong to "common" categories in the two classification. For example "Road, Railways, and Bridge" report-based category is associated with Road and Railway GIS category. Our validation works quite well for categories like Electricity Pylon. It is worth noticing that we performed badly for both Road and Railways and Village GIS categories.

GIS Categories vs Report Based Categories

	Matching Report-Based and GIS-Based Categories												
	Road, Railway, Bridge	Border	Protection Ring & Residential	Public Infrastructure	Military	River	Water Supply	Electricity Pylons	Footpath	Forest/Bush	Farm	Not Classified	Total GIS
GIS Road & Rail (100m)	**196**	106	104	38	130	108	24	17	97	36	7	478	1193
GIS Border (10000m)	36	**42**	40	34	53	38	12	84	29	21	31	260	618
GIS Cantinas (1000m)	44	65	**82**	18	53	75	9	2	57	19	3	269	617
GIS Civil War (1000m)	17	38	47	14	**23**	27	5	9	32	9	3	156	342
GIS River (100m)	5	1	7	2	3	**2**	0	0	3	1	0	16	37
GIS Village (1000m)	94	85	**129**	21	122	91	8	44	81	28	4	458	1052
GIS Electricity Grid (100m)	7	10	9	8	1	5	1	**256**	12	8	0	58	360
GIS Residual	302	313	378	234	578	430	69	658	235	121	1	1731	4656
Total Report-Based	669	542	667	331	845	661	117	957	448	218	32	2851	7423

Notes. The table reports cross-validation between the report-based and GIS-based categories. The Data Appendix gives detailed variable definitions and data sources.

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3 Disaggregation by Provinces and Periods

In this section we provide a detailed description of the three periods of the Mine Action program for each of the ten Mozambican provinces. In table 3 we summarize the statistics by province and period.

Table 3: **Affected Localities and Demining Totals.**

Province	Full Sample			Period 1		Period 2		Period 3	
	Localities		Interventions	Localities	Interventions	Localities	Interventions	Localities	Interventions
	Total	Affected	Total	Fully Cleared	Total	Fully Cleared	Total	Fully Cleared	Total
Cabo Delgado	130	98	508	0	3	86	484	12	21
Gaza	129	70	453	9	63	17	205	44	185
Inhambane	79	75	992	1	117	11	471	63	404
Manica	104	85	1053	2	79	7	197	76	777
Maputo	78	71	1211	3	187	2	163	66	861
Nampula	172	106	612	6	124	91	477	9	11
Niassa	87	73	572	3	96	41	430	29	46
Sofala	80	70	936	3	121	12	255	55	560
Tete	127	71	327	6	43	21	76	44	208
Zambezia	201	136	759	6	80	115	660	15	19

Notes. This Table reports the number of fully cleared localities and the number of interventions across the Mozambican provinces and by period: $1992 - 1999$, $2000 - 2007$, and $2008 - 2015$.

3.1 Cabo Delgado Province

The province of Cabo Delgado experienced 508 demining interventions from 1993 to 2012. As in the other three Northern provinces, the key player was HALO Trust. In fact, HALO performed 87.2% (443 interventions) of the demining activities in the region. Other demining operators include: AFROVITA (1), Empresa Moçambicana de Desminagem (EDM) Lda (5), IND (10), MONECHECHA Ltda (1), MOPROTECTOR Lda (3), and Mine Kills Lda (2). Moreover, we added 42 cleared minefields from the LIS 2007. According to GIS-classification, the two main categories of interventions were villages (93) and the transportation network (68) (see Figure 19).

Appendix Figure 18 portrays the spatial distribution of demining activities in Cabo Delgado for each of the three phases of the Mozambican Mine Action program. Out of the 130 localities in Cabo Delgado, 98 (75.4%) were affected by land mines contamination in 1992. In the first period of the Mine Action program (1992-1999), almost no demining activities took place. Starting in 1997, HALO Trust slowly started to deal with the contamination problem in the region. In the late 90s, HALO performed a total of 3 demining operations including a road and a village. The second period (2000-2007) represented a turning point in the demining activities of the province. HALO Trust completed 440 demining interventions, eliminating 86.6% of the total threats in Cabo Delgado. AFROVITA is the only other NGOs to be active in this period (1 intervention in 2004).

By the end of 2007, 86 out of the 98 contaminated municipalities were now free from landmines. After the departure of HALO Trust to the South of the country, some residual threats (21) were cleared by few Mozambican commercial operators: EMD (5), IND (10), MONECHECHA (1), MO-PROTECTOR (3), and Mine Kills (2).

Clearance of CHAs in Cabo Delgado 1993-1997   Clearance of CHAs in Cabo Delgado 2000-2007
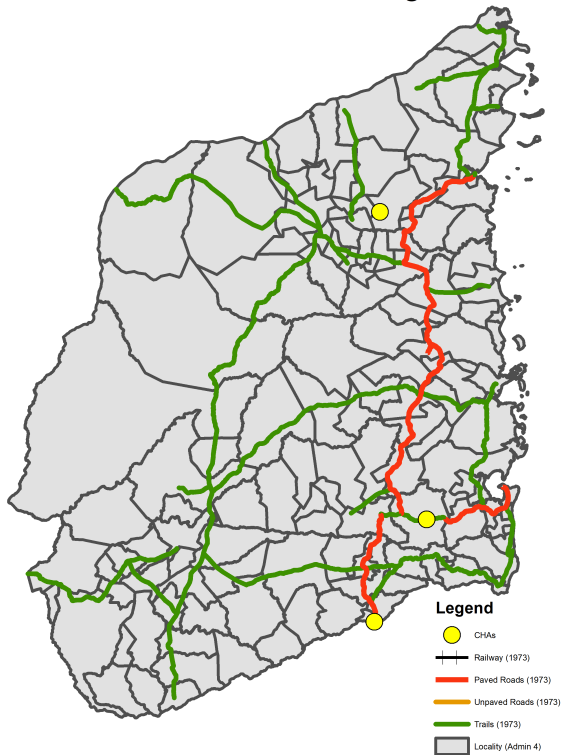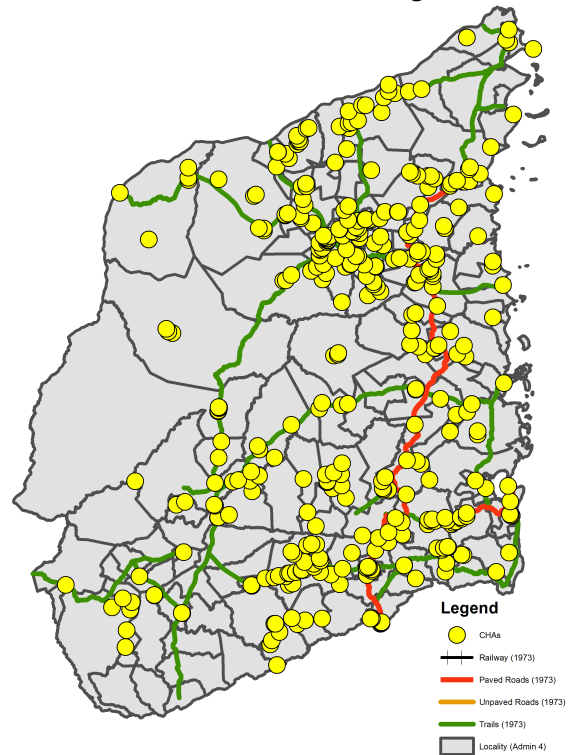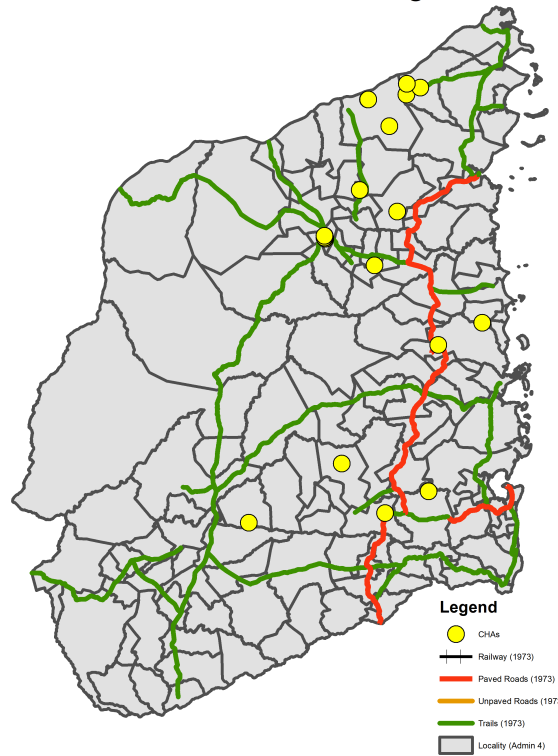
Clearance of CHAs in Cabo Delgado 2008-2015
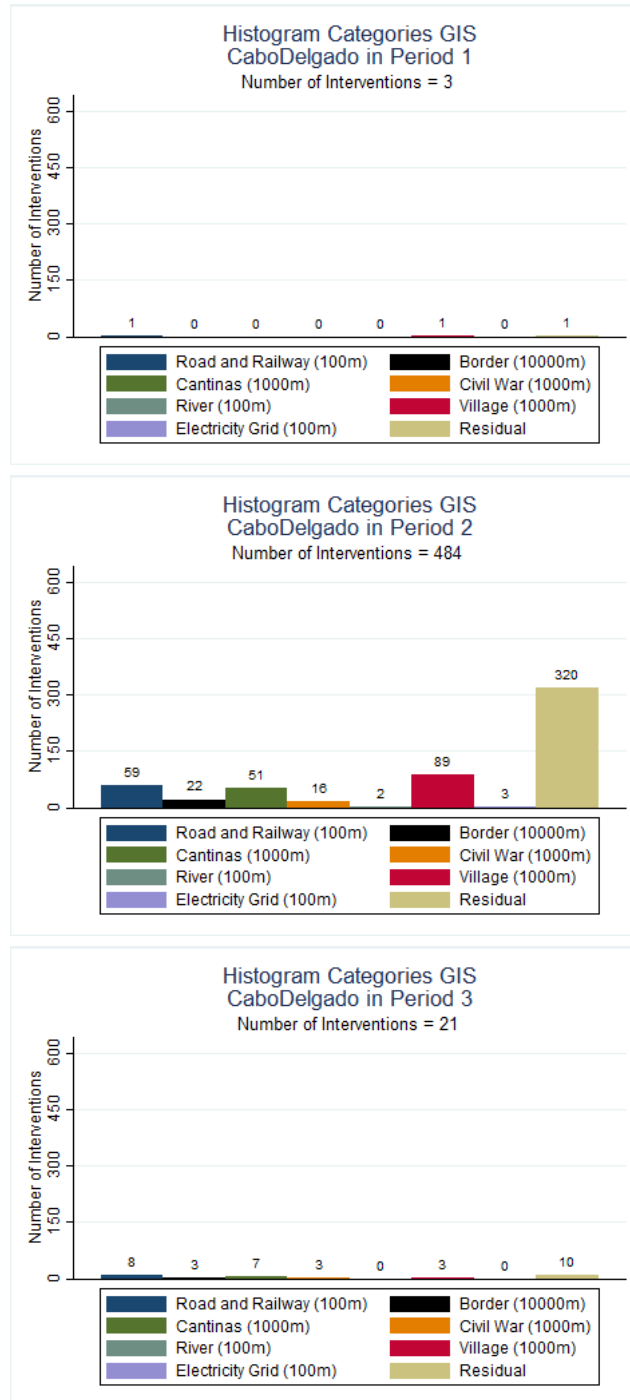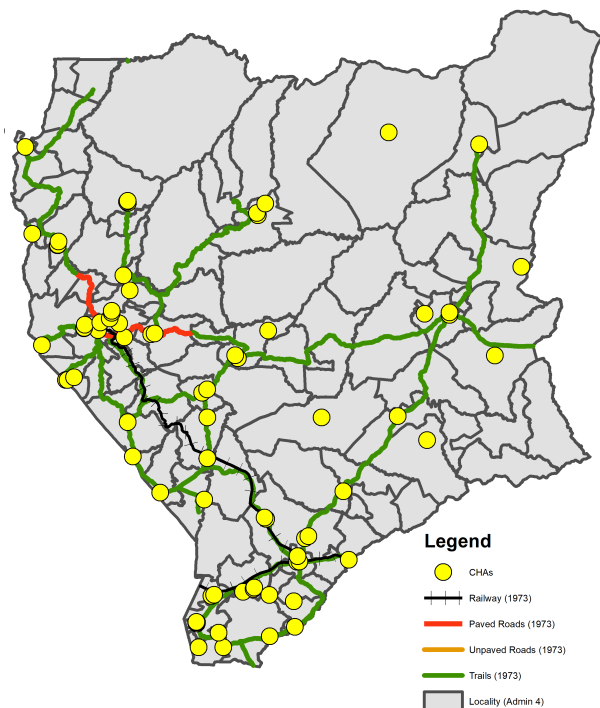

