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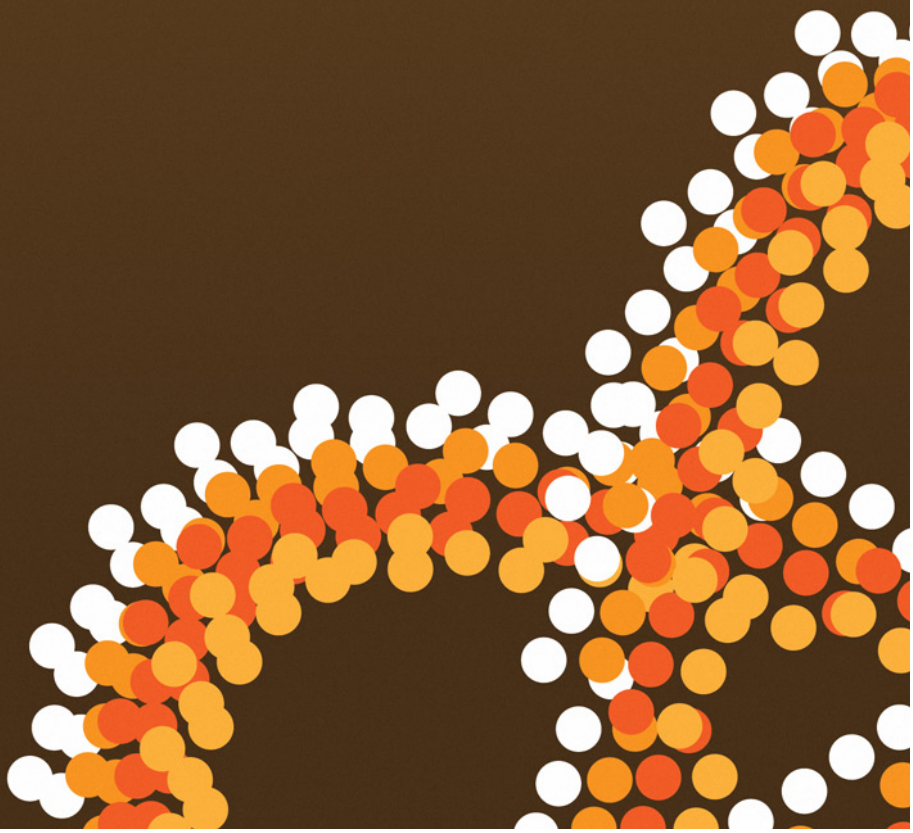
Vegetation monitoring: Pipeline servitude rehabilitation between Temane and the border at Ressano Garcia/Komatipoort

Monitoring report

Prepared to: Sasol



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1. Introduction

This document is the first report of pre-construction flora monitoring program, along the pipeline route in Mozambique, between Temane and the border at Ressano Garcia/Komatipoort. This pipeline has a 525km extension and it's the Mozambican part of the Mozambique to Secunda pipeline (MSP), which has 865km long.

Sasol Pipeline Operation is the supplier of natural gas sourced from the Pande and Temane gas fields in Mozambique via the existing MSP line to Secunda in South Africa. The gas pipeline is owned by Republic of Mozambique Pipeline Investments Company (PTY) Limited (ROMPCO) with Sasol and the South African and Mozambique governments as the Shareholders. The current MSP pipeline is designed to transport a total of 170 MGJ/annum (average load) of gas (this excludes interruptible capacity).

The approved Environmental Impact Assessment (EIA) for the existing Mozambique to Secunda pipeline was undertaken in 2001-2002 and an Environmental Management Plan was then prepared and executed between 2005 and 2011. Nowadays Phase II Pipeline (LompcoLine 2) which consists in building a new Pipeline parallel to the existing one, with a minimum distance of about 10m between the two, is starting to be installed as part of the expansion, and because of the construction activities all vegetation will be removed.

This monitoring program has the global purpose of verifying the effects of pipeline construction (update operation) over flora and vegetation. To do so, the overall program includes three different monitoring programs, each one with their own goals:

A. Erosion and alien vegetation monitoring

- Monitor the ecological stability in the Right of Way and other areas disturbed by construction;
- Verify if significant erosion has occurred as a consequence of construction
- Detect and monitor invasive alien species propagation along the pipeline corridor

B. Plant succession and recovery monitoring

- Attest if vegetation can gradually return to a pre-development condition, in areas that are not being kept clear of bush;

C. Hardwood and natural resource monitoring

- Verify if the pipeline Right of Way is used as a means of accessing natural resources such as wood and charcoal

In order to fulfil these goals, different methodologies were set to each one of the monitoring programs.

The monitoring activities of flora and vegetation monitoring plan tuck place during the month of July of 2016, between the days 14 and 23.

1.1. Study area

The pipeline route intersects three different Provinces: Inhambane, where it crosses the Districts of Inhassoro, Vilanculos, Massinga and Funhalouro, Gaza, where it crosses the Districts of Chigubo, Guijá and Chókwè, and Maputo, where it crosses the Districts of Magude and Moamba (Figure 1).

The project does not overlap with any of Mozambique conservation areas, and the closest one, Limpopo National Park, is about 35 km away to the West (Figure 1).

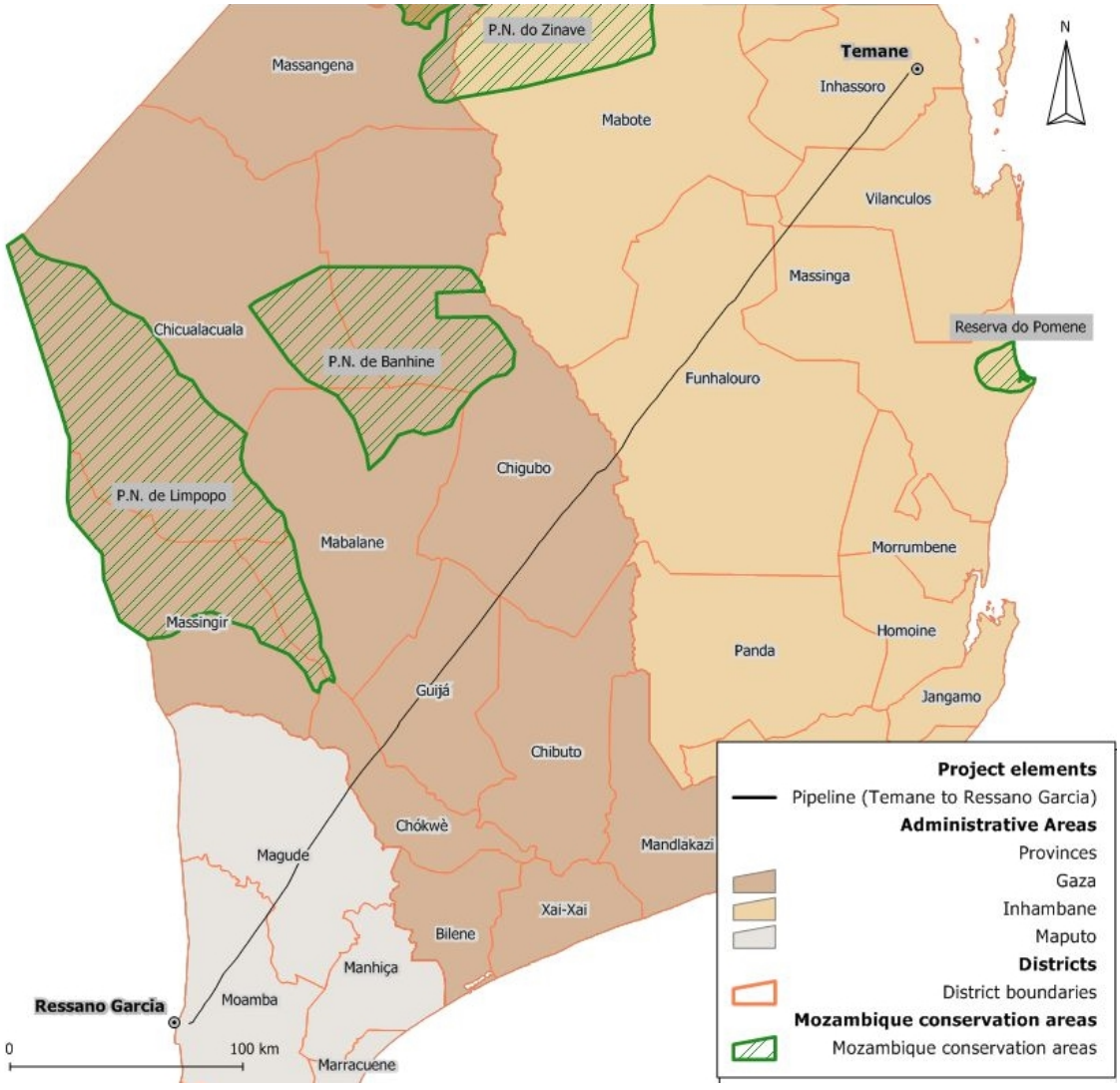

Figure 1 – Location of the project

2. Background

Sasol Pipeline Operation is the supplier of natural gas sourced from the Pande and Temane gas fields in Mozambique via the existing MSP line to Secunda in South Africa, 865 km long. The gas pipeline is owned by Republic of Mozambique Pipeline Investments Company (PTY) Limited (ROMPCO) with Sasol and the South African and Mozambique governments as the Shareholders. The current MSP pipeline is designed to transport a total of 170 MGJ/annum (average load) of gas (this excludes interruptible capacity).

The approved Environmental Impact Assessment (EIA) for the existing MSP was undertaken in 2001-2002 and an Environmental Management Plan prepared. This monitoring program began in 2005 (Deacon, 2005) and the final report was delivered in 2011 (Deacon, 2012). According to the last report the overall condition of the pipeline is stable since there is no sign of damage or significant adverse condition impacting on the pipeline servitude. In general, it was considered that vegetation across the pipeline was recovering.

Concerning alien species, it was considered that that alien vegetation did not appear to be dispersed actively along the pipeline and the infestation was low. As so it was anticipated that it would not become a major hazard to the integrity of the pipeline but It was important to continue the alien plant control.

By the end of this monitoring plan, in 2011, there were no signs of major erosion incidents along the pipeline servitude. Most of the areas have been rehabilitated and no new areas of erosion were observed on the ROW. Trampling of the pipeline by cattle and vehicles traveling on the ROW were the greatest potential contributor to erosion. Also the human settlement has slowed down and the quest for wood has decreased.

Nowadays, as part of the expansion, the current EMP (MSP and Loopline) is being updated. This repost refers to the pre-construction flora monitoring program, although it continues to analyse data from previous monitoring programs.

3. Approach to the Pipeline Right of Way Monitoring

The monitoring was performed in July, between days 14 and 23, during the dry season in Mozambique. As said before the vegetation monitoring program is divided in three different monitoring programs:

A. Erosion and alien vegetation monitoring
B. Plant succession and recovery monitoring
C. Hardwood and natural resource monitoring

In the next points it will be described the methodologies used to respond to the goals of each one of the monitoring programs.

A. Erosion and alien vegetation monitoring

During field work the entire pipeline was monitored, by travelling along the maintenance access road at low speed, and the follow situations were recorded and documented with photographs:

- Evident erosion signs;
- Different situations that can lead to erosion, such as: villages and settlements, rehabilitation failure, tracks and roads, cattle and agriculture;
- Presence of alien invasive plants. In each case the specie was registered and a coverage percentage was assigned based on the scale: 50%; 50 to 70%; 70 to 90%; >90%; 100%.

It will also be analyzed if the Plan for Routine Right of Way Grass Maintenance is being correctly implemented and what are the risks associated with unauthorized activities over the pipeline, by crossing data of unauthorized activities (Plan C) and erosion signs location.

B. Plant succession and recovery monitoring

THIS MONITORING WAS PERFORMED IN 38 FIXED POINTS ALONG THE PIPELINE (

Table 1 and Figure 2). At each site two permanent plots were monitored: one situated within rehabilitated areas of the Construction Right of Way, and the other within immediately adjacent areas of vegetation that were not impacted upon by construction. Sites location was the same used in previous monitoring programs (Deacon, 2012).

Table 1 – Characterization of the 38 fixed monitoring sites

Site	Coordinates		Vegetation unit
	x	y	
1.1	32,09361	-25,3983	Extratropical Lowland Grassland
1.2	32,35472	-25,0547	
1.3	32,30389	-25,1194	
1.4	32,16028	-25,3008	
1.5	32,13806	-25,3347	
2.1	33,35139	-23,7847	Tree savanna of medium altitudes and river valleys
2.2	33,18944	-23,9972	
2.3	32,53333	-24,7964	
2.4	32,49806	-24,8506	
2.5	32,69639	-24,5797	
3.1	33,33111	-23,8275	Vegetation on alluvium
3.2	32,77722	-24,4747	
3.3	32, 7767	-24,4989	
3.4	32,72083	-24,5453	
3.5	32,67472	-24,6075	
4.1	33,03806	-24,1661	Mopane woodland
4.2	33,00444	-24,2056	
4.3	32,91194	-24,3225	
4.4	32,7425	-24,5175	
5.1	33,75111	-23,3333	Deciduous miombo tree savanna with gregarious dense dry woodland
5.2	33,52278	-23,5917	
5.3	33,88278	-23,1994	
5.4	33,90611	-23,1594	
5.5	34,0225	-23,015	
5.6	34,19889	-22,8	
6.1	33,84528	-23,2478	Saline soils
6.2	33,85139	-23,2406	
6.3	33,77806	-23,3058	
7.1	34,61056	-22,2983	Dry deciduous miombo
7.2	34,64	-22,2625	
7.3	34,66917	-22,2267	
7.4	34,69861	-22,1908	
7.5	34,75667	-22,1189	
8.1	34,82111	-22,04	Miombo woodland on Sul de Save sands
8.2	34,88639	-21,9672	
8.3	34,93639	-21,8994	
8.4	34,96472	-21,8633	
8.5	35,02972	-21,7839	

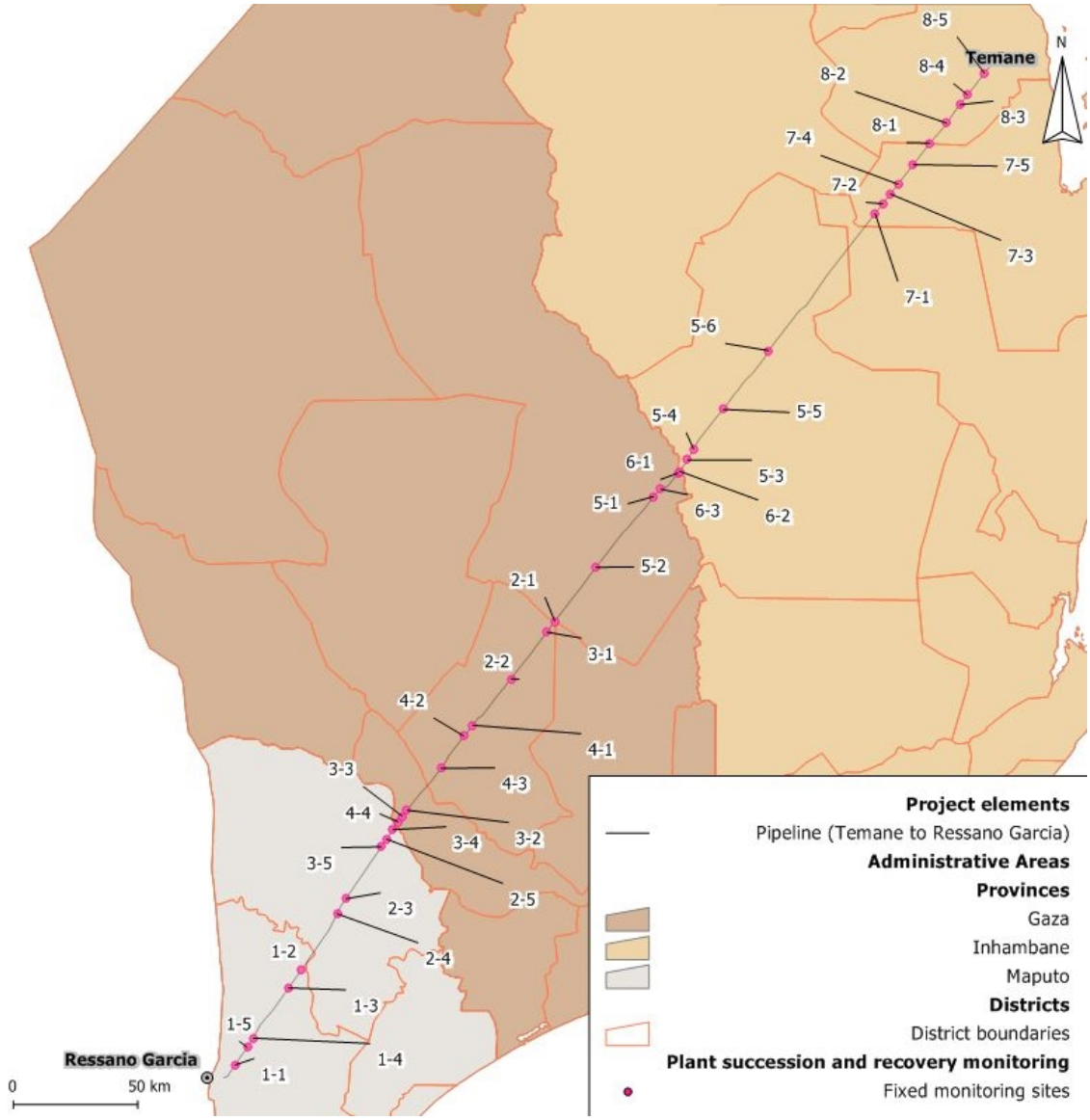

Figure 2 – Location of the 38 fixed monitoring sites

Monitoring activities were based on fixed point photography and annual sampling of the grass and shrubby layer using the one hundred nearest plant survey method.

As so, at each plot, conditions were documented by photographs facing different directions: facing south (Ressano Garcia direction) and facing north (Temane direction). The direction of each photograph was recorded, in order to allow images representing the same location throughout the monitoring.

