

Ecosystem Based Adaptation and Mitigation in Botswana's Communal Rangelands

Annex 2 - Feasibility Study

Section 3 – Carbon and Water Baseline

Appendix 3.1: Fieldwork Notes

1. Summary

In total, soil samples were collected from 36 sites, vegetation surveys were conducted at 21 sites and ad hoc vegetation observations were recorded at 157 locations (Figure 1). At each monitoring site, several observations were made to inform the carbon and water baseline assessments. Soils were sampled for chemical and bulk density analysis (Figure 2), the soil water infiltration rate (Figure 3), the grass basal cover (Figure 4), the grass phytomass (Figure 5A) and the tree and shrub cover (Figure 5B) were estimated.

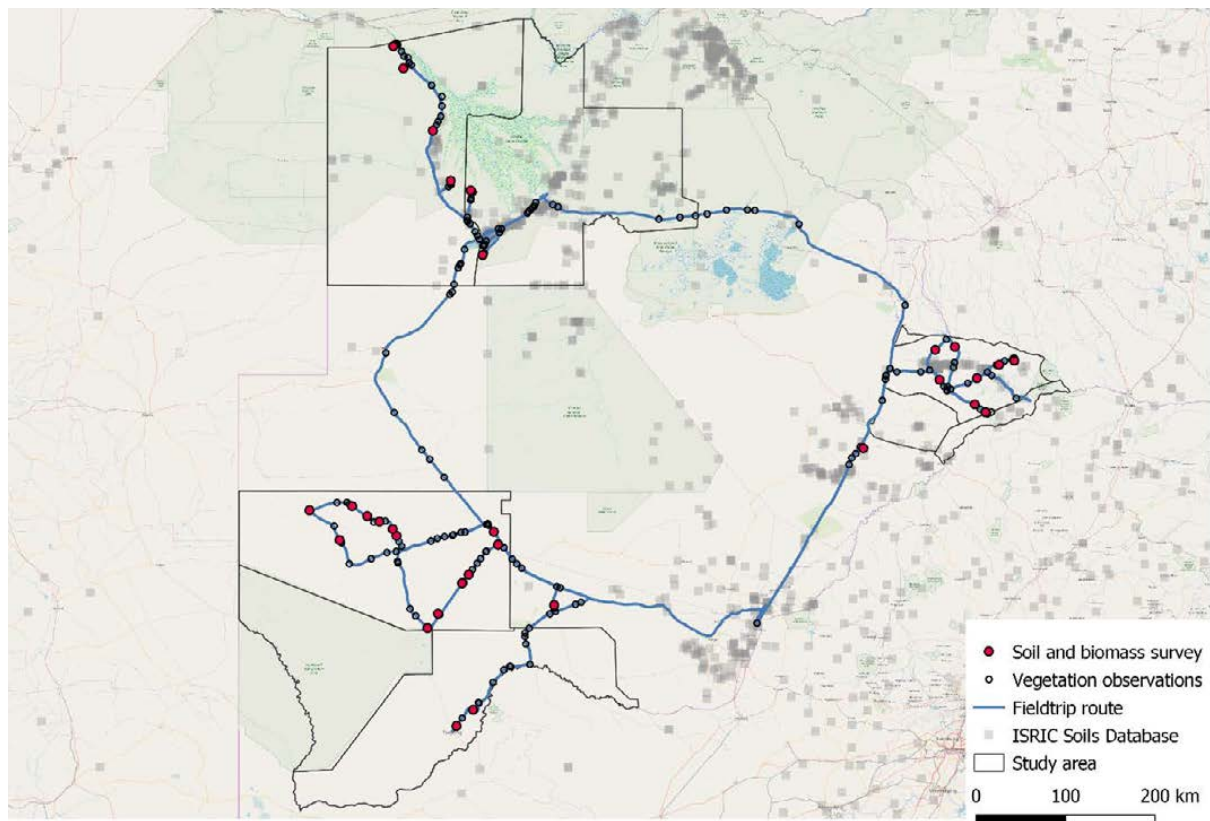


Figure 1. Location of the monitoring sites, vegetation observations, ISRIC soils database and fieldtrip route for the fieldwork conducted in Botswana



Figure 2. Soil sampling illustration. Leaf litter was cleared from the sampling point (A); the hand auger was hammered into the soil in 5 cm increments (B); a fixed volume was sampled using the removable sampling cylinder for the bulk density analysis (C); and 10 composite samples were collected under and outside the tree or shrub canopy cover, mixed and 200 ml of soil was sampled for chemical analysis (D).