Figure 18: **Interventions in Cabo Delgado**

Figure 19: **GIS Category Interventions in Cabo Delgado**

3.2 Niassa Province

Niassa province saw a total of 572 demining interventions from 1995 to 2012. HALO Trust, which completed 78% (446 interventions) in the region. The Mozambican Army (Forças Armadas de Defesa de Moçambique - FADM) has been second most important player in Niassa, with 47 interventions. The other operators active in Niassa were: EDM (2), IND (19), MF Investimentos (1), MONECHECHA (1), MOPROTECTOR (3), Mine Kills (11), and Scorpion Desminagem Lta (3). The LIS 2007 recorded additional 28 interventions. Figure 21 gives the non-mutually exclusive GIS-based categories for the province. Across the three periods, the majority of interventions were on the vicinity of the villages (89), border (55), and transportation network (54).

Appendix Figure 20 shows the spatial distribution of demining activities in Niassa for each of the three periods. Contamination across localities was severe: 83% (73 out of 87) localities were affected by minefields. Regarding the first period (1992-1999), HALO Trust commenced landmine clearance in 1996, after two demining interventions in 1995 (one performed by the UNHCR). By the end of 1999, 86 interventions were completed by HALO, with the majority of clearance targeting trails and roads (59%) and villages and colonial commercial places (32%). Some demining activities (8%) took place along the Lichinga-Cuamba railway line. In the beginning of 2000, no affected locality was listed as mine-free. With the new millennium, demining operations increased throughout the province. HALO Trust continued to be the principal player in Niassa. By the end of 2007, HALO had completed 81% (307) of the clearance activities. In 2003-2004, the FADM also completed several tasks (47). During this period, the Mozambican commercial operator EDM cleared a trail and part of the electric lines nearby Lichinga. These efforts allowed to declare 41 localities landmine free. In the last period (2008-2015), few more CHAs out of the HALO's "Baseline Assessment" were discovered. Additional 46 interventions were performed between 2010 and 2012. The IND, with its Northern office, directly performed 19 operations. Mozambican commercial operators completed the remaining 35 tasks in the following way: DAG (16), MF Investimentos (1), MONECHECHA (1), MOPROTECTOR (3), Mine Kills (11), and Scorpion Desminagem Lta (3).

Clearance of CHAs in Niassa 1993-1999

Clearance of CHAs in Niassa 2000-2007
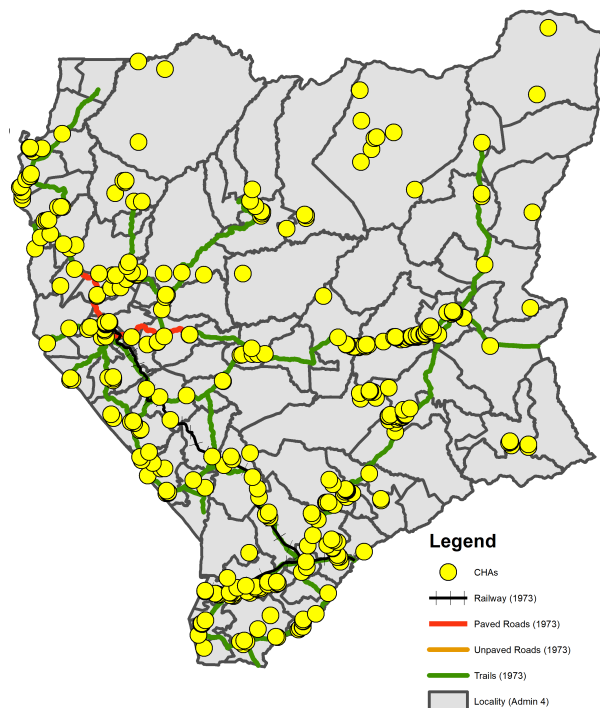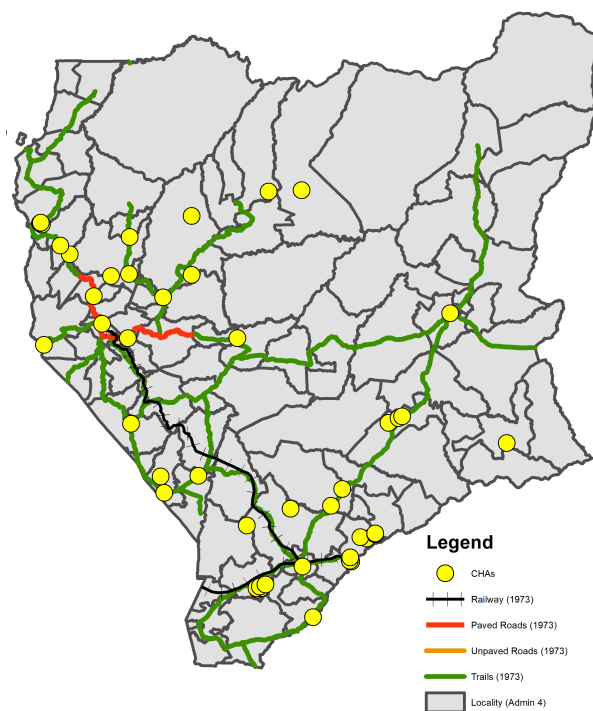
Clearance of CHAs in Niassa 2008-2015

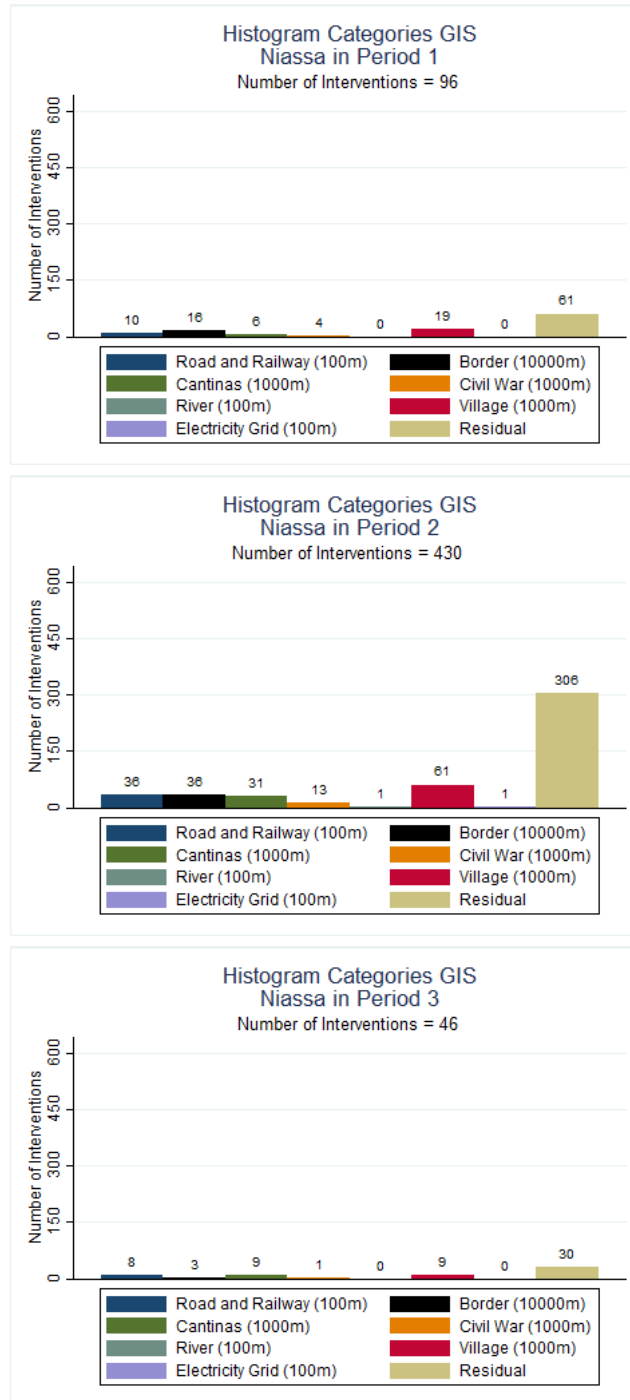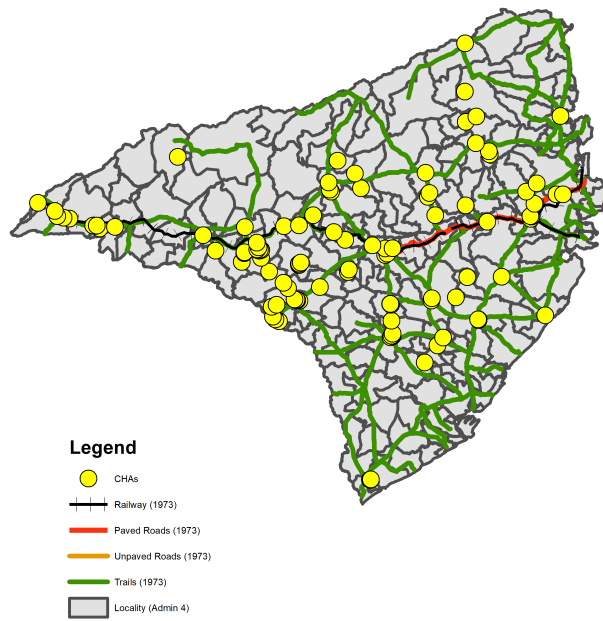Figure 20: **Interventions in Niassa**

Figure 21: **GIS Category Interventions in Cabo Delgado**
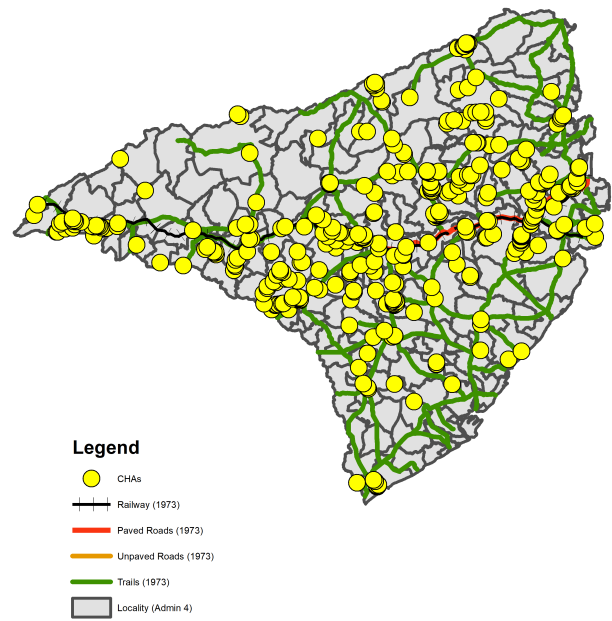
3.3 Nampula Province Summary

612 landmine clearance operations took place in Nampula province. HALO Trust was the main operator completing 92% (566) of the tasks. Residual tasks were performed by mostly commercial operators and one humanitarian demining company (Norwegian People's Aid). Among the commercial operators, most of them were Mozambican including Desminagem e Agricultura (DAG) (1), Empresa Moçambicana de Desminagem (EDM) Lda (2), MONECHECHA (4); while, the UK MINE-TECH and the Dutch REASeuro were among the foreign commercial demining companies active in Nampula. Finally, IND, which created a local office in Nampula in 2009, performed 6 demining interventions. Regarding the GIS-based categories, 137 interventions involved demining around villages; demining activities on roads and railways were also particularly intense: 79 intervention targeted the transportation network, with the railway line connecting Lichinga to Nampula severely affected. Figure 23 reports the GIS-categories interventions by period.

