

PASS NETZERO

Student Research Advancement Report

October 2026

Report Period	June – October 2026
Reporting Date	October 22, 2026
Source Documents	NUST Student Research Meeting (August 13, 2026) and LUANAR Student Research Meeting (October 16, 2026) — notes and transcripts; student presentation slides and written progress reports (all 5 students); status updates from students up to October 21, 2026
Universities	NUST Namibia • LUANAR Malawi
Active Students	5 (3 NUST Namibia, 2 LUANAR Malawi)
Programme Coordinator	Claude Martinet, President — Pass NetZero

PROGRAMME CONTEXT & COORDINATOR'S OVERVIEW

This report covers June to October 2026. It draws on two research progress meetings held separately for each university — the NUST Student Research Meeting on 13 August 2026 and the LUANAR Student Research Meeting on 16 October 2026 — together with the presentation slides and written progress reports submitted by each student. NUST results are those presented in August, with status updates provided by the NUST students in October 2026.

The gap between the two meetings is due to the universities' different academic calendars: LUANAR (Malawi) follows a different academic timeline from NUST (Namibia), with a holiday in August, so the LUANAR meeting could only be held in October. For the next report (December 2026), PNZ will try its best to resynchronise the progress meetings of both universities. Meetings will also be scheduled further in advance with the universities, to avoid such gaps and maintain more regular reporting.

The period marks the programme's move from field experimentation to laboratory analysis and results. Steven Chirwa (LUANAR) completed his Kauma experiment and presented the programme's first full set of statistical results (preliminary). Veruschka Dumeni (NUST) completed and decommissioned her Goreangab microcosm trial and completed her nutrient (TN/TP) analysis. Hilia Hatutale (NUST) and Ellen Kachulu (LUANAR), whose experiments were delayed or pending in May, both launched their experiments. Fenni Amadhila (NUST) extended her mortar testing to freshwater species harvested from Veruschka's trial.

Supervisory and expert feedback at the August meeting came from Prof. H.M. Kwaambwa (NUST) and Dr. Dikabo Mogopodi (University of Botswana), and is incorporated in the individual student sections below. Volunteer GIS specialist Meghan Hale and PNZ fundraiser Monica Brown joined the October meeting.

Status of Results — Read Before Quoting

- **All results in this report are preliminary, not final.** Review by the supervisors is in progress, and the results have not yet completed thesis examination or peer review, so they may still change. Any figure quoted from this report should be presented as preliminary and dated (October 2026).
- **Steven Chirwa:** full three-month dataset, statistically analysed — the most advanced results in the programme, but still preliminary while supervisor review is in progress and before thesis examination.
- **Veruschka Dumeni:** total phosphorus results shown for the first sampling event only; full TN/TP and trace-metal results are in analysis.
- **Fenni Amadhila:** mortar results for freshwater species are from a first trial without standard deviations; CHNS carbon results are in analysis.
- **Hilia Hatutale:** water-quality trends only (no figures); heavy-metal results pending ICP-OES analysis.
- **Ellen Kachulu:** no results yet; data analysis follows the final fish sampling.

PROGRAMME HIGHLIGHTS — JUNE TO OCTOBER 2026

Key Developments This Period

- **Steven Chirwa (LUANAR):** Kauma experiment completed (April–June 2026) and analysed (preliminary results). The Typha + Phragmites combination (T4) stored 442.73 gC/m² against 23.32 gC/m² in the unplanted control, and gave the strongest reductions on every water-quality and heavy-metal parameter (all differences significant, $p < 0.05$).
- **Steven Chirwa** attended the DAAD GeoTraining summer school in Germany (GIS and satellite remote sensing); the follow-on collaboration with the German hosts is on track.
- **Veruschka Dumeni (NUST):** final sampling on 3 June 2026 and site decommissioned; biomass harvested and dried. TN/TP digestion and UV-Vis methods established after extended troubleshooting, and TN/TP analysis now complete. The 62–68% total phosphorus decrease seen at the first sampling event (SE1) is likely due to an early eutrophication event (algal bloom) in all drums; plant removal came later.
- **Hilia Hatutale (NUST):** experiment launched in June 2026 — secondary and tertiary wastewater collected from Gammams and plants established in the Dutch bucket system. Since August, dead seedlings replaced, plant density increased, setup restored and pump replaced; biomass prepared for ICP-OES. Final sampling event pending.
- **Fenni Amadhila (NUST):** about 10 weekly natural Ulva samples collected and processed, and CHNS carbon analysis completed; mortar tests extended to Cyperus papyrus and Chrysopogon zizanioides (vetiver) and Chrysopogon nigritanus and now completed — freshwater species show higher strength retention than Ulva. Data analysis and thesis writing under way.
- **Ellen Kachulu (LUANAR):** Spirulina isolated locally and cultured; three mixing treatments run; carbon storage determined by the Walkley-Black method; Spirulina feeds formulated and fish sampled five times over three months. Final sampling pending.
- Agreed standard for all students: graphs and progress reports to show statistical variation (error bars, SD, confidence intervals) and measurement uncertainty.
- Namibia site maps prepared by volunteer Meghan Hale and circulated for review; Malawi maps to follow.