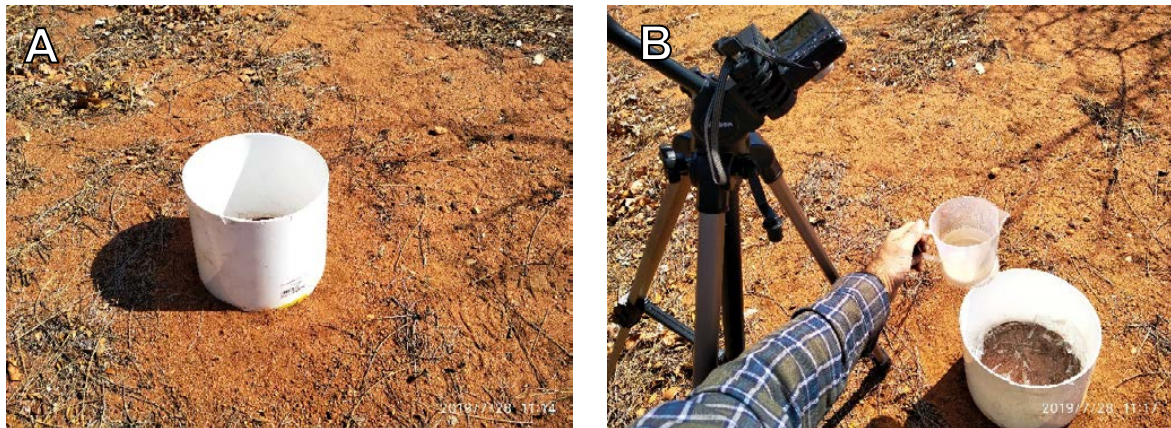


Figure 3. Soil infiltration test illustration. A cylinder with a radius of 11.75 cm (base area of 433.7 cm²) was inserted approximately 2 cm into the soil (A), a sheet of clingfilm was placed over the soil surface within the cylinder, 200 ml of water was poured over the clingfilm, the clingfilm was removed and the infiltration time was recorded (B).

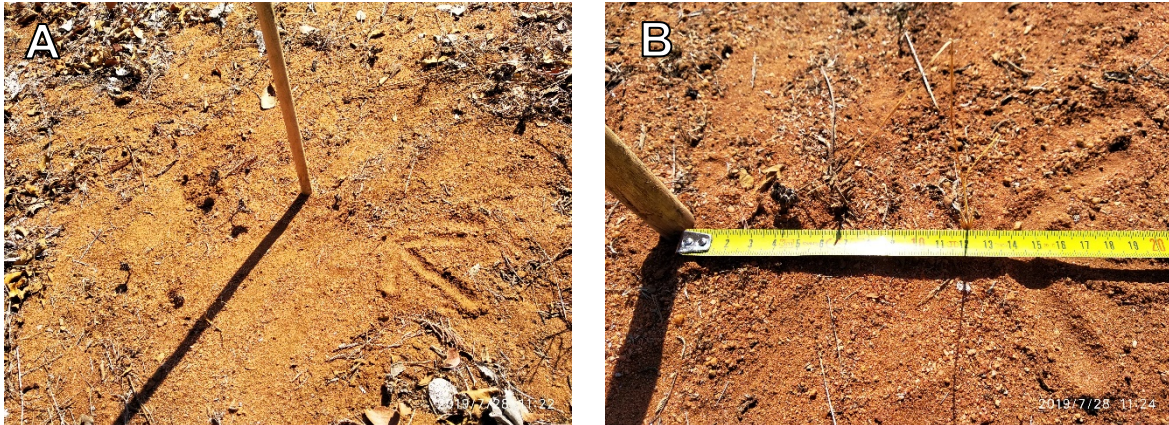


Figure 4. Grass basal cover estimation illustration. A 50 m descending point transect with 1 m interspaced points was surveyed using a wooden rod (A) and the distance to the nearest grass tuft was measured (B).

