

REPORT ABOUT THE CARBON SEQUESTERED IN WOODY VEGETATION AND SOIL CARBON STOCKS OF THE SANGO CLIMATE PROJECT / ZIMBABWE

Report no.: 8003061158 - 23/070

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Report: Carbon sequestered in woody vegetation and soil carbon stocks of the Sango climate project/Zimbabwe

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Summary:

LAM slu. commissioned TÜV Nord CERT GmbH to evaluate the carbon sequestered (in tCO₂) in woody vegetation biomass and soil stocks at Sango Wildlife Conservancy. The scope includes carbon stored in the following pools: living vegetation (trees and shrubs, above and belowground), dead wood (downed coarse woody debris and standing deadwood) and soil. The project area is a privately owned property and covers a total area of 57.299,35 hectares, out of which 56.908 ha constitute eligible vegetation area. The focus on the conservancy is sustainable ecosystem management including sustainable wildlife utilization and photographic safaris.

To get reliable data for the calculation of the sequestered carbon in the biomass, intensive field work for measuring has been taken in October/November 2023. With the results of this inventory and complementary satellite data processing, it was possible to estimate the amount of sequestered CO₂ in the biomass and soil of Sango Wildlife Conservancy.

This report confirms the correctness of the assumptions and **does not constitute a CO₂ certificate, i.e.** its use for the purpose of offsetting CO₂ emissions is excluded.

TÜV NORD CERT GmbH confirms the result of the report:

- ☒ All calculations for carbon storage in woody vegetation and soil (soil organic carbon) correspond to internationally recognized methods
- ☒ There are comprehensible and consistent data bases for the conservative determination of carbon sequestration in woody vegetation and soil stocks
- ☒ Sampling design, data management and analysis are in compliance with professional approaches in forestry and forest carbon projects.
- ☒ Carbon stocks in the woody vegetation and soil were determined conservatively.

TÜV NORD JI/CDM Certification Program hereby confirms, that the biomass and soil at the Sango Wildlife Conservancy sequesters on 56.908 ha eligible vegetation area at the 01.01.2024 the following amount of Carbon:

CO₂ sequestration performance:

Trees (living above- and below-ground biomass of trees)	4.357.316 tCO ₂
Shrubs (living above- and below-ground biomass of trees)	390.871 tCO ₂
Dead Wood (standing dead wood and coarse wood debris)	507.058 tCO ₂
Soil	3.952.037 tCO ₂
Total amount of sequestered CO₂	9.207.282 tCO₂
Total amount of sequestered CO₂ (net)	8.495.054 tCO₂

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1 ABBREVIATIONS

ABG.....	Above Ground Biomass
BGB.....	Below Ground Biomass
DBH.....	Diameter at Breast Height
DW.....	Dead Wood
PP.....	Project Proponent
SCP.....	Sango Climate Project
SOC.....	Soil Organic Carbon
SOP.....	Standard Operating Procedures

2 INTRODUCTION

2.1 Goal

The goal of the project is to estimate the woody vegetation and soil carbon stocks from a carbon inventory, i.e., the assessment of the data collection and calculations for the carbon sequestered (in tCO₂) in the eligible project area (carbon accounting area or vegetation area) and strive for confirmation by an independent third party (TÜV NORD CERT GmbH) regarding

- 1) determining the eligible project area,
- 2) proving ownership,
- 3) the compliance with state-of-the-art approaches used in the concept and inventory design, data collection, data management and analysis, and
- 4) the correctness of each step taken in data collection and the calculation of carbon stocks.

2.2 Criteria

2.2.1 The determination is based on the results of the calculations provided by the project developer. As far as possible the project is based on the methods provided by the VCS Standard and AR-Tool 14.

The values determined relate to the living above-ground and below-ground biomass of the trees and shrubs, dead wood and carbon stored in the soil.

The calculation is not intended to be used for the purpose of offsetting CO₂ emissions.

2.3 Level of security

The validation and verification were carried out in order to

- ☒ to achieve an appropriate level of security.
- ☐ limited degree of security.

2.4 Project summary

The project start date is defined as 01.01.2024 when the data collection for the inventory has been finalized. Its lifespan will be 40 years until the 31.12.2063 with a verification frequency of five years.

The Sango Wildlife Conservancy (SWC) is located in southeast Zimbabwe and is part of the Savé Valley Conservancy^{/PP09/}. After the failure of a cattle ranch in the early 1990s, Mr. Wilfried Pabst purchased the area to create a nature reserve with the overall goal of restoring the natural flora and fauna. This goes hand in hand with sustainable ecotourism and the involvement of local communities. A climate project is to be built at the SWC area as a new source of income. This project and the linked biomass inventory include the carbon stored in above- and below-ground biomass in trees and shrubs, dead wood and soil. Since there was no inventory of biomass and carbon sequestered in the soil, the project developer carried out intensive data collection in the fourth quarter of 2023^{/PP01/}. For this purpose, 293 test plots were created across the area and the vegetation was inventoried within a radius of 12.61 m (500 sqm) around the plots^{/PP02/}. With the results of the inventory, it was possible for the project developer to calculate the overall amount of sequestered carbon in tCO₂.

In order to confirm the inventory and calculated values, an independent third party was commissioned to verify the calculated amount of stored CO₂ in the project area. To verify the inventory and the numbers, an on-site visit took place in April 2024. This visit included an assessment of overall project development, data collection techniques, carbon calculations (including methods, models and assumptions used) and risk assessment. To cross-check the overall results, various research papers were taken into account.

The project developer showed with his calculations, that the amount of captured CO₂ at the 01.01.2024 is 9.207.282 tCO₂^{/PP29/} at a total eligible area of 56.908 ha^{/PP01/}.

