Carbon Storage Quantification and Degradation Status of Peat at Burrator's Bog

A Consultancy Report for Southwest Peatland Partnership

Uttam Kumar Tamboli

Consultancy Report

Environmental Management

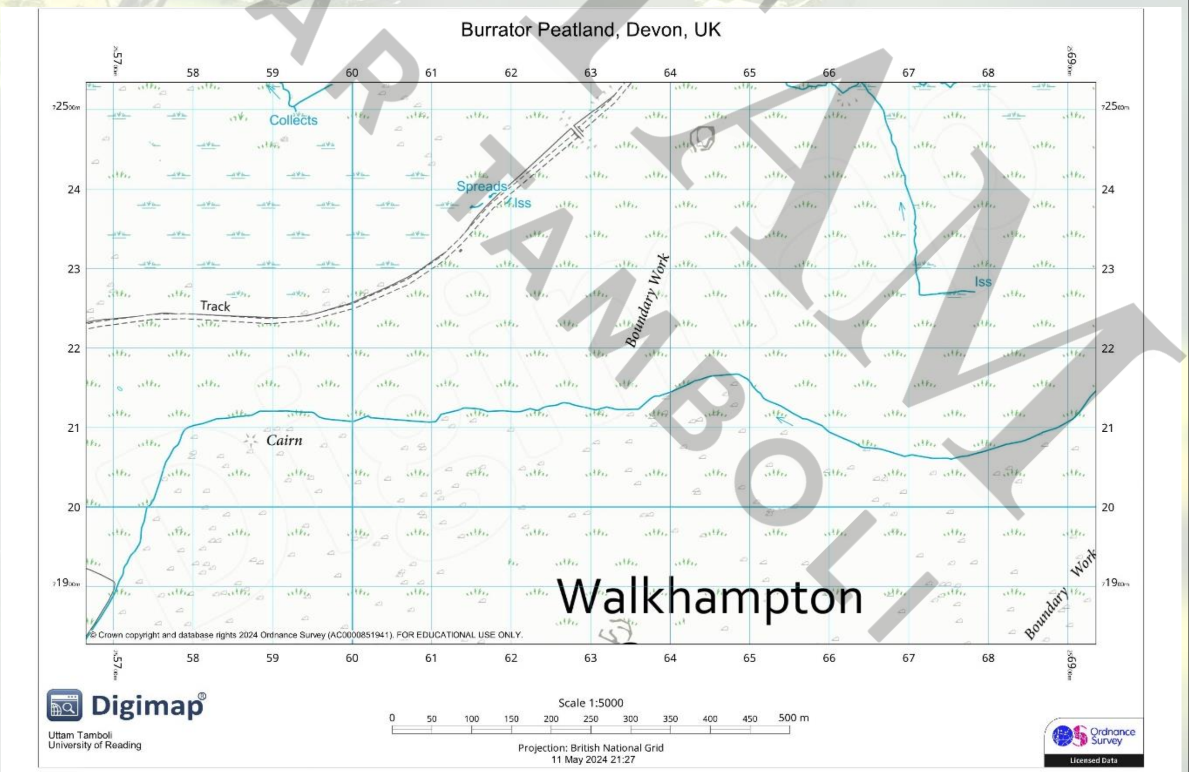
Contents

1. Introduction:

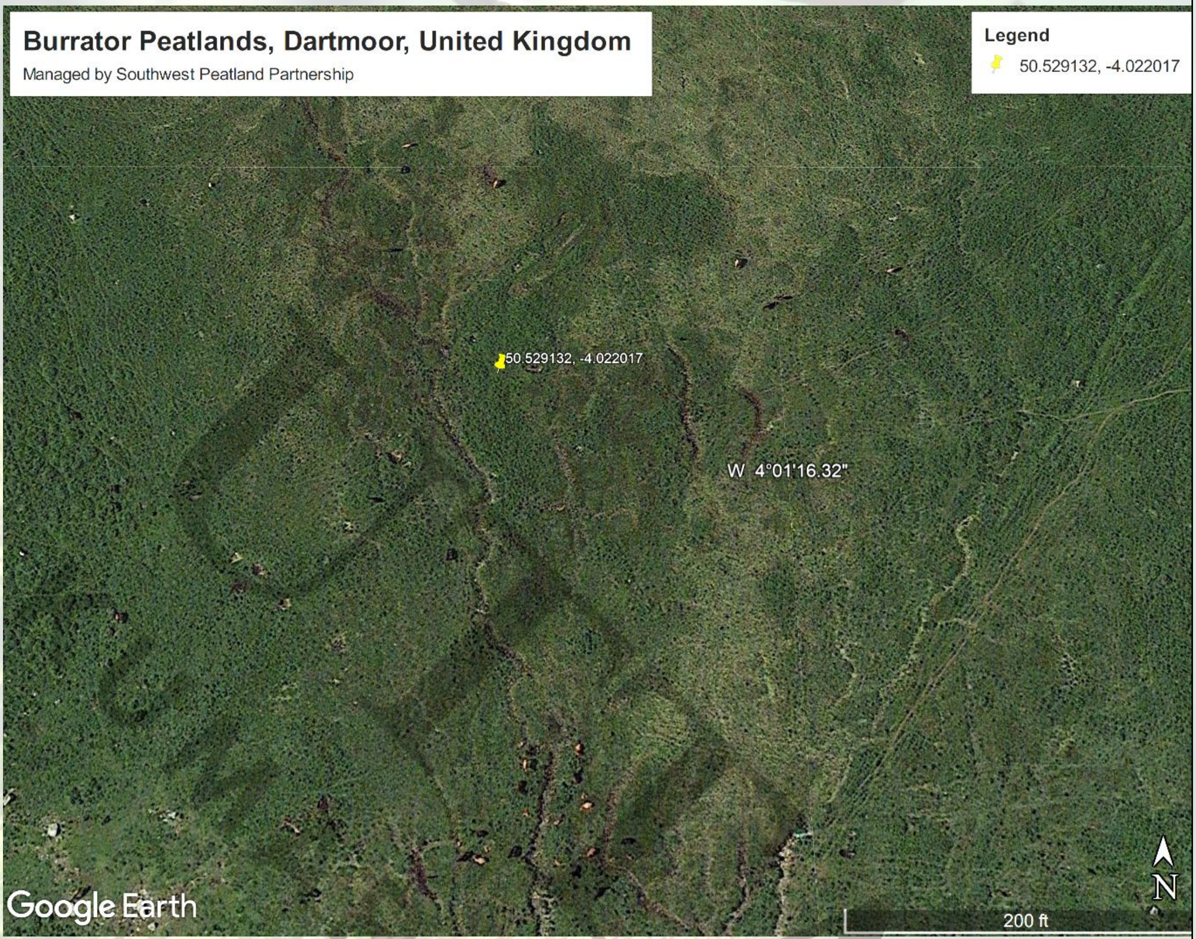
This consultancy report is based on the findings of a site visit to Burrator's Peatbogs situated in Dartmoor National Park, Devon, England and was aimed at quantity determination of carbon storage of peat bogs. Peatlands are important carbon sinks that are essential to the global cycling of carbon and the mitigation of climate change through carbon sequestration. Hence their restoration also helps in enhancing ecosystems, water quality, and natural flood control.

The initiative to replenish the Burrator's peatlands is being performed under the Nature for Climate Peatland Grant Scheme of the UK government which is a £13 million collaborative project with Southwest Peatland Partnership that aims to restore 2,600 hectares of degraded peatland across the Southwest of England, on Dartmoor, Exmoor, Bodmin Moor and West Penwith. (Dartmoor National Park, 2024).