ITEMS REQUIRING COORDINATOR ATTENTION

NUST items were updated with information provided by the NUST students in October 2026; resolved items have been removed.

⚡ MEDIUM — Hilia Hatutale: laboratory access and ICP-OES backlog

- Restricted access to the laboratory on Saturdays has led to missed sampling days and an extended sampling period.
- Backlog on the ICP-OES is delaying analysis of water and biomass samples.
- Resolved since August: dead seedlings replaced, more seedlings per bucket, setup restored and pump replaced.
- Action: discuss Saturday laboratory access and ICP-OES scheduling with NUST and the supervisors.

⚡ MEDIUM — Fenni Amadhila: coastal sampling costs and data clarifications

- Fenni paid for travel to the coast for weekly Ulva sampling from her own money.
- The freshwater-species mortar controls (28-day compressive strength 53.40 MPa) are on a different scale from the Ulva controls reported in May (7.42–8.08 MPa); the mix design behind each series needs to be stated.
- Resolved since August: CHNS analysis completed.
- Action: decide on a travel allowance; ask Fenni to state mix designs in the next report.

✕ MEDIUM — Steven Chirwa: results presentation and Kauma STP engagement

- Result tables do not yet show WHO / national discharge standards, nor a comparison with the conventional treatment already operating at Kauma STP.
- Heavy-metal units are not stated in the result tables.
- The latest figures are higher than the interim figures previously quoted (e.g. T4 carbon 442.73 vs. 211 gC/m²). Steven confirmed that the interim analysis covered 1.5 months of data and the latest analysis the full 3 months. Earlier figures used in proposals or communications should be updated to the latest results, still presented as preliminary.
- Action: Steven to add standards and the STP comparison, and send results to the plant; PNZ to arrange an informal meeting with Kauma STP staff about a possible 2027 pilot.

⊙ PENDING — Ellen Kachulu: final sampling and results

- Final fish sampling postponed for personal reasons; to be completed the week of 19 October.
- Carbon storage (Walkley-Black) and water-quality results not yet presented; data analysis to start after final sampling.
- Ellen was advised to repeat the Spirulina culture to document it fully (not enough photographs taken).

STUDENT RESEARCH UPDATES

1. Steven Chirwa — Wastewater Treatment & Carbon Sequestration (LUANAR Malawi)

Research Title	The Efficiency of Phragmites australis and Typha latifolia in Wastewater Treatment and Carbon Sequestration
Supervisor(s)	Dr. A. Mtethiwa Prof. J. Kang'ombe (LUANAR)
Study Site	Kauma Sewage Treatment Plant, Lilongwe, Malawi
Current Phase	Phase 2 — Experiment complete (April – June 2026); results analysed; thesis writing

Experimental Design (reminder)

Completely Randomised Design, 4 treatments × 3 replicates: T1 control (no macrophytes), T2 Typha latifolia, T3 Phragmites australis, T4 50% T. latifolia + 50% P. australis. 14-day hydraulic retention time and 14-day acclimatisation. On-site parameters measured twice daily; laboratory parameters at 2-week intervals at the AQFS Laboratory, LUANAR. Statistics in R: ANOVA with Tukey HSD for on-site parameters; Kruskal-Wallis with Dunn's post-hoc test (Holm adjustment) for carbon, ex-situ and heavy-metal data ($\alpha = 0.05$).

Preliminary Results — Carbon Content

Treatment	Carbon content (gC/m ²)
T1 — Control	23.32 ± 1.51 c
T2 — T. latifolia	242.87 ± 1.92 b
T3 — P. australis	225.84 ± 1.38 b
T4 — T. latifolia + P. australis	442.73 ± 2.18 a

Means with the same letter are not significantly different (Dunn's test, Holm adjustment, $p < 0.05$). T2 and T3 do not differ significantly from each other.

Preliminary Results — On-site Water Quality

Parameter	Raw influent	T1	T2	T3	T4
Temperature (°C)	30.80 ± 0.13 a	28.01 ± 0.44 a	26.78 ± 0.08 b	26.52 ± 0.07 b	25.18 ± 0.4 c
DO (mg/L)	8.11 ± 0.06 a	2.73 ± 0.04 d	4.70 ± 0.04 c	4.76 ± 0.04 c	6.46 ± 0.04 b

Parameter	Raw influent	T1	T2	T3	T4
pH	7.50 ± 0.02 a	7.21 ± 0.02 b	6.76 ± 0.02 d	6.84 ± 0.02 c	6.36 ± 0.02 e
Conductivity (µS/cm)	272.45 ± 16.4 a	231.72 ± 14.0 a	164.18 ± 9.9 b	153.73 ± 9.2 b	64.20 ± 3.8 c
Salinity (ppt)	2.46 ± 0.07 a	1.83 ± 0.03 b	1.34 ± 0.01 c	1.31 ± 0.02 c	1.01 ± 0.01 d

Tukey HSD, $p < 0.05$. Values as reported on the student's slides.