3 CALCULATION PROCESS

3.1 Methods and criteria

The calculation is performed in the following steps:

- Background research, interviews, document review
- Quantification of the sink performance
- Technical review
- Release of the calculation

3.2 Verification team member

Table 1 Team for verification

	Name	Company	Function ¹⁾	Qualification Status ²⁾	Scheme competence ³⁾	Technical competence ⁴⁾	Verification competence ⁵⁾	Host country Competence	On-site visit
☒ Mr. ☐ Ms.	Carl-Luis Weiss	TN CERT	TL	LA	☒	14.1	☒	n/a	☒
☐ Mr. ☒ Ms.	Friso Johann Junge	TN CERT	TR	A	☒	14.1	☐	n/a	☐
☐ Mr. ☒ Ms.	Alexandra Nuske	TN CERT	TR/FA	SA	☒	14.1	☒	n/a	☐

¹⁾ TL: Team Leader; TM: Team Member, TR: Technical review; OT: Observer Team, OR: Observer-TR; FA: Final approval

²⁾ GHG Auditor Status: A: Assessor; LA: Lead Assessor; SA: Senior Assessor; T: Trainee; TE: Technical Expert

³⁾ GHG auditor status (at least Assessor)

⁴⁾ As per S01-MU03 or S01-VA070-A2 (such as 1.1, 1.2, ...)

⁵⁾ In case of verification projects

A) Team Member: GHG auditor (at least Assessor status), Technical Expert (incl. Host Country Expert or Verification Expert), not ETE

B) No team member

3.3 Document review

The following documents were consulted for further review:

- AR-Tool 14 Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities.
- Aboveground biomass allocation, additive biomass and carbon sequestration models for *Pterocarpus erinaceus* Poir. in Burkina Faso
- Tree allometry and stand structure in dryland forests relics of northern Cote d'Ivoire
- Allometric equations and height-diameter models for estimating above-and below-ground biomass of *Colophospermum mopane* J.Léonard. in Mozambique
- Predicting forest carbon stocks from high resolution satellite data in dry forests of Zimbabwe: exploring the effect of the red-edge band in forest carbon stocks estimation

The list including the references used in the following provided by the client can also be found in Table 9 of this report.

3.4 Interviews

Interviews to clarify and verify facts and to hear further views on the project were conducted. A summary of topics with the interview partners can be found in Table 2.

Table 2 Interview partners and topics

Interview partners and organizations	Topics
Martin Seitz	- Description and implementation of the project - Technical details, design, running time - Data collection - Monitoring system
Brandon Giddey	- Description and implementation of the project - Technical details - Data collection - Monitoring system
Bayleigh Miles	- Description and implementation of the project - Technical details

Interview partners and organisations	Topics
	- Data collection - Monitoring system
William Young	- History and present conditions
David Goozen	- History and present conditions, stakeholders, communities
Lourette Joubert	- Ecological aspects, ownership, stakeholders
Laurent Gross	- LAM, Project Director
Dr. Michael Krause-Besan	- Inventory design - Data management and analysis

3.5 On-site field inspection

On-site project inspections were conducted in April 2024 to identify and verify carbon stocks.

Part of the visit included review of project boundaries, techniques for sampling plots (distribution, marking, identification of vegetation types), resurveying of 17 sampling plots, carbon calculations (including assumptions and applicability of formulas used) and techniques for soil sampling and various interviews.

To check the project boundaries, the specified GPS coordinates^{/PP04/} were compared with the provided GPS at several prominent points. The techniques used to create the sample areas were checked in several interviews^{/IM01, IM02, IM03/} and with the maps^{/PP05/} provided. In the next step, 17 samples were selected and remeasured. The calculations for the stored carbon were reconstructed and verified using the data from the subsequent measurement. This review also included the formulas, allometric models and equations used, as well as the comparison of the results from the inventory and the random follow-up measurements.

4 RESULT OF THE ASSESSMENT

4.1 History and the present condition

The project area has a long history that begins with the first hunter-gatherers around 2,000 years ago. The first Europeans came to the area in 1899 to mine. In 1920, the Devuli Cattle Ranching Company established a cattle ranch in the project area. Farmers began building infrastructure with roads and fences. The cultivation of various crops also began. By the early 1990s, the farm had failed financially four times due to droughts and disease outbreaks. After almost 90 years of intensive grazing, an over-grazed and devastated area remains. The natural ecosystem was no longer there.

In 1991, Mr. Wilfried Pabst purchased a bigger area and became part of the newly founded Savé Valley Conservancy to rehabilitate the area and enable sustainable wildlife utilization and ecotourism use. In order to build up a population of different wild animals, several reintroductions have been made over the years^{/IM04/}.

Today the project area is a protected area under Zimbabwe's Sixth National Report and is home for many threatened species such as black and white rhino, lion, elephant, wild dog and many other species. After 30 years of intensive work, the native ecosystem largely develops on its own and is monitored by an own team of ecologists. Due to the ongoing climate change, the long-term carbon storing in trees, shrubs and soil gets into the focus. Therefore, a sample plot-based inventory has been conducted in 2023 and will be repeated every five years. With the result of this inventory the amount of sequestered carbon can be calculated.

The activities mentioned are intended to result in a new product, the so-called "Sango climate certificate", which corresponds to one ton of CO₂ stored at Sango. The additional source of money is intended to finance further development in the coming years^{/PP01/}.