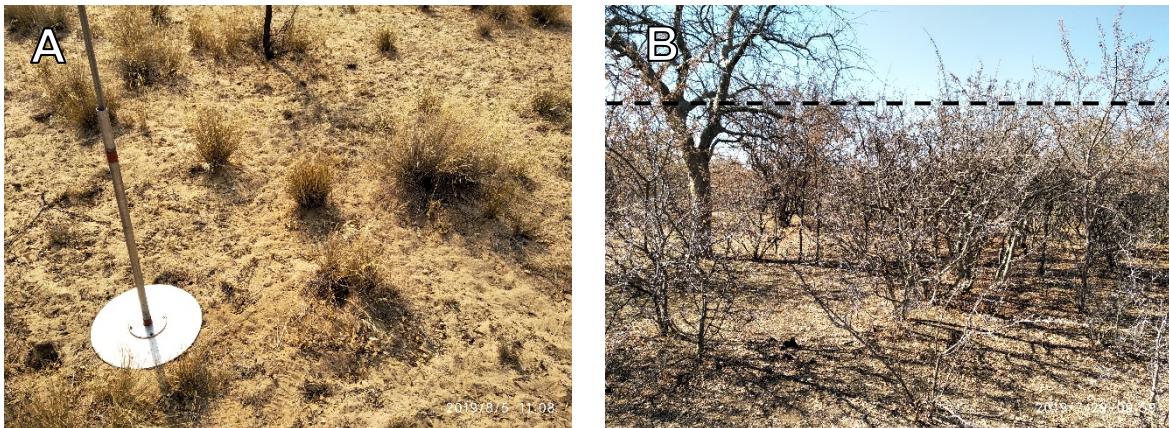


Figure 5. Grass phytomass and woody cover survey illustration. The grass phytomass at each site was estimated using a disc pasture meter (A) and the woody cover was visually estimated for trees (>2 m) and shrubs (<2 m), as distinguished by the dashed line (B).

2. Site details



Figure 6. Photographs of site BWACI_BOB_01 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code BWACI_BOB_01
Survey date 2019/07/27 14:00
Project area Bobirwa
Shrub cover 65%
Tree cover 10%

Latitude -22.82975
Longitude 27.03078
Elevation 1020 m
Basal cover 8.4 cm
Phytomass Below detectable limit

Notes

Overgrazed; very woody; cattle paths through site; close to villages.



Figure 7. Photographs of site BWACI_BOB_02 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code	BWACI_BOB_02	Latitude	-22,05914
Survey date	2019/07/28 08:45	Longitude	27,88975
Project area	Bobirwa	Elevation	831 m
Shrub cover	35%	Basal cover	20.1 cm
Tree cover	15%	Phytomass	Below detectable limit

Notes

Almost entirely bare ground; interspersed, dry tufts of grass; grass basal cover is greater under tree canopy; grass species dominated by annuals.