Appendix Figure 22 depicts the spatial distribution of demining activities in Nampula across the three periods. Contamination in Nampula province across localities was smaller, in relative terms, compared to the other Northern provinces: out of the 172 localities, 106 (62%) were affected by landmines. In spite of the dominance of HALO Trust in Nampula, NPA performed the first demining in 1994 in the village of Imala, nearby Mecuburi. In 1996 HALO Trust started to operate in the province. By the end of 1999, HALO had cleared 120 threats. In 1997 MINE-TECH made two interventions on the primary road connecting Lichinga to Nampula. EDM performed a demining intervention on the railway line linking Lichinga to Nampula in 1999. At the beginning of 2000, demining operations freed 6 localities from mine contamination. The second period of the Mine Action program saw significant progress in terms of demining activities in Nampula. HALO Trust had completed 446 interventions by the end of 2007. Between 2005 and 2006, the Dutch REASeuro completed 9 interventions on roads and on the electric grid between Nampula and the town of Mussuril. The Mozambican commercial firm EDM cleared a road nearby the town of Nametil in 2006. These efforts reduced significantly the number of localities affected by landmines to only 9 at the end of 2007. After 2007 and the departure of HALO Trust, subsequent surveys detected few new minefields. 13 additional operations were performed by the IND (6) and Mozambican commercial companies (DAG (1), JV Desminagem (2), and MONECHECHA (4)) between 2010 and 2012.

Clearance of CHAs in Nampula 1993-1999   Clearance of CHAs in Nampula 2000-2007

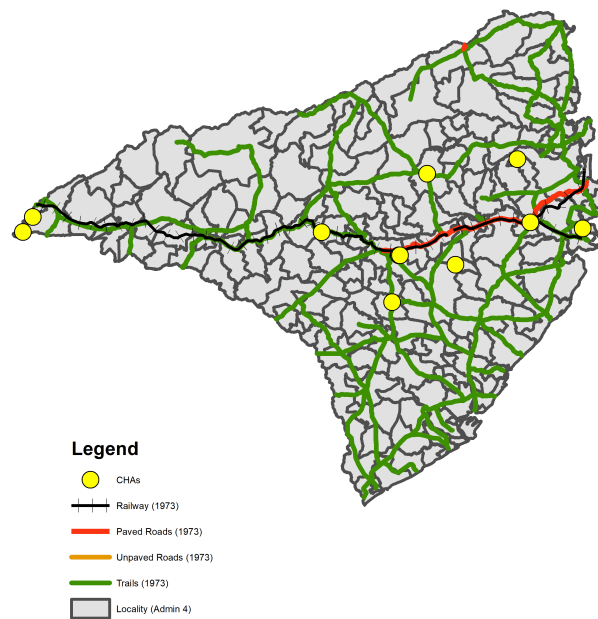Clearance of CHAs in Nampula 2008-2015
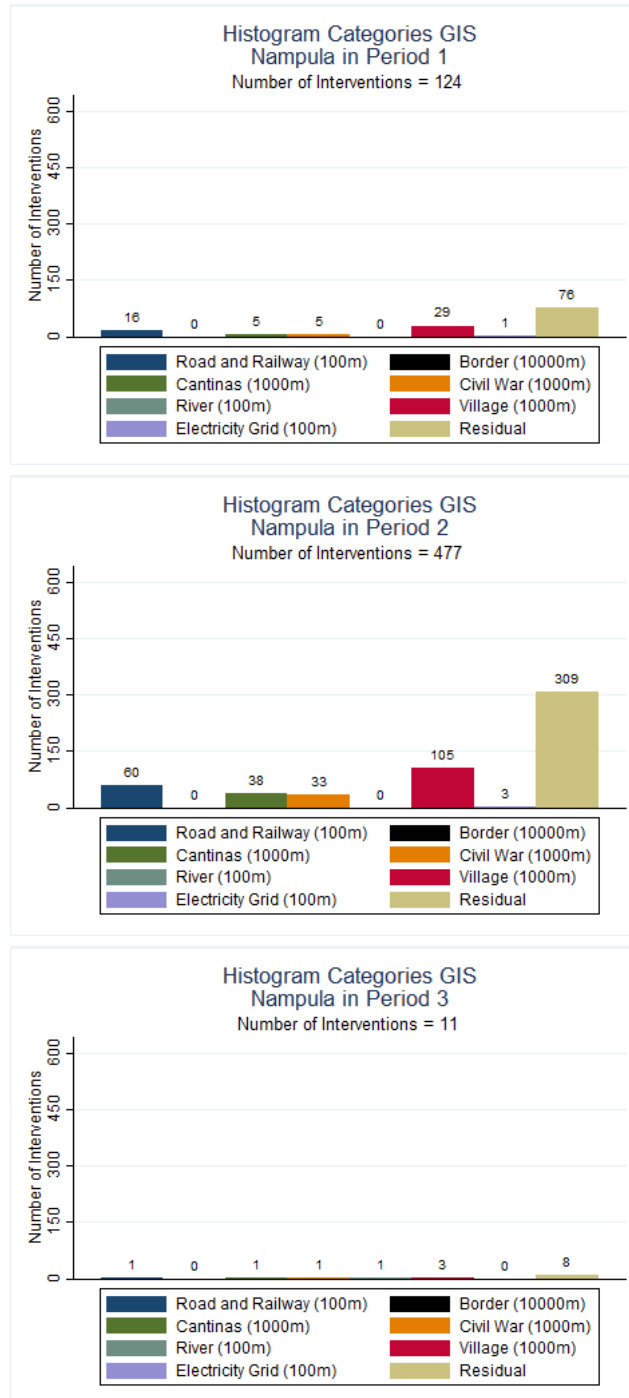

Figure 22: **Interventions in Nampula**

Figure 23: **GIS Category Interventions in Cabo Delgado**
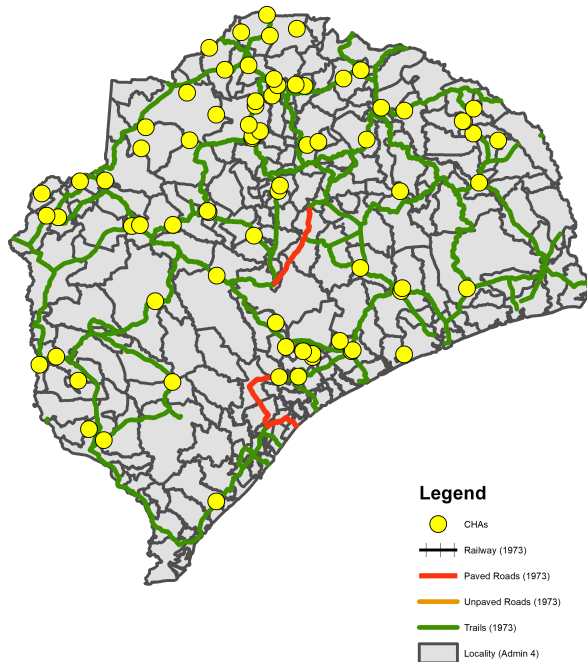
3.4 Zambezia Province Summary

The province of Zambezia experienced 759 demining interventions during the Mine Action program in Mozambique. HALO Trust performed 86% (654) of the interventions. The residual players were JV Desminagem (14), MINE-TECH (11), IND (12), RONCO (9), Desminagem e Agricultura (DAG) (8), Empresa Moçambicana de Desminagem (EDM) Lda (8), Mine Kills Lda (3), Norwegian People's Aid (3), MONECHECHA Lda (2). Figure 25 plots the distribution of GIS-based categories by period. The mostly affected category in Zambezia is the transportation network (192), followed by villages (109).

Appendix Figure 24 illustrates the spatial distribution of demining activities in Zambezia across time. At the time of the Peace Agreement in Rome, Zambezia presented the highest number of mine-affected municipalities in Northern Mozambique: a total of 136 (66% of the total number of localities). Between $1992-1994$ HALO Trust did 7 interventions and established its headquarters in this province. At the same time, RONCO (4) and NPA (1) were active on the ground. In response to the need for refugees repatriation from Malawi, the majority of demining operations in this period focused on the clearance of threats affecting roads and trails.

These initial operations allowed to fully clear only one locality. By the end of 1999, Halo Trust reached 61 interventions in the province. RONCO performed few interventions (5) in 1995 before terminating its contract with USAID; while in 1998 MINE-TECH did a couple of demining activities.

During the first phase, a total of 6 municipalities were completely demined. In the second phase (2000-2007) demining operations accelerated. A total of 660 clearance tasks were concluded. HALO Trust completed 586 demining activities and closed its operation in the province in 2007. Two Mozambican commercial operators EMD, JV Consultores and the UK MINE-TECH completed a total of 30 interventions (7, 14, and 9, respectively). As in the previous period, the majority of demining activities took place along roads (57%) and villages (28%). As a results of this process, 115 municipalities were declared fully cleared from the threats of landmines. After being declared mine-free in 2007, few more minefields were found in 2010 (19 interventions coordinated by the IND with the involvement of local commercial operators DAG, MONECHECHA, and Mine Kills) and in 2012 (2 demining activities from DAG).