The 100-point nearest plant survey (step-point method) was used to obtain data on species composition and percentage frequency of occurrence of each species at each sampling site. To undertake this method 100 random points were defined along a transect in each plot. In each one of the points the plant species that intersects its exact location, or the one that was nearest, was registered.

To check if there are significant differences between the existing vegetation (herb and scrub composition) in pipeline and control plots a PERMANOVA test was preformed, based on Bray-Curtis similarity matrix. Data collected through 100-point method (in percentage), was transformed through the function ASEN(RAIZQ(x/100)). To perform the test, the factor "location" (pipeline vs control) was imposed. When p-value is lower than 0,05 it means that there are significant differences between the vegetation of the two imposed groups: pipeline and control.

Whenever there are significant differences between groups a SIMPER (Similarity percentage) analysis was used to identify the species that contribute the most to the differences found. This analysis evaluates the partial contribution of each species to discriminate two groups previously imposed (pipeline and control).

Canopy cover of herbaceous and shrubby vegetation and density determinations were also estimated and recorded for each plot. Woody vegetation was not considered, since the Operator maintains the Right of Way free of woody (deep rooted) plants for reasons of safety.

The data collected in this sampling, the first after construction, will be used as a baseline, and subsequent annual monitoring will be compared to this data. Through this comparison it will be possible to access if the vegetation is recovering. Annual data will also be compared with adjacent (undisturbed) control plot transects, in order to verify if it is getting gradually more similar to the existing vegetation in the vicinity (that was not directly intervened).

C. Hardwood and natural resource monitoring

During field work the entire pipeline was monitored, by travelling along the maintenance access road at low speed. The field team focus on identifying the existence of hardwood and charcoal resource exploitation along the pipeline route, documenting different situations. Despite these activities are the main target of monitoring, signs of any other activity observed throughout the study area was also recorded.

Observations were made on the servitude only, so it is not possible to make consideration of the exploration of natural resources in more remote areas, accessible from the road by the numerous tracks.

4. Results and discussion

During fieldwork it was possible to travel along all the pipeline route. At some points construction activities had already begun. In this process the excavated soil of the new pipeline is placed in the area were the plan B plots were installed. As so, these situations can sometimes condition the results.

A. Erosion and alien vegetation monitoring

A.1 - Erosion signs or sign that can lead to erosion

During field work 563 situations of evident erosion signs or that can lead to erosion were recorded, in 359 different locations.

In total 6 different situations were recorded: presence of agricultural areas (agriculture); bare vegetation patches; presence of cattle (passing by or grazing); evident erosion signs; roads and patches used by vehicles, persons or cattle; villages and settlements.

The Table 2 summarizes the frequency of the different recorded situations. The most frequent one was the presence of cattle (208 locations), followed by the existence of roads and paths (191 locations). The less frequent one was the presence of bare patches along the pipeline (only 19 locations), which indicates that vegetation is continuously present along the pipeline.

Table 2 – Situations of evident erosion signs or that can lead to erosion recorded during field work

Situation	Number of locations
Erosion	68
Agriculture	26
Bare patches	19
Cattle	208
Roads and Paths	191
Villages and settlements	51
Total	614

By analyzing Figure 7 it is clear that most situations of erosion, or that can let to erosion, occur in the south area of the pipeline. In the North area, mainly on Inhambane Province, the number of erosion problems locations are clearly lower than in Gaza and Maputo Provinces.

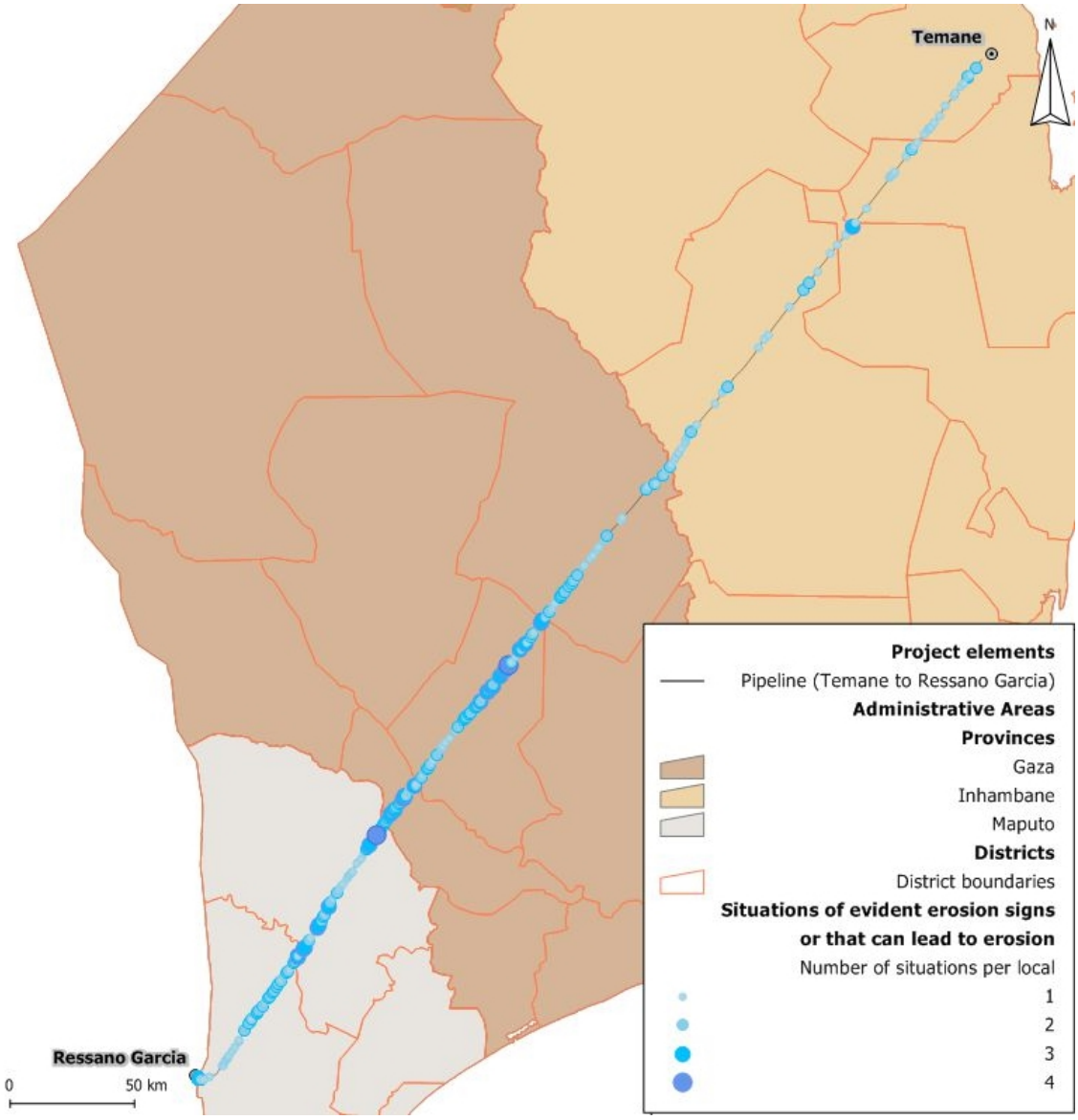

Figure 3 – Location of different situations of evident erosion signs or that can lead to erosion

Figure 4 present some photographic examples of erosion and Figure 5 represents the evident erosion signs or that can lead to erosion locations along the pipeline.

During field work evident erosion signs were recorded at 68 different locations, mainly located at the south part of the pipeline, were it seems to be a problem. Several situations seemed to occur due to water runoff, in a places that, prior to pipeline construction, should function as small streams. All situation seems to be normal for a post rainy season period, when heavy rain fall causes normal damages on dirt roads, and in some places it was possible to see small channels resulting intermittent water downstream precipitation. Documented situations occurred exclusively in sloping sites of the ROW in Magude, Chokwé and Ressano Gárcia districts, and no signs of erosion were seen in adjacent areas.

Figure 4 – Evident erosion signs along the pipeline

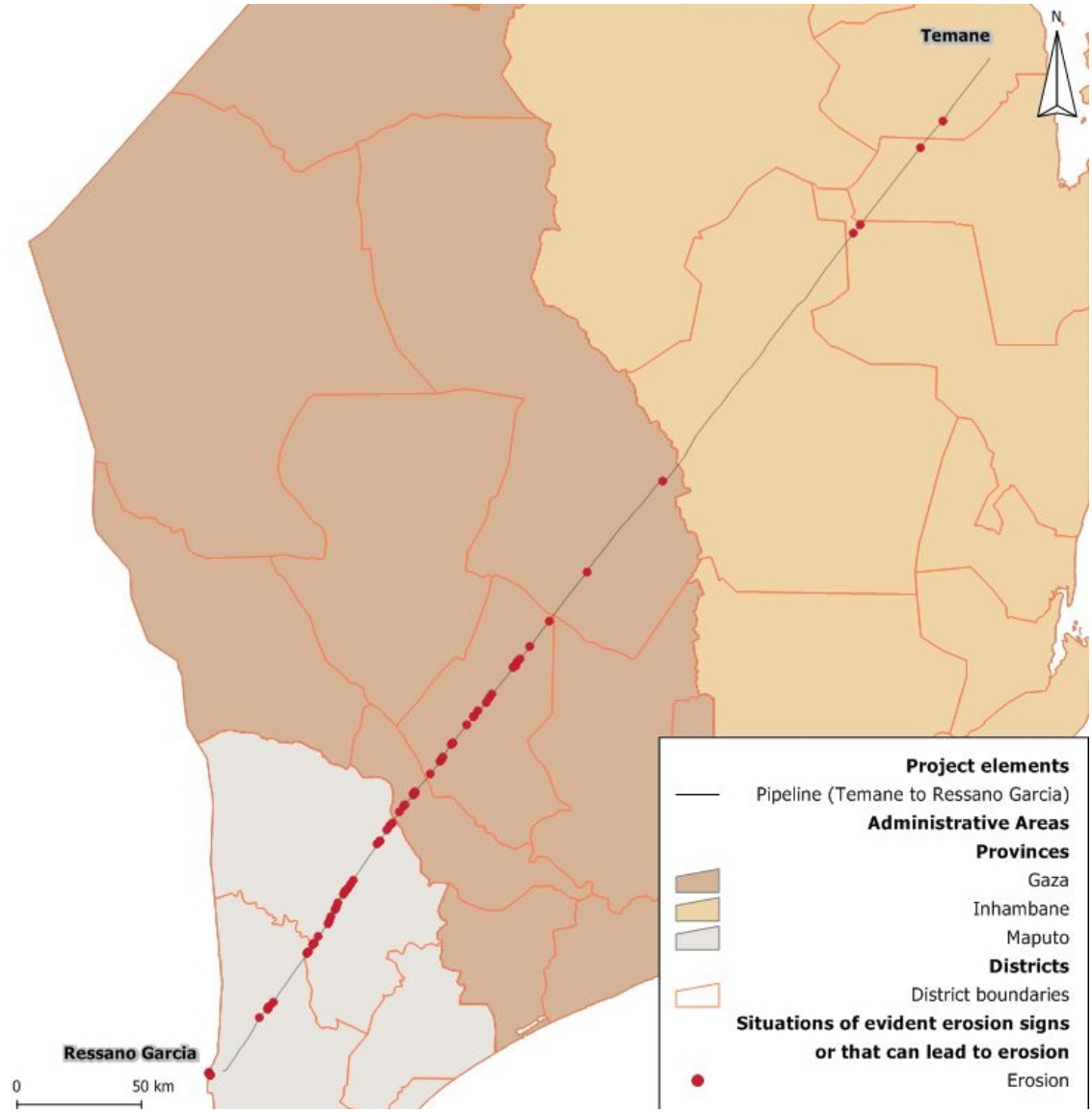

Figure 5 – Location of evident erosion signs along the pipeline

Agriculture was mainly registered in Gaza Province (Figure 7). Note that mostly of the observed agriculture are small areas (known as ´machambas´ in Mozambique) and are related with villages and settlements. As so, ´machambas` were included in Villages and settlements mapping (Figure 15). Only situations were no houses were seen were, recorded has “Agriculture”.

Although there are large agricultural areas, most agriculture along the pipeline seem to be of small dimension (machambas) and for own consumption. Cultivated products are traditional in Mozambique, such as maize, cassava, peanuts and pumpkin (Figure 6).

Figure 6 – Agriculture along the pipeline

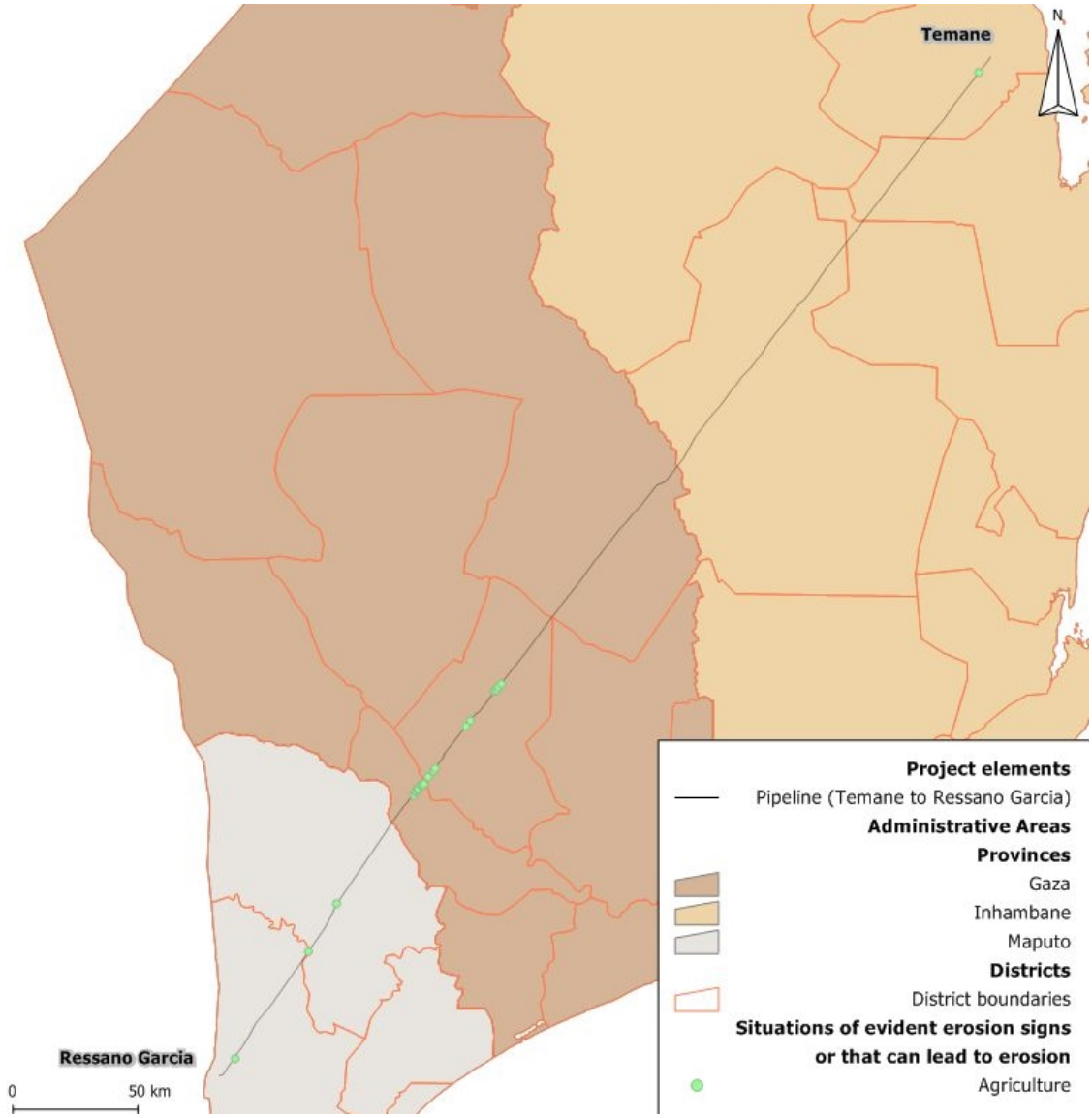

Figure 7 – Location of different Agriculture sites

The number of bare patches was low, only 19, and no fire signals were observed (FIGURE 8 and FIGURE 9). As so, these situations can result from soil characteristics (e.g. degree of sieving, the topsoil slope quantity of rock in the substrate, water availability); soil compaction that leads to the vegetation has more difficulty in establishing; or disturbances caused by human activities. By analyzing the data with other disturbances identified, sign of relation was found. Evident signs of erosion were not observed in any of the recorded situations (FIGURE 8).