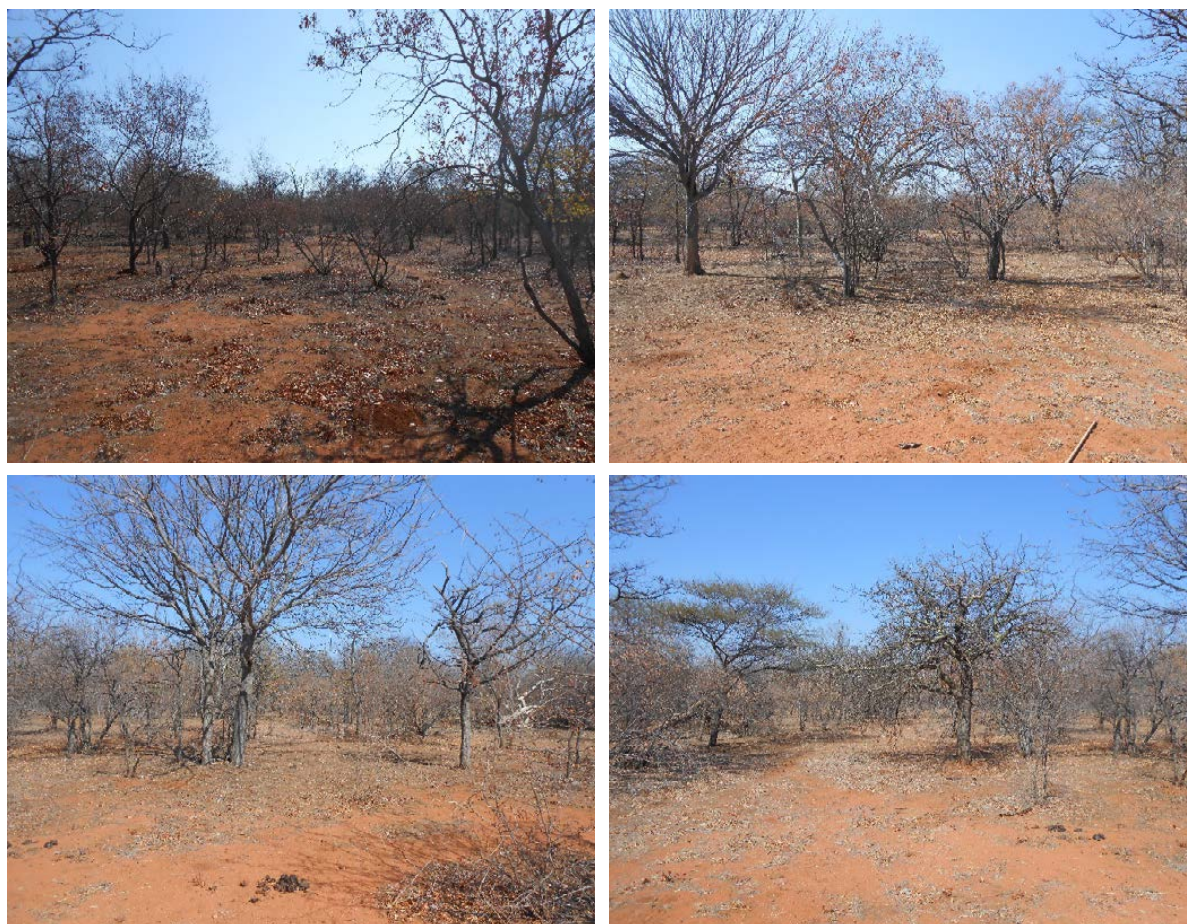


Figure 8. Photographs of site BWACI_BOB_03 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code BWACI_BOB_03
Survey date 2019/07/28 10:45
Project area Bobirwa
Shrub cover 65%
Tree cover 65%

Latitude -22,33378
Longitude 28,28517
Elevation 812 m
Basal cover 20.1 cm
Phytomass Below detectable limit

Notes

Lots of bare ground and leaf litter.

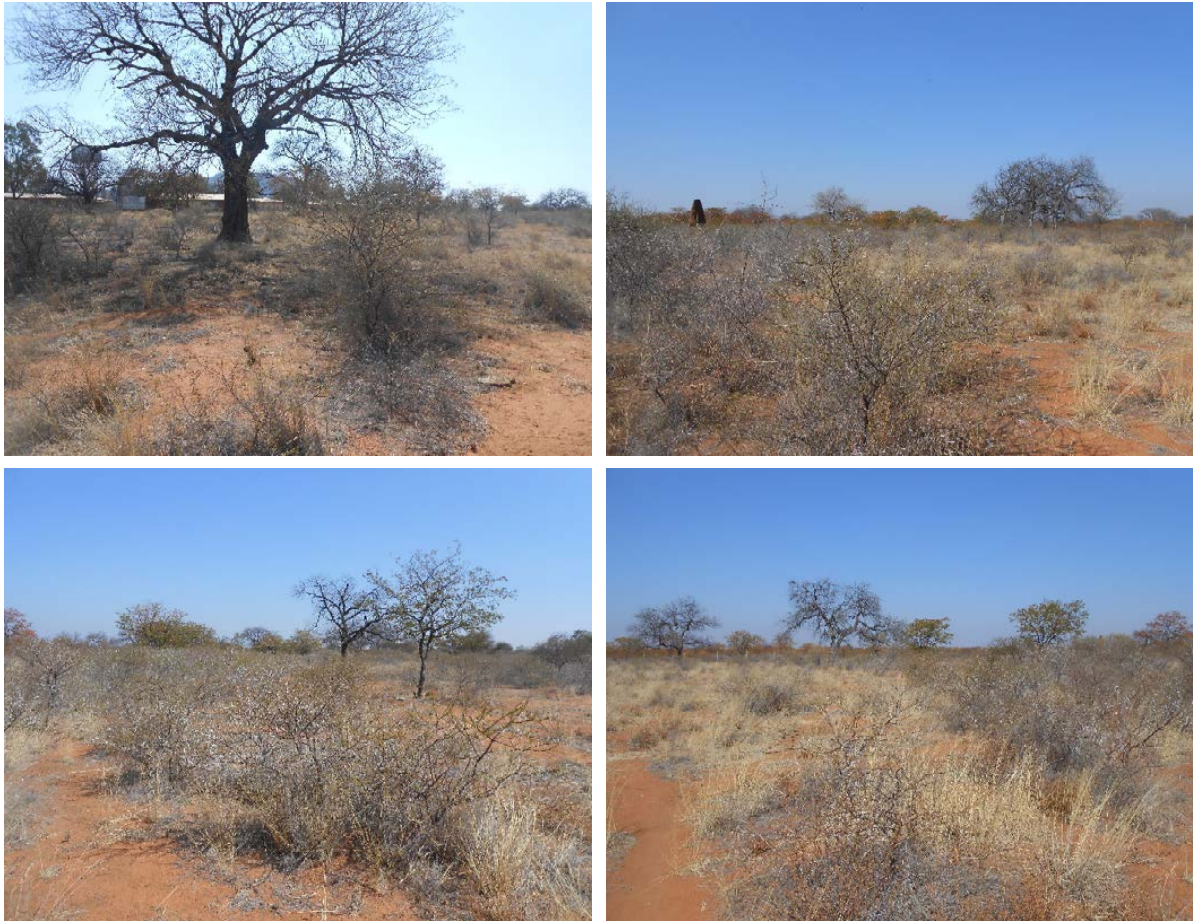


Figure 9. Photographs of site BWACI_BOB_04 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a southerly direction.