Clearance of CHAs in Zambezia 1993-1999
Clearance of CHAs in Zambezia 2000-2007
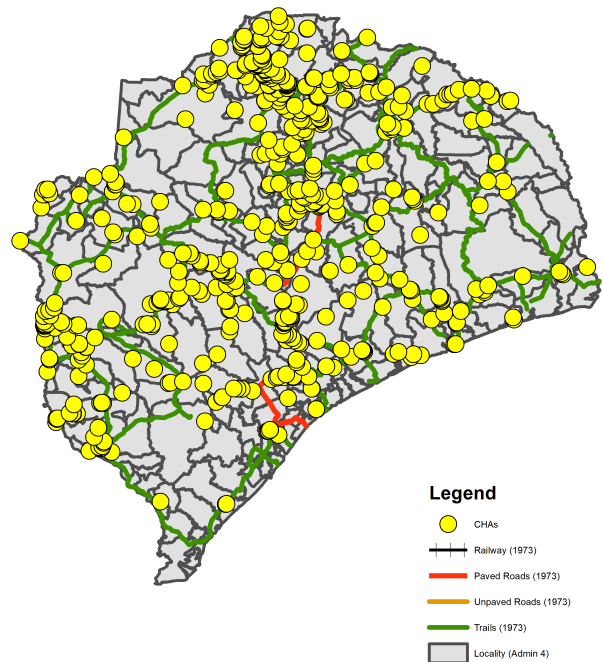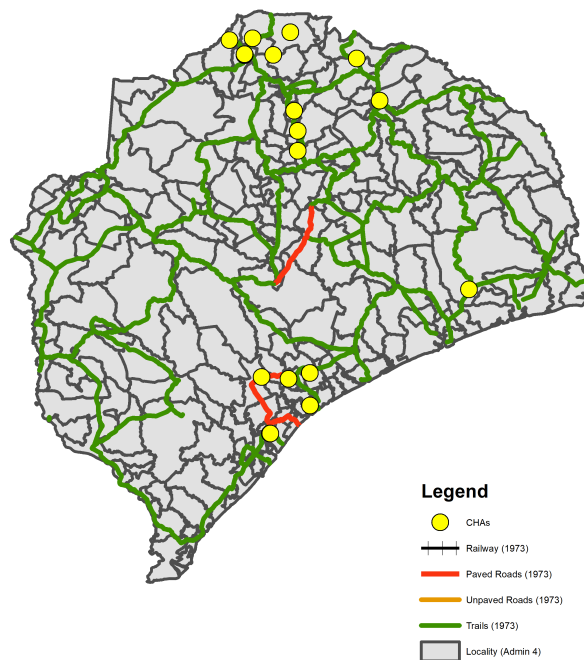

Clearance of CHAs in Zambezia 2008-2015

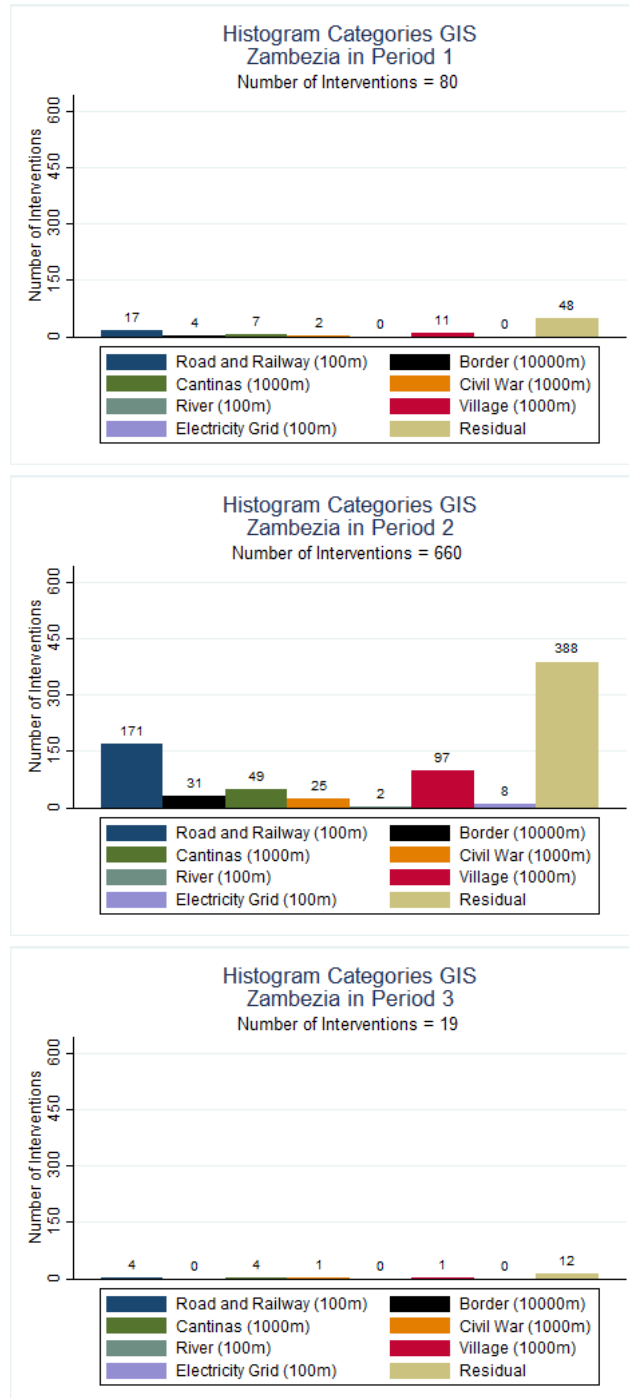
Figure 24: **GIS Category Interventions in Zambezia**

Figure 25: **Interventions in Zambezia**

3.5 Tete Province Summary

From 1993 until 2015, 327 demining interventions were performed in the Central-Eastern province of Tete. During this period 13 humanitarian and commercial, demining operators were active. HALO Trust completed 165 interventions and the Norwegian People's Aid 90. Other clearance actors were APOPO (10 interventions), BACTEC (2), Desminagem e Agricultura (6), Empresa Moçambicana de Desminagem (EDM) Lda (6), JV Desminagem (1), MF Investimentos Lda (4), Mechem (2), Mine Kills Lda (3), and RONCO (5). As Figure 27 shows, the majority of interventions were performed to clear the border with Zimbabwe (71 operations), followed by clearance of roads (58) and villages (46).

Appendix Figure 26 portrays the spatial distribution of demining activities in Tete. In 1992, 71 (56%) localities out of 127 were affected by landmines, one of the smaller contamination rates in the country. Tete was one of the provinces where the early years (1992-1994) of demining activities were highly productive. Under the direction of the ONUMOZ mission, both NPA and the commercial firms Mechem and RONCO undertook several road clearance interventions to facilitate refugees' repatriation from Malawi. NPA completed 11 demining interventions at the end of 1994; while, Mechem and Ronco performed 2 operations each. From 1995 to 1999, NPA kept on going with demining operations in the province, concluding 27 additional interventions by the end of 1999. In 1997, Mechem cleared a threat on the Zambezi river, nearby Cheuza locality in Mutarara district.

By the end of the first phase, 6 municipalities were freed from the threat of land mines. From 2000 to 2007, the clearance progress started to slow down. Only 76 interventions were completed by NPA (40), DAG (2), and RONCO(3). Ronco came back in the region in 2005 − 2006 to clear villages and roads nearby the town of Nhamayabue (Mutarara district). While the Northern provinces experienced an increase in the pace of demining across localities, only 21 were fully cleared during these 8 years in Tete. Following the departure of NPA from the Mozambique in 2006, several players entered Tete province to finish the demining process in the region. From 2008 till 2015, HALO Trust completed 165 interventions. APOPO contributed with 10 operations in 2013 and 2014. While, NPA, returning in Mozambique in 2012, completed 12 additional tasks from 2012 until 2015. The remaining operations were divided as follows: Bactect (2), DAG (4), EMD (6), IND (2), JV Desminagem (1), MF Investimentos (4), MOPROTECTOR (1), and Mine Kills (3).

Clearance of CHAs in Tete 1993-1999
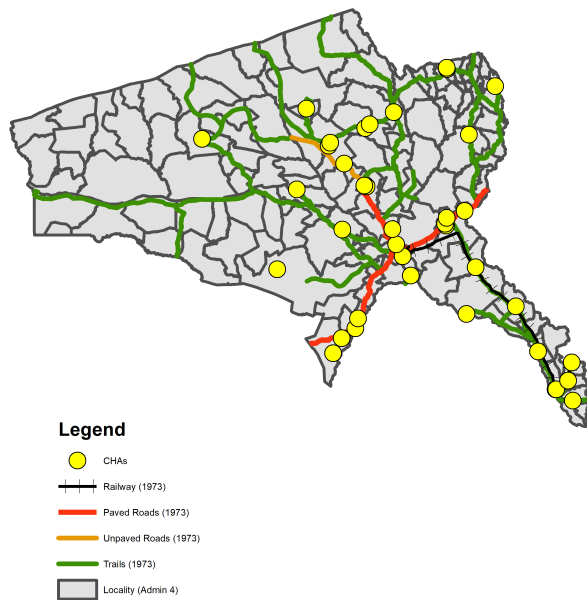
Clearance of CHAs in Tete 2000-2007
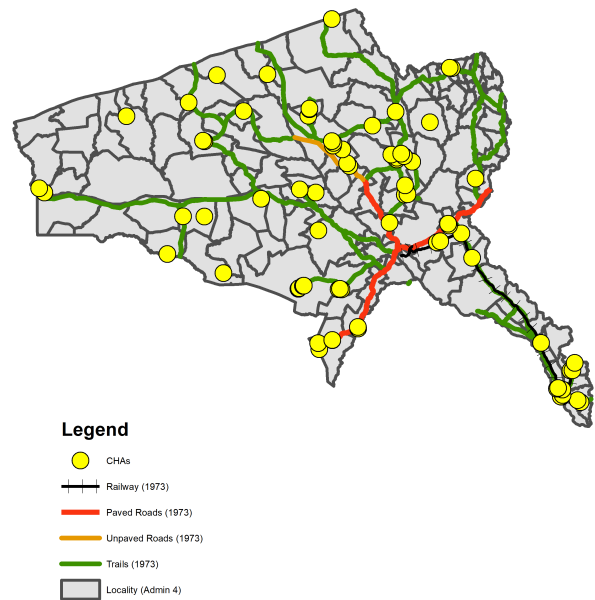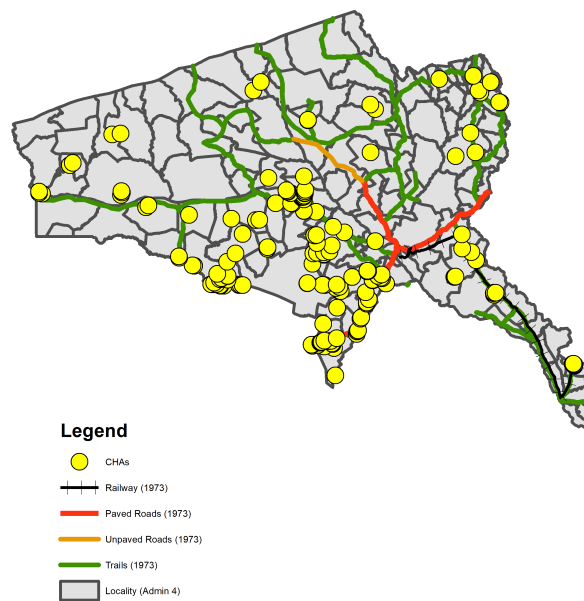
Clearance of CHAs in Tete 2008-2015