Preliminary Results — Ex-situ Water Quality and Heavy Metals

Parameter	Raw influent	T1	T2	T3	T4	T4 reduction*
COD (mg/L)	70.41 ± 0.84	46.43 ± 0.72	24.40 ± 0.49	25.24 ± 0.51	13.39 ± 0.42	81%
BOD (mg/L)	65.03 ± 0.80	41.84 ± 0.57	5.30 ± 0.30	7.10 ± 0.28	4.14 ± 0.17	94%
Ammonia (mg/L)	80.78 ± 1.24	24.30 ± 0.54	8.41 ± 0.22	9.36 ± 0.27	1.60 ± 0.12	98%
Total N (mg/L)	20.08 ± 0.90	12.26 ± 0.24	5.14 ± 0.11	5.50 ± 0.13	1.09 ± 0.06	95%
Phosphorus (mg/L)	15.42 ± 0.24	8.11 ± 0.11	2.34 ± 0.08	2.99 ± 0.07	0.75 ± 0.04	95%
Chlorophyll-a (mg/L)	42.85 ± 0.81	11.10 ± 0.21	3.09 ± 0.10	3.52 ± 0.09	0.05 ± 0.00	>99%
Turbidity (NTU)	190.37 ± 2.57	33.87 ± 0.80	9.81 ± 0.29	11.15 ± 0.29	2.18 ± 0.11	99%
TDS (mg/L)	164.51 ± 2.13	74.92 ± 1.06	15.07 ± 0.45	16.87 ± 0.44	4.07 ± 0.22	98%
Copper (Cu)	36.23 ± 0.31	30.18 ± 0.24	3.76 ± 0.12	2.18 ± 0.05	1.02 ± 0.03	97%
Zinc (Zn)	21.53 ± 0.32	18.46 ± 0.27	2.72 ± 0.06	1.90 ± 0.05	0.41 ± 0.01	98%
Iron (Fe)	27.40 ± 0.32	23.04 ± 0.31	3.38 ± 0.09	2.22 ± 0.04	1.05 ± 0.03	96%
Lead (Pb)	34.84 ± 0.35	29.62 ± 0.35	2.14 ± 0.06	1.91 ± 0.04	0.45 ± 0.01	99%
Cadmium (Cd)	24.63 ± 0.02	20.03 ± 0.02	2.09 ± 0.06	1.40 ± 0.01	0.30 ± 0.09	99%
Arsenic (As)	28.11 ± 0.27	23.66 ± 0.39	4.29 ± 0.11	2.84 ± 0.07	1.63 ± 0.04	94%

* Reduction from raw influent to T4, calculated by PNZ from the reported means. All parameters differ significantly among treatments (Kruskal-Wallis, Dunn's post-hoc test with Holm adjustment, $p < 0.05$); significance letters are on the student's slides. Heavy-metal units not stated on the slides — to be confirmed.

Key finding (preliminary): the mixed planting (T4) outperformed both single-species treatments on every parameter, and stored about 19 times more carbon than the unplanted control. The unplanted control removed only 14–19% of heavy metals, against 94–99% for T4, confirming that the macrophytes — not settling alone — drive most of the removal.

These results cover the full three-month experiment (interim figures reported earlier covered the first 1.5 months only). They remain preliminary while supervisor review is in progress and until the thesis is examined. Steven also observed that treatment efficiency increased in direct proportion to plant growth. Plant growth data have not yet been presented and would allow this relationship to be shown.

Remote Sensing Training — Germany

Steven attended the DAAD GeoTraining summer school "Environmental and remote sensing data analysis via geospatial technologies in research and teaching" (Universität Osnabrück, September 2026), covering GIS, satellite remote sensing and Sentinel-based land-cover classification. He plans to apply NDVI and land classification along the Lilongwe River — upper catchment, urban fringe, Kauma and the industrial area — to monitor vegetation change, industrial discharge and algal blooms. Meghan Hale suggested adding the NDWI (water index) to track water condition over time. The collaboration with the German hosts, facilitated by PNZ, is on track.

Key Panel Feedback (October 16)

- **C. Martinet:** add WHO / national recommended levels to the result tables, citing the literature.
- **C. Martinet:** compare the plant treatments with the conventional treatment already operating at Kauma STP (effluent quality released to the river).

- **C. Martinet:** connect PNZ with Kauma STP staff to discuss a possible pilot in 2027; Steven will first send the plant his completed results, as the plant requested.

Next Steps

- Add WHO / national standards and the Kauma STP comparison to results and thesis.
- Send final results to Kauma STP; help organise an informal meeting between PNZ and plant staff.
- Share Lilongwe River study locations and the GIS feasibility document with PNZ and Meghan Hale (Malawi site maps).
- Thesis: address supervisors' comments, defend, and submit the final thesis (planned September 2026 – June 2027).