4.2 Project ownership and Proof of Rights

The SWC is privately owned by its founder, Mr. Wilfried Pabst, and his foundation, Bateleur Foundation. The Foundation has 100% ownership of the company *Sango Wildlife AG based in Switzerland*. Sango Wildlife AG owns *Wilfried Pabst Zimbabwe G.m.b.H. based in Germany*. This company is the owner of *Sango Re Mhuka (Pvt) Ltd.* as a Zimbabwe based umbrella company for the five affiliated companies named *Chanurwe Ranch Properties (Private) Limited*, *Musawesi River Ranch (Private) Limited*, *Sabi River Ranch (Private) Limited*, *Lowveld Marketing Service (Private) Limited*

and Pabst Holdings Zimbabwe (Private) Limited. Each of these four land-holding companies is associated with a property that Mr. Pabst purchased.

Sango Wildlife Conservancy Company structure

Bateleur Foundation,
Liechtenstein
Owens 100% of:

Sango Wildlife AG,
Switzerland
Owens 100% of:

Wilfried Pabst Zimbabwe G.m.b.H.,
Germany
Owens 100% of:

Sango re Mhuka (Pvt) Ltd,
Zimbabwe
Owens 100% of:

Pabst Holdings Zimbabwe (Pvt) Ltd
Owens improvements on the land, conducts trade on the land:

Chanurwe Ranch Properties (Pvt) Ltd
Land ownership, not trade.

Musawezi River Ranch (Pvt) Ltd
Land ownership, not trade.

Sabi River Ranch (Pvt) Ltd
Land ownership, not trade.

Lowveld Marketing Services Pvt Ltd (Chapungu)
Land ownership, not trade.

Figure 1 Company structure of SWC

To verify the ownership of the project area, the relevant documents were considered during the audit. A detailed list of the reviewed documents can be found in Table 9. The reviewed documents clearly demonstrated the corporate structures and ownership structure of each company. The entire owner of all companies involved is Mr. Wilfried Pabst. The ownership structure of the properties involved was also the subject of the audit. For all four properties, the documents presented showed that they are legally privately owned by the respective companies.

During the audit no evidence was found that the projects violate any applicable national laws. To verify this several interviews were conducted^{/IM01, IM03, IM04/}. Besides that, different relevant legislations and policies were used to review the provided information^{/E02, E03, E04, E05/}.

4.3 Project area and its boundaries

The entire project area is divided into four separate plots. A detailed map for each of these lots and the information provided were verified^{/PP06, PP07, PP08/}. The verification process included a random visit to various boundary markers and a comparison of the provided coordinates with a GPS device in the possession of the auditor. Attractions such as the Save River were also visited to confirm the information given.

To mark the boundary of the SWC, markers were placed along the boundaries. Either posts are used, or concrete blocks have been installed. The site visit showed that the Save River has not changed its course significantly in recent decades and is a reliable landmark that can be used as a natural boundary. This was particularly visible in the old trees along the riverbed. Also, the comparison of given boundary data with the GPS data didn't show any significant differences. The total size of the project area for the carbon accounting is 56,908 ha and hence slightly smaller than the area of the SWC, as areas used for infrastructure development were not counted as project areas.

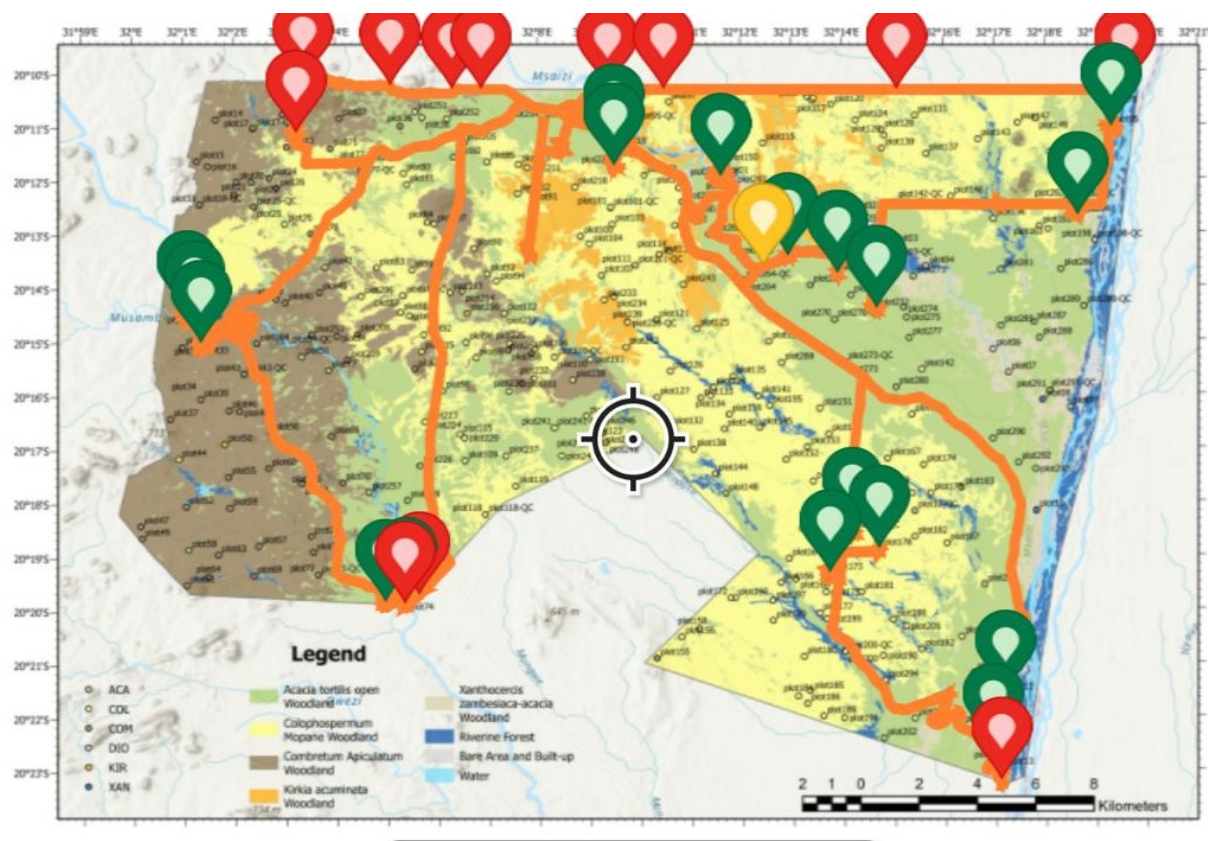


Figure 2 Project area and visited boundary points (travel route in orange)

In the provided documents the total area of all four lots is 57.299,35ha.

