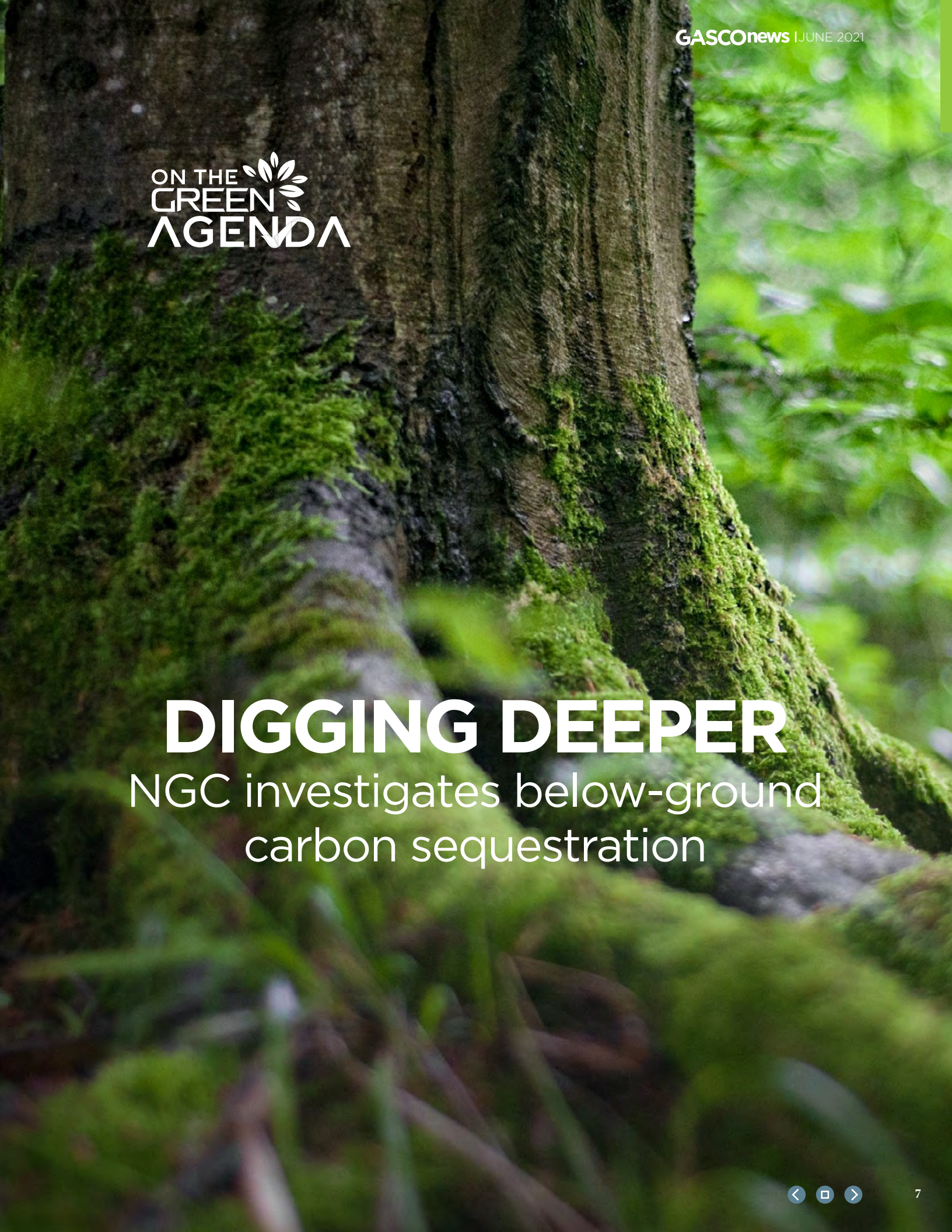

DIGGING DEEPER

NGC investigates below-ground carbon sequestration

ON THE GREEN AGENDA

IMAGES OF TREE SELECTION, SITE PREPARATION AND ROOT BIOMASS BEING WEIGHED

> Trees are widely recognised as important carbon sinks, with a big role to play in the carbon mitigation strategies of the future.

Earlier this year tech giant Elon Musk launched a competition with a US$100 million cash prize, to be awarded to the inventors of the best scalable carbon capture technology. Of the hundreds who reacted to his announcement on Twitter, many offered up the same million-dollar idea as one user who declared: "I have invented a concept called planting trees. Where do I send my bank details?"[1]

Trees are widely recognised as important carbon sinks, with a big role to play in the carbon mitigation strategies of the future. However, the climate fight is in many ways a numbers game — balancing carbon outputs and offsets, to slow the net rise in greenhouse gas (GHG) levels, and the pace of global warming. This means that we need accurate assessments of both our emissions and the mass of carbon we subtract through capture and sequestration.

We know that trees store carbon, and we have good estimates of how much they sequester, but those figures vary according to species, age, climate, soil and geography. In light of this, there is merit in conducting region-specific studies to determine how much carbon is sequestered by trees in a particular area. This can not only help countries more accurately gauge how much of their carbon footprint is offset by trees, but it can guide them as to which species might work best for future carbon capture in their local context.