2. Fenni Amadhila — Ulva Carbon Capture & Cement Biomass Additive (NUST Namibia)

Research Title	Evaluating the Potential of Ulva sp. for Carbon Capture and Its Application as a Biomass Additive in Cement
Supervisor	Prof. H.M. Kwaambwa (NUST)
Co-Supervisor	Prof. E. Omoregie (NUST)
Study Sites	Coastal locations near Swakopmund, Namibia
Current Phase	Phase 2 — CHNS analysis and mortar tests completed; data analysis and thesis writing (October 2026)

Objective 1: Carbon Sequestration Monitoring — Status

About 10 weekly samples of naturally occurring Ulva were collected and processed from late March 2026. The CHNS analysis of carbon content, delayed in August by the lack of instrument gas, has now been completed; results are being analysed and will be presented at the next meeting.

Status updated by Fenni (October 2026).

Objective 2: Biomass Characterisation — FTIR

Wavenumber (cm ⁻¹)	Functional group
3300–3400	O–H stretching
2850–2860	C–H stretching
1639–1430	COO ⁻ asymmetric stretching / H ₂ O bending

Functional group table added following Dr. Mogopodi's May recommendation.

Objectives 3 & 4: Mortar Testing — Statistical Analysis

A two-way ANOVA without replication is being applied to the May mortar dataset. Preliminary outcome (reported verbally): mean strength varies between collection sites but **the differences are not significant**, whereas **increasing the Ulva dosage significantly reduces compressive strength**.

Comparison with Freshwater Species (PNZ project activity)

As agreed in May, Fenni ran mortar tests with biomass harvested from Veruschka's trial; these tests are now completed (October 2026). Preliminary results presented in August (first trial, no standard deviations):

Dosage	Cyperus papyrus	Chrysopogon zizanioides (vetiver)	Chrysopogon nigritanus
Control	53.40 / 8.40	53.40 / 8.40	53.40 / 8.40
2.5 g	44.80 / 6.87	46.75 / 7.71	48.95 / 6.84
5.0 g	42.00 / 6.89	45.85 / 6.50	44.55 / 6.99
10.0 g	40.50 / 6.53	37.20 / 5.42	43.35 / 7.11

Dosage	Cyperus papyrus	Chrysopogon zizanioides (vetiver)	Chrysopogon nigritanus
Strength retained at 10 g*	76%	70%	81%

28-day compressive / flexural strength (MPa). * 28-day compressive strength at 10 g as a share of the control, calculated by PNZ.

Key finding (preliminary): the freshwater species retain more strength than Ulva — C. nigritanus retained the most, followed by C. papyrus — and up to 10 g can be incorporated, although coarser particles require more water. Fenni attributes Ulva's weaker performance to its salt content and overall chemical composition.

Key Panel Feedback (August 13)

- **Prof. Kwaambwa:** determine lignin, cellulose and hemicellulose content of the biomass, which likely affects mechanical properties.
- **C. Martinet:** account for measurement uncertainty inherent to each method, in addition to variation between repeats; include the result tables in the written progress report for numerical review, combined into one table.
- **Dr. Mogopodi:** explain the differences in performance between species.

Next Steps

- Complete data analysis, including the CHNS carbon results and the ANOVA on mortar data (standard deviation, percentage difference).
- Determine lignin, cellulose and hemicellulose content of Ulva and freshwater biomass.
- Include all result tables in the next written progress report.
- Continue thesis writing.

3. Veruschka Dumeni — Phytoremediation of Goreangab Dam Water (NUST Namibia)

Research Title	Concentration-Dependent Phytoremediation of Eutrophic Dam Water in Namibia: A Microcosm Assessment of Native and Adaptive Aquatic Macrophytes
Main Supervisor	Prof. E. Omoregie (NUST)
Co-Supervisor	Prof. H.M. Kwaambwa (NUST)
Study Site	Goreangab Dam, Windhoek, Namibia
Current Phase	Phase 2 — Field trial complete (final sampling 3 June 2026); laboratory analysis

Progress Since May

Month	Milestone
June 2026	Final sampling (3 June); research station decommissioned about a week later; remaining wastewater returned to the Gammams primary treatment point; plants harvested, rinsed, dried, weighed and stored; T1–T6 workbooks.
July 2026	Drum water-mark, rainfall and evapotranspiration/dilution dataset; nitrate and phosphate working standards; TN/TP method testing and SOP (TNTP-W10900, 4500-P E, HJ 636-2012); QC criteria, glassware cleaning, deionised-water checks.
Aug 2026	Calibration redesign; UV-Vis reagent ratios; baseline control and blank behaviour; first TP and TN measurements.

Analytical Method

Alkaline persulfate digestion converts all organic and inorganic forms to orthophosphate and nitrate. TP is read by ascorbic acid–molybdenum blue colorimetry at 880 nm; TN by UV-Vis following HJ 636-2012, with ion chromatography (ASTM method) available to validate nitrate readings. The methods were chosen because they can be run at NUST and use fewer reagents with less toxic waste. Current TP calibration: $y = 0.0976x - 0.0385$, $r^2 = 0.981$.