2. Study Area:



Ordnance Map (Created by the author using Digimaps)



Aerial Map (Created using Google Earth by Author)
Geolocation of Sampling Area: 50.529132, -4.022017 (Pointed in the Map)

Fig 1: Ordnance & Aerial Map of Study Area. (Made by Author)

Fig 2: Peatbog Sphagnum Moss. (Cairngorms Connect, 2024)

The restoration of peatlands lowers downstream floods, improves water quality, locks carbon, builds habitat for species, and increases drought resistance. Because of this, human intervention is also required to maintain the peat bog's depth by mechanical excavation and to encourage a healthy recolonization. For that reason, currently, efforts are carried out at Burrator's Peatbog to conserve the sphagnum moss shown in Figure 2. For that reason, several ponds were made by digging peat bogs from some spots and shifting them on other spots of the land.

3. Methodology

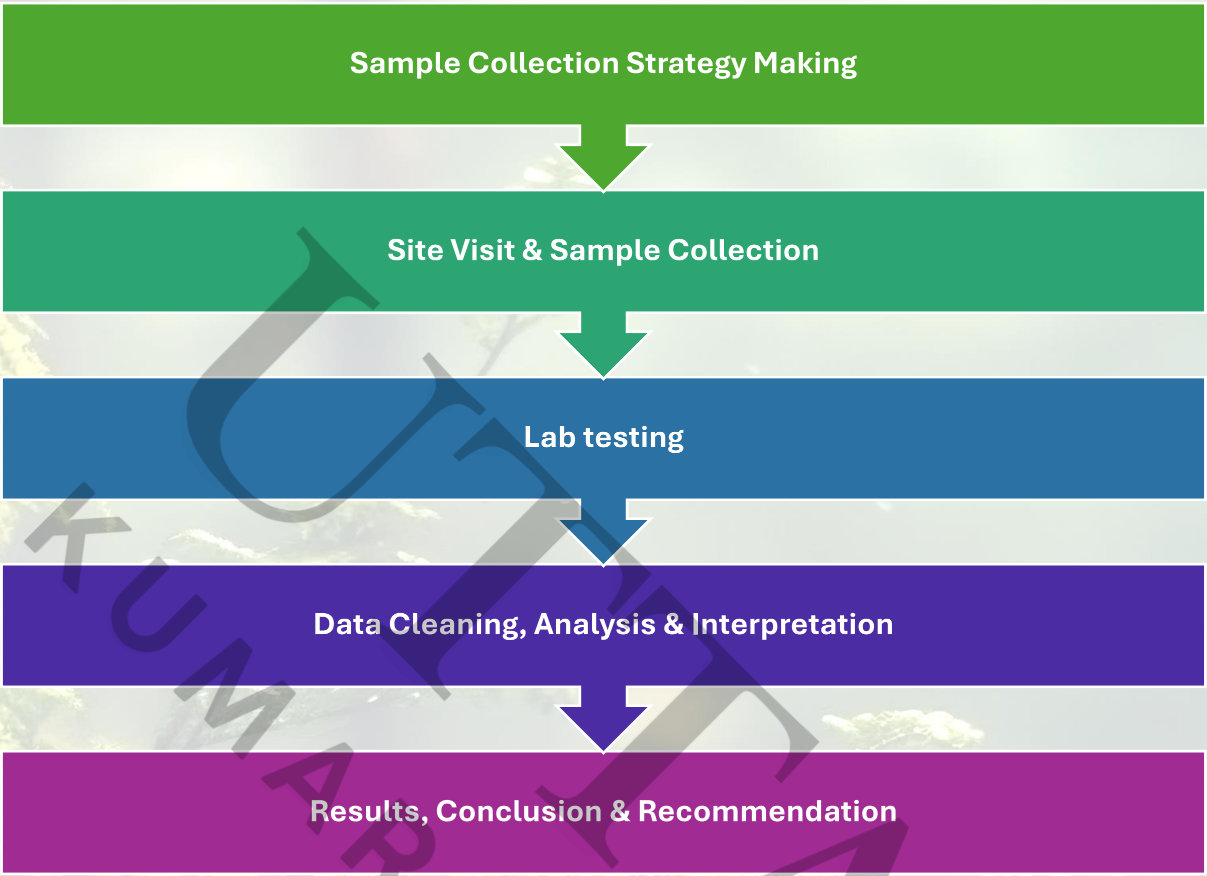


Fig 3: Flowchart of Methodology followed.