In 2018, NGC partnered with The University of the West Indies (The UWI) on a project with those goals in mind. After planting 315 hectares of trees in the NGC Reforestation Programme, the Company decided to investigate the carbon impact of the exercise, looking initially at above-ground biomass at project sites. In 2020, The UWI was engaged once more to quantify the carbon stored below ground at those sites, and generate a more holistic picture of the programme's impact.

[1] https://twitter.com/elonmusk/status/1352392678177034242

Programme background
In 2005, NGC launched a reforestation exercise to replant an area of forest equivalent to the acreage cleared for construction of the Cross-Island Pipeline, Beachfield Upstream Development and Union Industrial Estate. This project was aligned to the Company's policy of achieving 'no net loss' from business operations. With the guidance of the Forestry Division, the project was executed in seven (7) phases across sites in the south-west and south-east forest conservancies: Rousillac, Guapo-Parrylands, Moruga, Rio Claro and Mayaro. Over 100,000 saplings were planted, including 17 different species of fruit and tropical hardwood trees.

At the close of the seventh project phase in 2018, a team from The UWI, led by Professor John Agard, was contracted to calculate the tonnage of carbon sequestered by the trees planted since the start of the programme. They were also asked to estimate the tonnage that would be sequestered by the year 2030, and the value of that carbon at prevailing market prices.

The scope of the 2018 study was limited to the carbon held in the above-ground biomass (AGB). Height and diameter of trees were measured in sample plots, and wood core samples were taken for lab analysis to determine the carbon-to-biomass ratio for each species. This data was combined with a remote sensing technique called Light Detection and Ranging (LiDAR), with which the heights of all trees at the project sites could be very accurately determined. The plot-level carbon data and the LiDAR tree height data were then used to develop mathematical models which estimated the carbon stored in the AGB of the trees planted.

Below-ground study
According to The UWI, existing scientific literature indicates that tree-root biomass is around 0.26 times that of shoot biomass. If roots account for one-fifth of a tree's total biomass, then a considerable quantity of carbon is sequestered underground.

NGC recognised that the above-ground carbon estimates from its initial study did not tell the whole story, so in 2020 the UWI team was asked to quantify the volume of carbon held below ground at NGC's reforested sites. This was the first study of its kind ever conducted in the Caribbean.

Despite having a formula for calculating below-ground biomass (BGB) from AGB, the team needed to verify that the ratio held true in the domestic context. A licence was obtained from the Forestry Division for a small sample of seven (7) trees to be felled to enable root excavation and weighing. This also allowed for sampling of root biomass to determine the carbon density. The felled trees were subsequently earmarked for donation to an NGC CSR partner organisation for woodworking projects.

The field measurements and lab analysis confirmed the ratio documented in previous studies. Accordingly, the team was able to calculate the BGB using the AGB data from the above-ground study, and thereafter revise the carbon estimates for NGC's Reforestation Programme to include the underground stores.

The results of the study are summarised in the table below.

TABLE 1. TOTAL CARBON ESTIMATE IN 2020 FROM TREES PLANTED BY NGC

SAMPLE PLOT LOCATION	CARBON ESTIMATES FROM NGC-PLANTED TREES		
	Above-Ground Carbon estimate (kg)	**Below-Ground Carbon estimate (kg)**	**Total Carbon estimate (kg)**
Rousillac	1,785,891	464,330	**2,250,222**
Moruga	339,953	88,388	**428,342**
Mayaro	164,029	42,648	**206,677**
Rio Claro	125	33	**158**
TOTAL	**2,289,998**	**595,366**	**2,885,399 or 2885 Metric Tonnes**

ON THE GREEN AGENDA

Per the scope of the study, the team also projected how much carbon would be stored up to the year 2030, as the trees continue to grow and mature. The tonnage of carbon was converted to its carbon dioxide equivalent, and a market value given.

The study revealed that as at 2020, NGC's trees had sequestered approximately 2,885 metric tons of pure carbon, or 10,589 metric tons of carbon dioxide. At a market price of €39.28 per metric ton, that CO_2 was valued at €415,946 (just under TTD$3.5 million). Estimating conservatively into the future, those numbers increase more than sixteen-fold by 2030.

Study implications
NGC's carbon sequestration study is a ground-breaking effort by a local company to quantify the carbon impact of one of its interventions. When the above-ground results were first shared in 2019, they attracted attention from as far afield as Fiji.

The Inter-American Development Bank and the National Aeronautics and Space Administration (NASA) even made contact with The UWI team to discuss lessons learned as they try to develop a project along similar lines to measure blue carbon (i.e., coastal mangrove sequestration) in the Caribbean. With the results now expanded to include below-ground carbon stores, this has become an even more valuable benchmark study to guide regional and international projects.

Implications for national forests
According to the World Bank, around 44% or 226,000 hectares of Trinidad and Tobago's land space lie under forest.[2] NGC's reforestation project sites represent just 0.1% of that area.