Preliminary Total Phosphorus Results — Pre-trial to SE1 (two weeks)

Treatment	Baseline TP (mg P/L)	Mean residual TP at SE1 (mg P/L)	Mean reduction ($\pm$ standard error)
T1 — Dam water only	10.85	4.08	62.4% ($\pm$ 3.71)
T2 — 50:50 dam : wastewater	15.60	5.90	62.2% ($\pm$ 1.50)
T3 — Wastewater only	20.34	6.48	68.2% ($\pm$ 0.47)

Plant group (SE1, n = 3)	T1	T2	T3
C. nigritanus (CN)	59.8%	56.0%	66.3%
V. zizanioides (CZ)	61.4%	69.7%	70.7%
C. papyrus (CP)	63.5%	59.6%	67.9%
Combination (COMB)	71.8%	62.3%	68.4%
Unplanted control (CTRL)	55.4%	63.3%	67.6%

Mean TP reduction relative to the pre-trial raw-water mean. T2 is labelled "assumed 50:50" in the student's slides.

Important caveat: unplanted controls also fell by 55–68%, so the SE1 decrease cannot yet be attributed to plant uptake. A major algal bloom occurred in all drums before SE1; part of the reduction may be phosphorus temporarily held in algal biomass and settled material. If TP stays low after the bloom subsides, this supports lasting removal; if it rises, it may indicate algal decomposition and release. Veruschka notes that plant removal came later in the trial; the plant contribution is being separated from the control effect in the ongoing data analysis of SE1–SE6.

Status of Analyses (updated October 2026)

Analysis	Status
TN / TP (all sampling events)	Complete — in data analysis. Calibration standards were outsourced from a private laboratory and used.
Heavy metals Cr/Zn/Pb/Cu/Cd (ICP-OES)	ICP-OES back in service; trace-metal analysis near complete.
Biomass data digitisation	Under way, near complete.
COD (closed reflux)	Cancelled for this study — the large number of samples would have depleted the laboratory's COD resources.

Status updated by Veruschka in comments on the draft report.

Key Panel Feedback (August 13)

- **C. Martinet:** confirmed that sample preservation ($\text{pH} < 2$) protects results from the calibration delay; the calibration uncertainty (about 2%) is acceptable for the study.
- **C. Martinet:** report the phosphorus-to-nitrogen ratio, to check that neither nutrient remains in excess — relevant when selecting species combinations to avoid eutrophication. Veruschka noted that TP is linked to methane emissions and TN to eutrophication.

Next Steps

- Complete TN/TP data analysis and separate the plant effect from the algal-bloom and control effect across SE1–SE6.
- Complete trace-metal analysis.
- Finalise biomass digitisation and correlate growth with removal efficiency.
- Calculate and report the TP : TN ratio; integrate the physico-chemical water-quality data.

4. Ellen Christabel Kachulu — Spirulina Carbon Sequestration & Fish Growth (LUANAR Malawi)

Research Title	Efficacy of Spirulina (<i>Arthrospira platensis</i>) in Carbon Sequestration and Growth Performance of <i>Oreochromis shiranus</i>
Supervisor(s)	Dr. A. Mtethiwa Prof. J. Kang'ombe (LUANAR)
Study Site	Bunda Fish Farm, Lilongwe, Malawi
Current Phase	Phase 2 — Experiments implemented; final fish sampling pending

Progress Since May

The main barrier reported in May — obtaining a Spirulina culture — was resolved by sourcing Spirulina locally.

Step	What was done
Sourcing and confirmation	Pond water containing Spirulina sourced from a local farmer, whose original stock came from ProAgricaSA Spirulina and Chlorella (South Africa); the farmer's production system is still at trial stage and is not named. A sample was oven-dried in trays for 48 hours to confirm the alga in the dry lab, and the remaining pond water was examined under a compound microscope (40× objective, 10× eyepiece).
Pure culture and medium	Selected filaments transferred with a 1 ml micropipette (sterile disposable tip) into freshly prepared Zarrouk's medium (sodium bicarbonate, sodium carbonate, potassium nitrate, sodium chloride, potassium sulphate, magnesium sulphate heptahydrate, calcium chloride dihydrate, iron sulphate heptahydrate, disodium EDTA, potassium hydrogen phosphate, potassium dihydrogen phosphate). The two phosphates, initially missing, were later sourced from Lilongwe Lab Enterprises.
Culture and mixing treatments	Pure culture grown in three outdoor concrete tanks — one per mixing treatment (no mixing / every 24 h / every 12 h) — until sufficient biomass was established; sunlight as the main light source, and the alkaline culture limited competing microorganisms. Each treatment's culture was then transferred into three separate hapas (three replicates per treatment). This pre-stocking period let biomass accumulate for harvesting and feed preparation without interference from fish feeding.
Carbon storage	Dry biomass from the three mixing treatments analysed in triplicate by Walkley-Black wet oxidation: potassium dichromate and concentrated sulfuric acid, 30 minutes of oxidation, dilution with distilled water, diphenylamine indicator, then titration of excess dichromate with ammonium ferrous sulfate to a distinct green endpoint. Organic carbon calculated from the difference between sample and reagent-blank titrations.
Feed formulation	Pellets made from cassava (binder), soybean, dried Spirulina and minerals: 0%, 15% and 30% Spirulina diets.
Fish growth	<i>O. shiranus</i> fingerlings stocked in hapas; weight, total length and standard length sampled fortnightly — five samplings over three months. Water quality recorded throughout.