Figure 8 –Bare patches along the pipeline

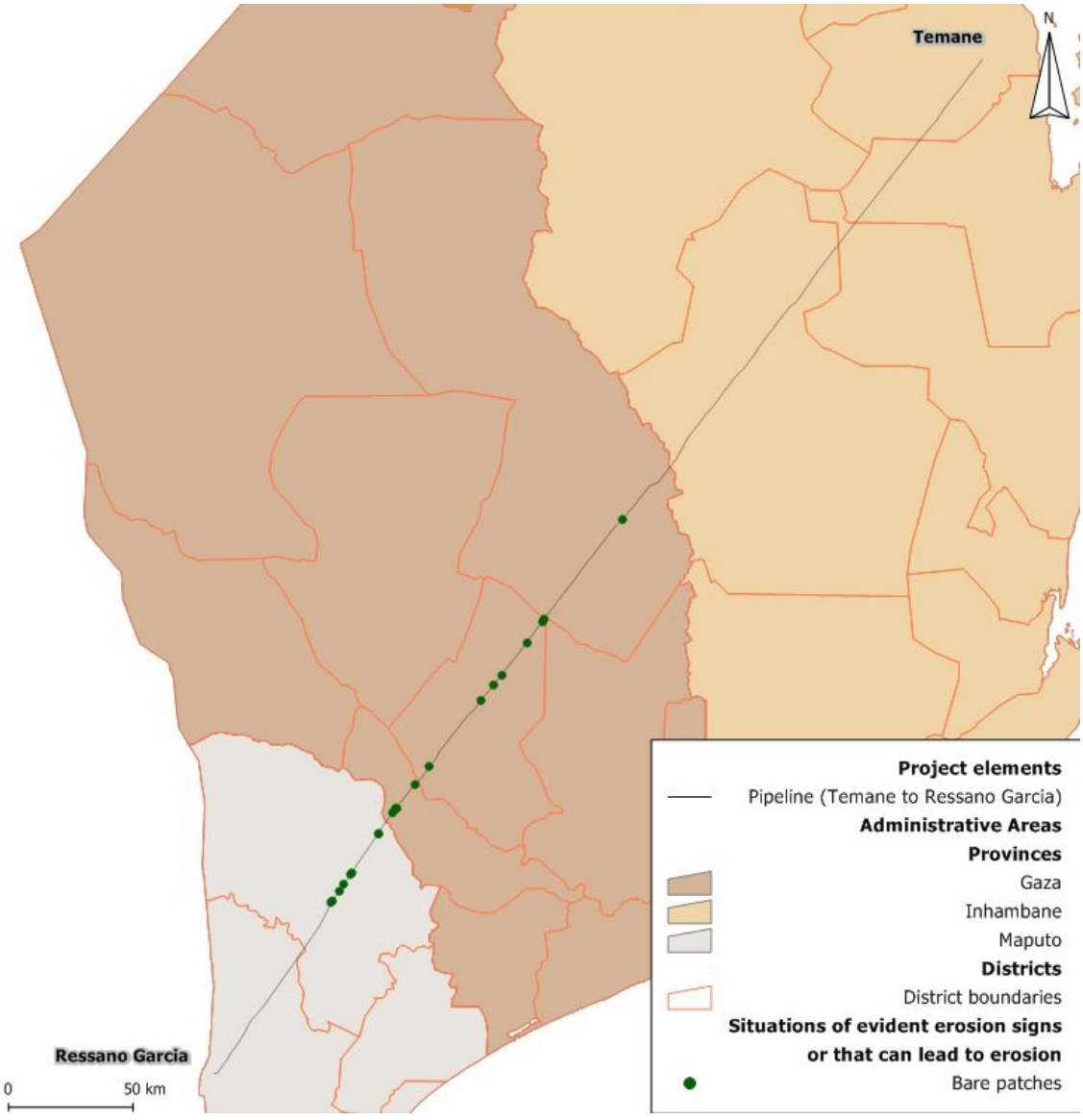

Figure 9 – Location of different Bare patches

The use of the ROW by cattle was documented in the previous monitoring results, and, according to 2016 data (**Figure 10** and FIGURE 11), it continues to grow. With the higher number of settlements an increase in livestock is naturally expected. Even so, bare patches were not common across the ROW and vegetation of the pipeline area is in a good condition (Plan B), so, for now it seems that cattle does affects the growth of vegetation.

Figure 10 – Cattle observations along the pipeline

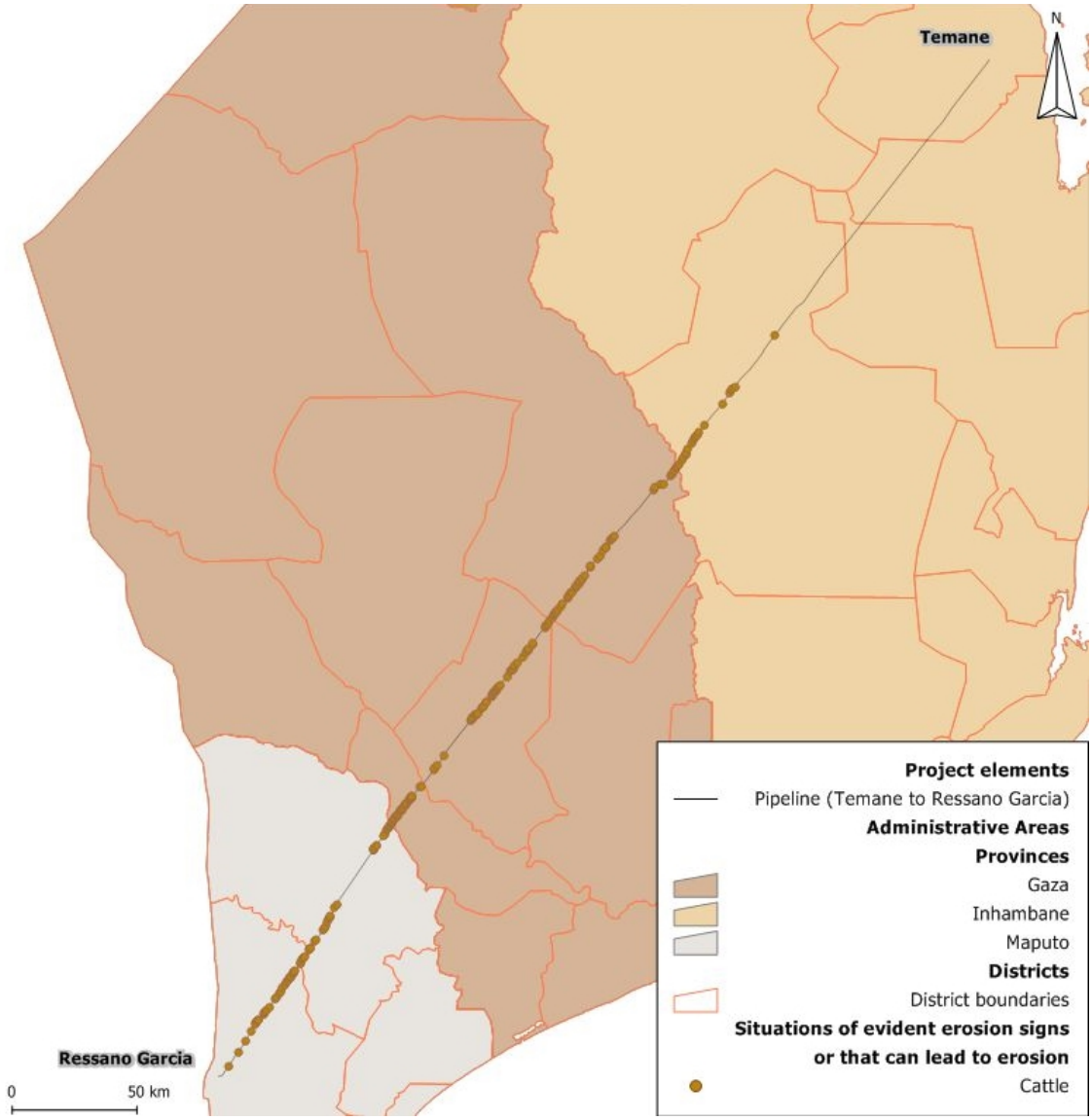

Figure 11 – Location of cattle observations

Since the beginning of the project the number of roads and paths along the pipeline has increase greatly. Nowadays there are 191 roads and paths that cross the pipeline Right of Way. Some of the paths seen are probably cattle paths, and may be used by local population (Figure 12). The ROW itself is also used by vehicles that are not SASOL service vehicles, which is used to access major roads that depart from it (Figure 12 and Figure 13). As so, it is considered that the use of the ROW as well as the crossing roads and paths by locals is well-establish (Figure 14).

Figure 12 – Different roads and paths along the pipeline

Figure 13 –Pipeline ROW

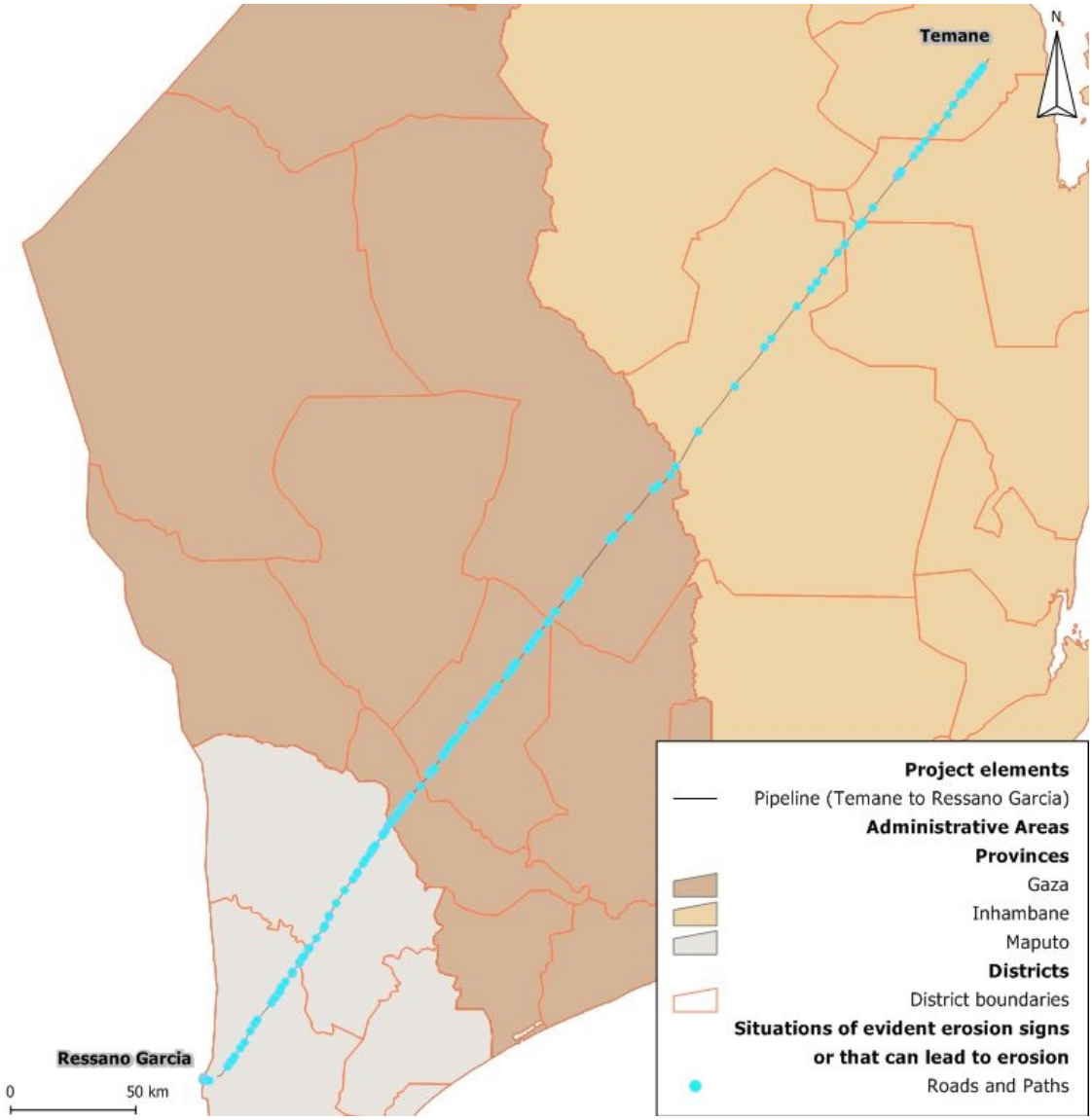

Figure 14 – Location of different roads and paths along the pipeline

The number of settlements and villages along the pipeline seems to be persistent, with no signs of new establishments (Figure 15 and Figure 16). Even so, there are no data regarding the number of houses and population in these locations, so human presence may be increasing throughout the pipeline.

Settlements and villages are related with agricultural areas (machambas) which seems to indicate that these are not temporary settlements.

Figure 15 – Villages and settlements along the pipeline

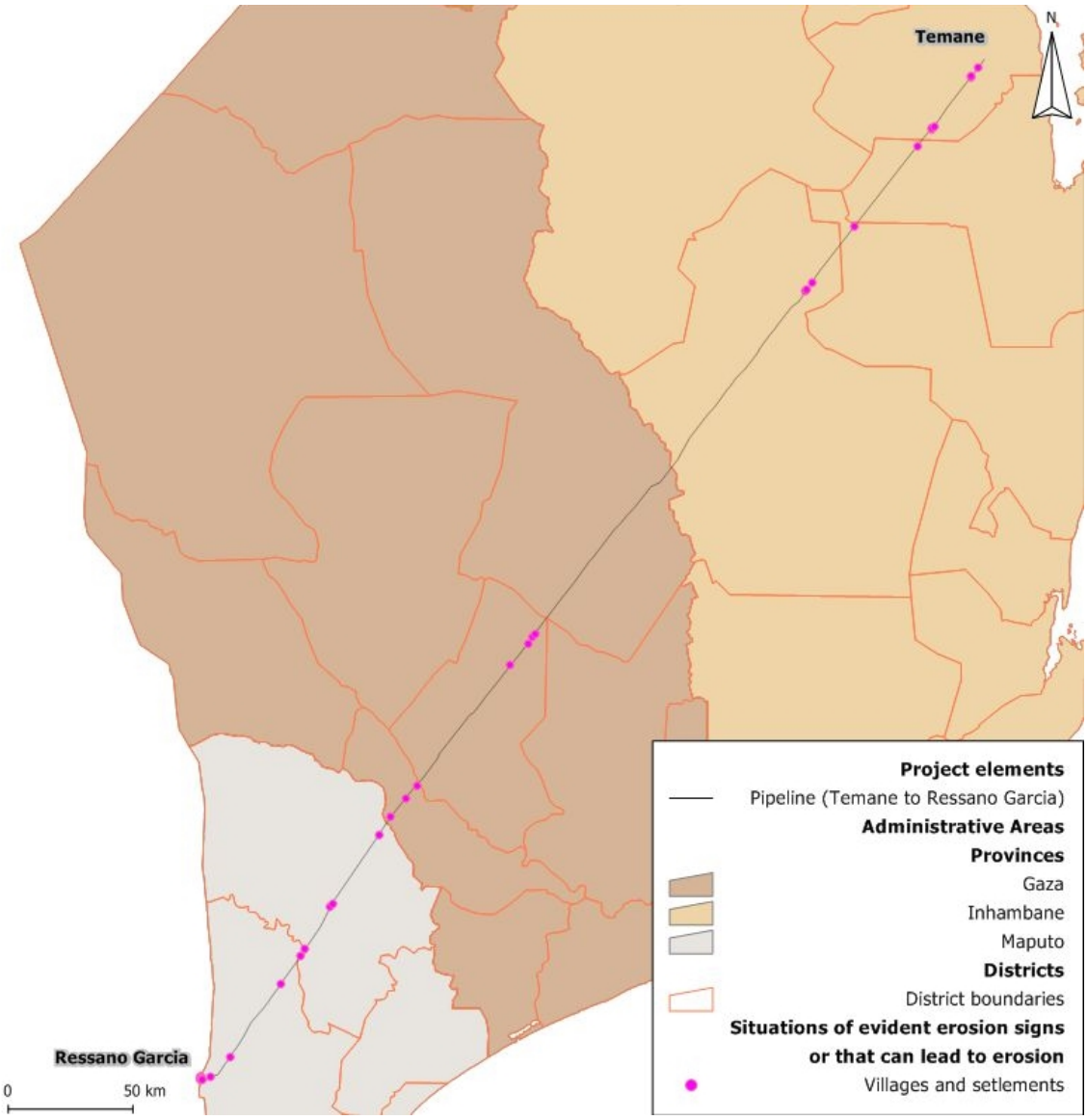

Figure 16 – Location of different Villages and settlements along the pipeline

Comparing 2016 data with previous monitoring results, it seems that all situations, except Villages and settlements, had increased along the servitude (Table 3). However, this analysis should be done with caution, since the data collection done in the field was carried out by different teams, probably with different criteria. For example, in the case of cattle presence, in the present sampling all direct contact with animals was documented, but in previous samplings this criterion seems not to have been adopted. Yet, it passed 5 years since the last sampling (2011), so is normal that existing Villages and settlements have extended, and consequently, the number of situations that can lead to erosion have increased.

Table 3 - Situations of evident erosion signs or that can lead to erosion recorded during field work of previous monitoring programs performed along the pipeline. Data from 2006 to 2011 extracted from Deacon (2012)

Situation	2006	2007	2008	2009	2011	2016
Agriculture	0	1	0	0	0	77
Bare patches	0	1	1	1	0	19
Cattle	0	0	0	0	0	208
Erosion	7	7	9	11	0	68
Roads and paths	4	40	77	92	121	191
Villages and settlements	58	58	58	58	57	51
Other activities	2	1	0	0	0	0
Total	71	108	143	146	81	572

A.2 – Alien species

Regarding invasive alien species, there were 12 different plant species identified along the pipeline ROW. Invasive species were seen in 26 different locations, with one to five different species in each one (Table 4). They are mainly present in the Gaza province, from the Guijá district to the south (Figure 17).

Table 4 – Number of locations with 1 to 7 invasive species.