[2] https://tradingeconomics.com/trinidad-and-tobago/forest-area-percent-of-land-area-wb-data.html

NGC's data cannot be extrapolated to calculate the carbon stock held in national forests because the age and species of trees affects how much carbon they sequester. However, there is no doubt that the national forest carbon stock is hundreds of times greater than that of NGC's planted trees. As our country works to bring emissions down by 2030 in line with Paris Agreement commitments, it should be evident that sequestration by natural forest is a major offset to consider in our carbon accounting. That said, we will need to know what the real numbers are. NGC's study demonstrates the value of conducting similar investigations at the broader national level, and gives a template for how it can be done. It also provides evidence to justify investment in national reforestation programmes.

Contribution to future research
A key takeaway from this study for researchers who might wish to replicate it in the future, is that the quantum of carbon stored in tree biomass can be determined using technology and scientific formulas.

Before the sample trees were felled for this study, The UWI team used side-scan laser technology to capture them in three dimensions to scale. The above-ground volume was then calculated and converted to weight using special software.

After they were cut, the trees were weighed using conventional equipment, and the results compared against the computer-generated figure. The computer-estimated weights were close enough to the actual weights to support the conclusion that laser scanning can reliably estimate tree weights. The study also confirmed the root-to-shoot biomass ratio of 0.26 which was cited in previous research. These findings effectively eliminate the need to fell trees in future investigations of above and below-ground carbon stores.

Value of young trees
Another takeaway from this research is that younger trees sequester carbon at a faster rate. Looking at the numbers for the Rio Claro sites, planted between 2014 and 2017, versus Rousillac sites which have

YOUNGER TREES ARE PROJECTED TO STORE MORE THAN **70,000 TIMES** THE CARBON THEY DO TODAY BY THE YEAR **2030**, COMPARED TO A SIX-FOLD INCREASE FOR THE OLDER TREES.

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TABLE 2: PROJECTED ABOVE & BELOW GROUND CARBON THAT WILL BE SEQUESTERED BY TREES PLANTED BY NGC AT ROUSILLAC, MORUGA, MAYARO AND RIO CLARO

ESTIMATED TOTAL CARBON SEQUESTERED

REFORESTATION SITE	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Rousillac (Grant Trace, Guapo Parrylands, Morne L'Enfer)	2,251	3,401	4,551	5,701	6,852	8,002	9,153	10,303	11,453	12,604	13,754
Moruga (Edward Trace)	428.3	1,579	2,729	3,879	5,030	6,180	7,331	8,481	9,631	10,782	11,932
Mayaro	206.7	1,357	2,507	3,658	4,808	5,959	7,109	8,259	9,410	10,560	11,711
Rio Claro	0.158	1,151	2,300	3,451	4,602	5,752	6,902	8,053	9,203	10,354	11,504
TOTAL carbon sequestered (metric tons)	2,885.4	7,488	12,087	16,689	21,292	25,893	30,495	35,096	39,697	44,300	48,901
Total CO_2 = Total Carbon x 3.67	10,589.2	27,481	44,359	61,249	78,141	95,027	111,917	128,802	145,688	162,581	174,467
Approximate value at EUA spot price39.28 (€) per Tonne CO_2	415,946	1,079,454	1,742,422	2,405,861	3,069,378	3,732,661	4,396,100	5,059,343	5,722,625	6,340,659	6,853,064

trees over 14 years old, we see that the younger trees are projected to store more than 70,000 times the carbon they do today by the year 2030, compared to a six-fold increase for the older trees.

Since carbon is stored in biomass, trees tend to accumulate more carbon during the growing phase. This supports the widely-held belief that planting trees is a good way for our time-pressed planet to remove carbon from the atmosphere. NGC's carbon sequestration study now forms part of an extended programme called 'Beyond 315', through which the Company is looking to expand its initial reforestation project. Among the objectives of this programme will be knowledge-sharing to encourage other entities to invest in tree-planting exercises on an equal or even larger scale. It will also include training and empowerment of members of the site communities to develop entrepreneurial ventures based on sustainable forest management.

Natural technology

NGC continues to demonstrate its deep commitment to sustainability and climate action with a variety of carbon mitigation projects. In recent months, the Company began to leverage infrared and satellite technology to track methane emissions from its infrastructure; entered into a partnership with the University of Trinidad and Tobago for the execution of a Climate Change Mitigation Project; entered the green hydrogen and solar energy space with subsidiary National Energy; launched a consumer-targeted app Energy SmarTT to raise awareness around energy efficiency; and introduced drone technology and smart reporting to reduce the carbon footprint of field operations.

The NGC Reforestation Programme and pioneering carbon sequestration study are part of this broad and impactful portfolio of initiatives. As NGC has shown, while it may not be cutting-edge technology, reforestation is a proven-effective carbon capture solution we can readily mobilise and scale up. The humble tree belongs on the frontline of the climate fight, and we need as many of them as we can get. ■