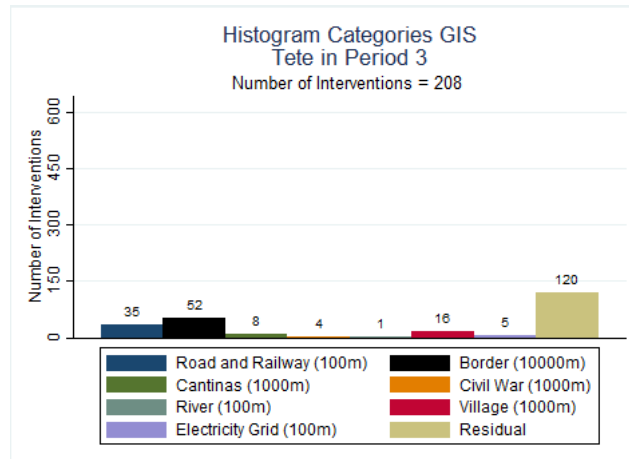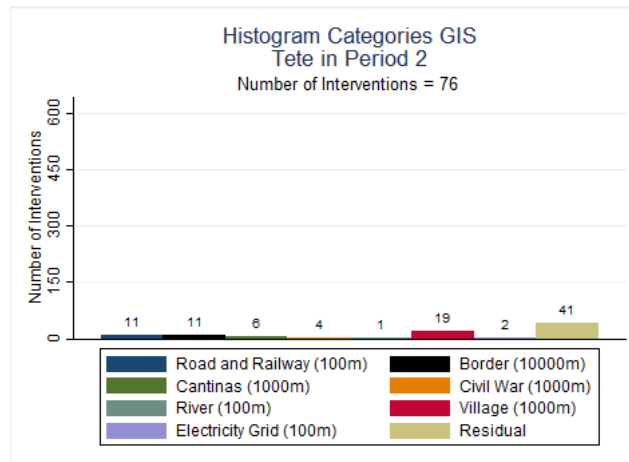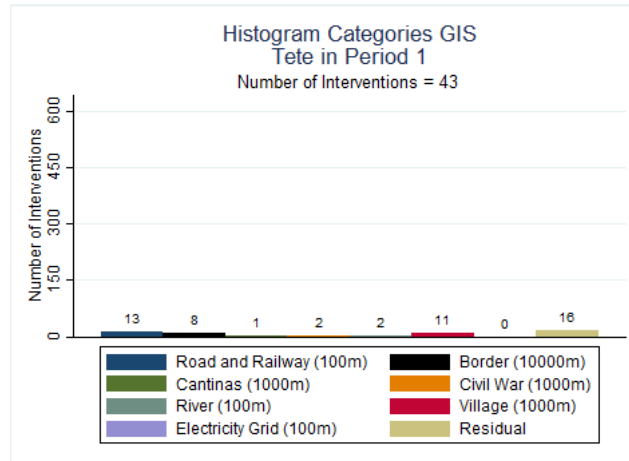Figure 26: **GIS Category Interventions in Tete**
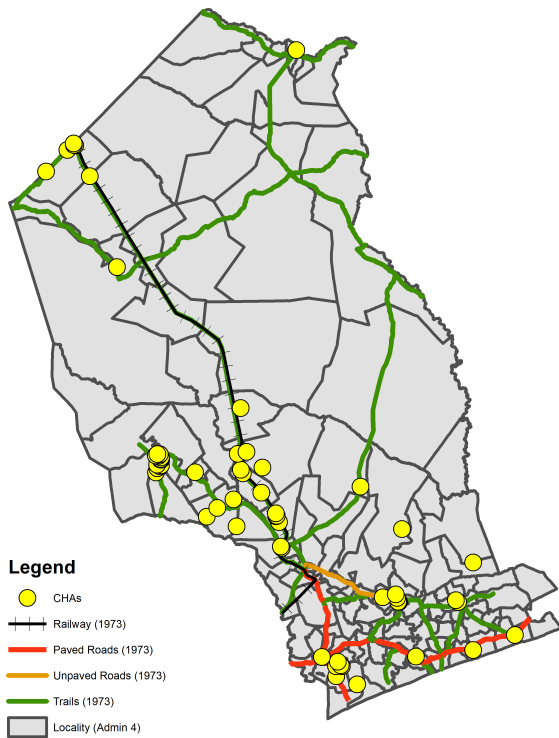
Figure 27: **Interventions in Tete**

3.6 Gaza Province Summary

In the Southern province of Gaza, our dataset reports a total of 453 demining interventions between 1995 and 2015. During the Mine Action program, 17 demining operators were active. The actor that completed most activities in the province was APOPO, conducting almost 39% (175) of the interventions. Other important players for the province were United Nation's Accelerated Demining Program (UNADP) (64), Mozambique Mine Action (MMA) Lda (61), MECHEM (60), and Menschen gegen Minen (MGM) (40). The remaining players, operating at different stages of the program, were: AFROVITA (2), Associacao de Sapadores Macambicanos (2), ECOMS Desminagem (1), Empresa Moçambicana de Desminagem (EDM) Lda (1), Mozambican Army (Forças Armadas de Defesa de Moçambique - FADM) (3), GPC International (1), Halo Trust (9), JV Desminagem (6), MF Investimentos (1), MINE-TECH (4), and NECOCHAMINAS (6). Focusing on the GIS-based categories of interventions, 85 operations interested the transportation network (like the railway line connecting Maputo to Chicualacuala); 44 interventions were performed to clear mined-affected villages; while, 42 interventions involved the clearance for the Zimbabwean border. Figure 29 delivers the tabulation for the three periods.

Appendix Figure 28 portrays the spatial distribution of demining activities in Gaza across periods. In the beginning of 1992, the landmine contamination was present in 70 out of 129 localities (56%). Reflecting the logistic difficulties of the UNADP, which was the most important player in the South in the initial phase (1992-1994), no demining activities were recorded in Gaza until the end of 1994. From 1995, landmine clearance started in the province. The UNADP completed 42 demining operations, mostly focusing on village protection-ring clearance (like Macia, Eduardo Mondlane and Mandlakaze villages) and demining of trails. Commercial operators were active during this period: MECHEM completed 16 tasks; while, MINE-TECH finished 4. Yet, locality-level clearance remained low, with only 9 becoming landmine free. By the end of 2007, more operators entered the region. The UNADP performed only 22 operations in these 7 years. At the same time, MMA (61), Mechem (44) and MGM (40) started to operate extensively in Gaza. In spite of the increased participation in the province, only 17 additional localities were listed as fully cleared during these 8 years. In the beginning of the fourth period, the shutdown of the UNADP in 2006 changed the composition of demining operators in the Gaza. APOPO became the main demining operator. From 2008 to 2015, APOPO completed 175 tasks, targeting the remaining affected roads, river access, railways and villages. Among the remaining operators, HALO Trust played an important role in the clearance of the Zimbabwean border between

2009 and 2011.

Clearance of CHAs in Gaza 1993-1999

Clearance of CHAs in Gaza 2000-2007
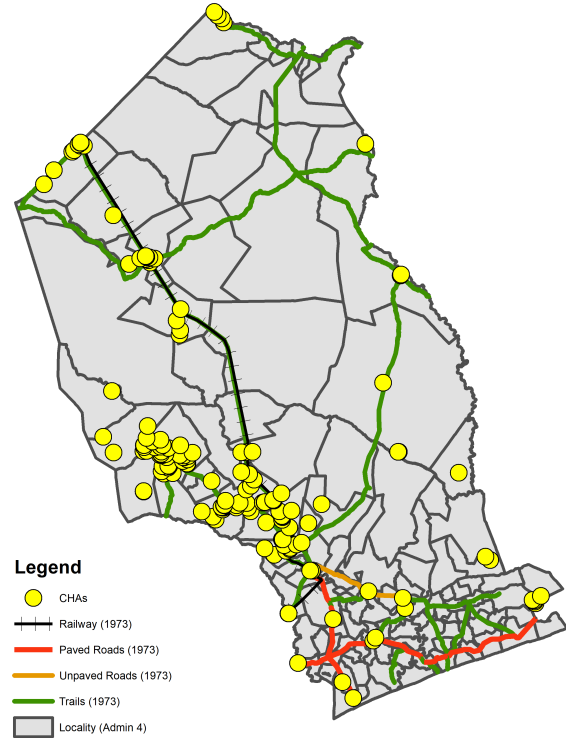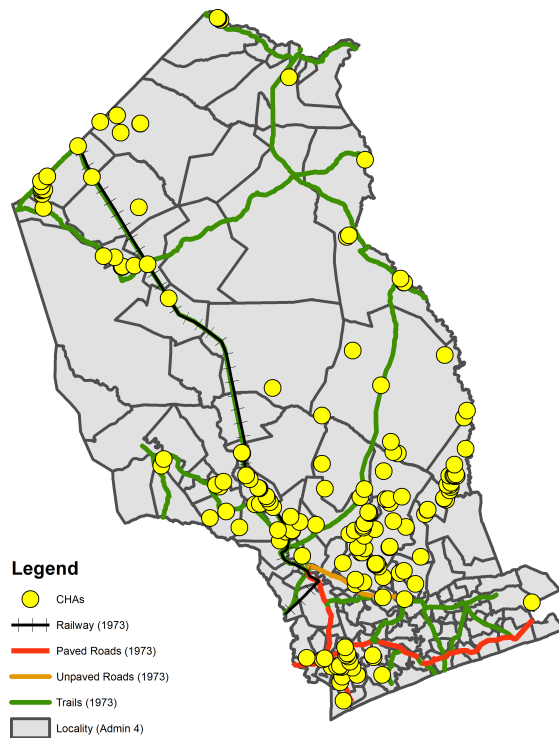
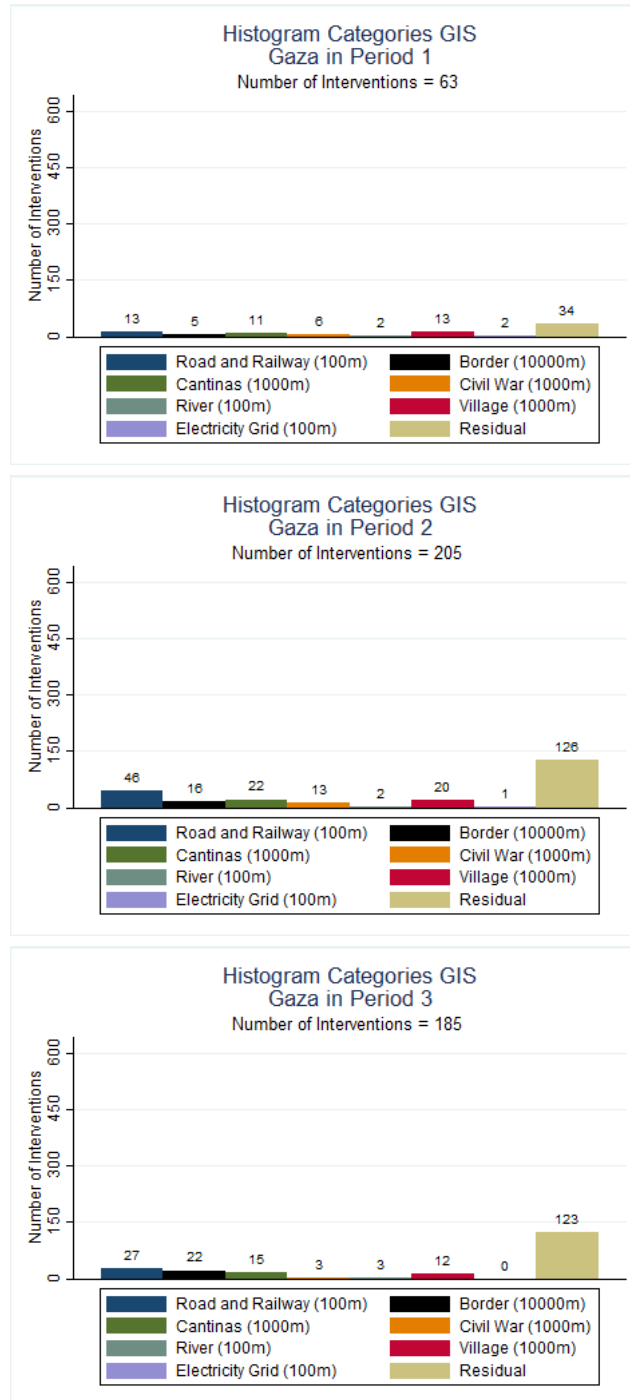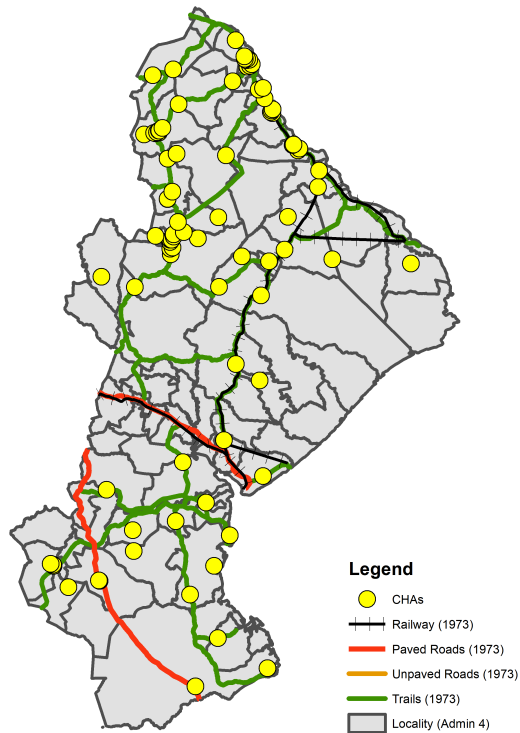Clearance of CHAs in Gaza 2008-2015