Table 3 Lot sizes and total size of the project area

Lot name	Size [ha]
Chanurwe	12.877,911
Musawezi	12.661,4421
Sabi	18.790,0
Chapungu	12.970,0
Total	57.299,3531

In the course of the project development remote sensing data was used to delineate the boundary of the property. This analysis resulted in an area of 58.082 ha. The difference to the title deeds was explained with uncertainties in the original measurement of the area in the title deeds. Nevertheless, the project uses the conservative area of 57.299,35 ha in line with the official land documents and the area of 56,908 ha for the carbon calculation. Hence, conservativeness of the calculation is secured.

4.4 Carbon pools considered

The following carbon pools are considered in the calculation of the carbon stocks in woody vegetation (trees and shrubs) and soil (soil organic carbon):

Table 4 CO₂ sinks considered in calculations

Potential CO ₂ sink	Considered in calculations
Trees (Living Above-ground biomass)	Included
Trees (Living Below-ground biomass)	Included
Shrubs (Living Above-ground biomass)	Included
Shrubs (Living Below-ground biomass)	Included
Deadwood (standing/laying Coarse Woody Debris)	Included
Soil	Included

4.5 Concept and Inventory design

Assessment results:

By concept, an integrated remote-sensing and terrestrial carbon stock assessment framework has been implemented in the SCP, which is a concept used worldwide for vegetation carbon stock estimation in both, scientific studies and carbon projects^{/PP12, PP13, PP14, PP15, PP16, PP17/}. The assessment comprised, first, a terrestrial inventory of carbon stocks in four carbon pools, aboveground- and belowground biomass (AGB, BGB) in tree and shrub species groups, deadwood (DW) and Soil Organic Carbon (SOC). Second, a pre-stratification of vegetation classes and non-vegetated land based on satellite imagery classification algorithms and the feedback of observed vegetation classes from ground-based data collection to result in a final stratification is widely done and good practice. The satellite data used are multi-spectral images from Sentinel 2 in conjunction with Copernicus digital elevation model data at resolutions between 10 and 30 m^{/PP18/} which is well in line with the satellite data and resolution employed in carbon projects.

The core of the terrestrial carbon inventory design is the sampling design^{/PP01, PP11/} which has been developed based on probabilistic sampling theory^{/PP19, PP12, PP20/} and in line with the sampling principles required by IPCC^{/PP21/}.

The stratified systematic sampling is based on a 1 ha base grid with random positioning^{/PP18/} and overlaid by the pre-stratified vegetation classes.

The number of sample plots included in the ground survey is derived proportionally to strata area (sum of all 1 ha sample plots per stratum), each plot center point being defined by the centroid of each 1 ha grid cell.

The plot layout follows a circular shape around the plot center with a size of 500 m² where all variables of interest were measured according to the SOP.

The conformity of the sampling design and the plot layout with international standards is hereby confirmed.

Conclusion:

Full compliance with state-of-the-art approaches used in the elaborated concept and inventory design including the sampling design and plot layout.

The “Concept and Inventory design–” - work package of the project follows internationally recognized standards and employs state-of-the-art approaches in conceptually integrating remote sensing and terrestrial data approaches in the inventory design. The stratified systematic sampling design is referenced by literature and credibly applied.

The standards in integrating the remote sensing analysis by pre-stratifying the project area in preparation for terrestrial data collection and finally stratifying as post-processing of the ground survey correspond to good practice, which is hereby confirmed.

4.6 Ground-based Data collection and SOPs

No data was available for the project area to determine sequestered amount of carbon. For this reason, the project owner carried out extensive data collection. Therefore, an SOP was developed in which all procedures for data collection are described.

As part of the project, sample points were distributed across the entire project area. The aim was to record all different forms of vegetation to obtain a realistic picture of the biomass. Since some of the points were not measurable (e.g. in the river or with a too great risk for the measurement team), 293 sample points were taken and measured. For this purpose, all bushes, trees, and dead wood (standing and on ground) were measured within a radius of 12.61 m (500 sqm) and a soil sample was taken. The exact instructions to the measurement team are documented in the so called SOP^{/PP02/}. Before starting work, each of the four measurement teams received intensive training^{/IM03/}.

As part of the audit, a total of 17 of the sample points were re-measured under the supervision of the auditor. These points were selected as part of a randomly selected sample and included all four vegetation types. The following aspects were checked: findability and presence of the specified markings in the soil, specified vegetation type, correct implementation of the measuring instructions and the procedure for taking soil samples.

The audit showed that the measurement team is very familiar with the contents of the SOP. The document was always carried along but not picked up because all its contents were known by heart. The correct implementation of the specifications was always ensured in all cases. In addition, the team members remembered in some cases exactly where they were located for some plots. All measurements were carried out in accordance with the SOP specifications. Since inaccuracies were known when using laser rangefinders, measurements were always carried out manually in borderline cases.