3.1. Sample Collection Strategy Making:

As the weather was wet and windy for the entire week of the field visit, the peatlands were filled with water and most of the parts were submerged as well. Hence, to perform the sample collection by managing these circumstances, a 20m x 20 m grid was made using guiding poles and meter tapes and the entire square was divided into 5m x 5m meter grids.

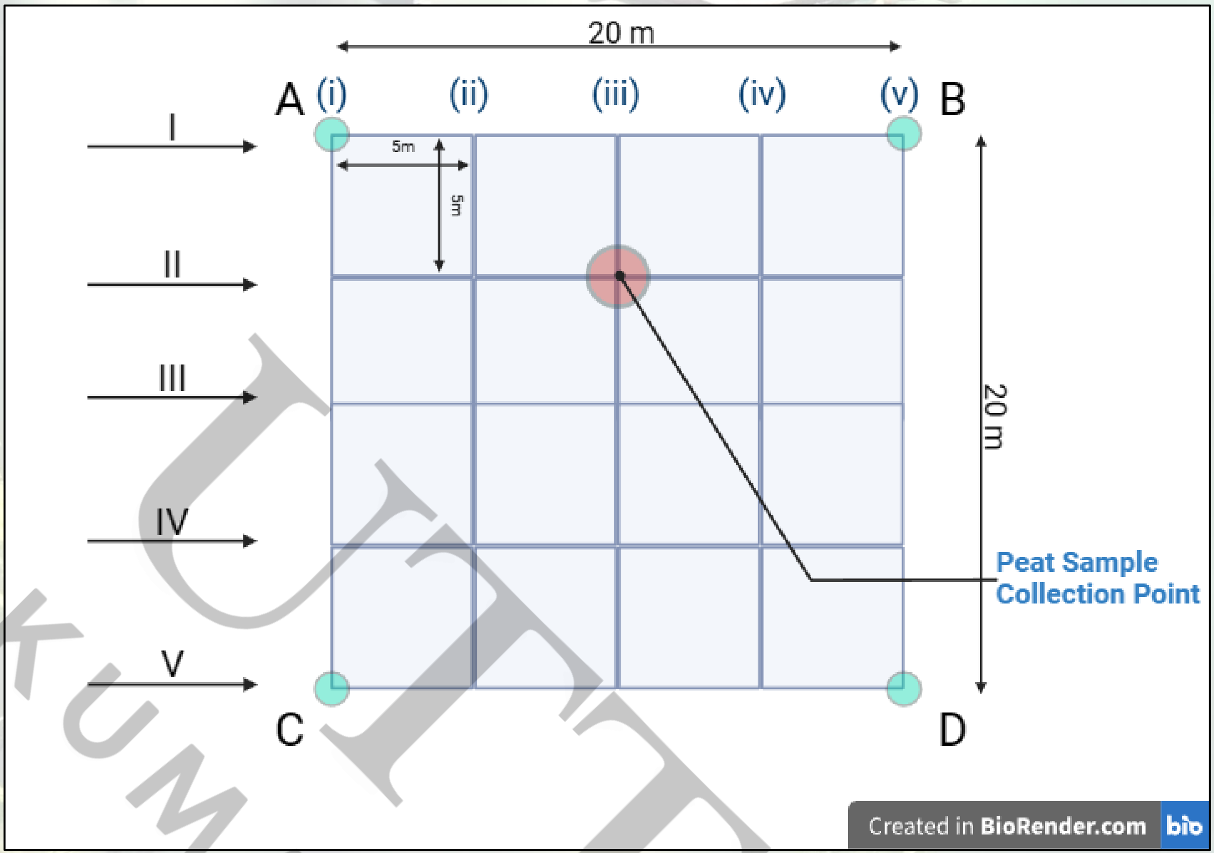


Fig 4: Sample Collection Design Strategy. (Made by Author)

3.2. Site Visit and Sample Collection:

The site was visited on 10th April 2024, sample collection strategy was followed and peat depth at each point of Fig 4 was measured using a peat probe (utility probe) and meter tape. Apart from this, a 30 cm peat sample was taken from the collection point mentioned in Fig 4 using an Edelman auger. The sample was divided into 6 pieces of 5 cm each and collected in pre-labelled bags. After that, 3 water samples were collected in pre-labelled bottles from the river feeding the Burrator's reservoir.