Figure 28: **Interventions in Gaza**

Figure 29: **GIS Category Interventions in Gaza**
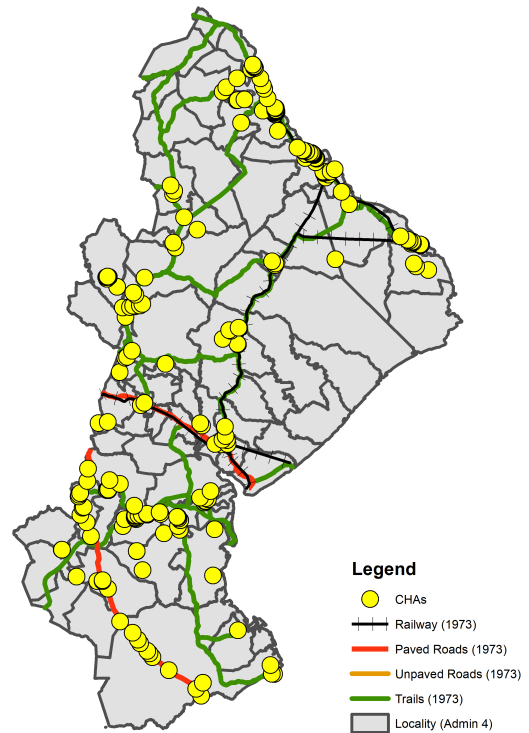
3.7 Sofala Province Summary

Between 1992 and 2015, 27 demining operators got involved in demining activities in the province of Sofala, completing a total of 936 interventions. According to our database, Handicap International (HI) was the main player in this region. Starting its operations in the province in 1999, HI completed a total of 562 (60%) landmine clearance interventions. APOPO (57), NPA (67), HALO Trust (48), EMD (36), MINE-TECH (42), and RONCO (23) have been other important players throughout the years. Figure 31 gives the tabulation of GIS-based categories by period. Clearance of the transportation network was important with 144 activities performed. Demining activities on villages and colonial commercial harbors were frequent as well (93 and 78); while 32 clearance activities were related to area of confrontation between FRELIMO and RENAMO (Gorongosa, the main headquarters of RENAMO, is located in Sofala).

Appendix Figure 30 presents the spatial distribution of demining activities in Sofala across the different demining phases of the Mozambican Mine Action program. Almost all localities were affected by minefields: 72 out of 81. Sofala was one of the province in which the ONUMOZ mission was active in the post-Peace agreement period (1992-1994). Hence, it is no surprise that all the interventions (24 in total) in this initial phase came from UN's and USAID's contracts like GSG/Lorhno (4), MECHEM (6) and RONCO (13). All activities involved road clearance as the main task of these commercial actors was to free communications and transportation for the refugees' repatriation. Despite the relatively large number of interventions in these early years, only one locality became landmine free. From 1995 to 1999, due to the limited capacity of NPA, HI start assisting the Norwegian NGO in the region. Among the two, they performed 77 out of the 97 interventions in this period. The remaining operations were completed by MINE-TECH (18). These tasks added merely 2 more landmine free localities. During the second phase of Mine Action (2000-2007), HI and NPA maintained their cooperation, until NPA left the country in 2006. This joint effort allowed to complete 153 out of the 255 interventions in this period, with HI covering 119 interventions and NPA 34. 12 more municipalities were declared mine-free. Finally, in the last period (2008-2015), HI increased its capacity in the province and was able to cover 377 operations (67% of the total for the period). Additional help came from APOPO (57) and HALO Trust (48). Thanks to the efforts in this final period, the remaining 55 affected municipalities were finally declared free from contamination.

Clearance of CHAs in Sofala 1993-1999

Clearance of CHAs in Sofala 2000-2007
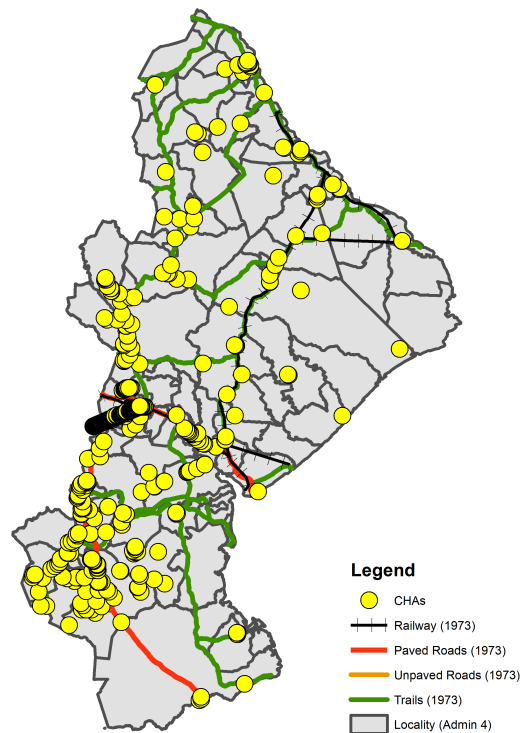
Clearance of CHAs in Sofala 2008-2015

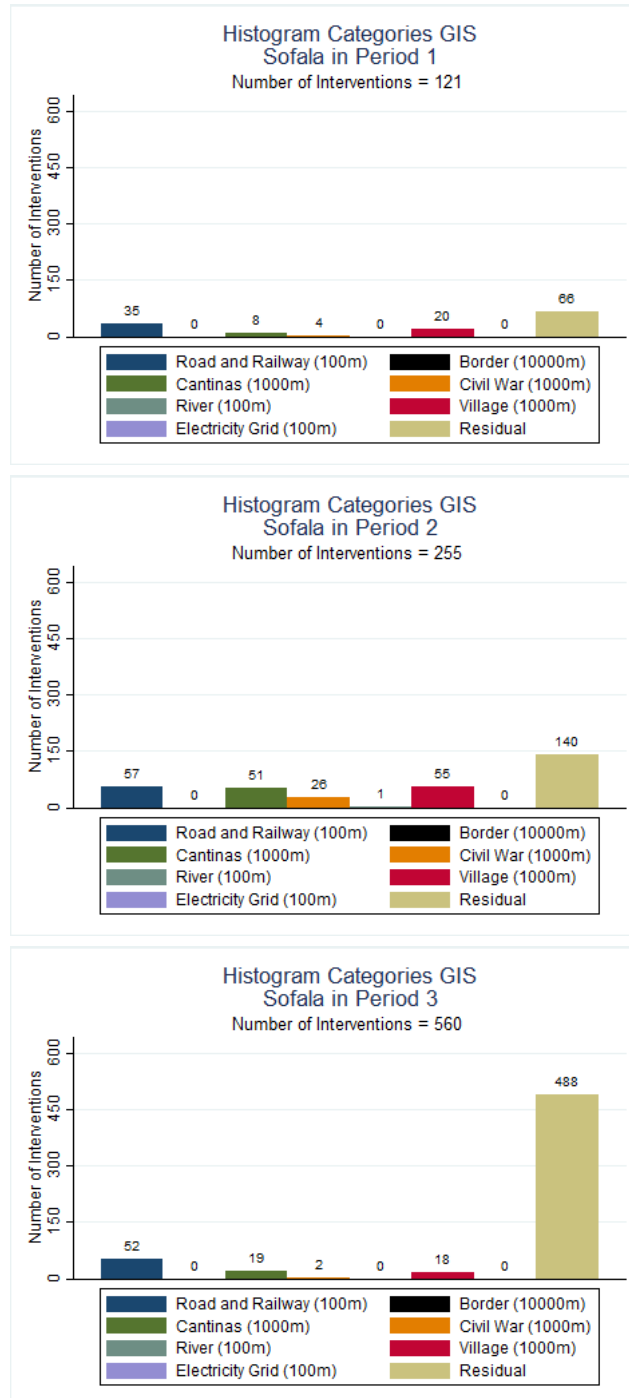Figure 30: **Interventions in Sofala**

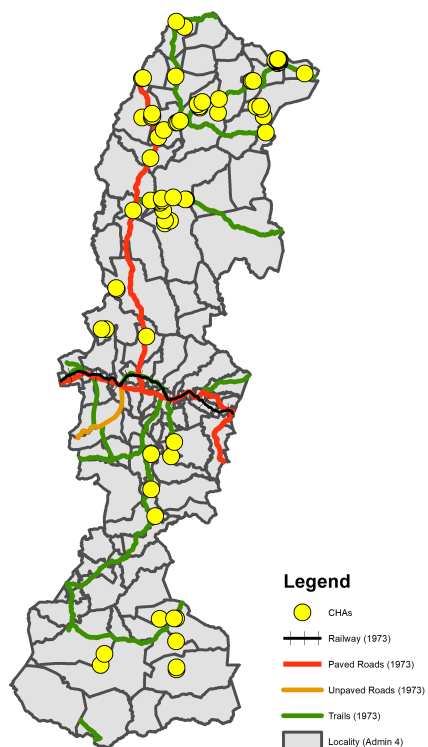Figure 31: **GIS Category Interventions in Sofala**

3.8 Manica Province Summary

According to our dataset, the number of demining activities in Manica province, throughout the 23 years of Mine Action totaled 1,053. An important actor in the province was HALO Trust, which conducted a total of 595 (56% of all operations). Handicap International and APOPO were prominent players with 198 (19%) and 90 (8.5%) interventions, respectively. Norwegian People's Aid played a non-negligible role with 88 (almost 8%) interventions. The other demining actors were AFROVITA (1), Associacao de Sapadores Moçambicanos (ASM) (9), IND (1), MINE-TECH (15), Mozambique Mine Action (MMA) Lda (10), Mine-Tech (15), RONCO (3), and Special Clearance Services (SCS) (5). Figure 33 reports the GIS-based categories by period for Manica. The most represented categories are clearance of villages (142) and demining on the transportation network (128). Very importance is the clearance activity on borders with Zimbabwe (103).

Appendix Figure 32 portrays the spatial distribution of demining activities in Manica across time. In Manica, the contamination was extensive with 85 out of 104 municipalities affected by landmines. Similar to the other Southern regions, the start of demining activities was sluggish. In the initial years (1992-1994), RONCO delivered the only demining operation in the region, clearing part of a trail connecting Chiramba to Nhacolo (Tambara district). From 1995 to 1999, NPA and HI started to operate in the region, entering from the North and the South, respectively. HI completed 63% (49) of the interventions in the second period; while, NPA conducted 24% (19) of them. Additional operations were delivered by MINE-TECH, MT, and SCS (mostly involved in clearance of villages).

42 localities were declared mine free by 2000. The activities of NPA (68) and HI (59) kept on expanding in the second period (2000-2007). MINE-TECH (9) remained present in the province (along with RONCO and SCS). MMA entered the province, by establishing its headquarters in Chimoio. MMA performed 10 interventions in Barue, Gondola, Guro and Sussundenga districts. In spite of the efforts in this phase, only 7 additional localities were freed from landmines by the end of 2007. The final phase (2008-2015) saw an increased impetus for mine clearance in Manica. The operations in this phase account for 74% (777) of total clearing activities in the province. This push towards completion was due to the efforts of HALO Trust (595) and the help of all the other main players in this final period (APOPO (90), HI (90), NPA (1)). The remaining 76 affected localities were cleared during these final 8 years.