Site code	BWACI_BOB_04	Latitude	-22,42408
Survey date	2019/07/28 12:40	Longitude	28,40583
Project area	Bobirwa	Elevation	794 m
Shrub cover	40%	Basal cover	18.0 cm
Tree cover	10%	Phytomass	1458 t ha ⁻¹

Notes

Tsetsebjwe Junior Secondary School; protected from grazing; lots of *Aristida spp.*, but also *Eragrostis spp.*, *Panicum spp.*, *Pogonathria squarosa* and *Digitaria spp.*



Figure 10. Photographs of site BWACI_BOB_05 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code BWACI_BOB_05
Survey date 2019/07/28 14:10
Project area Bobirwa
Shrub cover 0%
Tree cover 15%

Latitude -22,42336
Longitude 28,40792
Elevation 799 m
Basal cover 11.6
Phytomass Below detectable limit

Notes

Directly adjacent to grassy school (BWACI_BOB_04); many more trees present; very bare ground; within village and all-year grazing.



Figure 11. Photographs of site BWACI_BOB_06 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code BWACI_BOB_06
Survey date 2019/07/29 08:20
Project area Bobirwa
Shrub cover 60%
Tree cover 60%

Latitude -22,03997
Longitude 28,31000
Elevation 767 m
Basal cover 24.3 cm
Phytomass Below detectable limit

Notes

Dark red soils (perhaps higher clay content).



Figure 12. Photographs of site BWACI_BOB_07 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code	BWACI_BOB_07	Latitude	-21,88861
Survey date	2019/07/29 09:59	Longitude	28,56022
Project area	Bobirwa	Elevation	722 m
Shrub cover	75%	Basal cover	40.1 cm
Tree cover	10%	Phytomass	Below detectable limit

Notes

Lots of thorny shrubs; greater basal cover under canopy; almost entirely *Aristida spp.*, but also evidence of *Tricholaena monachne*.



Figure 13. Photographs of site BWACI_BOB_08 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in an easterly direction.

Site code	BWACI_BOB_08	Latitude	-21,84347
Survey date	2019/07/29 12:01	Longitude	28,72933
Project area	Bobirwa	Elevation	734 m
Shrub cover	30%	Basal cover	10.9 cm
Tree cover	15%	Phytomass	2134 t ha ⁻¹

Notes

Gobojango Junior Secondary School; protected from grazing all year, only some goats; stony soil; high proportion of pioneer grass species, but also perennials.