Number of species	Number of locations
1	18
2	3
3	2
4	1
5	2
Total	26

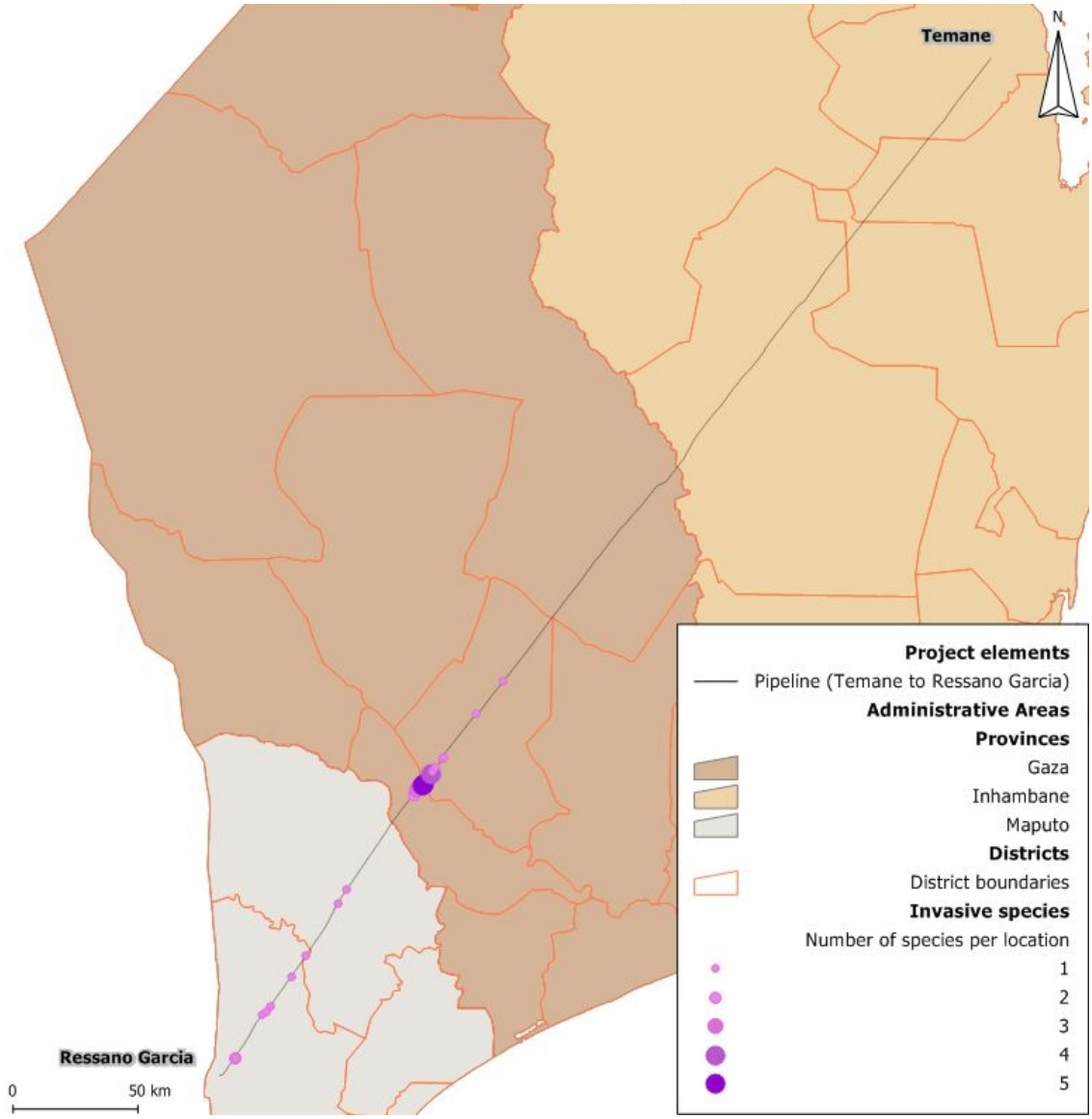

Figure 17 – Location of invasive plant species along the pipeline

Opuntia sp. is the most common invasive species in the pipeline area. It has been spotted in 8 locations (Table 5). The second and third more frequent species are *Argemone mexicana* and *Xanthium strumarium*, which were seen in 6 locations, each (Table 5).

Table 5 – Number of locations with cover percentage under 50% for each invasive plant species identified along the pipeline

Specie	Cover (%)
Agave sisalana	3
Argemone mexicana	6
Azolla pinnata	1
Caesalpinia decapetala	3

Specie	Cover (%)
Cereus jamacaru	1
Datura stramonium	1
Opuntia ficus-indica	8
Parthenium hysterophorus	3
Pistia stratiotes	1
Ricinus communis	5
Senna occidentalis	1
Xanthium strumarium	6

Figure 18 – *Agave sisalana* present along the pipeline

Figure 19 – *Argemone mexicana* (http://www.invasives.org.za/)

Figure 20 – *Azolla pinnata* (http://www.invasives.org.za/)

Figure 21 – *Caesalpinia decapetala* (http://www.invasives.org.za/)

Figure 22 – *Cereus jamacaru* (http://www.invasives.org.za/)

Figure 23 – *Datura stramonium* (http://invasoras.pt/)

Figure 24 – *Opuntia ficus-indica* (http://invasoras.pt/)

Figure 25 – *Parthenium hysterophorus* (http://www.invasives.org.za/)

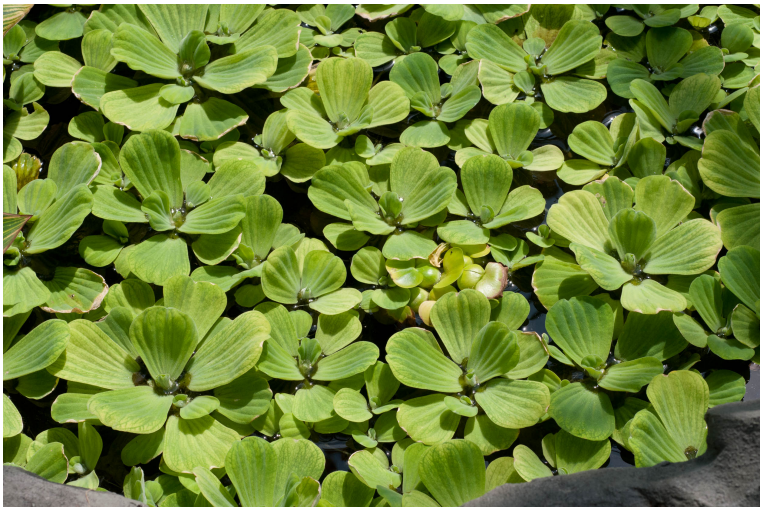

Figure 26 – *Pistia stratiotes* (http://www.florafinder.com/)

Figure 27 – *Ricinus communis* present along the pipeline

Figure 28 – *Senna occidentalis* (Photograph by Jason Hollinger (http://tropical.theferns.info/))

Figure 29 – *Xanthium strumarium* present along the pipeline

In previous years only 6 invasive species were identified: *Agave sisalana* (**Figure 18**), *Opuntia ficus-indica, Opuntia monacantha, Lantana camara, Ricinus communis* (FIGURE 27) *and Xanthium strumarium* (FIGURE 29).

For these species, especially for *Agave* and *Opuntia* species, number of sites seems to be decreasing along the years. For *Ricinus communis* and *Xanthium strumarium* it looks like there is an increase between 2011 and 2016. Nerveless, in 2011 these annual plants were not seen due to the fact that the survey was done in the dry period (Deacon, 2012). The control of these species should be considered a priority, has the pipeline ROW acts as a privileged path for these species dispersion and building will probably aggravate the problem. A control plan has been implemented in previous years, and, according to Deacon (2012) it has been successful. Even so, we had no access to the plan itself or to its results.

It is important to point out that eight species that are considered as invasive in South Africa and are also alien in Mozambique were seen during field work, namely: *Argemone Mexicana* (6 locations), *Caesalpinia decapetala, Parthenium hysterophorus* (3 locations each), *Azolla pinnata, Cereus jamacaru, Datura stramonium*, *Pistia stratiotes* and *Senna occidentalis* (1 location each). This species will probably be invaders in Mozambique, and so its control should be considered a priority.

Table 6 – Alien species recorded during field work of previous monitoring programs performed along the pipeline. Data from 2006 to 2011 extracted from Deacon (2012)

Espécie	2005	2006	2007	2008	2009	2011	2016
Agave sisalana	2	1	6	10	8	4	3
Opuntia sp.	6	1	13	19	22	12	8
Lantana camara	0	1	1	0	0	0	0
Ricinus communis	3	2	8	0	5	1	5
Xanthium strumarium	4	8	9	0	4	0	6
Total per year	15	13	37	29	39	17	22

Comparing locations of evident erosion signs and of unauthorized activities over the pipeline servitude no evident correlations has been found. Even so, the presence of invasive plant species seems to be correlated with the presence of Agricultural sites (Figure 30).

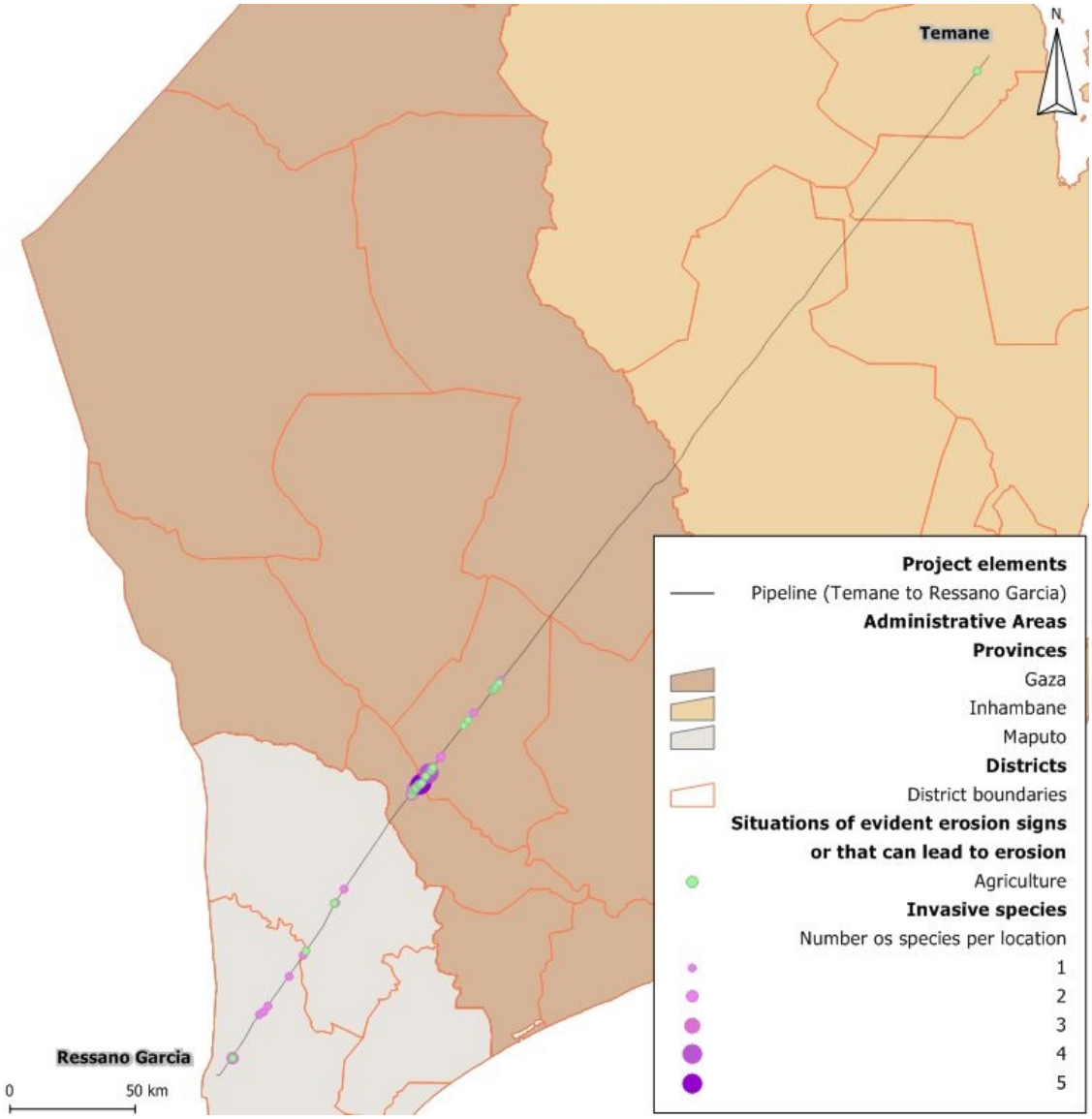

Figure 30 - Comparing the location of agricultural areas and invasive plant

B. Plant succession and recovery monitoring

This monitoring was performed in 38 fixed points along the pipeline, during the month of July of 2016. At each site two permanent plots were monitored: one situated within rehabilitated areas of the Construction Right of Way, and the other within immediately

adjacent areas of vegetation that were not impacted during construction. Sites location were the same of the previous monitoring years, to allow comparisons (

Table 1).

In two plots situated in the rehabilitated area of site 5 (5.5 and 5.6) sampling was constrained due to construction works that was underway.

During the sampling 128 different plants were identified, distributed through 34 different families. The most frequent family was Poaceae, with 31 different species. It was not always possible to identify the plant to the species levels, and in that cases only the gender or family was identified, due to the lack of elements that allow the correct identification.

Site 1 - Extratropical Lowland Grassland

In this site it was possible to successfully survey all sampling plots and a total of 50 plant were identified. Considering the coverage percentage of herbs, scrubs and bare soil (Figure 31) it can be seen that there are some differences between pair of plots. Larger differences seem to exist in P1.1, where the control plot had a very low percentage of bare soil, only 5%, while pipeline plot has around 30%. In P1.3 pipeline plot there are no scrubs whereas in the control plot this vegetation represents 20% of the total coverage. Even so, in average, pipeline and control plots are quite similar (Figure 31).

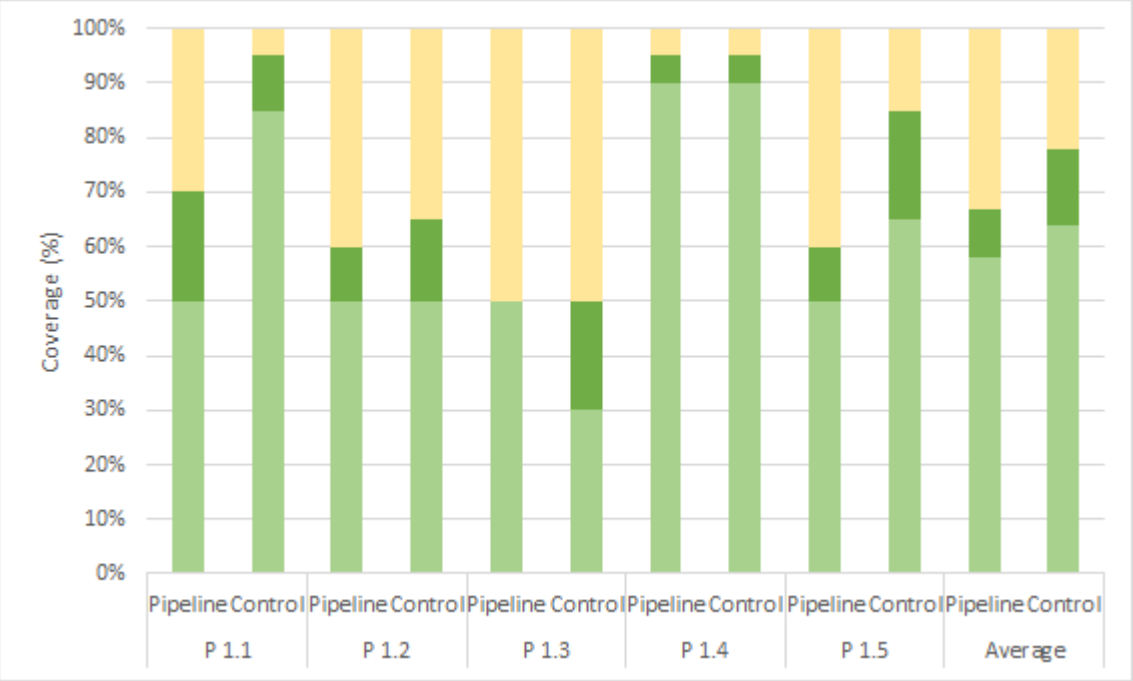

FIGURE 31 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 1. HERBS, SCRUBS, BARE SOIL.

The PERMANOVA test, in which the factor "location" (pipeline vs control) was imposed, indicates that there are no significant differences between plots located in the pipeline area and plots

located at control areas (p(*perm*)=0,7877> 0,05). As so, we could conclude that vegetation in the two different type of plots is quite similar. This was expected, since the first construction period was long ago and construction activities in this site have not begun yet. Even so, this is a very positive data since it reveals that vegetation on pipeline area is able to evolve, despite the presence of cattle and humans.

TABLE 7 – FIXED POINT PHOTOGRAPHY IN SITE 1 MONITORING PLOTS

Plot	South	North
1.1		
1.2		
1.3		

Plot	South	North
1.4		
1.5		

Site 2 - Tree savanna of medium altitudes and river valleys

In this site a total of 28 plant species were identified, and all plots were sampled. Considering the coverage percentage of herbs, scrubs and bare soil (Figure 32) it can be seen that in average, pipeline and control plots seem to be very similar. There are some differences between pair of plots, namely in plots 2.1 where scrub vegetation reaches 50% coverage in the control plot and only 20% in the pipeline plot. Even so, bare soil percentage seems equivalent between pairs of plots, with the exception of plots 2.5, where it reaches 45% in the pipeline, and only 20% in the control plot (Figure 32).

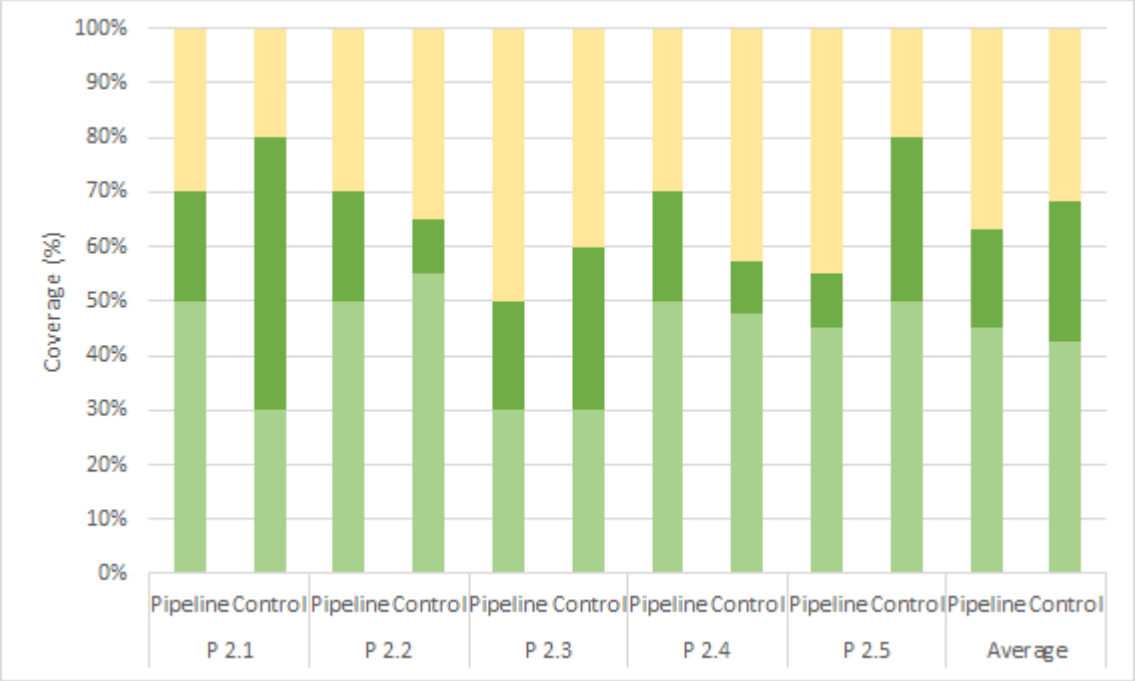

FIGURE 32 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 2. HERBS, SCRUBS, BARE SOIL.