Clearance of CHAs in Manica 1993-1999

Clearance of CHAs in Manica 2000-2007
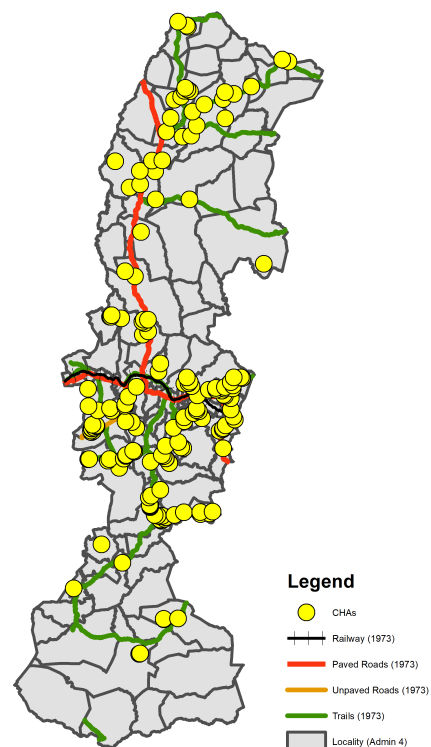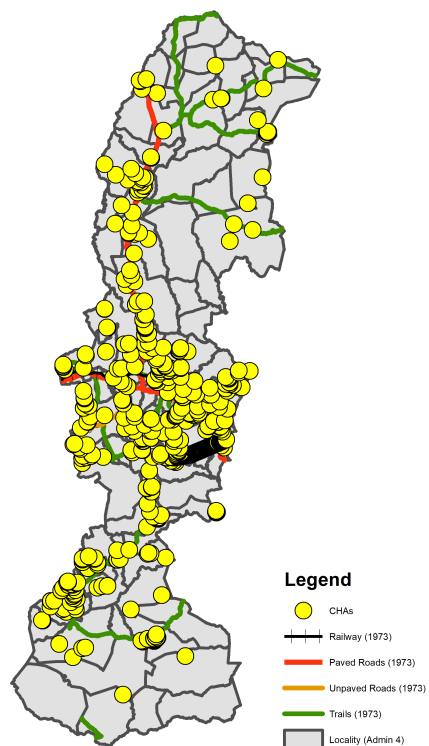
Clearance of CHAs in Manica 2008-2015
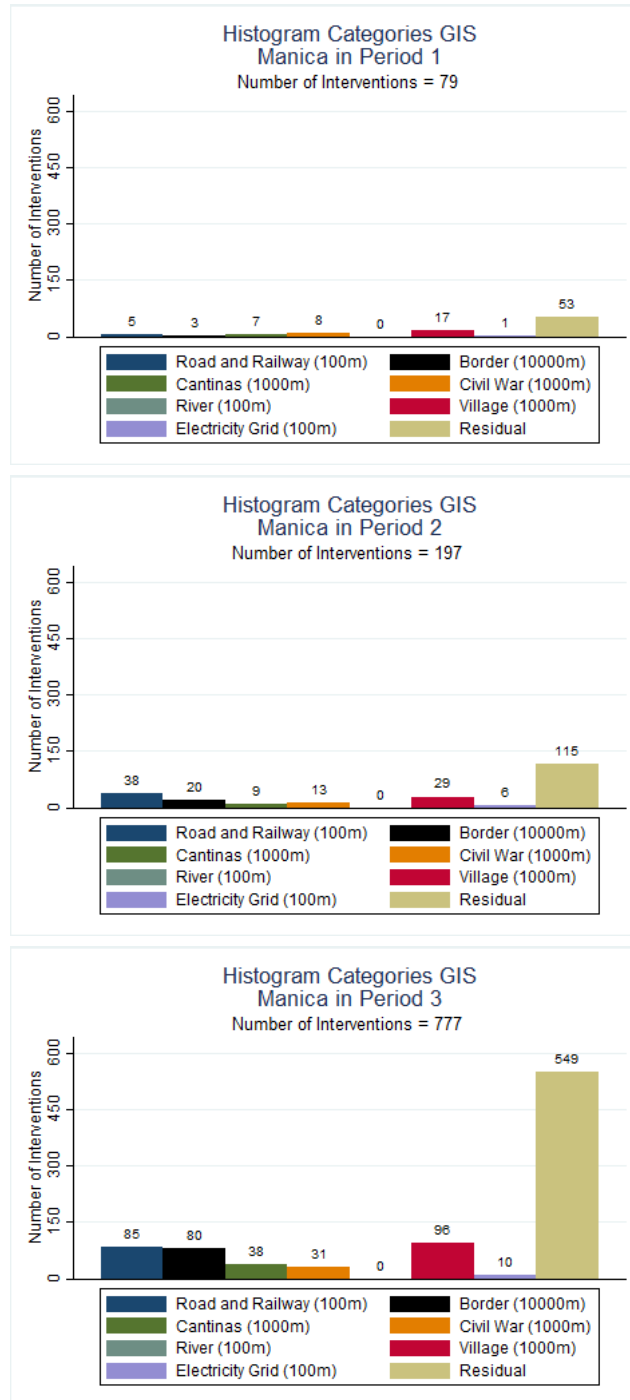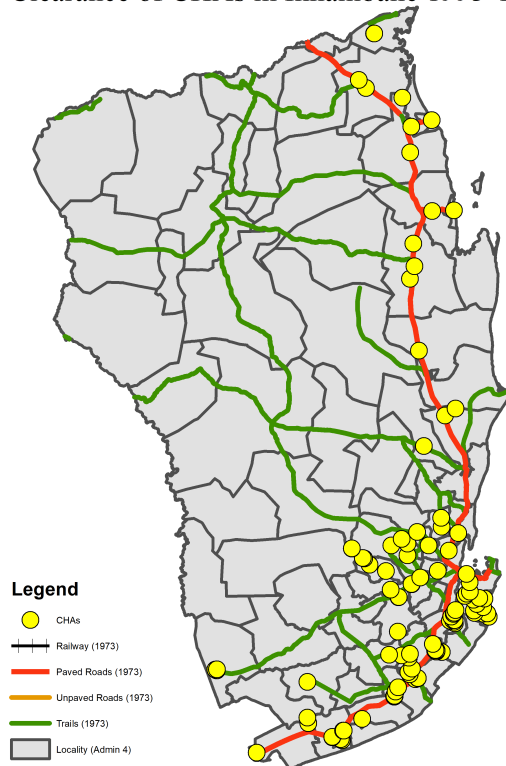

Figure 32: **Interventions in Manica**

Figure 33: **GIS Category Interventions in Manica**
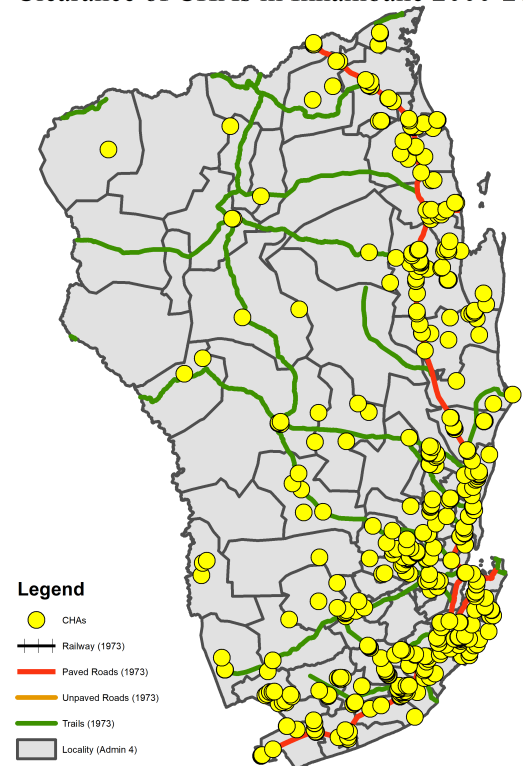
3.9 Inhambane Province Summary

Inhambane was one of the most affected provinces in Mozambique with 992 demining activities. A key player for the province was Handicap International, that started its demining activities in 1998. By the end of 2015, HI conducted a total of 653 operations (66% of the total interventions). In the initial phase, United Nation's Accelerated Demining Program played an important role, completing 184 clearance activities. Another 16 players were present in Inhambane at different points of the demining process: BACTEC Mozambique (13), BICKMUTI LDA (7), EMD (10), FADM (1), GPC (1), HALO Trust (182), IND (1), JV Desminagem (9), MF Investimentos Lda (5), MINE-TECH (36), MMA (6), MONECHECHA-Lda (1), MOPROTECTOR Ltda (8), Mamacoma (16), Mine Kills Lda (1), NPA (1), and RONCO (1). Regarding the GIS-based classification of threats, the majority of interventions (211) involved sites in proximity of the transportation network; 169 and 99 interventions happened in the vicinity of villages and colonial commercial towns, respectively.

Appendix Figure 34 presents the spatial distribution of demining activities in Inhambane over time. This province had the highest rate of landmine contamination in the country, with almost 94% of its localities (75) being mined. As for the Manica province, the initial years of Mine Action (1992 − 1994) in Inhambane were characterized by very few interventions (NPA (1) and UNADP (4)). From 1995−1999, UNADP started to increase its presence in the province, performing 78 interventions (of mostly trails and roads as well as villages). An important contribution to mine clearance in this phase was that of MINE-TECH with 30 interventions (e.g., Quissico village), HI started its operations (4) in the later phase of the first period (specifically, in Inhassoro and Inharrime). By the end of 1999, only 1 municipality was declared free from mines. During the second phase (2000 − 2007), HI escalated its presence completing 341 demining operations, spanning from village clearance (like Vilankulo, Massinga and Morrumbene) to trails and roads. Before shutting down its program in 2006, the UNADP delivered 102 demining operations. In this phase, 11 additional localities were completed freed from minefields. Finally, the third period (2008-2015) allowed to declare Inhambane as mine free by 2015. By increasing even further its capacity, HI completed 341 demining activities. These efforts allowed to clear the remaining 63 mine-affected municipalities.