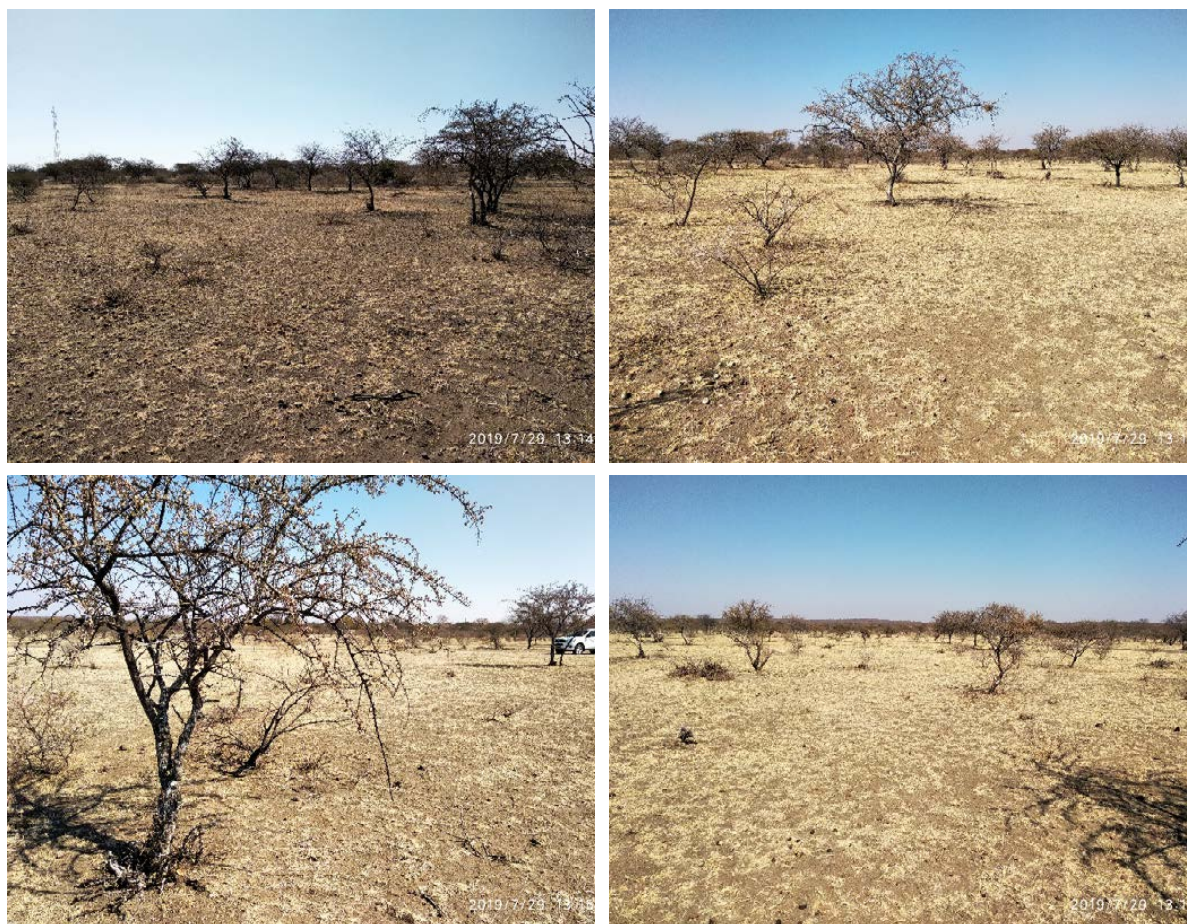


Figure 14. Photographs of site BWACI_BOB_09 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in an easterly direction.

Site code	BWACI_BOB_09	Latitude	-21,84447
Survey date	2019/07/29 13:15	Longitude	28,73144
Project area	Bobirwa	Elevation	737 m
Shrub cover	20%	Basal cover	5.8 cm
Tree cover	0%	Phytomass	Below detectable limit

Notes

Directly adjacent to Gobojango Junior Secondary School (BWACI_BOB_08); very stony soil; almost exclusively *Aristida barbicolis*.



Figure 15. Photographs of site BWACI_BOB_10 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in an easterly direction.

Site code BWACI_BOB_10
Survey date 2019/07/30 09:02
Project area Bobirwa
Shrub cover 60%
Tree cover 20%

Latitude -21,72153
Longitude 27,84089
Elevation 884 m
Basal cover 15.7 cm
Phytomass Below detectable limit

Notes

High proportion of sedges compared to grass tufts.



Figure 16. Photographs of site BWACI_BOB_11 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code	BWACI_BOB_11	Latitude	-21,68733
Survey date	2019/07/30 10:54	Longitude	28,06164
Project area	Bobirwa	Elevation	864 m
Shrub cover	75%	Basal cover	19.0 cm
Tree cover	5%	Phytomass	Below detectable limit

Notes

High thorny shrub cover; soil softer at the base of trees and shrubs; lots of leaf litter; more grass under the canopy, but unpalatable *Aristida* spp.



Figure 17. Photographs of site BWACI_NGA_01 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code	BWACI_NGA_01	Latitude	-19,25467
Survey date	2019/08/01 08:35	Longitude	22,18369
Project area	Ngamiland	Elevation	948 m
Shrub cover	70%	Basal cover	45.7 cm
Tree cover	15%	Phytomass	Below detectable limit

Notes

Sandy soil; high shrub cover; greater basal cover under trees; although sparse, there are some perennial grass tufts.



Figure 18. Photographs of site BWACI_NGA_02 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a southerly direction.

Site code	BWACI_NGA_02	Latitude	-18,30433
Survey date	2019/08/01 12:27	Longitude	21,73689
Project area	Ngamiland	Elevation	1029 m
Shrub cover	75%	Basal cover	21.6 cm
Tree cover	5%	Phytomass	Below detectable limit

Notes

Sandy unconsolidated soil; sparse, but large perennial grass tufts.

