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Notes and Comments

Preserving *Mauritia flexuosa* L.f. (Arecaceae) ecosystems during Guyana's first oil boom

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In recent years, Guyana has made one of the world's most significant oil discoveries, boosting its economy fourfold. Globally, economic development has contributed to increased levels of greenhouse gases, and like most developing countries, Guyana may be at risk of prioritizing monetary gain over development that is environmentally sustainable. *Mauritia flexuosa* L.f. (Arecaceae) is one the most common palm species that grows in extensive stands (cananguchal and morichal ecological systems) throughout tropical South American peatlands (as well as Trinidad), and may be capable of reducing the impacts of greenhouse gases (GHGs) at the regional level. *Mauritia flexuosa* ecological systems do this by storing carbon (the most abundant GHG) belowground within their waterlogged environs, in the form of peat deposits. Atmospheric carbon is absorbed by *M. flexuosa* palms and plants growing at the surface, via photosynthetic carbon assimilation, and then accumulates in the substrate as a result of the waterlogged conditions preventing aerobic decomposition and thus the consequent release of the organic carbon held in dead plant matter. Ecological managers and policy-makers should, therefore, be made aware of the importance of these ecosystems in the global carbon balance and climate change mitigation.

Forest vegetation covers over three-quarters of the land area of the Guianas (Raghoenandan, 2000) and constitutes one of the few remaining tracts of tropical primary rainforest left on the planet (Mittermeier et al., 1998). Flooded forests (1.12%); swamp forests—open canopy with palms (0.03%); flooded savannas (1.81%); and open savannas (1.97%) cover approximately 5% of the total land area of South America (17,778 300 km^2) (Eva et al., 2004), and are known to be very efficient ecosystems, due to their capability of mitigating global warming through absorbing carbon dioxide and nitrous oxides from the atmosphere and storing them in belowground biomass (Bhomia et al., 2019; Draper et al., 2014, 2018). *Mauritia flexuosa* ecosystems in the Guianas account for over 2.5% of its total area (approximately 450,000 km^2) (Ruokolainen et al., 2001) and can sequester large volumes of atmospheric carbon (Hergoualc'h et al., 2017; Trumper, 2009). Additionally, ecosystems that contain *M. flexuosa* in Guyana (i.e., palm marsh woodlands, flooded riparian forests, herbaceous swamps, and lowland savannas) have been identified as effective carbon sinks (Butt et al., 2015; Huber et al., 1995; ter Steege, 2001).

The first step in preserving Guyana's peatland and carbon stores is to recognize their international conservation importance (Page et al., 2011), both in the highlands (Zinck and Huber, 2011) and in the lowlands (Huber et al., 1995; Delprete, 2003). By acknowledging the Guianas' contribution towards mitigating against climate change (i.e., through forest conservation), these countries can be encouraged/motivated to conserve existing peatlands from commercial agriculture and commercial development (Roucoux et al., 2017; Ruokolainen et al., 2001). According to the Economic Commission for Latin America and the Caribbean (ECLAC), presently in Guyana, some expected impacts from climate change (as a result of anticipated agricultural activities, coastal developments and human settlements) involve an increase in sea-surface temperature and a reduction of freshwater resources (ECLAC, 2011). However, with the discovery of over 10 billion barrels of oil equivalent (Myers, 2018) and 32 trillion cubic feet of natural gas reserves (Krane, 2020), carbon dioxide emissions (generated from the extraction and burning of fossil fuels by Guyana industrial sectors) are expected to get close to 850 million tonnes from oil and 1.7 billion tonnes from natural gas reserves (Elias-Roberts, 2020; Kaieteur News, 2020), further threatening the global climate system. It is therefore critical for the government of Guyana to ensure that environmental laws are updated according to their vision 2040–Green State Development Strategy (GSDS), following the objectives of the UN 2030 Agenda for Sustainable Development (Elias-Roberts, 2020). Furthermore, the government should aim to understand the importance of *M. flexuosa* ecosystems as an effective way of mitigating GHG emissions through the conservation of *M. flexuosa* landscapes (Bhomia et al., 2019; Elias-Roberts, 2020; Kallweit, 2020; Lawson et al., 2015; van der Hoek et al., 2019; Virapongse et al., 2017).

Towards the aim of conserving *M. flexuosa* ecosystems, governments of the Guianas' are encouraged to use UAV-based (Unmanned Aerial Vehicle) RGB (Red, Green and Blue) orthomosaic imagery as a tool for identifying and quantifying the stands of these palms. With this tool, total areas of potential peatland and carbon stores within the Guianas can be mapped and quantified

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(Hergoualc'h et al., 2017; Lawson et al., 2015; Tagle Casapia et al., 2020), and can also provide evidence for the enforcement of environmental laws aiming to protect biological diversity and conserve these ecosystems against the threat of onshore petroleum projects (Elias-Roberts, 2020).

Mauritia flexuosa is a hyperkeystone species that plays an essential role within the range of ecosystems named above. At a regional scale, *M. flexuosa*-dominated peatlands (Ité palm marshes—Guyana; palmier bâche marais—French Guiana; maurisie zwampbos—Suriname; buritizal—Brazil; cananguchal—Colombia; Aguajals—Peru; moretals—Ecuador; palma real swamps—Bolivia; morichales—Venezuela and Trinidad) have high ecological value to wildlife, as they provide multiple types of resources (food, nest sites, habitat) for over 900 vertebrate species; 28 of which are threatened species (van der Hoek et al., 2019). At the local scale, *M. flexuosa* palms are referred to as the 'tree of life' by many indigenous communities as they provide a wide range of products (e.g. juices, candies, flour, edible larvae [Otocumba], hammocks, chairs, thatch [tibisiri], clothes, canoes, bridges, planks, jewellery, cosmetics, warishis [backpacks], carpets, baskets, toys, medicine and ceremonial objects), and services (e.g. windbreaks, hunting grounds, recreation and religious activities) for many villages (Arneaud, 2018; Arneaud et al., 2017; Martins et al., 2012). Still, very little is known about the ecology, livelihood value, and management of *M. flexuosa* palms in the Guianas (Virapongse et al., 2017); especially, within the permanent wetland regions of Guyana.

Mauritia flexuosa ecosystems also support marine primary productivity. The Caribbean Province (during the summer) is responsible for sequestering some of the highest levels of carbon dioxide from the Atlantic Ocean, over 40 gigatonnes of carbon per year (Gt C yr^{-1}) (Kulk et al., 2020). Some of these productive marine provinces are supplied with nutrient-rich waters originating from *M. flexuosa* ecosystems (Echezuría et al., 2002; Klotz et al., 2020; Kulk et al., 2020). It is therefore critical to understand the role of *M. flexuosa* ecosystems in mitigating global carbon emissions, and the interrelationship between landscape and seascape carbon sinks.

With so many potential negative impacts of global climate change, the government of Guyana needs to ensure that environmental protection laws preserve *M. flexuosa* peatland ecosystems and their associated carbon stores. Ecological managers and policy-makers should, therefore, use evidence-based research findings to identify and fill gaps in knowledge and environmental policies (similar to Hernández-Valencia et al., 2018). This can be achieved by improving ecological impact assessments and finalizing strategic planning principles (i.e., based on government legislations which mandate the country's growth and development towards a greener economy) to ensure that ongoing economic development/activities resulting from the oil boom are performed in an environmentally sustainable way.

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