Figure 3 Basal diameter measuring on a shrub



Figure 4 DBH Measuring on a tree.

In order to increase the repeatability of the measurements, the alignments (azimut) to the magnetic north pole were documented for all measurements. This also confirms a thoroughly precise approach. The correctness of the information was also checked as part of the audit and no deviations were found. This information is particularly important if the sample plots are to be retrieved without a metal detector.

Before the actual CO₂ storage performance was calculated, the data collected as part of the inventory, were digitized and stored in Excel tables. This data collection served as the basis for all further calculations.

Conclusion:

Full compliance with state-of-the-art approaches used in defining the Standard Operating Procedures (SOPs) and conducting ground-based data collection.

4.7 Data management and analysis: Parameters in Baseline carbon stock calculation

The “data management and analysis” - work package of the project follows internationally recognized standards and employs state-of-the-art approaches in compiling, ensuring quality and analysing data. The parameters used in conjunction with the ground based data from the field survey are well referenced, up to date and correctly applied. The calculations of all carbon stocks are correctly done, and the equations referenced. The processes of calculations can be easily traced and are thus transparent.

The standards in preprocessing data (routines established to ensure data quality) and calculating carbon stocks correspond to good practice, which is hereby confirmed.

Assessment results:

As part of the audit, the data management and analysis and final calculation of carbon stocks in all carbon pools has been reviewed based on available references provided. In addition, the consistency and correctness of calculations has been demonstrated in a workshop-like live session with the project team on 14.05.2024 ^{/IM01, IM08/} and outputs provided in an easy-to-read spreadsheet format.

The audit showed that the ground-based data, obtained from the digitized tally sheets, is well-managed in each step up to the final calculation of carbon stocks. This comprises various checks of data conformity in tally sheets with prescribed data formats, the completeness of data sets such as species names and dendrometric variables as well as the data quality, e.g. DBH/H ratios and extreme values. Data management measures, e.g. how to treat missing values, extreme outliers, DBH/H ratios outside lower and upper bounds and alike follow high standards as also applied in national forest inventories and are referenced ^{/PP11/}. Thus, the standards in preprocessing data (routines established to ensure data quality) correspond to good practice, which is hereby confirmed.

In addition, the work done shows high technical expertise of the project developer's team in distinguishing 14 species' groups by woody plant types (trees / shrubs) in 6 vegetation strata and establishing a flexible analysis framework for the explicit use of species-specific and general allometric models ^{/PP03/}.

The use of tools programmed in the scripting language R is state of the art in preprocessing data in forest inventories and calculating carbon stocks and stock changes

/PP22, PP23, PP24/. The SCP which uses R scripts in conjunction with selected outputs provided in spreadsheet format (Microsoft Excel) therefore pursues a highly professional approach to data management and analysis and uses internationally recognized tools and standards.

19 calculations on aggregating plot-based data to means / total values and error terms for strata and the entire eligible project area are based on standard equations published by forestry experts in international projects /PP19, PP12/ and world-wide leading statisticians /PP20/.

Additional inputs and parameters used like

- the areas of vegetation strata as provided by the remote sensing and land cover classification work package /PP03/
- the tree and shrub species listed incl. scientific and common names, wood densities and attribution to allometric models as referenced /PP03, PP25/
- carbon fraction /PP26/
- Root-shoot ratio /PP27/
- Upper and lower bounds of DBH/ H ratio /PP28/

correspond to standard inputs also used in comparable carbon projects in the voluntary carbon market and are state of the art.

Conclusion:

Full compliance with state-of-the-art approaches used in data management and analysis and proven correct calculations of carbon stocks.

4.8 Result of the calculation of the carbon stock

Applying the parameters and assumptions listed in the sections above, results in the following carbon stock:

Table 5 CO₂ sink capacities /PP29/

No	CO ₂ sink	Amount [tCO ₂]	Amount in %
1	Trees (above and below ground biomass)	4.357.316	47
2	Shrubs (above and below ground biomass)	390.871	4
3	Dead wood (laying and standing)	507.058	6
4	Soil	3.952.037	43

Total		9.207.282	100
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For the project with an area of 56.908 ha, this results in 9.207.282 tCO₂ sequestered.

4.9 Project risk assessment on non-permanence

To evaluate the potential risks for the successful project implementation, a risk assessment took place prior to the project start. In addition, potential stakeholders were identified, and possible impacts were discussed.

As part of the risk assessment 18 potential risks were identified and part of the risk rating. These are for example project management, funding, political risk, human-wild-life conflict, fire, elephant damage or stakeholder participation. 17 of these risks were rated with a low risk and don't need any further reactions. Just for "elephant damage" a medium risk has been identified. No high risk was identified during the process.

As part of the stakeholder identification, the project developer differentiated between affected and interested stakeholders. Only the owner and directors of the company were identified as affected stakeholders, so a direct consultation was not necessary. A total of seven groups were identified as interested stakeholders. In summary, all stakeholders will benefit from the implementation of the climate project through aspects such as new jobs, more tourists and increased income.

Due to the private ownership of the project area, the overall risk for the project is low. The SWC's 30-year history shows that the owner and his employees are capable of successfully managing the area. During the site visit the processes to develop the risk assessment and the stakeholder identification has been verified with the project developer and no uncertainties have been identified. To verify the information about the interested stakeholder some people of the community have been interviewed about their interests and expectations of the project. The interviewees confirmed the conclusions of the project developer and that there have been no major negative incidents for stakeholders in the last 30 years. They also do not expect any negative consequences for the climate project.

The descriptions, interviews and observations of the onsite visit and the provided documents confirm that the project developer's work was flawless and there is no doubt that essential aspects were not taken into account or were not sufficiently taken into account for the risk assessment.