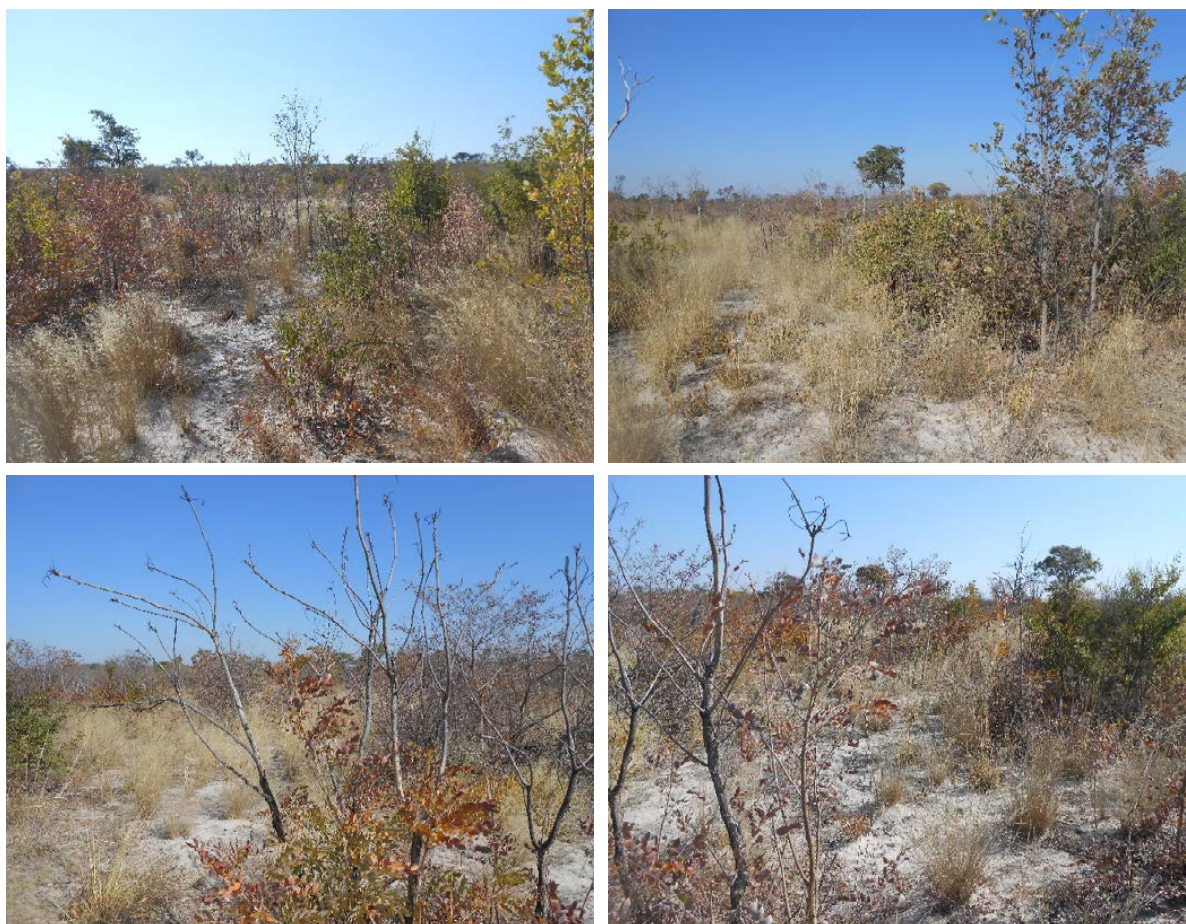


Figure 19. Photographs of site BWACI_NGA_03 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in an easterly direction.

Site code	BWACI_NGA_03	Latitude	-18,55289
Survey date	2019/08/01 15:02	Longitude	21,85053
Project area	Ngamiland	Elevation	999 m
Shrub cover	45%	Basal cover	16.1 cm
Tree cover	2%	Phytomass	3752 t ha ⁻¹

Notes

Sandy unconsolidated soil; many large perennial grass species. Fair species richness; some grass tufts moribund.



Figure 20. Photographs of site BWACI_NGA_04 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code	BWACI_NGA_04	Latitude	-19,81608
Survey date	2019/08/02 07:23	Longitude	22,38483
Project area	Ngamiland	Elevation	947 m
Shrub cover	50%	Basal cover	51 cm
Tree cover	2%	Phytomass	Below detectable limit

Notes

Sandy unconsolidated soil; thorny shrubs; very small, sparse grass tufts.