Results for carbon storage, fish growth and water quality will be presented at the next meeting, after the final sampling and data analysis.

Key Panel Feedback (October 16)

- **C. Martinet:** explore Spirulina as an affordable protein source for people — for example a recipe combining it with nsima — sold through the university kitchen, nearby restaurants or local markets, alongside its use in fish feed.
- **C. Martinet:** seek letters of support from community members or small businesses interested in Spirulina, for use in funding applications.
- Sandra offered to support the Spirulina work; PNZ noted that Spirulina production next year could offer Ellen an internship or earning opportunity.

Next Steps

- Complete the final fish sampling (postponed for personal reasons) during the week of 19 October.
- Analyse fish growth (weight gain, FCR, SGR), carbon storage and water-quality data.
- Repeat the Spirulina culture with full photographic documentation.

- Contact the university kitchen and local businesses; secure letters of support.

5. Hilia Ndawapeka Hatutale — Heavy Metal Phytoremediation, *Cyperus* spp. (NUST Namibia)

Research Title	Evaluating the Potential of <i>Cyperus papyrus</i> and <i>Cyperus alternifolius</i> in Heavy Metal Removal from Wastewater: A Comparative Study of Native Plants for Phytoremediation and Wastewater Treatment in Gammams Wastewater, Namibia
Main Supervisor	Prof. H.M. Kwaambwa (NUST)
Co-Supervisor	Prof. E. Omoregie (NUST)
Study Site	Dutch bucket system at Goreangab Dam, Windhoek; secondary (T1) and tertiary (T2) treated wastewater from Gammams Water Care Works
Current Phase	Phase 2 — Experiment running since June 2026; final sampling event pending (October 2026)

Progress Since May

The wastewater supply problem reported in May was resolved: secondary and tertiary wastewater were collected from Gammams and the Dutch bucket system filled. Plants were separated, washed free of soil and transferred into LECA growth medium; baseline water quality was measured before planting. Water samples were preserved with nitric acid for ICP-OES. Photographs show clear root growth in both species between June and July 2026. Unplanted control buckets are run in triplicate in each treatment.

Water Quality Trends (three sampling events)

Parameter	Trend	Interpretation
Turbidity	Decreased over time in both treatments	Clearest improvement — better water clarity
Dissolved oxygen	Fluctuated; similar in T1 and T2	Comparable biological activity in both systems
pH	Stable, gradually shifting slightly alkaline	Influenced by algal growth, wastewater composition and plant activity more than by treatment
Conductivity / TDS	Increased or stable over time	Accumulation or persistence of dissolved ions in the recirculating system
Salinity	Stable, minor fluctuations	—
Temperature	Similar in both treatments	Reflects seasonal (winter) conditions

Factors Affecting Removal and Proposed Adjustments

Algal growth, winter conditions (studies run in summer report better results), plant mortality and replacement, and too short an acclimatisation for replacement seedlings before sampling. Proposed: more seedlings and LECA per bucket to shade the water surface and limit algae, higher plant density for uptake, at least 1–2 weeks of acclimatisation for new plants, and possibly sampling every second week.

Update — October 2026

Since the August meeting, Hilia replaced the dead seedlings and increased the number of seedlings per bucket, restored the setup and replaced the pump, and pulverised plant biomass for ICP-OES bioaccumulation analysis. Remaining challenges: restricted laboratory access on Saturdays, which led to missed sampling days and an extended sampling period, and a backlog on the ICP-OES.

Update provided by Hilia (progress report, 21 October 2026).

Key Panel Feedback (August 13)

- **Dr. Mogopodi:** all graphs must show statistical information — error bars, standard deviations or confidence intervals, and the number of measurements.
- **C. Martinet:** show the unplanted controls alongside the planted buckets in each graph, to see whether changes are due to the plants.

Next Steps

- Carry out the final sampling event.
- Remove the experimental setup and restore the site.
- Analyse water samples and plant biomass (bioaccumulation) by ICP-OES.
- Send plant biomass samples to Fenni for the cross-species cement comparison.
- Analyse the raw water-quality data; redo graphs with error bars and control comparisons.

SUMMARY & PROGRAMME STATUS

Student	University	Research Focus	Status	Key Milestone This Period
Steven Chirwa	LUANAR Malawi	Typha/Phragmites wastewater treatment & C sequestration	✓ Data analysed (preliminary)	Full statistical analysis of 3-month dataset; T4 best on all parameters; DAAD GeoTraining summer school
Fenni Amadhila	NUST Namibia	Ulva carbon capture & cement biomass additive	✓ Active — data analysis	CHNS analysis and freshwater-species mortar tests completed; data analysis and thesis writing
Veruschka Dumeni	NUST Namibia	Phytoremediation of Goreangab Dam — 45-drum FCW trial	✓ Active — data analysis	Trial complete and decommissioned; TN/TP analysis complete; trace metals near complete
Ellen Kachulu	LUANAR Malawi	Spirulina C sequestration & fish growth	✓ Active (was pre-launch)	Spirulina cultured; feeds formulated; 5 fish samplings; final sampling pending
Hilia N. Hatutale	NUST Namibia	Cyperus spp. heavy-metal phytoremediation	✓ Active (was delayed)	Setup restored, seedlings replaced; biomass prepared for ICP-OES; final sampling event pending