A PERMANOVA test was performed to verify the existence of significant differences between the vegetation (herb and scrub composition) in pipeline and control plots, imposing the factor "location" (pipeline vs control).

The result from PERMANOVA indicates that there are no significant differences between plots located in the pipeline area and plots located in control areas (p(*perm*)=0,5496> 0,05). As so, floristic communities in pipeline and control plots are equivalent. Since the construction of the existing MSP occurred to some time ago and the construction activities did not begun yet in this site these results were expected. Even so, there are other disturbances in the area that can affect the growth of vegetation, such as the presence of cattle. However, according to this results, vegetation on pipeline area is able to evolve, despite these other disturbances.

TABLE 8 – FIXED POINT PHOTOGRAPHY IN SITE 2 MONITORING PLOTS

Plot	South	North
2.1		
2.2		
2.3		

Plot	South	North
2.4		
2.5		

Site 3 - Vegetation on alluvium

In these site all the plant surveys were successfully sampled during field work and a total of 46 plant species were identified. By analyzing the coverage percentage of herbs, scrubs and bare soil (Figure 33Figure 31) it can be seen that in general the plots composition is very similar. In fact, in average the coverage of herbs, scrubs or bare soil is 35%, 10% and 55% in the pipeline plots and 40%, 15% and 45% in the control points.

There are some differences between pair of plots, especially in plot 3.5. In this location bare soil in the pipeline plot is 85%, which is much higher than in the control plot, where it reaches 50% (Figure 33).

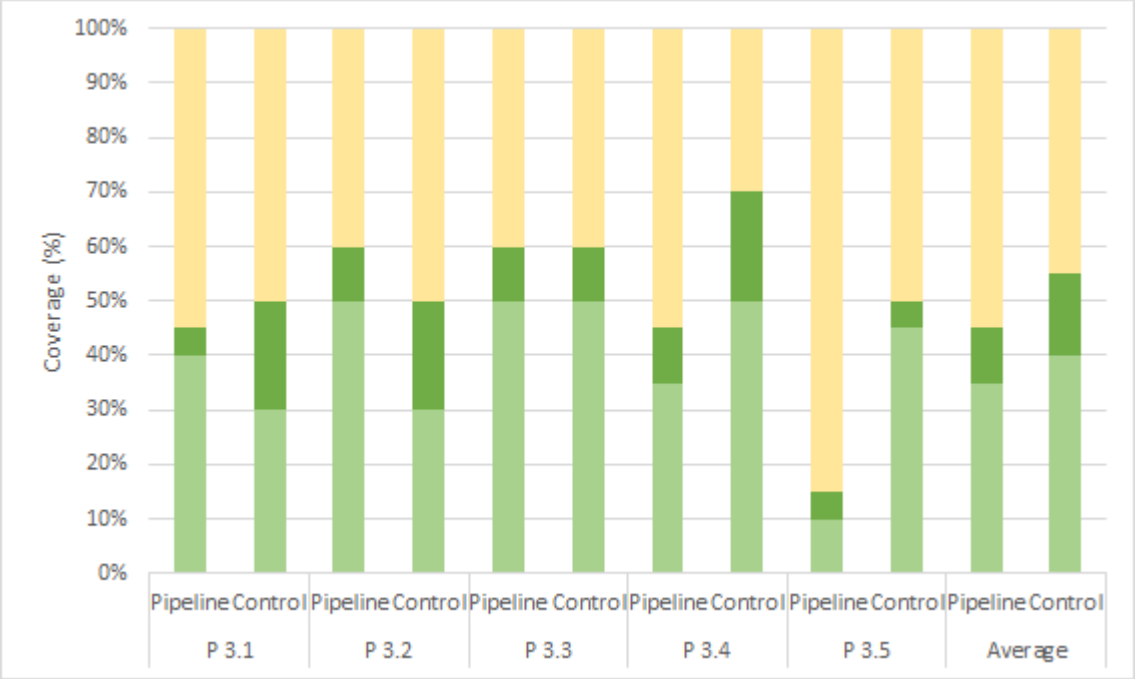

FIGURE 33 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 3. HERBS, SCRUBS, BARE SOIL.

A PERMANOVA test was performed to test the existence of significant differences between the vegetation in pipeline and control plots, imposing the factor "location" (pipeline vs control).

The p-value obtained (p(*perm*)= 0,5455> 0,05) confirms the hypothesis that floristic communities in pipeline and control plots are equivalent and no significant differences were detected, that is, the plots are similar regarding their herb and scrub composition. This was expected, since the construction of the existing MSP occurred to some time ago and the construction activities in this site did not begun yet. Even so this is a very positive data: since vegetation on pipeline area is able to evolve, despite the presence of cattle and humans.

TABLE 9 – FIXED POINT PHOTOGRAPHY IN SITE 3 MONITORING PLOTS

Plot	South	North
3.1	-	-
3.2		-
3.3		
3.4		

Plot	South	North
3.5		

Site 4 - Mopane woodland

In site 4 a total of 32 different plants species were identified during field work. The exploratory analyses of the coverage percentage of herbs, scrubs and bare soil shows that, in general, pairs of plots are very alike (Figure 34). In average herb and scrub coverage differ slightly in pipeline and control plot, but bare soil coverage is very similar: 28% in pipeline plots and 33% in control plots. As so, in average vegetation coverage in pipeline area is higher than in control areas (Figure 34). Nevertheless, there are some plots where the differences are more evident, as plots 4.2. In this plots bare soil coverage is much higher in control area, reaching 50%, than in the pipeline plot, where it reaches only 20%.

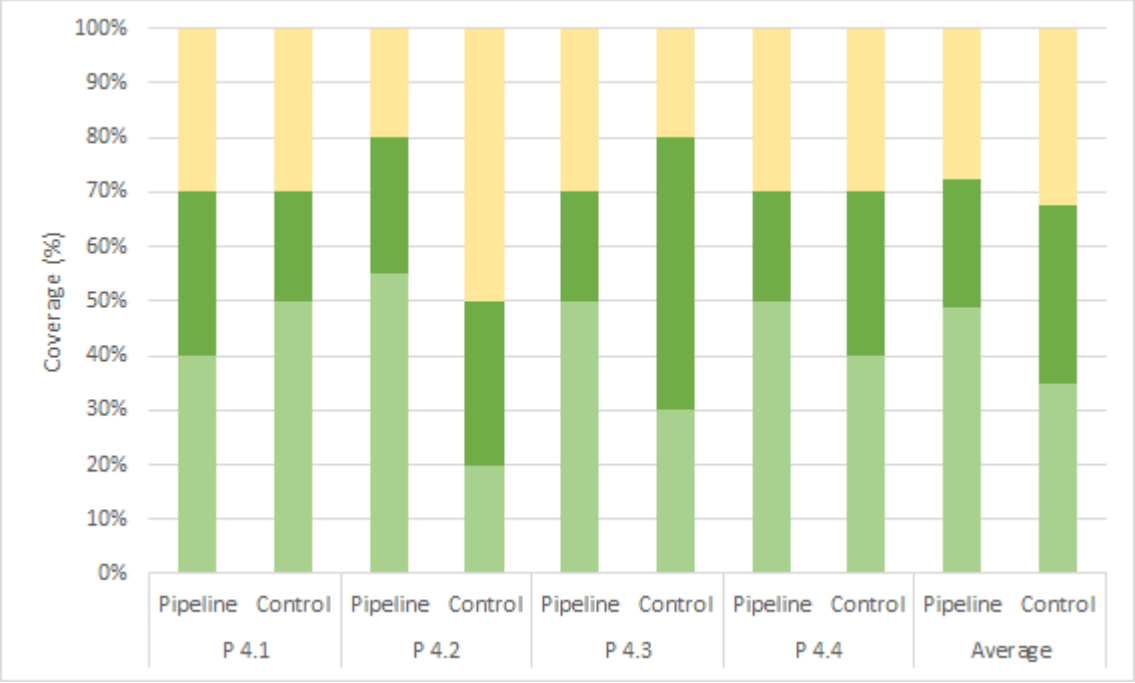

FIGURE 34 - SOIL COVERAGE (IN PERCENTAGE) IN THE 4 MONITORING PLOTS IN SITE 4. HERBS, SCRUBS, BARE SOIL.

The statics result from PERMANOVA, in which the factor "location" (pipeline vs control) was imposed, indicates that there are no significant differences between pipeline and control plots, since the p-value obtained is 0,1472 (p(*perm*)=0,1472> 0,05). As so, vegetation in the two different type of plots, concerning herb and scrub species composition, is similar. Since construction activities Since the construction of the existing MSP occurred to some time ago and the construction activities did not begun yet in this site these results were expected. Even so, there are other disturbances in the area that can affect the growth of vegetation, such as the presence of cattle. According to this results, vegetation on pipeline area is able to evolve, despite these other disturbances.

TABLE 10 – FIXED POINT PHOTOGRAPHY IN SITE 4 MONITORING PLOTS

Plot	South	North
4.1		
4.2		

Plot	South	North
4.3		
4.4		

Site 5 - Deciduous miombo tree savanna with gregarious dense dry woodland

In these site it was not possible to sample two plots situated in the rehabilitated area (5.5 and 5.6) due to the start of construction works of the new pipeline. As so, statistical analysis was performed without data from plots 5.5 and 5.6.

Sampling of site 5 allowed the identification of 36 plant species. By analyzing the coverage percentage of herbs, scrubs and bare soil (Figure 35Figure 31) it can be seen that in average pipeline and control plots have similar vegetation coverage, although in control plots scrubs represent a higher percentage than in pipeline plots. Looking at each one of the plot major differences can be seen between plots 5.2, where the control area has more than 50% of bare soil, whereas the pipeline bare soil coverage is 40%. Another situation that stands out is the pipeline area of 5.4 plot, where shrub species were not observed. These species represent 25% of the control area of sampled in plot 5.4 (Figure 35).

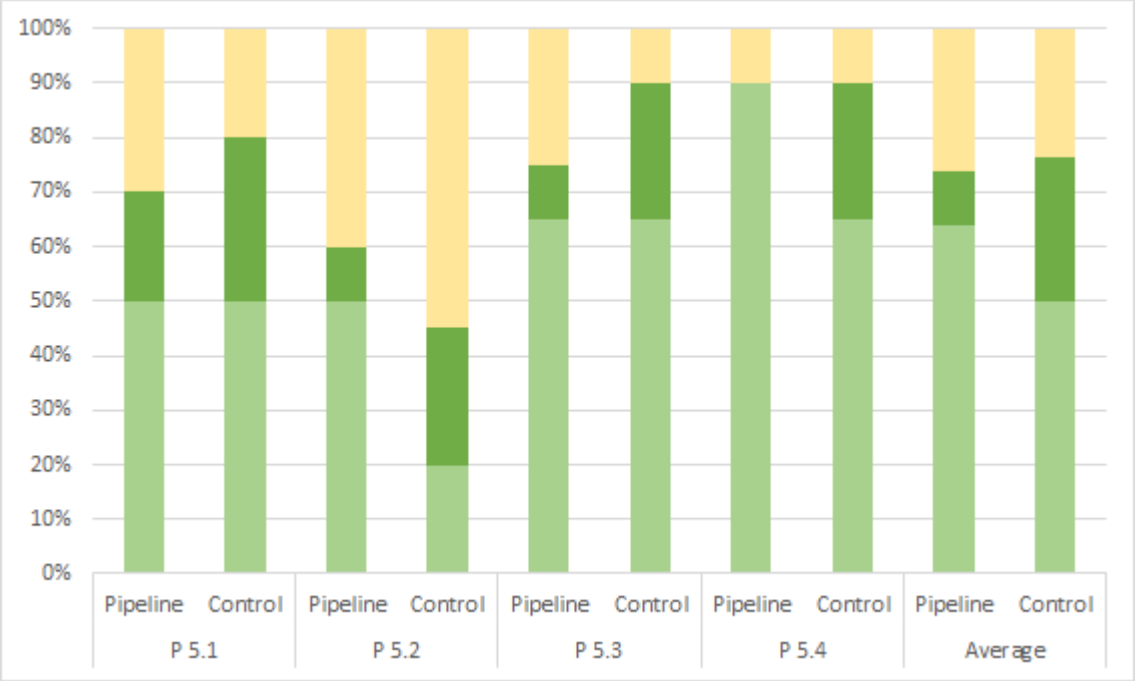

FIGURE 35 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 5. HERBS, SCRUBS, BARE SOIL.

A PERMANOVA test was performed to test the existence of significant differences between the vegetation in pipeline and control plots, imposing the factor "location" (pipeline vs control).

The p-value obtained (p(*perm*)= 0,028> 0,05) shows that there are significant differences between the floristic communities in pipeline and control plots. As so the plots are not similar regarding their herb and scrub composition.

The SIMPER analysis shows that there is a dissimilarity of 75,9% between the two groups, and that 12 species are enough to justify up to 70% of those differences (Table 11). The two species that better characterize the pipeline area are *Dactyloctenium aegyptium* and *Sesamum alatum*, both absent from the control plots. In control plots *Sporobolus* sp. and *Eragrostis* sp. are the ones that better characterize vegetation.

TABLE 11 – SIMPER ANALYSIS RESULTS. SPECIES THAT MOST CONTRIBUTE TO A 70% OF ACCUMULATED DISCRIMINATION BETWEEN PIPELINE AND CONTROL PLOTS.

Species	Average abundance Pipeline plots	Average abundance Control plots	Average dissimilarity	Dissimilarity/ standard deviation	% Contribution	% Cumulative contribution
Dactyloctenium aegyptium	0.91	0.26	12.89	1.96	16.98	16.98
Sporobolus sp.	0.00	0.35	7.32	0.90	9.64	26.62
Eragrostis sp.	0.02	0.30	5.26	0.97	6.93	33.55

Species	Average abundance Pipeline plots	Average abundance Control plots	Average dissimilarity	Dissimilarity/ standard deviation	% Contribution	% Cumulative contribution
Sesamum alatum	0.27	0.00	5.18	0.71	6.82	40.37
Panicum maximum	0.02	0.21	4.30	0.63	5.67	46.05
Melhania forbesii	0.23	0.22	4.09	1.34	5.38	51.43
Celosia sp.	0.21	0.16	3.10	1.25	4.08	55.51
Tephrosia purpurea	0.09	0.16	3.08	1.19	4.06	59.57
Digitaria eriantha	0.04	0.11	2.86	0.72	3.77	63.34
Cyperus sp.	0.00	0.10	1.89	0.94	2.50	65.83
Blepharis maderaspatensis	0.05	0.07	1.80	0.99	2.38	68.21
Maerua edulis	0.00	0.09	1.79	0.96	2.35	70.56

Although sites where the project is in full construction were excluded from the analysis, these findings are not surprising, since construction has been initiated in some locations. Higher movement of heavy machinery and personnel and initial construction activities may already operate changes upon pipeline plots.

TABLE 12 – FIXED POINT PHOTOGRAPHY IN SITE 5 MONITORING PLOTS

Plot	South	North
5.1		

Plot	South	North
5.2		
5.3		
5.4		

Plot	South	North
5.5		
5.6		

Site 6 - Saline soils

In this site all the plots were successfully sampled during the field work and a total of 27 plants were identified. On the coverage percentage of herbs, scrubs and bare soil all plots are very similar, and scrubby vegetation was only present in the control plot of site 6.1 (Figure 36 and Figure 31). In average, pipeline and control sites are look alike, with bare soil coverage of 30 and 25% each.

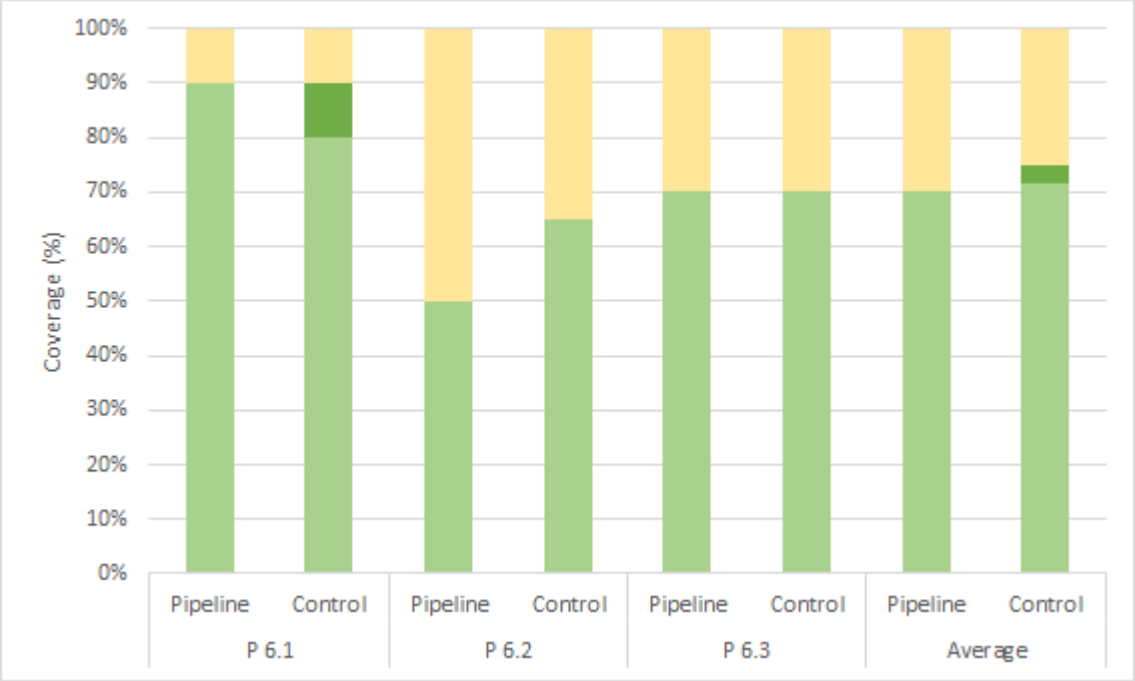

FIGURE 36 - SOIL COVERAGE (IN PERCENTAGE) IN THE 3 MONITORING PLOTS IN SITE 6. HERBS, SCRUBS, BARE SOIL.