Clearance of CHAs in Inhambane 1993-1999

Clearance of CHAs in Inhambane 2000-2007
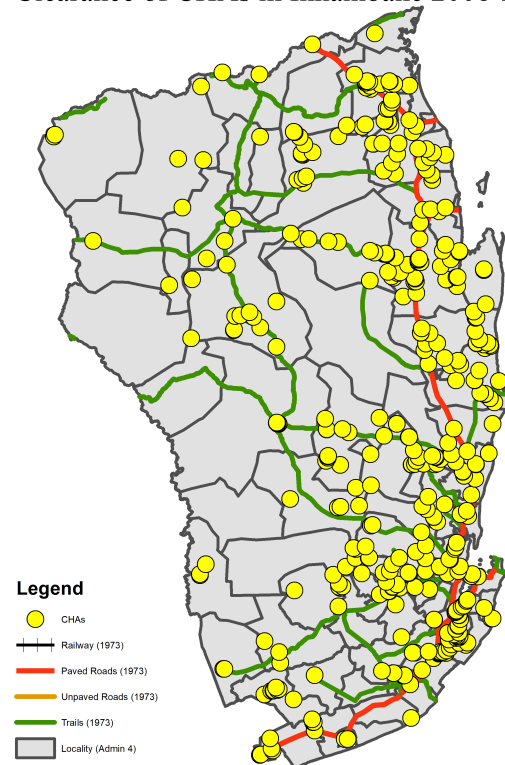
Clearance of CHAs in Inhambane 2008-2015
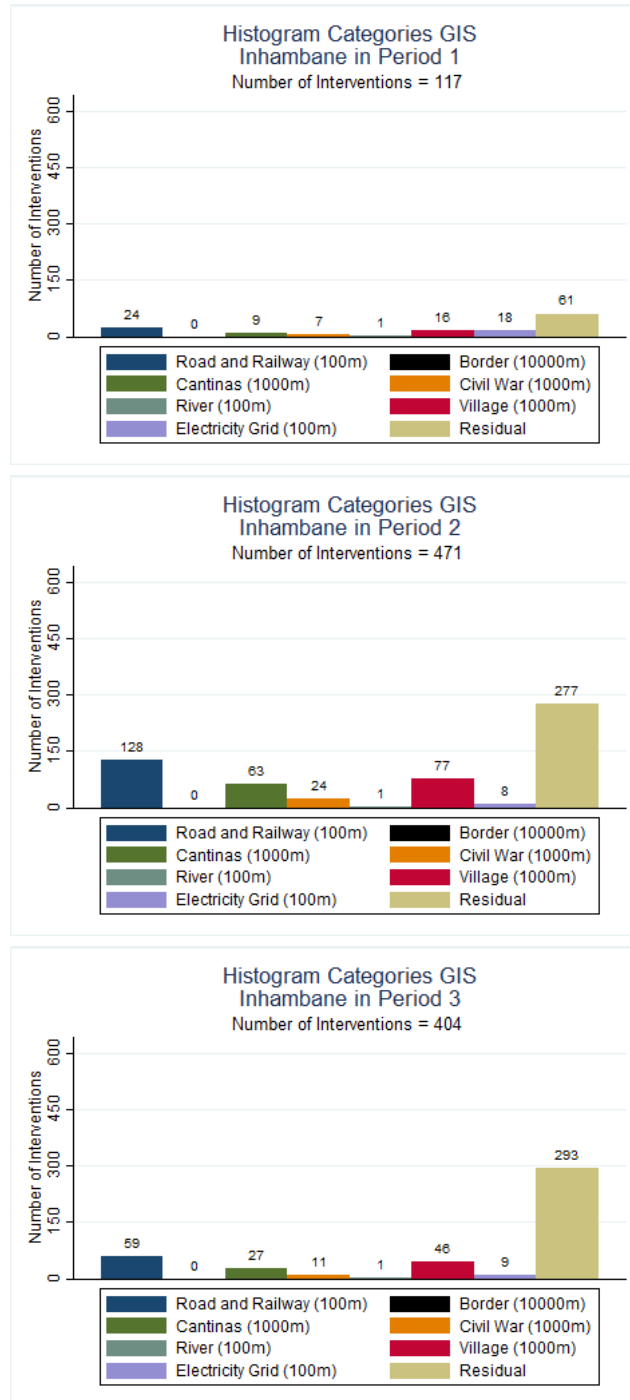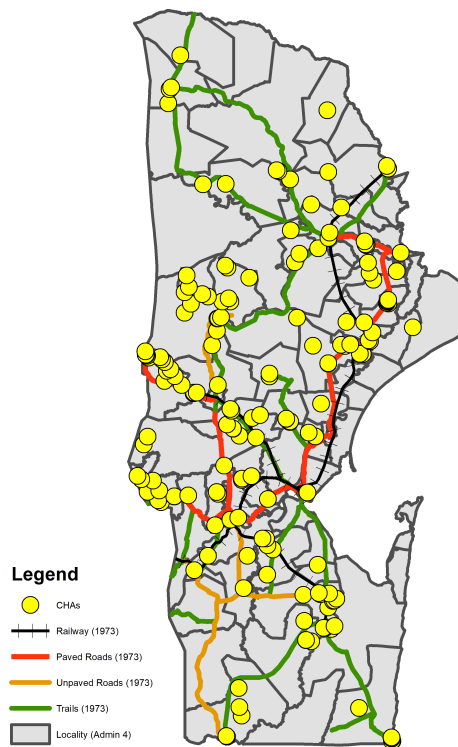

Figure 34: **Interventions in Inhambane**

Figure 35: **GIS Category Interventions in Inhambane**

### 3.10 Maputo Province Summary

The province of Maputo (including the capital of Maputo) was the province with the highest number of interventions: $1,206$. The capital was barely contaminated (only 5 interventions are recorded in our database over 23 years). The dominant actor in the province was HALO Trust, that moved to Maputo after 2007, with 798 interventions (66%). UNADP (275) and APOPO (452) were also important actors during the program in Maputo. The other deminers that contributed to the clearance of Maputo province are AFROVITA (4), BACTEC Mozambique (1), BICKMUTI LDA (1), CGTVA (2), CODEG-Desminagem (1), EMD (12), FADM (10), GPC International (4), JV Desminagem (2), MECHEM (7), MGM (7), MINE-TECH (5), MMA (7), MSF (25), Mine Kills Lda (1), Ronco (9). Figure 37 depicts the distribution of GIS-based categories across the three periods of demining activties. The most represented categories are the clearance of the borders with South Africa, Swaziland, and Zimbabwe (288 interventions) and the restoration of the electric line connecting Maputo to South Africa (282). Demining of transportation network (174) and villages (158) was also substantial.

Appendix Figure 36 shows the spatial distribution of demining activities in Maputo province for phase of the Mozambican Mine Action program. 71 out of the 78 localities were contaminated by landmines. In the first phase (1993-1999), UNADP performed 172 interventions. Several involved clearing trails/roads and villages (like the Moamba and Boane rings cleared in collaboration with MINE-TECH/GTZ). Only 3 localities were freed from landmines by the end of 1999. The second period of interventions $(2000-2007)$ saw a slowdown in the demining activities in the province. A total of 161 interventions were recorded at the end of 2007. UNADP was still the main player at the time, with 103 interventions. Some activities from RONCO (9), MGM (7), AFROVITA (4) took place, along with those of HALO Trust (6) in 2007. Similarly, the speed of clearance across localities was also very low: with 32 more municipalities becoming land-mine free during the second phase. Starting in 2008, the pace of demining picked up. HALO Trust, after establishing its base in Maputo, completed 792 interventions by the end of 2014. APOPO performed several interventions (52) between 2012 and 2014.

Clearance of CHAs in Maputo 1993-1999   Clearance of CHAs in Maputo 2000-2007
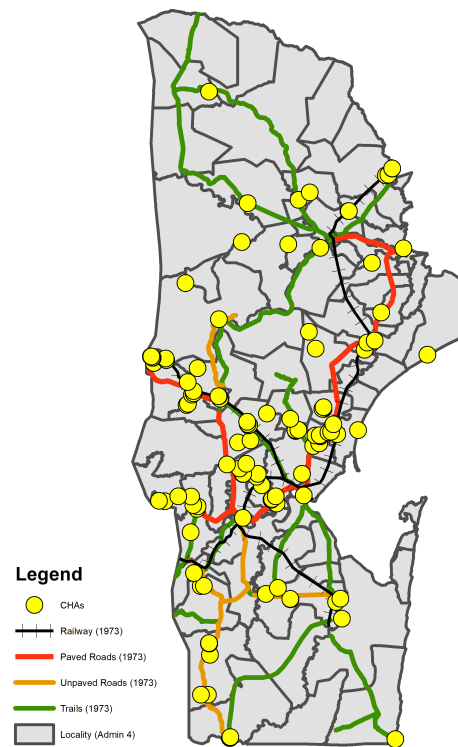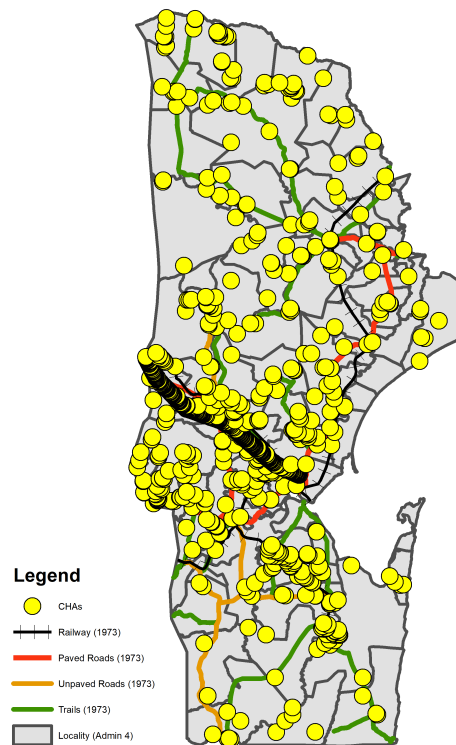
Clearance of CHAs in Maputo 2008-2015
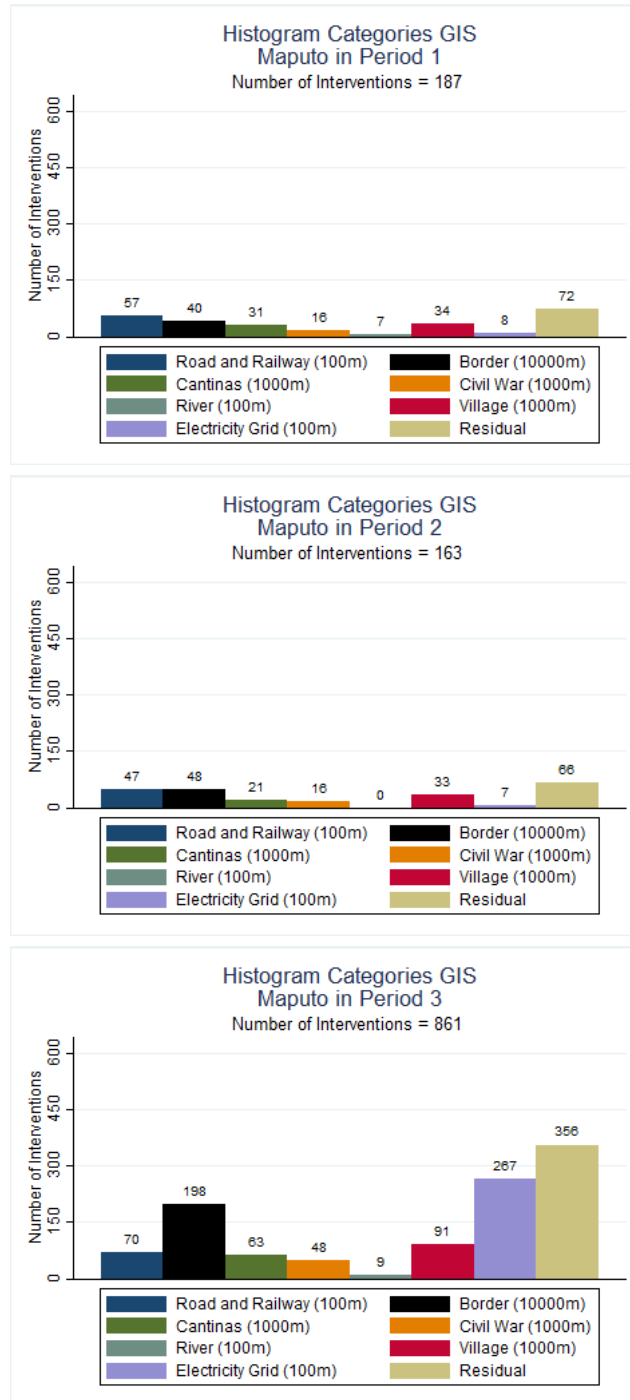
Figure 36: **Interventions in Maputo Province**

Figure 37: **GIS Category Interventions in Maputo Province**