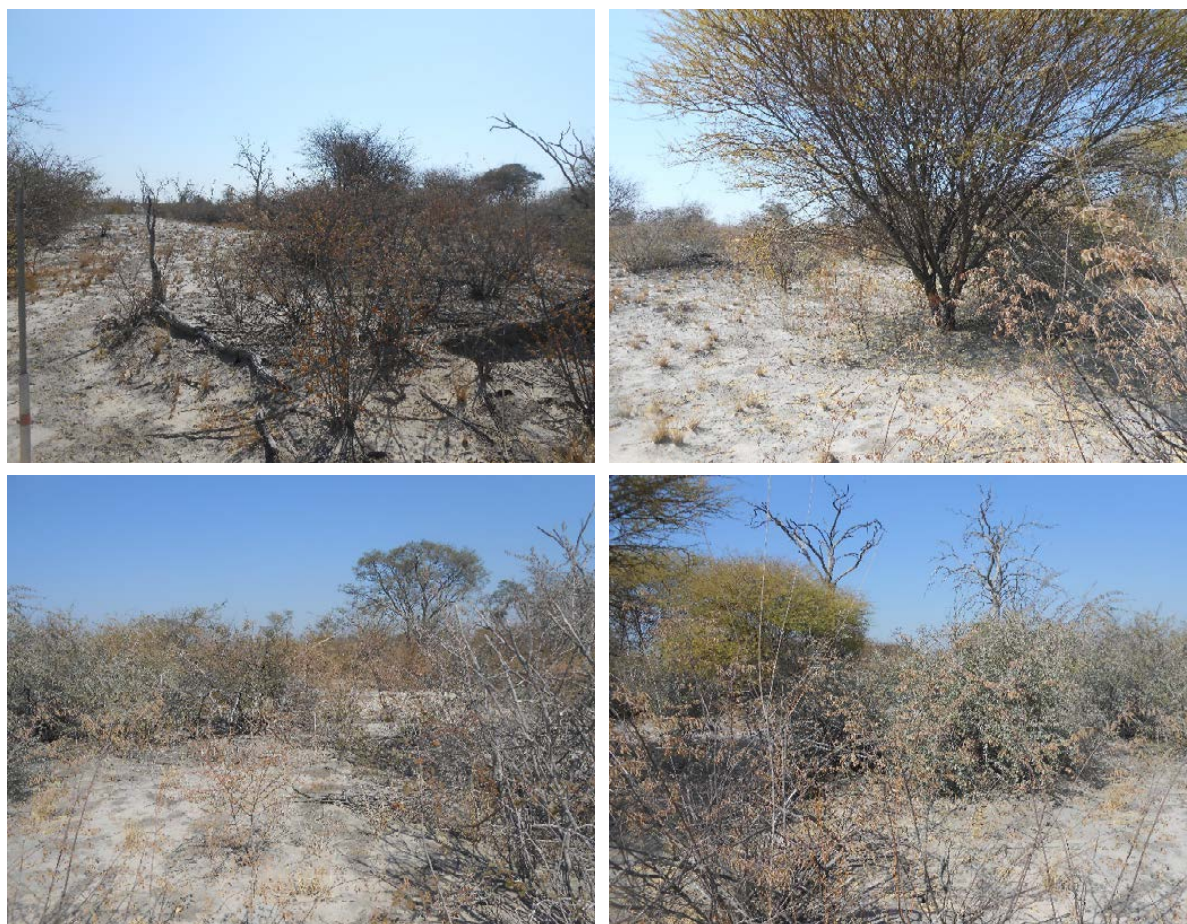


Figure 21. Photographs of site BWACI_NGA_05 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code	BWACI_NGA_05	Latitude	-19,92675
Survey date	2019/08/02 11:04	Longitude	22,61003
Project area	Ngamiland	Elevation	950 m
Shrub cover	40%	Basal cover	31.8 cm
Tree cover	10%	Phytomass	1613 t ha ⁻¹

Notes

Sparse, well grazed perennial grass tufts. Near Habu.



Figure 22. Photographs of site BWACI_NGA_06 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code	BWACI_NGA_06	Latitude	-20,65292
Survey date	2019/08/03 10:36	Longitude	22,74344
Project area	Ngamiland	Elevation	941 m
Shrub cover	5%	Basal cover	3.4 cm
Tree cover	2%	Phytomass	Below detectable limit

Notes

High degree of soil crusting; likely a flood plain; sparse tall shrubs



Figure 23. Photographs of site BWACI_KGA_01 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in an easterly direction.

Site code	BWACI_KGA_01	Latitude	-23,81425
Survey date	2019/08/05 10:04	Longitude	21,77372
Project area	Kgaligadi	Elevation	1144 m
Shrub cover	50%	Basal cover	51.8 cm
Tree cover	2%	Phytomass	Below detectable threshold

Notes

Unconsolidated red sand; annual, sparse annual grass species.



Figure 24. Photographs of site BWACI_KGA_02 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a south-westerly direction.

Site code	BWACI_KGA_02	Latitude	-23,73831
Survey date	2019/08/05 10:44	Longitude	21,73131
Project area	Kgaligadi	Elevation	1140 m
Shrub cover	30%	Basal cover	13.8 cm
Tree cover	5%	Phytomass	3704 t ha ⁻¹

Notes

Sandy soil; perennial grass species abundant; low shrub height.



Figure 25. Photographs of site BWACI_KGA_03 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a westerly direction.

Site code	BWACI_KGA_03	Latitude	-25,03222
Survey date	2019/08/03 10:36	Longitude	23,23100
Project area	Kgaligadi	Elevation	1016 m
Shrub cover	40%	Basal cover	12.9 cm
Tree cover	2%	Phytomass	Below detectable threshold

Notes

Sandy soil; low shrub species diversity



Figure 26. Photographs of site BWACI_KGA_04 in north, east, south and westerly directions (clockwise from the top left). The transect direction at this site was in a northerly direction.

Site code	BWACI_KGA_04	Latitude	-24,25169
Survey date	2019/08/07 10:55	Longitude	22,58722
Project area	Kgaligadi	Elevation	1068 m
Shrub cover	50%	Basal cover	11.7 cm
Tree cover	2%	Phytomass	3695 t ha ⁻¹

Notes

High proportion of perennial grass species, including *Eragrostis gummifloa*, indicating a high water table or seep line.