A PERMANOVA test was performed to test the existence of significant differences between the vegetation (herb and scrub composition) in pipeline and control plots, imposing the factor "location" (pipeline vs control).

The statics result from PERMANOVA indicate that there are no significant differences between plots located in the pipeline area and plots located at control areas (p(*perm*)=0,3951> 0,05). As so, floristic communities in pipeline and control plots are equivalent. This was expected, since the construction of the existing MSP occurred to some time ago and the construction activities are only beginning and vegetation removal, in this site, has not begun yet.

TABLE 13 – FIXED POINT PHOTOGRAPHY IN SITE 6 MONITORING PLOTS

Plot	South	North
6.1		
6.2		
6.3		

Site 7 - Dry deciduous miombo

In site 7 a total of 32 different plants species were identified during field work. The exploratory analyses of the coverage percentage of herbs, scrubs and bare soil shows that, in general, pairs of plots are very look alike (Figure 37 and Figure 34). The average values for pipeline and control plots are very similar, as total vegetation (herbs and scrubs) covers 90% in pipeline plots and 91% in control plots.

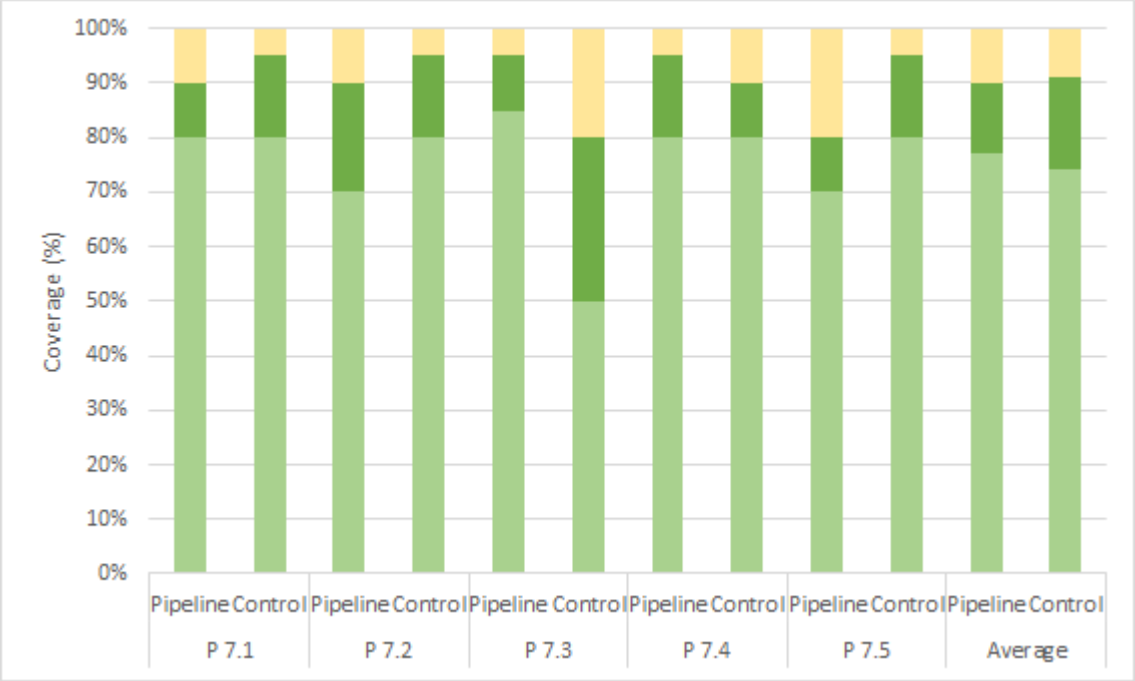

FIGURE 37 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 7. HERBS, SCRUBS, BARE SOIL.

The statics result from PERMANOVA, in which the factor "location" (pipeline vs control) was imposed, indicates that there are significant differences between plots located in the pipeline area and plots located at control areas (p(*perm*)=0, 0169> 0,05). As so, although coverage percentage of herb and scrub seem to be similar, vegetation in the two different type of plots is different regarding the herb and scrub species composition, although construction activities have not begun.

The SIMPER analysis shows that there is a dissimilarity of 75,9% between the two groups, and that 12 species are enough to justify up to 50% of those differences (Table 14). The two species that better characterize the pipeline area are *Dactyloctenium aegyptium* and *Hyparrhenia filipendula*, although they are also present in the control plots. In control plots Lippia javanica and *Panicum deustum* are the ones that better characterize vegetation, since they are absent from pipeline plots.

TABLE 14 – SIMPER ANALYSIS RESULTS. SPECIES THAT MOST CONTRIBUTE TO A 70% OF ACCUMULATED DISCRIMINATION BETWEEN PIPELINE AND CONTROL PLOTS.

Species	Average abundance Pipeline plots	Average abundance Control plots	Average dissimilarity	Dissimilarity/ standard deviation	% Contribution	% Cumulative contribution
Panicum maximum	0.19	0.60	8.80	1.66	17.36	17.36
Dactyloctenium aegyptium	0.79	0.52	5.15	1.52	10.17	27.54
Hyparrhenia filipendula	0.55	0.36	3.93	1.57	7.75	35.29

Species	Average abundance Pipeline plots	Average abundance Control plots	Average dissimilarity	Dissimilarity/ standard deviation	% Contribution	% Cumulative contribution
Digitaria eriantha	0.12	0.22	3.80	1.39	7.51	42.80
Melhania forbesii	0.16	0.07	2.47	1.59	4.87	47.68
Lippia javanica	0.00	0.13	2.26	1.04	4.47	52.14
Panicum deustum	0.00	0.10	2.13	1.03	4.19	56.34
Abutilon guineense	0.04	0.10	2.06	1.09	4.06	60.40
Eragrostis sp.	0.07	0.08	1.97	1.04	3.89	64.28
Indigofera sp.	0.07	0.05	1.61	1.04	3.17	67.46
Asparagus africanus	0.00	0.08	1.60	1.13	3.16	70.62

As so, according to our results, sites are similar respecting coverage percentage of herbs, scrubs and bare soil, but different in respect of the species that area present in each type of plots. Differences between pipeline and control vegetation in this site may be explained by disturbances not related to the project. According to previous works done in the area, the sites are regularly burned by local people during the spring, what might influence grass cover rehabilitation (Deacon, 2012) and species composition. Other important fact is that vegetation on control area has a great percentage of trees. Shading effect of high tree cover on control plots can also affect species composition, constraining the grown of sunlight depending herbs, which does not occur in pipeline plots. As so, in sites were the control plots area mainly occupied by trees these differences are expectable.

TABLE 15 – FIXED POINT PHOTOGRAPHY IN SITE 7 MONITORING PLOTS

Plot	South	North
7.1		

Plot	South	North
7.2		
7.3		
7.4		

Plot	South	North
7.5		

Site 8 - Miombo woodland on Sul de Save sands

In these site all the plots were successfully sampled during field work. A total of 28 plant species were identified in the 10 sampled plots. Figure 38 shows that the coverage percentage of herbs, scrubs and bare soil is very similar in all the plots, with the exception of control plot in site 8.3, where the percentage of bare soil is 20%, while the other plots does not exceed 10%. In average pipeline and control plots are very alike, although in control plots the percentage of scrubs is slightly higher (Figure 38).

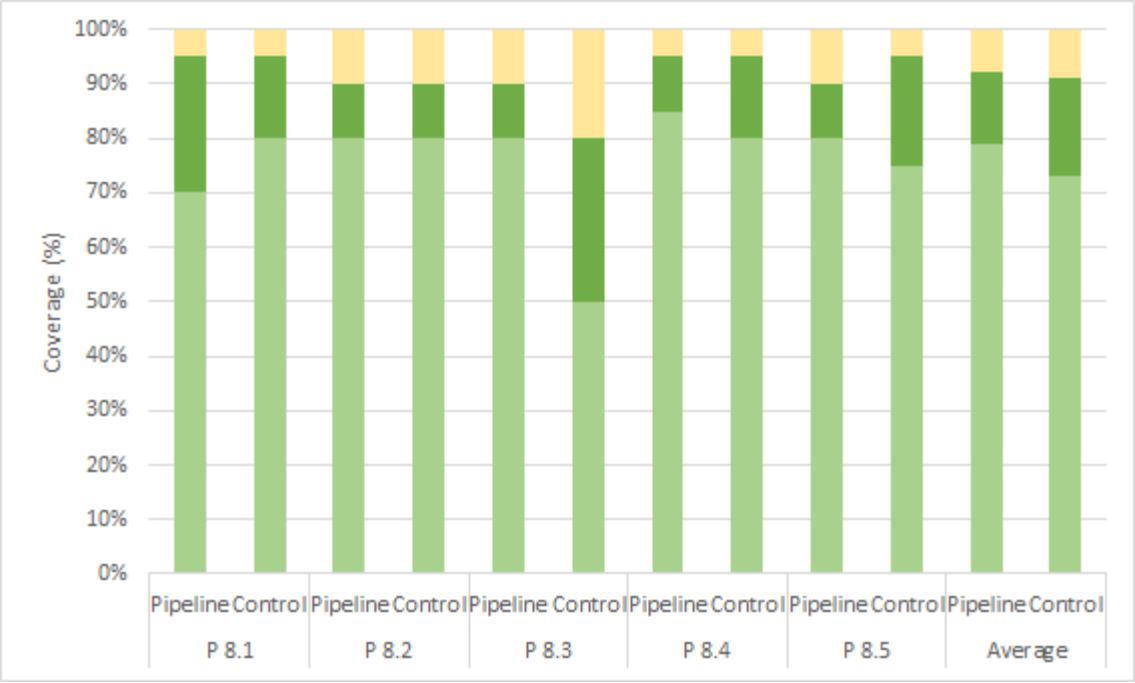

FIGURE 38 - SOIL COVERAGE (IN PERCENTAGE) IN THE 5 MONITORING PLOTS IN SITE 8. HERBS, SCRUBS, BARE SOIL.

The statics result from PERMANOVA, in which the factor "location" (pipeline vs control) was imposed, indicates that there are no significant differences between plots located in the pipeline area and plots located at control areas (p(*perm*)=0, 0557> 0,05). As so, vegetation in the two

different type of plots is similar in regard to their herb and scrub composition, despite the fact that control plots are mainly occupied by trees and shading effect of high tree cover can affect species composition, constraining the grown of sunlight depending herbs and scrubs. In this specific case, maybe vegetation burn is not as severe as in sites 7, where significant differences between plot have been point out, and vegetation had the change to evolve since the construction of the existing MSP, which occurred some time ago. Also, in this site the construction activities and vegetation removal, has not begun yet. Even so this is a very positive data: since vegetation on pipeline area is able to evolve, despite the presence of cattle and humans.

TABLE 16 – FIXED POINT PHOTOGRAPHY IN SITE 8 MONITORING PLOTS

Plot	South	North
8.1		
8.2		
8.3		

Plot	South	North
8.4		
8.5		

C. Hardwood and natural resource monitoring

During the field work natural resource exploitation was registered in 31different locations. Charcoal exploitation was the most frequent situation, and it was document in 19 locations (Table 17, Figure 39 and Figure 40). Wood harvesting and pole cuts were also seen along the pipeline, and were documented in 12 different situations (Table 17, Figure 39 and Figure 41).

TABLE 17 – SITUATIONS OF EVIDENT EROSION SIGNS OR THAT CAN LEAD TO EROSION RECORDED DURING FIELD WORK

Action	Number of locations
Charcoal	19
Wood harvesting and poles cut	12
Total	31

In general, natural resources exploitation seems to be more frequent in Gaza and Maputo Provinces. In Maputo province only charcoal exploitation was detected and, in Inhambane, most situations were associated with wood harvesting.

No chopped up trees were seen and wood longs were not detected along the pipeline. As so, signs of timber industry activities were not perceived. All logging appeared to be for personal use of the population and not for the timber industry.

In this survey it was only possible to identified one specie, the *Androstachys johnsonii* (Cimbirre or Mecrusse), but, according to Castro (2012), in previous years, beyond this species the most affected species was *Afzelia quanzensis* (Chanfuta), although other species were also affected: *Spirostachys Africana*, *Combretum imberbe*, *Dalbergia mealanoxylon*, *Guibourtea conjugata*, *Balanites maughamii* and *Albizia versicolor*.

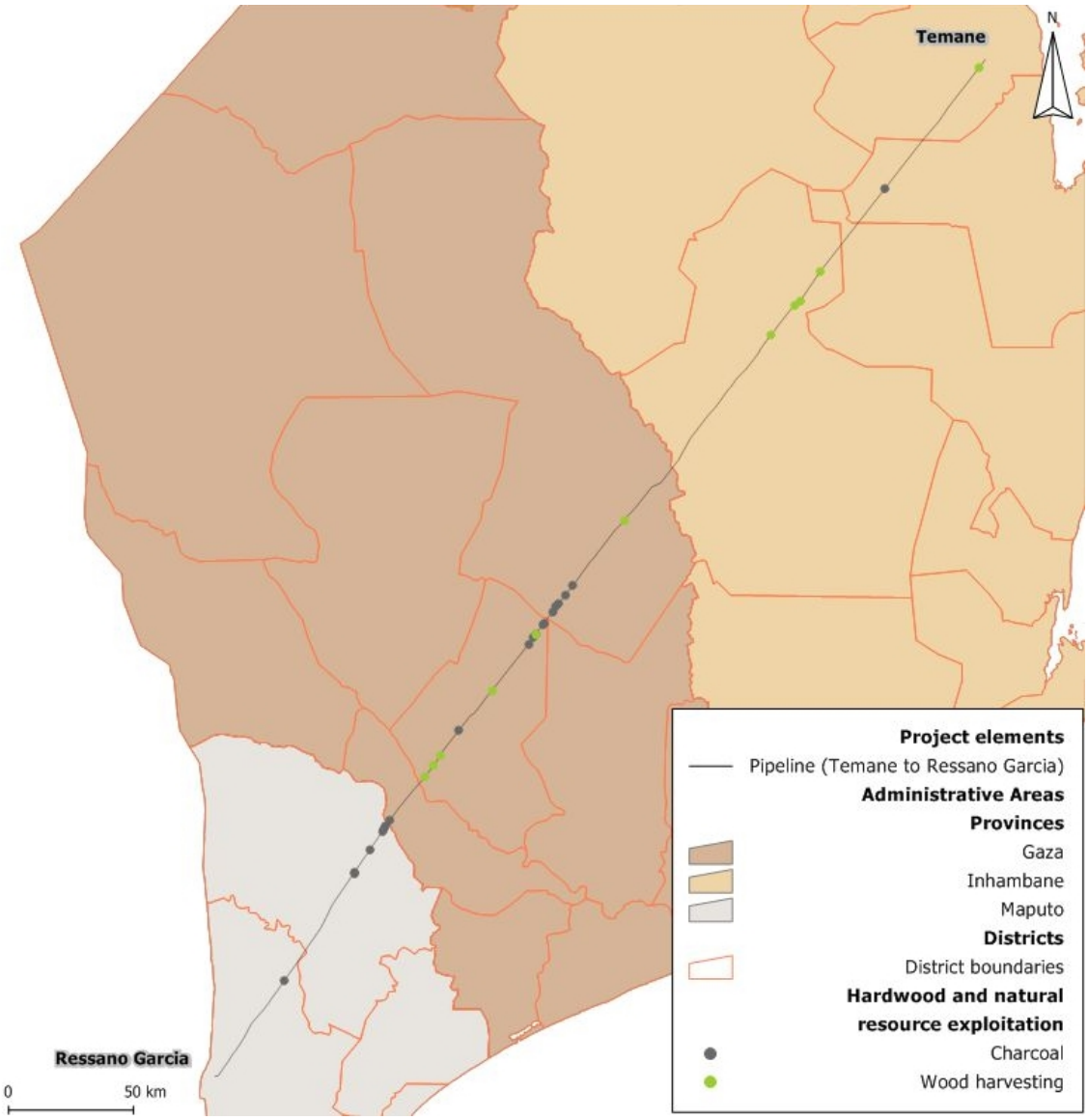

FIGURE 39 – LOCATION OF DIFFERENT NATURAL RESOURCE EXPLOITATION DOCUMENTED DURING FIELD WORK

FIGURE 40 – CHARCOAL BAGS PILED UP ALONG THE PIPELINE

Figure 41 – Wood harvesting and pole cuts along the pipeline

According to Deacon (2012), natural resources exploitation seemed to be decreasing in 2011, compared to the situation observed in 2008 and 2009 (Table 18). In 2016, charcoal exploitation appears to have increased, while the use of wood cutting and continues to decrease. However, this data should be analyzed carefully as the collected information is a small sample of the reality, since it only reflects the situations observed in only one pass through the project area, providing a picture of a given time. Thus, small variations in the observed numbers may not reflect the reality of the situation, since they are the reflection of the activities that were being carried out on a certain day at a certain place. It should also be noted that this monitoring only contemplates pipeline servitude and no data on what happens around the project has been registered. Thus, the situation on surrounding area is unknown, such as impacts in areas that are now accessible from the ROW and/or the new existing paths and roads linked with the ROW.

Table 18 – Evolution of natural resources exploitation on pipeline servitude over the years.

	Number of locations					
Action	**2006**	**2007**	**2008**	**2009**	**2011**	**2016**
Charcoal	5	11	29	21	6	19
Wood harvesting and poles cut	18	22	36	44	18	12
Total	23	33	65	65	24	31

Since the beginning of the monitoring program natural resources exploitation has grown and data seems to indicate that increased accessibility has led to accelerated and unsustainable extraction of commercially valuable hard wood species along the Pipeline alignment (Castro, 2012; Deacon, 2012). Proposed mitigation measures to limit the use of the ROW by all vehicles except SASOL service vehicles seem to prove unsuccessful. Human presence along the project is a reality and limiting the use of the ROW in its all extension seems like an impossible task. Therefore, other ways do address this problematic should be thought.