Collaboration & Strategic Notes

- **Reporting standard:** agreed on 13 August — all graphs and progress reports to include statistical variation and measurement uncertainty.
- **Nutrient balance:** the TP : TN ratio is to be reported, to guide future species selection towards a balanced nutrient outcome.
- **Cross-species cement comparison (Fenni, Veruschka, Hilia):** under way as a PNZ project activity, using biomass harvested from Veruschka's Goreangab trial; Hilia will also send her Cyperus biomass to Fenni.
- **Kauma STP:** PNZ to meet plant staff informally about the results and a possible 2027 pilot; plant staff could also be invited to a research meeting.
- **Germany (Osnabrück / Münster):** collaboration following Steven's summer school is on track; Steven's Lilongwe River GIS work could serve as its starting point.
- **Mapping:** Meghan Hale (volunteer) prepared the Namibia site maps; impact mapping to follow once affected communities are defined. Malawi maps next, with input from Steven and from Sandra, who is making the connection with YOBO.
- **Fundraising:** Monica Brown (PNZ freelance fundraiser) joined the October meeting and has asked for a meeting with the team to discuss elements that would strengthen the GEF SGP Malawi application.
- **New participants:** a new volunteer from Burkina Faso (Fazia — name to confirm), introduced through APEST, joined to translate PNZ documents from English to French; Yame Wilfred (University of Botswana student) observed the August meeting.

ACTION ITEMS — NEXT REPORTING PERIOD

Actions agreed at the meetings or drawn from the next steps above. Their status will be reviewed at the next progress meeting (December 2026). Target dates are to be agreed with each owner.

Action	Owner	Target date	Status
Add WHO / national standards and the Kauma STP comparison to results and thesis	Steven Chirwa	To be agreed	Open
Send results to Kauma STP; help organise an informal meeting between PNZ and plant staff	Steven Chirwa	To be agreed	Open
Share Lilongwe River study locations and GIS feasibility document with PNZ and Meghan Hale	Steven Chirwa	To be agreed	Open
Address supervisors' comments; defend and submit the thesis	Steven Chirwa	June 2027	Open
Complete final fish sampling and analyse growth, carbon and water-quality data	Ellen Kachulu	To be agreed	Open
Repeat Spirulina culture with full photographic documentation	Ellen Kachulu	To be agreed	Open
Secure letters of support from local businesses / university kitchen	Ellen Kachulu	To be agreed	Open
Complete TN/TP data analysis, separating plant effect from algal-bloom and control effect; report TP : TN ratio	Veruschka Dumeni	To be agreed	Open
Complete trace-metal analysis and biomass digitisation	Veruschka Dumeni	To be agreed	Open
Complete data analysis (CHNS results, ANOVA on mortar data); state mix designs	Fenni Amadhila	To be agreed	Open
Determine lignin, cellulose and hemicellulose content of biomass	Fenni Amadhila	To be agreed	Open
Carry out final sampling; remove setup and restore site	Hilia Hatutale	To be agreed	Open
ICP-OES analysis of water and biomass; send biomass to Fenni	Hilia Hatutale	To be agreed	Open
Redo graphs with error bars and control comparisons	Hilia Hatutale	To be agreed	Open
Send Namibia site maps for review; prepare Malawi maps	Meghan Hale	To be agreed	Open
Arrange informal meeting with Kauma STP staff on a possible 2027 pilot	PNZ	To be agreed	Open
Decide on a travel allowance for Fenni's coastal sampling	PNZ	To be agreed	Open
Discuss Saturday laboratory access and ICP-OES scheduling for Hilia with NUST	PNZ / supervisors	To be agreed	Open
Schedule the December progress meeting with both universities in advance	PNZ	November 2026	Open
Meet Monica Brown on strengthening the GEF SGP Malawi application	PNZ	To be agreed	Open

LESSONS LEARNED

Lesson	What happened this period	Practice going forward
Check methods and reagents before the laboratory phase	One of Veruschka's analytical steps had to be replaced because the reagents were not available locally, and calibration troubleshooting took about four weeks.	Confirm reagent availability and run a trial calibration before or during field work, not after it.
Preserve samples	Samples preserved at pH < 2 kept their value despite the calibration delay.	Keep preservation as standard practice whenever analysis may be delayed.
Shared instruments are a single point of failure	The lack of gas for the ICP-OES and CHNS analyser at NUST blocked three students for several weeks, and the ICP-OES now has a backlog delaying Hilia's analysis.	Identify a backup laboratory early and keep an outsourcing option in the budget; outsourcing calibration standards saved Veruschka time.