4.10 Accuracy of the project work and calculations

During the documents review and the onsite visit some critical points with a direct influence on the projects results has been identified:

Retrievability of sample plots:

During the re-measurement of the sample plots, various inaccuracies were found regarding the retrieval of the mark areas. First, the GPS is not accurate enough to find the metal pins in the ground. Therefore, a metal detector was used. In one case, the soil contained magnetic ores and the metal pins could not be found. With the documents from the inventory and the documented information (azimuth and centre distance), it was possible to identify a conspicuous tree and measure it backwards. This method made it possible to find all sample areas in cases where the SOP approach was not possible.

Measuring of sample plots:

The comparison of the inventory results and the results from the remeasuring showed that there were some differences as some of the plots had more trees in the inventory than in the remeasuring. A double check of the documents and the field revealed that one type of rangefinder was not as accurate as needed and that the field team did not use the tape measure for trees that were close to the border of the sample plots. Another source of uncertainty was the documentation process itself, as typographical errors were also identified.

In order to eliminate these uncertainties, the affected test areas were remeasured again, and the results revised. Comparing the old and new results showed that the differences were very small, and the measurement teams carried out precise work.

Dead wood:

The site visit and the re-measurement of the dead wood revealed that there are also uncertainties regarding the dead wood content of the sample plots. The reasons for this are diverse. The main reasons for differences between the inventory and the re-measurement are destruction caused by animals such as elephants. This causes the dead wood to break, and the remaining pieces no longer meet the SOP criteria. In other cases, trees from outside the property fell into the property, resulting in a significantly higher proportion of dead wood.

In order to prevent an overestimation of the sequestered carbon (in t CO₂), the project developer and the field team choose the conservative approach and excluded this dead wood from the calculations.

Applicable formulas

The applicability of the allometric equations has been confirmed during the audit by document review and interview with the ecologists.

Carbon calculations were designed in R and crosschecked during the audit.

Carbon Content

Internal QA/QC procedures applied by the project proponent, which included the re-measurement and reassessment of 10 % (30) of the sample plots (QC) showed the following results compared to the inventory (CI):

Min.	Max.	1st Q.	Median	3rd Q.	Mean
51,0	151,1	78,0	85,8	99,2	88,7

Standardized values of QA/QC (QC) results (tCO₂) compared to Carbon Inventory (CI) results (CI = 100,
 $AUD = \{[AUD-CI]/CI*100+100\}$)

In the course of the audit, 17 sample plots have been remeasured and assessed, showing the following results compared to the inventory (CI):

Min.	Max.	1 st Q.	Median	3 rd Q.	Mean
38,3	117,7	79,6	83,3	95,2	87,8

Standardized values of AUDIT (AUD) results (tCO₂) compared to Carbon Inventory (CI) results (CI = 100,
 $AUD = \{[AUD-CI]/CI*100+100\}$)

The comparison of the values for Mean AGB in combination with the other descriptive statistical values shows that the results of the internal accuracy assessment of 88,7 and the audit assessment of 87,8 are comparable. Both values are within the expected accuracy level of +/- 15 %.

Nevertheless, the results show a systematic overestimation of the initial carbon inventory assessment (CI) compared to the internal quality control (QC: 11,3%) and the audit assessment (AUD: 12,2%).

Hence the auditor follows the proposal of the project proponent to deduct a 15% discount of the biomass, below- and aboveground of trees and shrubs for uncertainty caused by field measurements.

The soil samples for determining the SOC were collected as described in the SOP and send to a certified laboratory for the determination of the bulk density and the SOC content. The process of collection of soil samples in the field, processing to the laboratory and the data reception and evaluation has been crosschecked^{/PP30, PP31/}. No non-conformities were detected during the audit.

Size of SWC

As described under 4.3, the PP used remote sensing technology to delineate the boundary of the property. This analysis resulted in an area of 58.082 ha. The difference to the title deeds was explained with uncertainties in the original measurement of the area in the title deeds. Nevertheless, the project uses the conservative area of 57.299,35 ha in line with the official land documents and the area of 56,908 ha for the carbon calculation. Hence, conservativeness of the calculation is secured.

Conclusion:

Full compliance with state-of-the-art approaches in carbon sequestration calculations and data processing. In all cases where concerns were raised, the conservative approach was used to avoid overestimating the amount of carbon sequestered.

5 CONCLUSION OF THE CALCULATION AND FINAL DECLARATION

Based on the results of the inventory and the applicable formulas provided by the project developer, the following amount of sequestered CO₂ in the area of the SWC can be confirmed as of 01.01.2024:

Table 6 CO₂ sink capacities^{/PP29/}

No	CO ₂ sink	Amount [tCO ₂]	Amount in %
1	Trees (above and below ground biomass)	4.357.316	47
2	Shrubs (above and below ground biomass)	390.871	4
3	Dead wood (laying and standing)	507.058	6
4	Soil	3.952.037	43
Total		9.207.282	100

Table 7 Results after the deduction of 15% in tree and shrub biomass due to uncertainty in measurement^{t/PP29/}.

No	CO ₂ sink	Amount [tCO ₂]	Amount in %
1	Trees (above and below ground biomass)	3.703.719	44
2	Shrubs (above and below ground biomass)	332.240	4
3	Dead wood (laying and standing)	507.058	6
4	Soil	3.952.037	46
Total		8.495.054	100

TÜV NORD JI / CDM CP hereby confirms that:

- an appropriate level of security has been applied and
- the calculation of the potential CO₂ sink performance is complete and correct,
and in a transparent and conservative manner.

This report deals exclusively with the collection of ground-based data and the calculation of the sequestered amount of carbon in biomass and soil at the Sango Wildlife Conservancy.