5. Conclusions

This document is the report of pre-construction phase of the ongoing Phase II Pipeline (LompcoLine 2), while it continues to incorporate and analyze data collected in previous years of the monitoring program.

Erosion seems to be a problem on the southern half of the pipeline, where it was seen in several locations. Despite the great utilization of the ROW by local population and cattle, erosion seems to be connected to water runoff in places that were small streams prior to pipeline construction. . This situation does not seem to cause much impact over surrounding vegetation areas, where no major signs of erosion were seen. However, after the new pipeline installation, disturbances caused by construction actions and heavy vehicles traffic, may change this situation. To avoid major erosion problems in upcoming years some in the mitigation measures are proposed (Chapter 6).

During 2016, several invasive plant species were seen in the ROW. Some of those species, eight in total, were first seen this year: *Argemone mexicana, Azolla pinnata, Caesalpinia decapetala, Cereus jamacaru, Datura stramonium, Parthenium hysterophorus, Pistia stratiotes* and *Senna occidentalis*. Although an invasive species control program has been implemented, to which we had no access, the disturbed habitats of the ROW continue to function as a dispersal corridor for these species, and and future building will certainly increase alien species dispersion along the project. As so, it is urgent to continue the control program, and to decide whether more species should be included. For that matter, we propose an update of the control program based on its success over the past years and the characteristics of the invasive species that are present along the ROW.

According to previous studies (Castro, 2012; Deacon, 2012), natural resources exploitation has grown since the project was installed and increased accessibility has led to accelerated and unsustainable extraction of commercially valuable hard wood species. Proposed mitigation measures to limit the use of the ROW by all vehicles except SASOL service vehicles were unsuccessful and human presence seems to be well establish, and growing. As so, it is proposed the possibility of compensation measures implementation, such as planting of most affected tree species, for example. Decision-making should be based on additional studies, as proposed in Chapter 6.

According to 2016 monitoring results, pipeline rehabilitated area has been successfully revegetated by indigenous plant communities, since the last construction phase. Herbs and scrub composition in pipeline and control areas are very similar and, in the majority of situations, there are no significant differences between the two situations. As so, it is expected that, after the construction of the new pipeline, vegetation will equally recover. Data collected in 2016 will function as a baseline for comparing future results and confirm that indeed the vegetation is able to recover after this new disturbance.

6. Recommendations

In this chapter some recommendations will be done, in order to ensure the preservation of surrounding areas and minimum disturbance in the ROW. Concerning the Flora and vegetation monitoring, all the Plans (A, B and C) must continue annually during the operation phase of the project.

To avoid major erosion problems and preserve the surrounding vegetation, the following mitigation measures are proposed:

- Construction vehicles should only use the ROW and cannot circulate or park in the adjacent area. This is especially important during rainy season;
- Water runoff drain pipes should be installed in areas where erosion is due to Water runoff;
- Vegetation removal should be just the necessary to ensure proper functioning of the ongoing work;
- Clearing of trees with a diameter of greater than 20cm from the construction servitude should be avoided, wherever possible;
- Topsoil removed from the construction ROW must be stockpiled separately to the subsoils and used to rehabilitate the area after construction completion, in order to facilitate the revegetation process;

Controlling the expansion of invasive species must be a priority, as so:

- Invasive species control must continue, in the terms agreed with ROMPCO;
- The ongoing plan should be evaluated and adjusted in accordance with its success and the results from 2016 monitoring;
- The incorporation in the control program for the new invasive species recorded in the area in 2016 (ArgemoneArgemone mexicana, Azolla pinnata, Caesalpinia decapetala, Cereus jamacaru, Datura stramonium, Parthenium hysterophorus, Pistia stratiotes and Senna occidentalis) should be addressed. For that matter, a comprehensive study about these species should be made, and the control plan adjusted in accordance;
- Control plan updating must be done by a team of biologists, with knowledge on invasive species.
- In the next table are provided some recommendations about the methods for removing the invasive species that were identified in 2016 monitoring actions:

Table 19 – Methods for removing invasive species that were identified in 2016 monitoring actions.

Specie	Control Method/ Recommendations
Agave sisalana	Cut of the central growth stem as low as possible and herbicide solution application immediately after cutting (within 20 s).
Argemone mexicana	Hand weeding. It should be carried out before the plant has set seed.
Azolla pinnata	Manual removal by using thin-meshed nets. It is the preferred methodology when the invaded areas are relatively small. All material should be removed from the location, as this plant reproduces vegetatively through fragments of stems that root easily
Caesalpinia decapetala	Seedlings and saplings can be dug up or pulled up manually. Larger plants must be cut and stumps treated with herbicide.
Cereus jamacaru	Single, isolated seedlings should be uprooted and placed onto a place where they will be unable to set roots again. Care must be taken that no part of the plant is left lying where it can root. Under no circumstances must pieces of the plant simply be carted away to be discarded, since this is one of the most common ways in which cactus infestations originate
Datura stramonium	Isolated plants should be hand-pulled before they set seed and larger infestations can be controlled by tillage when weeds are in the seedling stage. In larger plants it may be necessary to spray with herbicide, limiting as much as possible its application to the target species.
Opuntia ficus-indica	Manual/mechanical pulling preceded (or not) by the stem cut (preferred methodology). In compacted substrates, uprooting must be during the rainy season as to facilitate the removal of the root system. It should be guaranteed that there are no fruits, large roots and cladode fragments left in the ground, which root easily and originate new invasion foci. All pulled material should be removed from the location for posterior destruction and burning.
Parthenium hysterophorus	Pull out the plants before they flower, making sure to remove all of the root system to avoid regrowth from root remnants
Pistia stratiotes	Small scale infestations can be controlled manually. Larger infestations have been tackled with specially made machinery or by using chemical control which can be effective in the short term but needs to be reapplied over a long period.
Ricinus communis	It can be controlled through cultivation and mowing or physical uprooting. Herbicides can be effective as cut stump treatments or basal bark applications (painting herbicide onto the bark).
Senna occidentalis	It can be successfully controlled when in the seedling stage by cultivation. Likewise, a variety of herbicides can successfully control the species.
Xanthium strumarium	Single plants and small infestations can be hoed and larger infestations sprayed with herbicide. All control efforts should be aimed at preventing seed formation.

Other mitigation measures have been proposed over the years, namely measures to constrain and discourage the use of the ROW by other vehicles than the SASOL ones. Those measures does not seem to have effective, has human use of the ROW and sorrowing area

continues to grow. As so, we believe that this is an impossible task and that other ways to mitigate natural resources exploitation should be addressed, for instance, planting the most affected areas with affected native tree species. To implement this type of mitigation, additional information is required, so we propose the following actions:

- Perform studies to access the extension of natural resources exploitation in the surrounding area, to confirm which are the most affected areas and species, establishing the baseline situation nowadays and accessing the expected evolution;

- Only after that characterization will be possible to access the real impact and define the most adjusted measures to mitigate those impacts. One possibility may be the plantation of the most affected species in specific areas, in order to offset the losses caused by increased accessibilities. However, only with the suprarrefered specific studies will be possible to propose additional mitigation measures.

Finally, monitoring plans should continue on. Even so, it is considered that sampling frequency of Plan B - plant succession and recovery monitoring - can be changed from annual to each 2 years, since the vegetation growth is slow and does not justify the need to carry out samples every year.

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8. Appendix

A. Erosion and alien vegetation monitoring

TABLE 20 - SITUATIONS OF EVIDENT EROSION SIGNS OR THAT CAN LEAD TO EROSION

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
320.816	-254.089					x	
320.843	-254.055				x		
320.935	-253.935				x		
320.993	-253.859				x		
321.093	-253.728				x		
321.220	-253.562					x	
321.320	-253.432				x		
321.483	-253.210				x		
321.503	-253.177					x	
321.744	-252.783				x	x	
321.920	-252.511	x				x	
321.882	-252.559				x	x	
321.963	-252.466					x	
322.004	-252.422				x	x	
322.017	-252.408					x	
322.228	-252.185	x				x	
322.245	-252.166	x				x	
322.307	-252.102	x				x	
322.339	-252.067					x	
322.475	-251.923	x				x	
322.558	-251.816				x		
322.687	-251.650				x	x	
322.737	-251.585				x	x	
322.864	-251.422				x	x	
322.895	-251.381				x	x	
323.006	-251.239				x	x	
323.161	-251.038				x	x	
323.212	-250.973					x	
323.273	-250.894					x	
323.297	-250.863					x	
323.325	-250.826					x	
323.421	-250.703				x	x	
323.439	-250.679					x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
323.458	-250.655				x	x	
323.496	-250.605					x	
323.718	-250.356				x	x	
323.731	-250.336				x	x	
323.790	-250.242					x	
323.838	-250.166	x			x	x	
323.850	-250.148	x				x	
323.871	-250.120	x			x	x	
324.076	-249.855	x			x	x	
324.099	-249.826	x				x	
324.117	-249.803	x			x	x	
324.288	-249.582	x				x	
324.352	-249.500					x	
324.397	-249.442				x		
324.637	-249.132					x	
324.668	-249.085	x			x	x	
324.727	-248.980	x			x	x	
324.798	-248.849	x				x	
324.862	-248.732					x	
324.879	-248.700				x	x	
324.915	-248.633				x	x	
324.946	-248.575	x					
324.985	-248.501	x					
325.172	-248.184		x		x		
325.294	-248.023	x					
325.349	-247.950	x					
325.409	-247.872	x					
325.441	-247.829	x	x				
325.501	-247.749				x		
325.576	-247.651	x					
325.628	-247.580		x				
325.681	-247.511	x					
325.822	-247.323				x		
325.902	-247.215		x				
325.955	-247.146		x				
325.992	-247.097				x		
326.035	-247.041				x		
326.249	-246.755				x		
326.365	-246.601				x		
326.507	-246.412				x		

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
326.625	-246.255				x	x	
326.636	-246.241				x	x	
326.647	-246.226				x	x	
326.650	-246.221	x				x	
326.727	-246.118	x				x	
326.746	-246.092	x			x	x	
327.025	-245.722		x				
327.039	-245.704	x			x		
327.059	-245.677					x	
327.123	-245.587				x		
327.155	-245.539	x				x	
327.199	-245.473					x	
327.238	-245.416	x				x	
327.247	-245.402				x		
327.261	-245.381				x	x	
327.289	-245.342				x	x	
327.337	-245.285				x	x	
327.371	-245.245				x	x	
327.422	-245.184					x	
327.471	-245.125				x	x	
327.544	-245.030	x				x	
327.555	-245.016				x	x	
327.581	-244.981		x		x	x	
327.632	-244.916				x	x	
327.711	-244.826	x				x	
327.719	-244.817		x			x	
327.730	-244.805		x		x	x	
327.734	-244.799	x				x	
327.798	-244.726				x	x	
327.885	-244.627					x	
327.891	-244.620				x	x	
327.940	-244.565				x	x	
328.031	-244.461				x	x	
328.040	-244.451				x	x	
328.082	-244.402	x			x	x	
328.100	-244.378	x				x	
328.111	-244.369				x	x	
328.120	-244.358				x	x	
328.124	-244.354	x			x	x	
328.136	-244.341	x			x	x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
328.150	-244.324				x	x	
328.161	-244.311	x			x		
328.163	-244.308					x	
328.874	-243.544				x		
328.948	-243.451				x		
328.955	-243.443				x		
328.984	-243.406				x		
328.998	-243.388				x		
329.055	-243.317		x			x	
329.063	-243.308				x		
329.143	-243.201	x				x	
329.187	-243.150	x					
329.256	-243.069	x					
329.384	-242.869				x		
329.395	-242.847				x		
329.407	-242.822				x	x	
329.569	-242.617				x		
329.577	-242.608				x		
329.606	-242.573	x					
329.623	-242.555	x					
329.649	-242.524	x					
329.751	-242.404				x		
329.921	-242.205				x		
330.138	-241.951				x		
330.199	-241.881	x					
330.456	-241.581	x				x	
330.470	-241.564	x					
330.505	-241.522				x	x	
330.514	-241.512				x	x	
330.534	-241.488				x	x	
330.556	-241.463				x	x	
330.605	-241.405				x		
330.657	-241.369				x	x	
330.671	-241.362	x				x	
330.691	-241.350				x	x	
330.743	-241.321				x	x	
330.763	-241.308				x	x	
330.918	-241.119				x	x	
330.943	-241.097				x	x	
330.969	-241.067	x				x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
330.992	-241.039				x	x	
331.101	-240.906	x	x			x	
331.110	-240.895				x	x	
331.226	-240.753	x					
331.288	-240.678					x	
331.330	-240.630				x	x	
331.376	-240.577				x	x	
331.473	-240.469					x	
331.523	-240.413					x	
331.598	-240.327		x		x	x	
331.902	-239.972		x		x	x	
332.058	-239.789	x			x	x	
332.094	-239.752	x					
332.112	-239.726				x	x	
332.131	-239.704	x			x	x	
332.204	-239.617					x	
332.318	-239.486				x	x	
332.331	-239.470	x					
332.509	-239.266					x	
332.659	-239.092					x	
332.703	-239.038	x			x	x	
332.726	-239.011				x	x	
332.766	-238.959				x	x	
332.930	-238.754				x	x	
333.213	-238.401				x		
333.387	-238.183					x	
333.423	-238.138					x	
333.446	-238.109					x	
333.457	-238.094	x					
333.513	-238.025		x		x	x	
333.586	-237.936		x		x	x	
333.680	-237.823					x	
333.734	-237.757					x	
333.734	-237.757					x	
333.804	-237.672					x	
333.816	-237.658				x	x	
333.843	-237.626				x	x	
333.933	-237.516					x	
334.020	-237.410					x	
334.071	-237.350					x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
334.273	-237.105				x	x	
334.296	-237.077				x	x	
334.329	-237.038				x	x	
334.412	-236.942				x	x	
334.446	-236.902				x	x	
334.577	-236.748					x	
334.601	-236.719				x	x	
334.644	-236.670					x	
334.711	-236.591				x	x	
334.763	-236.530				x	x	
334.824	-236.451					x	
334.872	-236.388					x	
334.937	-236.302	x				x	
335.154	-236.020					x	
335.194	-235.968					x	
335.460	-235.669					x	
335.536	-235.577					x	
335.692	-235.387					x	
335.756	-235.310					x	
335.771	-235.292					x	
335.788	-235.271					x	
335.974	-235.046				x	x	
336.023	-234.989					x	
336.066	-234.934					x	
336.109	-234.882				x	x	
336.658	-234.288		x				
336.710	-234.227				x		
337.633	-233.199				x	x	
337.715	-233.099					x	
337.896	-233.019				x		
337.940	-233.000	x				x	
338.040	-232.958					x	
338.291	-232.680				x	x	
338.350	-232.610					x	
338.407	-232.540					x	
338.450	-232.488					x	
338.539	-232.380				x	x	
338.601	-232.307					x	
338.647	-232.252					x	
338.747	-232.131					x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
338.810	-232.029					x	
338.887	-231.898					x	
338.900	-231.874					x	
338.903	-231.869					x	
338.989	-231.724					x	
339.140	-231.476					x	
339.189	-231.395					x	
339.236	-231.316					x	
339.292	-231.241					x	
339.352	-231.168					x	
339.399	-231.112				x	x	
339.621	-230.845					x	
340.313	-230.043					x	
340.594	-229.677					x	
340.675	-229.571					x	
340.733	-229.513					x	
340.811	-229.430				x	x	
341.976	-228.022				x		
342.227	-227.699				x		
342.367	-227.534					x	
343.217	-226.515				x		
344.271	-225.216				x		
344.781	-224.596				x		
345.054	-224.264				x		
345.349	-223.904	x					
345.600	-223.599				x		
345.736	-223.432				x		
346.150	-222.927				x		
347.065	-221.810				x		
347.101	-221.766				x		
347.157	-221.697				x		
347.179	-221.671				x		
347.240	-221.596				x		
347.688	-221.047				x		
347.926	-220.755	x			x		
348.115	-220.523				x		
348.395	-220.202				x		
348.582	-219.996				x		
348.769	-219.790	x					
348.977	-219.509				x		

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
349.216	-219.173				x		
349.494	-218.833				x		
349.588	-218.717				x		
349.794	-218.463				x		
349.880	-218.357				x		
350.229	-217.927				x		
349.879	-218.358				x		
319.988	-254.576				x		
320.099	-254.590				x		
321.038	-253.800						x
324.009	-249.942						x
325.138	-248.230		x				x
328.173	-244.298						x
328.256	-244.203						x
328.269	-244.189						x
328.312	-244.138						x
328.343	-244.117						x
328.378	-244.063						x
328.448	-243.982		x				x
328.465	-243.973						x
328.475	-243.969					x	x
328.568	-243.924						x
328.557	-243.938						x
328.571	-243.920						x
328.770	-243.673	x					x
328.959	-243.437						x
329.030	-243.349					x	x
330.233	-241.841				x		x
330.422	-241.619						x
331.385	-240.568					x	x
331.412	-240.538				x	x	x
331.453	-240.492					x	x
331.553	-240.378				x	x	x
331.639	-240.281					x	x
350.135	-218.043						x
321.055	-253.778			x			
323.089	-251.131			x		x	
323.885	-250.104			x			
324.067	-249.868			x			
325.081	-248.328	x		x		x	