3.3. Lab Testing:

The samples were brought back to the lab and prepared for tests. 0.4 to 0.6 grams of each of the 6 soil samples considered and were added with 25 ml of sodium hydroxide. They were then shaken for one hour using the shaker equipment for one hour at 40 RPM (Rotation per minute). After that, the standard procedure of the Humification Test was performed using them. Apart from this, the water samples were subjected to spectrophotometry to determine their per cent transmission value.

3.4. Data Cleaning, Analysis & Interpretation:

With the collected data on peat depth, grid dimension and peat carbon density, per location and total carbon storage of peat was mathematically calculated. Moreover, humification test results were analysed and interpreted.

3.5. Result, Conclusion & Recommendations:

Based on the produced lab results, calculations and data analysis, results and conclusions were prepared and recommendations were proposed for future works.

4. Site & Lab Work Photographs

Fig 5: Site Visit Photographs. (Captured by Author)

Fig 6: Lab work Photographs. (Captured by Author)

5. Result & Discussion:

5.1. Humification Index Test

Sample	Soil Weight Taken	Humification Index
0-5 cm	0.464 g	4.6
5-10 cm	0.494 g	8.5
10-15 cm	0.455 g	0.6
15-20 cm	0.464 g	7.6
20-25 cm	0.553 g	10.3
25-30 cm	0.464 g	14.0

Table 1: Humification Index Test results for soil samples

As per Table 1, There is a large range in the values of the Humification Index. It is a key indicator of the quality of peat which shows how much organic matter has broken down and how much carbon it may hold. Reduced potential for future carbon sequestration is generally suggested by higher values of the humification index, which typically implies a more advanced breakdown. These results were slightly unexpected and might be due to the restoration activity of pond creations for protecting sphagnum moss. As it was raining during the entire week of the field visit and before, the peatland was flooded with water. They draw attention to the fact that varying saturation conditions have a substantial impact on the rates of methane and carbon dioxide emissions, which in turn impacts the quality of peat and its ability to store carbon. This is consistent with the findings of (Blodau, Basiliko & Moore, 2004), who mentioned that carbon dynamics in peatlands are strongly influenced by varying saturation conditions and water tables.

5.2. Carbon Storage Calculation

A						B
		(i)	(ii)	(iii)	(iv)	(v)
	I	29 cm	28 cm	42 cm	37 cm	39cm
	II	34cm	48 cm	50cm	23 cm	42 cm
	III	41cm	22cm	30 cm	19 cm	41 cm
	IV	17 cm	26 cm	25 cm	18 cm	27 cm
	V	34 cm	39 cm	38 cm	38 cm	38 cm
C						D

Table 2: Peat depth at each point of the grid shown in Fig 4

For the calculation of carbon storage of peatland, the carbon density of peat considered was 50 Kg/m^3. The calculation was done for every 5 x 5m square grid and the values were combined to obtain the total carbon storage of 20 x 20m square area of peatland considered in the study area. Following was the equation considered for calculation:

$$\textit{Carbon Storage of peat (in Kg) at each } 5 \text{ x } 5m \textit{ grid} = \textit{area of grid}(m^2) X \textit{ depth of peat}(m) X \textit{ carbon density of peat}(kg/m^3)$$

For instance, considering the first grid point,

Carbon storage at A (I)(i) = 5 X 5 X 0.29 X 50 = 362.5 Kg

Note: All the peat depth values in Table 2 were changed to metres before the calculation of carbon storage.