The report does not constitute a certificate, i.e. its use for the purpose of offsetting CO₂ emissions is excluded.

Baiersbronn, 08 July 2024



TÜV NORD JI/CDM Certification Program

Leading expert

Carl-Luis Weiss

Hannover, the 08 July 2024



TÜV NORD JI/CDM Certification Program

Final Approver

Alexandra Nuske

6 REFERENCES

Table 8 Documents provided by the project participant

Reference	Document
/PP01/	Project Document_SCP_V1.1_03.07.2024
/PP02/	230925_SOP for Carbon Field Tree and deadwood Sampling_rev4
/PP03/	SWC_Biomass allometry_20.03.2024
/PP04/	1_SWC_Project Boundary PDF
/PP05/	Sango_Stratification_with_PlotIDs
/PP06/	Lot 7 Devuli
/PP07/	Lot 8 Devuli
/PP08/	Lot 9 Devuli
/PP09/	Confirmation of Membership_SangoWC_2024
/PP10/	Sango_Veg_Stratification_AGB_Report_V1.4
/PP11/	SCP-Carbon Inventory, Data management and analysis Report
/PP12/	Wallner et al. 2021, https://doi.org/10.1093/forestry/cpab055
/PP13/	Dickinson et al. 2023, https://www.mpi.govt.nz/dmsdocument/59710-Maximising-Forest-Carbon-Review-of-methods-for-measuring-forest-carbon-for-national-and-property-scale-reporting%26ved%3D2ahUKEwiC9de0yr2GAxXJhv0HHRexD-IQFnoE-CAw-QAQ%26usg%3DAOvVaw3WyC6zi6QsYty9qQQ5sFVh&sa=D&source=docs&ust=1717922895230589&usg=AOvVaw00WJbSsq8eJliJ5vF3Ymfx
/PP14/	Goetz et al. 2009, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2667409/
/PP15/	Havelman 2009, https://www.un-redd.org/document-library/measuring-and-monitoring-terrestrial-carbon-part-redd-mrv-systems

Reference	Document
/PP16/	Issa et al. 2020, https://www.mdpi.com/2072-4292/12/12/2008
/PP17/	Batsaikhan et al. 2020, https://www.researchgate.net/publication/343400603_CARBON_STOCK_ESTIMATION_USING_REMOTE_SENSING_DATA_AND_FIELD_MEASUREMENT_IN_HALOXYLON_AMMODENDRON_DOMINANT_WINTER_COLD_DESERT_REGION_OF_MONGOLIA
/PP18/	Remote Sensing Solutions 2024, Sango_Veg_Stratification_AGB_Report_V1.4
/PP19/	Fehrmann et al. 2017, https://www.forclime.org/documents/Books/Minimum%20standard_final%20%20finish%20Ready%20print%20(Inggris)%20Lowrest.pdf
/PP20/	Cochran 1977, Sampling_Techniques
/PP21/	IPCC 2003, Good Practice Guidance LULUCF, Chapter5.1 & 5.2
/PP22/	Gonzalez-Akre et al. 2024, https://github.com/ropensci/allodb , https://docs.ropensci.org/allodb/
/PP23/	Hill et al. 2021, https://www.jstatsoft.org/article/view/v097i04
/PP24/	Stanke et al. 2020, https://www.sciencedirect.com/science/article/abs/pii/S1364815219311089?via%3Dihub
/PP25/	Joubert 2012, MSc-Thesis, Joubert2012_Resource_Assessment_chap4_vegetation_classification_Sango
/PP26/	IPCC 2003, Good Practice Guidance LULUCF, Chapter3.2
/PP27/	Rozendaal et al. 2022, https://iopscience.iop.org/article/10.1088/1748-9326/ac45b3
/PP28/	Mugasha et al. 2013, Mugashaetal2013_H-D_relationship
/PP29/	Carbon Calculations: - PD_results_all_Cpools_07.06.2024 - Sango_CCP_Species_Code_List_UPDATED

Reference	Document
	- 240516_Sango_CI2023_Script3_comparision_CI-AUD_data_CO2_ha
/PP30/	SOC_Lab_Data
/PP31/	Sango_FI2023_FullIS_data_soc

Table 9 Documents consulted by the expert

Reference	Document
/E01/	AR-Tool 14 Estimation of carbon stocks and change in carbon stocks of trees and shrubs in A/R CDM project activities
/E02/	Parks and Wild Life Act Chapter 20:14
/E03/	Zimbabwe Protected Places and Areas Act Chapter 11:12
/E04/	https://www.awf.org/where-we-work/28imbabwe (07.05.2024)
/E05/	https://www.zimparks.org.zw/sanctuaries.html (07.05.2024)
/E06/	Aboveground biomass allocation, additive biomass and carbon sequestration mod-els for Pterocarpus erinaceus Poir. in Burkina Faso, Article in Heliyon April 2020 DOI: 10.1016/j.heliyon.2020.e03805, https://www.researchgate.net/publication/340881448 (14.05.2024)
/E07/	Tree allometry and stand structure in dryland forests relics of northern Cote ^ d'Ivoire, Article January 2024, DOI: 10.1016/j.tfp.2023.100478, https://www.researchgate.net/publication/379655479 (14.05.2024)
/E08/	Allometric equations and height-diameter models for estimating above-and below-ground biomass of Colophospermum mopane J.Léonard. in Mozambique, April 11th, 2024, https://doi.org/10.21203/rs.3.rs-4125867/v1 (14.05.2024)
/E09/	Predicting forest carbon stocks from high resolution satellite data in dry forests of Zimbabwe: exploring the effect of the red-edge band in forest carbon stocks esti-mation, Article in Geocarto International April 2015, https://www.researchgate.net/publication/277613522 (14.05.2024)