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
325.152	-248.210			x		x	
327.495	-245.096			x		x	
328.059	-244.429			x	x	x	
328.522	-243.953			x	x	x	
332.222	-239.596	x		x	x	x	
332.903	-238.789		x	x	x	x	
333.097	-238.545			x	x		
333.168	-238.456			x	x		
343.724	-225.971			x			
343.757	-225.925			x	x		
343.959	-225.644			x	x		
345.619	-223.575	x		x	x		
348.016	-220.646			x			
348.549	-220.032			x			
348.566	-220.014			x			
348.651	-219.920			x			
350.063	-218.130			x	x		
350.077	-218.115			x	x		
350.359	-217.768			x	x		
319.846	-254.482	x		x			
319.848	-254.489			x	x		
319.849	-254.493			x	x		
319.852	-254.502			x	x		
319.853	-254.504			x	x		
319.853	-254.509			x	x		
319.854	-254.513	x		x			
319.856	-254.518			x	x		
319.859	-254.525	x		x			
319.861	-254.538			x	x		
319.865	-254.555			x	x		
319.868	-254.565			x	x		
319.871	-254.573			x	x		
319.873	-254.586			x	x		
319.874	-254.589			x	x		
319.876	-254.598			x	x		
319.880	-254.600			x	x		
319.911	-254.595	x		x			
319.914	-254.595			x	x		
319.932	-254.590			x	x		
319.940	-254.588	x		x			

Longitude	Latitude	Erosion	Bare patches	Villages and setlements	Roads and Paths	Cattle	Agriculture
319.950	-254.585	x		x			
320.286	-254.499			x			
327.007	-245.746		x	x	x	x	

TABLE 21 - INVASIVE ALIEN SPECIES

Longitude (l)	Latitude (l)	Invasive Species
321.035	-253.803	*ArgemoneArgemone mexicana, Parthenium hysterophorus*
321.038	-253.800	*Ricinus communis*
322.159	-252.258	*Opuntia ficus-indica*
322.282	-252.127	*Caesalpinia decapetala*
322.475	-251.923	*Caesalpinia decapetala*
323.297	-250.863	*Caesalpinia decapetala*
323.885	-250.104	*Opuntia ficus-indica*
325.152	-248.210	*Agave sisalana*
325.501	-247.749	*Cereus jamacaru*
328.169	-244.303	*Argemone mexicana, Xanthium strumarium*
328.269	-244.189	*Argemone mexicana, Xanthium strumarium*
328.312	-244.138	*Argemone mexicana, Parthenium hysterophorus, Xanthium strumarium*
328.343	-244.117	*Ricinus communis*
328.419	-244.016	*Ricinus communis*
328.465	-243.973	*Azolla pinnata, Pistia stratiotes, Xanthium strumarium*
328.568	-243.924	*Argemone mexicana, Datura stramonium, Parthenium hysterophorus, Senna occidentalis, Xanthium strumarium*
328.557	-243.938	*Argemone mexicana, Datura stramonium, Parthenium hysterophorus, Senna occidentalis, Xanthium strumarium*
328.775	-243.666	*Opuntia ficus-indica*
328.830	-243.599	*Opuntia ficus-indica*
328.857	-243.565	*Argemone mexicana, Agave sisalana, Ricinus communis, Xanthium strumarium*
328.948	-243.451	*Opuntia ficus-indica*
329.055	-243.317	*Opuntia ficus-indica*
329.333	-242.974	*Agave sisalana*
329.338	-242.963	*Caesalpinia decapetala*
330.657	-241.369	*Opuntia ficus-indica*
331.703	-240.206	*Ricinus communis*

B. Plant succession and recovery monitoring

TABLE 22 – RESULTS OF PIPELINE PLOTS SAMPLING

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Malvaceae	*Abutilon guineense*	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	5	0	0	0	0	0	0	0	0
Malvaceae	*Abutilon sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	2	1	2	0	0	0	0	0
Fabaceae	*Acacia sp.1*	0	0	0	1	0	2	0	2	8	6	0	5	0	4	7	1	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Dicliptera sp*	0	2	0	0	7	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Hygrophila auriculata*	0	0	3	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaranthoideae	*Amaranthus hybridus*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boraginaceae	*Heliotropium ciliatum*	12	0	13	0	7	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Aristida sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	16	0	0	0	0	2	4	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Aristida adscensionis*	2	2	55	0	0	0	0	0	0	0	0	0	0	0	0	1	4	0	0	0	0	0	0	0	1	1	1	3	0	0	0	0	0	0	0	0
Fabaceae	*Bauhinia galpinii*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Blepharis maderaspatensis*	2	0	0	1	0	2	4	1	0	4	1	0	0	2	3	0	0	0	8	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Capparaceae	*Boscia sp.*	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Celastraceae	*Cassine aethiopica*	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Amaranthoideae	*Celosia sp.*	0	0	0	0	0	3	1	0	0	0	3	0	0	0	0	0	0	0	0	2	13	10	0	0	0	0	1	2	0	0	0	0	0	0	0	0
Fabaceae	*Senna occidentalis*	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella sp.*	0	0	1	0	0	0	0	0	0	0	0	0	52	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Fabaceae	*Sesbania sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria incrassata*	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria sp.1*	0	0	0	0	0	0	2	0	0	0	0	17	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	0	0	0	0	0	0	0	0
Caesalpiniaceae	*Chamaecrista mimosoides*	18	0	6	0	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Achariaceae	*Xylotheca kraussiana*	0	0	0	0	0	2	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commelinaceae	*Commelina benghalensis*	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Corchorus trilocularis*	2	0	0	0	5	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Crotalaria monteiroi*	0	0	0	0	0	0	0	0	0	0	0	1	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
Poaceae	*Cynodon dactylon*	0	0	0	0	0	1	16	0	0	0	8	0	0	0	0	3	29	0	0	0	1	0	0	74	79	15	0	0	0	0	0	0	0	0	0	0
Poaceae	*Dactyloctenium aegyptium*	0	0	0	0	0	85	53	0	0	0	84	64	0	0	0	83	45	0	0	25	65	89	65	0	0	3	60	56	48	39	50	51	7	9	12	79
Pedaliaceae	*Dicerocaryum senecioides*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Digitaria eriantha*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	7	0	10	10	0	0	0	0
Poaceae	*Digitaria sp.*	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphorbiaceae	*Euphorbia sp.2*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Euphorbiaceae	*Euphorbia hirta*	1	1	2	9	4	0	1	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Bulbostylis hispidula*	0	0	0	0	0	0	0	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Gossypium herbaceum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Helichrysum sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	14	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis sp.*	16	90	2	0	0	0	0	83	0	85	0	11	16	48	82	6	5	48	3	0	1	0	0	1	0	72	3	0	3	0	0	3	0	0	0	1

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Poaceae	*Eragrostis ciliaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Dichanthium insculptum*	42	0	0	0	0	0	0	0	0	0	0	0	0	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
not identified	not identified	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Hibiscus rosa-sinensis*	0	0	2	0	0	1	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Hyparrhenia filipendula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	30	32	17	34	27	30	84	71	12
Poaceae	*Hyperthelia dissoluta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6
Convolvulaceae	*Ipomoea sp.*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Indigofera astragalina*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Fabaceae	*Indigofera sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	3	0	1	0	0	2	0
Verbenaceae	*Lippia javanica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Capparaceae	*Maerua edulis*	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Melhania forbesii*	0	0	2	0	0	2	1	0	1	0	0	0	4	0	0	2	3	17	0	0	9	1	25	2	0	0	3	1	1	6	4	0	0	0	0	0
Convolvulaceae	*Merremia tridentata*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	2	1
Convolvulaceae	*Merremia sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	0	0	0	0	0
Cucurbitaceae	*Momordica balsamina*	0	0	6	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum maximum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	6	31	0	5	0	0	0	0
Poaceae	*Panicum sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	1	0	0	0	0	2	0	0
Poaceae	*Panicum sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Poaceae	*Peniseto sp.*	0	0	0	0	0	0	0	0	56	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Poaceae	*Peniseto sp. 2*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	63	0	0	0
Lamiaceae	*Plectranthus sp.*	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Poaceae*	0	0	0	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Poaceae*	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Rhynchosia velutina*	0	0	1	4	9	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Apiaceae	*Centella sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedaliaceae	*Sesamum alatum*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	61	4	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida alba*	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	5	0
Menispermaceae	*Cissampelos sp.*	2	0	1	7	0	0	0	0	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Solanum panduriforme*	0	0	1	0	0	0	0	14	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	4	0	0
Poaceae	*Sporobolus pyramidalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sporobolus sp.*	0	0	0	0	0	0	0	0	0	0	0	0	1	5	0	0	12	17	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sporobolus sp. 1*	4	0	0	65	45	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Fabaceae	*Tephrosia purpurea*	0	0	2	1	2	0	1	0	0	0	0	0	2	0	0	2	0	0	2	5	2	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
Poaceae	*Themeda triandra*	0	0	0	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Zygophyllaceae	*Tribulus terrestris*	0	0	0	1	0	1	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Vernonia sp.*	0	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

TABLE 23 – RESULTS OF CONTROL PLOTS SAMPLING

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Malvaceae	*Abutilon guineense*	0	0	0	0	1	0	2	0	0	1	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	5	3	0	1	0	0	0	0	0
Fabaceae	*Acacia sp.1*	0	0	0	1	0	0	0	3	1	0	9	5	0	0	0	0	0	0	4	0	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Fabaceae	*Acacia sp.2*	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	2	2	17	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Acacia sp.3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Dicliptera sp*	0	8	22	0	7	3	1	0	0	1	0	0	2	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commelinaceae	*Aneilema sp.*	7	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Boraginaceae	*Heliotropium ciliatum*	2	0	6	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	36	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Aristida adscensionis*	1	3	45	0	1	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	9	7	0	17	3	0	0	0	0	0	0	0	0	1
Asparagaceae	*Asparagus africanus*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	2	1	0	1	1	0	0
Acanthaceae	*Asystasia gangetica*	0	0	0	4	0	5	0	0	8	1	9	1	1	0	0	0	4	0	0	0	2	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Barleria sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	2	9	0	0	4	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Bauhinia sp.*	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rhamnaceae	*Berchemia sp.*	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acanthaceae	*Blepharis maderaspatensis*	0	0	0	0	0	3	7	0	0	12	9	0	4	0	11	1	2	2	0	0	7	0	0	0	0	3	3	0	0	0	0	0	0	0	0	0
Capparaceae	*Boscia filipes*	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	7	5	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capparaceae	*Boscia sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Celastraceae	*Cassine aethiopica*	0	2	0	0	0	0	0	0	0	0	1	0	0	0	0	6	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Celastraceae	*Cassine aethiopica*	0	0	0	0	0	3	0	0	0	0	22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Amaranthoideae	*Celosia sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	2	3	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Setaria sp.1*	0	0	0	0	0	0	10	0	0	0	4	13	45	0	0	0	0	0	0	3	0	0	0	3	0	0	0	0	0	0	0	0	0	7	0	0
Poaceae	*Setaria sp.2*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	6	0	0
Caesalpiniaceae	*Chamaecrista mimosoides*	1	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Achariaceae	*Xylotheca kraussiana*	0	0	0	0	0	11	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitaceae	*Cissus sp.*	0	0	0	0	0	11	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commelinaceae	*Commelina benghalensis*	0	2	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Commelinaceae	*Commelina sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitaceae	*Cissus quadrangularis*	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Corchorus trilocularis*	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Crotalaria monteiroi*	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Crotalaria monteiroi*	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2	0	0	0	2	0	0	3	0	0
Poaceae	*Cynodon dactylon*	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	35	6	11	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Cyperus sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Dactyloctenium aegyptium*	0	0	0	0	0	5	20	0	0	0	7	38	0	0	0	9	39	0	0	15	0	5	17	0	0	0	30	40	9	43	10	38	2	3	11	37
Pedaliaceae	*Dicerocaryum sp.*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Digitaria eriantha*	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	18	0	0	0	10	3	0	1	23	15	1	0	2	3
Nectariniidae	*Dreptes sp.*	0	0	0	0	0	0	0	0	10	0	1	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphorbiacea	*Euphorbia*	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
e	*sp.1*																																				
Euphorbiaceae	*Euphorbia hirta*	1	0	0	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Euphorbiaceae	*Euphorbia sp.3*	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Fabaceae*	1	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cyperaceae	*Bulbostylis hispidula*	0	0	0	0	0	0	3	0	0	0	0	0	3	0	0	1	0	1	2	0	0	0	0	35	19	0	0	0	0	0	0	0	0	0	0	0
Phyllanthaceae	*Phyllanthus reticulatus*	0	0	0	0	0	1	0	0	1	0	9	1	2	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Phyllanthaceae	*Phyllanthus sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0
Cyperaceae	*Bulbostylis hispidula*	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capparaceae	*Boscia filipes*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Gossypium herbaceum*	0	0	0	0	0	0	0	0	1	0	0	1	0	2	0	0	0	2	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Grewia bicolor*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	8	0	0	0	1
Malvaceae	*Grewia sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Grewia caffra*	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Asteraceae	*Helichrysum sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis sp.*	0	71	1	17	0	28	9	96	0	39	2	23	12	59	81	0	26	43	50	3	49	1	2	2	0	3	1	0	8	0	0	0	0	0	0	0
Poaceae	*Eragrostis ciliaris*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	5	0	0	0	0	0	0	0	0	0	0
Poaceae	*Eragrostis sp. 2*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Hibiscus rosa-sinensis*	0	0	0	0	0	0	0	0	0	0	0	4	1	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0
Poaceae	*Hyparrhenia filipendula*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	24	19	10	5	8	19	67	56	79	26

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Poaceae	*Hyperthelia dissoluta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3
Convolvulaceae	*Ipomoea sp.*	2	0	0	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	0	0	0	0
Convolvulaceae	*Ipomoea sp. 2*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Indigofera sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	3	0	0	0	0	0
Verbenaceae	*Lippia javanica*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	0	1	0	6	0	4	0	1	0
Capparaceae	*Maerua edulis*	0	0	0	0	0	0	0	0	1	0	5	0	0	0	0	0	0	0	0	0	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Capparaceae	*Maerua cafra*	0	0	0	0	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Celastraceae	*Gymnosporia heterophylla*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
Malvaceae	*Melhania forbesii*	0	2	6	0	0	6	2	1	1	1	0	1	8	0	0	69	0	9	18	12	12	3	0	8	0	0	2	0	0	0	5	0	0	0	0	1
Malvaceae	*Melhania sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Convolvulaceae	*Merremia tridentata*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	1	39	0	0	0	0	1	3	0	0	2	2
Cucurbitaceae	*Momordica balsamina*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Ochnaceae	*Ochna sp.*	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Passifloraceae	*Passifloraceae*	1	0	0	0	2	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Panicum deustum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	1	5	0	0	0	3	0	0
Poaceae	*Panicum maximum*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	57	0	4	0	0	6	30	52	44	36	14	17	17	1	15
Poaceae	*Peniseto sp.*	0	0	0	0	0	0	0	0	43	44	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	0	0	0
Poaceae	*Perotis patens*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
Poaceae	*Poaceae*	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Poaceae*	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Fabaceae	*Rhynchosia velutina*	0	0	0	3	3	0	0	0	0	0	0	0	0	0	0	0	4	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Vitaceae	*Rhoicissus revoilii*	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
Juncaceae	*Juncus sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
Asparagaceae	*Sansevieria sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Senecio sp.*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Pedaliaceae	*Sesamum alatum*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
Malvaceae	*Sida alba*	0	0	0	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0
Menispermaceae	*Cissampelos hirta*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0
Menispermaceae	*Cissampelos sp.*	4	2	0	0	4	0	0	0	21	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Solanum panduriforme*	0	5	2	3	0	0	0	0	10	0	0	1	2	0	0	2	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solanaceae	*Solanum sp.*	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sporobolus pyramidalis*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	1	0	0	0	0	0	0	0	0	0	8
Poaceae	*Sporobolus sp.*	0	3	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Poaceae	*Sporobolus sp. 1*	70	0	0	64	27	0	0	0	0	0	0	0	5	0	0	7	0	0	0	30	0	0	52	0	0	0	2	0	0	0	0	0	0	0	0	0
Poaceae	*Sporobolus sp. 2*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0
Poaceae	*Sporobolus sp. 3*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
Asparagaceae	*Drimia maritima*	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Loganiaceae	*Strychnos sp.*	0	0	0	0	0	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Tephrosia purpurea*	1	0	2	2	4	0	2	0	0	0	1	1	2	0	0	0	0	4	0	15	0	6	0	0	0	0	1	0	6	0	0	2	0	0	0	0

Family	Species	P 1.1	P 1.2	P 1.3	P 1.4	P 1.5	P 2.1	P 2.2	P 2.3	P 2.4	P 2.5	P 3.1	P 3.2	P 3.3	P 3.4	P 3.5	P 4.1	P 4.2	P 4.3	P 4.4	P 5.1	P 5.2	P 5.3	P 5.4	P 6.1	P 6.2	P 6.3	P 7.1	P 7.2	P 7.3	P 7.4	P 7.5	P 8.1	P 8.2	P 8.3	P 8.4	P 8.5
Zygophyllaceae	*Tribulus terrestris*	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubiaceae	*Tricalysia sp.*	0	0	0	0	0	0	0	0	0	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rubiaceae	*Vangueriopsis sp.*	0	0	0	0	0	0	0	0	0	0	0	0	0	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rutaceae	*Teclea pilosa*	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	2	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Asteraceae	*Vernonia sp.*	0	0	2	0	0	0	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Vigna sp.*	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Fabaceae	*Vigna vexillata*	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0

C. Hardwood and natural resource monitoring

TABLE 24 – SITUATIONS OF HARDWOOD AND NATURAL RESOURCES EXPLOITATION

Longitude	Latitude	Charcoal	Wood harvesting
323.212	-250.973	x	
325.992	-247.097	x	
326.035	-247.041	x	
326.625	-246.255	x	
327.123	-245.587	x	
327.199	-245.473	x	
327.247	-245.402	x	
327.422	-245.184	x	
328.830	-243.599		x
329.128	-243.220		x
329.407	-242.822		x
330.163	-241.922	x	
331.453	-240.492		x
332.903	-238.789	x	
333.097	-238.545	x	
333.168	-238.456	x	
333.446	-238.109	x	
333.513	-238.025	x	
333.843	-237.626	x	
333.982	-237.457	x	
334.071	-237.350	x	
334.329	-237.038	x	
334.644	-236.670	x	
336.658	-234.288		x
342.367	-227.534		x
343.269	-226.474		x
343.467	-226.329		x
344.271	-225.216		x
346.734	-222.214	x	
350.359	-217.768		x
333.168	-238.456		x