A						B
		(i)	(ii)	(iii)	(iv)	(v)
	I	362.5 Kg	350 Kg	525 Kg	462.5 Kg	487.6 Kg
	II	425 Kg	600 Kg	625 Kg	287.5 Kg	525 Kg
	III	512.5 Kg	275 Kg	375 Kg	237.5 Kg	512.5 Kg
	IV	212.5 Kg	325 Kg	312.5 Kg	225 Kg	337.5 Kg
	V	425 Kg	487.5 Kg	476 Kg	475 Kg	475 Kg
C						D

Table 3: Carbon storage of peatland at each 5m x 5 m grid.

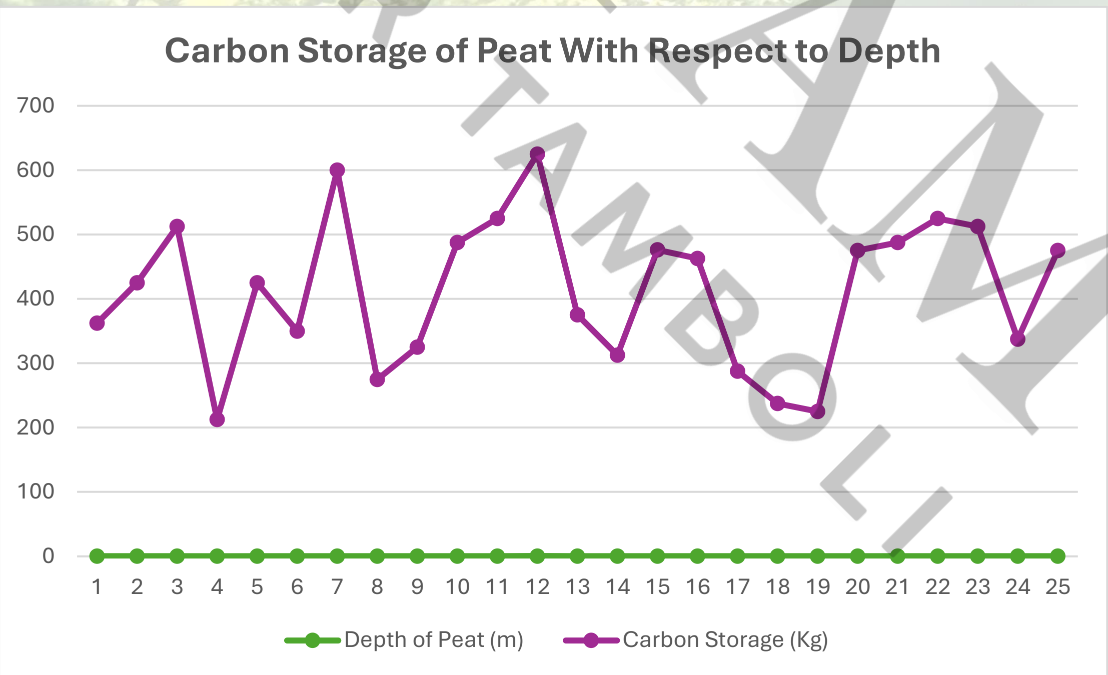


Fig: 7: Graph showing carbon storage of peat with respect to depth.

Considering Table 3, the Total Peat Carbon storage of 20 x 20 m grid in the study area = 10,312.5 Kg. As per Fig 7, significant variations in peat depth, water saturation levels, and vegetation density could be the cause of the variation in the data of carbon storage across the grid. This has also been pointed out by (Blodau, 2002). They also discussed that peatlands are degraded because of drainage issues, changing land uses, and climate change, which has a major negative influence on the ecosystem and carbon loss. Drainage speeds up breakdown rates and releases stored carbon as CO2 and methane by disturbing the wet conditions necessary for peat buildup. Peatlands' ability to absorb carbon dioxide is threatened by degradation, which also increases greenhouse gas emissions and exacerbates climate change. Changes in land use, such as switching to forestry or agriculture, disrupt peatland ecosystems and increase carbon leakage by removing plants and disturbing the soil.