Table 10 Interview partner

Referenz	Mol ¹		Name	Organisation / Funktion
/IM01/	V	☒ Mr. ☐ Ms	Martin Seitz	LAM, Project Coordinator
/IM02/	V	☒ Mr. ☐ Ms	Brandan Giddey	SWC, Ecologist
/IM03/	V	☐ Mr. ☒ Ms	Bayleight Miles	SWC, Ecologist
/IM04/	V	☒ Mr. ☐ Ms	David Goozen	SWC, Board member
/IM05/	V	☒ Mr. ☐ Ms	William Young	SWC, General Manager
/IM06/	V	☐ Mr. ☒ Ms	Lourette Joubert	LAM, Project Ecologist
/IM07/	V	☒ Mr. ☐ Ms	Laurent Gross	LAM, Project Director
/IM08/	V	☒ Mr. ☐ Ms	Dr. Michael Krause-Besan	LAM, Project Analyst, Inventory design, Data Management and Analysis

7 ANNEXES

7.1 Annex 1 Documents for proof of ownership

Number	Document	Date of signature
1	Amtsbestätigung für die nichteingetragene Stiftung „Batler Foundation“	16.05.2024
2	Öffentliche Urkunde über die Gründung der „Sango Wildlife AG“	23.05.2024
3	Handelsregisterauszug (commercial register of Germany) for the “Wilfried Pabst (Zimbabwe) GmbH”	22.04.1993
4	Certificate of Incorporation “Sango-Re-Muka (Privat) Limited”	04.09.1995
5	Certificate of Incorporation “Pabst Holdings Zimbabwe (Private) Limited”	26.04.1994
6	Certificate of Incorporation “Chanurwe Ranch Properties (Privat) Limited”	27.05.1994
7	Deed of transfer “Chanurwe Ranch Properties (Privat) Limited”	27.09.1994 and 23.01.1995
8	Share Certificate “Chanurwe”	
9	Certificate of Incorporation “Musawesi River Ranch (Privat) Limited”	20.04.1994
10	Deed of transfer “Musawesi River Ranch (Privat) Limited”	23.01.1995
11	Share Certificate “Musawesi River Ranch (Private) Limited”	30.10.1996
12	Certificate of Incorporation “Sabi River Ranch (Privat) Limited”	20.04.1994
13	Deed of transfer “Sabi River Ranch (Privat) Limited”	23.01.1995
14	Share Certificate “Sabi River Ranch (Private) Limited”	30.10.1996
15	Certificate of Incorporation “Lowveld Marketing Service (Private) Limited”	02.11.1993
17	Deed of transfer “Chapungu” (Lowveld Marketing Service (Private) Limited)	18.09.2002
18	Share Certificate No. 2 “Lowveld Marketing Service (Private) Limited”	30.09.2001
19	Share Certificate No. 3 “Lowveld Marketing Service (Private) Limited”	30.06.2002
20	Share Certificate No. 4 “Lowveld Marketing Service (Private) Limited”	30.06.2002
21	Bilateral Investment Promotion and Protection Agreement (BIPPA)	29.09.1995

7.2 Annex 2 Carbon Stock

C-Pool		Dry matter (tDM)				Carbon stock (tCO ₂)				
		Mean per ha	Total	Lower bound @ 90% CI	Upper bound @ 90% CI	Mean per ha	Rel. margin of error (%)	Total	Lower bound @ 90% CI	Upper bound @ 90% CI
Vegetation	To-tal		2.590.388	2.321.009	2.859.767			4.748.187	4.254.370	5.242.004
Trees	AGB	33,68	1.916.937	1.733.953	2.099.921	61,75	9,55	3.513.964	3.178.494	3.849.434
	BGB	8,08	460.065	416.149	503.981	14,82	9,55	843.351	762.839	923.864
Shrubs	AGB	3,02	172.086	137.829	206.342	5,54	19,91	315.219	252.449	377.988
	BGB	0,73	41.301	33.079	49.522	1,33	19,91	75.652	60.588	90.717
Deadwood			276.611	183.793	369.429			507.058	336.899	677.218
Standing deadwood		2,20	124.953	103.218	146.687	4,02	17.39	229.047	189.204	268.890
Coarse woody debris		2.66	151.658	80.575	222.742	4.89	46,87	278.012	147.695	408.328
Soil						69,45	4,56	3.952.037	3.771.873	4.132.201
Grand total			2.866.999	2.504.802	3.229.196	157		9.207.282	8.363.141	10.051.424

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Table 2

C-Pool		Carbon stock	
		Total (tCO ₂)	% of Grand total
Vegetation	Total	4,748,187	52%
<i>Trees</i>	AGB	3,513,964	38%
	BGB	843,351	9%
<i>Shrubs</i>	AGB	315,219	3%
	BGB	75,652	1%
Deadwood		507,058	6%
<i>Standing dead-wood</i>		229,047	2%
<i>Coarse woody debris</i>		278,012	3%
Soil		3,952,037	43%
Grand total		9,207,282	100%

Table 3

-15% Vegetation Total - uncertainty

C-Pool		Carbon stock	
		Total (tCO ₂)	% of Grand total
Vegetation	Total	4.035.959	48%
<i>Trees</i>	AGB	2.986.870	35%
	BGB	716.849	8%
<i>Shrubs</i>	AGB	267.936	3%
	BGB	64.305	1%
Deadwood		507.058	6%
<i>Standing dead-wood</i>		229.047	3%
<i>Coarse woody debris</i>		278.012	3%
Soil		3.952.037	47%
Grand total		8.495.054	100%