Lesson	What happened this period	Practice going forward
Match the analytical plan to laboratory capacity	Veruschka's COD analysis was cancelled because the number of samples would have depleted the laboratory's COD resources.	Check at design stage that the laboratory can process the planned number of samples for each parameter.
Plan sampling around laboratory access	Hilia missed sampling days because the laboratory is closed to her on Saturdays, which extended her sampling period.	Agree sampling days and laboratory access with the university before the experiment starts.
Unplanted controls are essential	Veruschka's controls showed that an algal bloom, not only the plants, caused the early phosphorus decrease.	Run and show controls alongside planted treatments in every graph and table.
Seasonal timing affects results	Hilia's experiment started in winter; cold weather killed plants, and replacements were sampled before they had acclimatised.	Plan start dates around the season; acclimatise replacement plants for at least 1–2 weeks before sampling.
Field set-ups need protection	Hilia's water-flow timer was tampered with and a delivery tube dislodged.	Consider site security and regular checks when choosing and running a site.
Document every step	Ellen was advised to repeat her <i>Spirulina</i> culture because it was not photographed enough.	Photograph each experimental step as it happens.
Report variation and uncertainty	Graphs were presented without error bars or measurement uncertainty.	Statistical variation and method uncertainty are now a reporting standard for all students.
Field costs should not fall on students	Fenni paid for coastal sampling travel herself.	Include sampling travel in each student's research budget.
Sharing biomass between studies creates synergy	Fenni's mortar tests used biomass from Veruschka's trial, and Hilia will send her <i>Cyperus</i> biomass to Fenni.	Plan biomass hand-over between studies from the start, so one experiment's harvest feeds another's analysis.
Align meetings with academic calendars	Different academic calendars at NUST and LUANAR created a two-month gap between meetings.	Schedule progress meetings further in advance with both universities.

FUNDING & COMMUNICATIONS

Communications

- **Documentary:** the first version of the PNZ documentary has been produced. It is expected to be a key communications asset for outreach to funders and partners.
- **IEC Stuttgart (23–25 October 2026):** PNZ will attend the conference.
- **COP31 (Antalya, November 2026):** PNZ will attend.

Active Funding Pipeline

- **UNDP GEF Small Grants Programme (Malawi, with YOBO):** proposal ready but not submitted — the call has not opened yet. To be strengthened with letters of support (e.g. the university kitchen for *Spirulina*); Monica Brown has asked for a meeting on how to strengthen it.
- **Global EbA Fund (IUCN):** PNZ decided not to pursue the application because its intellectual-property terms conflict with PNZ's model.
- **UN-Habitat / IsDB / Earthna (Windhoek River Walk):** selected for the second stage.

ABBREVIATIONS

Abbreviation	Meaning
ANOVA	Analysis of variance
APEST	Partner organisation in Togo

Abbreviation	Meaning
AQFS	Aquaculture and Fisheries Science (laboratory, LUANAR)
BOD / COD	Biochemical / chemical oxygen demand
CHNS	Carbon, hydrogen, nitrogen and sulfur (elemental analysis)
CN / CZ / CP / COMB / CTRL	C. nigritanus / C. zizanioides (vetiver) / C. papyrus / species combination / unplanted control (Veruschka's trial)
COP31	31st UN Climate Change Conference
DAAD	German Academic Exchange Service
DO	Dissolved oxygen
FCR / SGR	Feed conversion ratio / specific growth rate
FCW	Floating constructed wetland
FTIR	Fourier-transform infrared spectroscopy
GEF SGP / UNDP	Global Environment Facility Small Grants Programme / UN Development Programme
GIS	Geographic information system
HSD	Honestly significant difference (Tukey test)
ICP-OES	Inductively coupled plasma optical emission spectrometry (metals analysis)
IEC	International conference attended in Stuttgart, Germany
IUCN / EbA	International Union for Conservation of Nature / Ecosystem-based Adaptation
LECA	Lightweight expanded clay aggregate (growth medium)
LUANAR	Lilongwe University of Agriculture and Natural Resources (Malawi)
MPa	Megapascal (unit of strength)
NDVI / NDWI	Normalised difference vegetation / water index
NTU	Nephelometric turbidity unit
NUST	Namibia University of Science and Technology
PNZ	Pass NetZero
QC / SOP	Quality control / standard operating procedure
RI	Raw influent (untreated wastewater)
SD	Standard deviation
SE1–SE6	Sampling events 1 to 6
STP	Sewage treatment plant (Kauma, Lilongwe)
T1–T4	Experimental treatments (defined in each student section)
TDS	Total dissolved solids
TN / TP	Total nitrogen / total phosphorus
UV-Vis	Ultraviolet–visible spectrophotometry
WHO	World Health Organization
YOBO	Youth On Board Organization (Malawi)

Disclaimer: This report was generated by artificial intelligence (Claude, Anthropic) on the basis of the NUST Student Research Meeting notes and transcript of 13 August 2026, the LUANAR Student Research Meeting notes and transcript of 16 October 2026, the student presentation slides and progress reports submitted for those meetings, and status updates provided by the students up to 21 October 2026. All results are preliminary. Content has been reviewed and approved for release by the Pass NetZero programme coordinator. Source documents are retained on file.