6. Recommendations:

Based on the degradation status and observed carbon storage, the following measures are recommended:

1) Large Scale Testing: Due to limited time and resources, a grid of 20m x 20m was considered which cannot represent the status of the entire peat bog of Burrator's peatland. Hence large-scale testing using larger areas of multiple grids in different locations of the study area is recommended.
2) Hydrological Restoration: Restoring proper water levels is a critical stage in the rehabilitation of peatlands. One method is to elevate water levels by blocking drainage ditches. This can help prevent peat from drying out and oxidizing, which lowers CO2 emissions and promotes the regrowth of characteristic bog flora like sphagnum mosses (Rochefort et al., 2003). This step may look counterproductive considering the submerged condition during the site visit. However, due to climate change, the UK is facing dynamic weather conditions. The record-breaking summer in 2022 is an apt example of that. (Met Office, 2023). Hence, to maintain a static water level in the peat bog, the hydrological restoration will be a considerable option.
3) Nutrient Management: Even though peatlands normally have low nitrogen levels, careful phosphorus management can help plants reestablish themselves without encouraging invasive species. Based on preliminary soil tests, phosphorus supplementation should be

carefully assessed to make sure it helps the native vegetation without causing eutrophication or unfavourable changes in the plant community. (Sottocornola, Boudreau & Rochefort, 2007)

7. Conclusion:

This consultancy report reveals that Burrator's Peatbogs play a pivotal role in carbon storage, yet they face significant challenges due to degradation. The rigorous field data and laboratory analyses presented here show substantial variability in carbon storage across the peat bog. This variability is primarily influenced by peat depth, water saturation levels, and vegetation cover. Further insights from the humification index indicate varied levels of organic matter decomposition, with higher values suggesting more advanced decomposition and reduced potential for future carbon sequestration.

The findings emphasize the complex interactions between environmental factors and peat quality, which are critical in assessing the peatland's carbon sequestration capabilities. Given the ongoing impacts of climate change, the recommendations for large-scale testing, hydrological restoration, and strategic nutrient management are crucial. These measures are aimed at enhancing the resilience and functionality of the peatland, ensuring its effectiveness as a carbon sink.

Underscoring the significance of peatlands in global climate mitigation initiatives, this research helps local conservation efforts and makes a substantial contribution to the larger understanding of peatland dynamics. For peatlands like Burrator's to continue playing a vital role in the worldwide cycle of carbon and to counteract the negative consequences of climate change, management and restoration efforts must be sustained.

8. References:

1. Blodau, C., 2002. Carbon cycling in peatlands: A review of processes and controls. Environmental Reviews, 10, pp.111-134. Available at: https://doi.org/10.1139/A02-004.
2. Blodau, C., Basiliko, N. & Moore, T.R., 2004. Carbon turnover in peatland mesocosms exposed to different water table levels. Biogeochemistry, 67(3), pp.331-351. Available at: https://doi.org/10.1023/B:BIOG.0000015788.30164.e2.
3. Cairngorms Connect, 2024. Role of Sphagnum Mosses in Peatland Restoration. Available at: https://cairngormsconnect.org.uk/news/role-of-sphagnum-mosses-in-peatland-restoration [Accessed 15 May 2024].
4. Met Office, 2023. Record breaking 2022 indicative of future UK climate. Available at: https://www.metoffice.gov.uk/about-us/news-and-media/media-centre/weather-and-climate-news/2023/record-breaking-2022-indicative-of-future-uk-climate [Accessed date].
5. National Park, 2024. South West Peatland Partnership. [online] Available at: https://www.dartmoor.gov.uk/wildlife-and-heritage/our-conservation-work/the-south-west-peatland-project [Accessed 14 April 2024].
6. Rochefort, L., Quinty, F., Campeau, S. et al., 2003. North American approach to the restoration of Sphagnum dominated peatlands. Wetlands Ecology and Management, 11, pp.3-20. Available at: https://doi.org/10.1023/A:1022011027946.
7. Sottocornola, M., Boudreau, S. & Rochefort, L., 2007. Peat bog restoration: Effect of phosphorus on plant re-establishment. Ecological Engineering, 31, pp.29-40. Available at: https://doi.org/10.1016/J.ECOLENG.2007.05.001.