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Connecting Innovative Eco-Entrepreneurship Model and Sustainable Nature-Based Solutions to Advance Climate Action, Biodiversity and SDGs †

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Abstract: The state of climate emergency threatens oysters, which are species that provide immense development–environment benefits in the world's coastal regions, including the global south. Currently, extreme climate change combines with toxic chemicals to alter ecosystem services by 70%, resulting in oyster decline, habitat shifts, school dropouts, poverty and ecological job loss. This poses complex transformative challenges for the UN Sustainable Development Goals (SDGs). In response, GreenOyster Opportunities for Development (GOOD) integrates a GOOD Eco-Entrepreneurship Model (GEEM) into oyster conservation as a Sustainable Nature-based Solution (SNbS) for providing food and scientific ecotourism services. This article succinctly elaborates the GEEM-SNbS concept and theory of sustainable change in favour of the SDGs and to inspire in-depth research into SNbS financing, new carbon policies and reframing biodiversity conservation and sustainability actions.

Keywords: sustainability; eco-entrepreneurship; GEEM; SDGs; SNbS; oysters; climate action

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1. Introduction

The UN Sustainable Development Goals (SDGs) are optimistic foresights for good Anthropocene futures [1,2] and, as such, must be publicly defended, sustainably financed and politically reactivated. It is not surprising that the urgency to achieve the SDGs, within the next 10 years, to unleash sustainable well-beings to reach everyone is becoming competitively intense among nations through the SDG indexing [3]. Although the roadmap to realise SDGs is still open, the journey to the 1.5 °C world envisioned by the Paris Agreement is full of polycomplex socio-ecological and legal setbacks mainly attributable to the overheating of the Earth's climate (sub-)systems, about which scientists, experts and climate activists have given repeated warnings [4–9].

The tragedy is that over 6000 published studies revealed that the outcome of climate mitigation ambitions from all nations amounted to 52–58 $GtCO_2eq\ yr^{-1}$ by 2030, which would not 'limit global warming to 1.5 °C' [10] (p. 18). As revealed by the Club of Rome, IPCC and researchers, the atmospheric CO_2 at 400 ppm is over the limits and has irreversibly damaged the planetary boundaries [11] and global and regional economies [12,13] in excess of US$11 trillion [14]. The World Economic Forum predicts the extinction of 200 species annually and the loss of 10% of GDP due to climate disasters in the US before the 21st century ends [15], and The Economist indicated a dangerous destabilising of Amazon biodiversity assets across tipping points [16]. Also, carbon-induced instability has exacerbated social vulnerabilities, insecurities and inequalities [14,17], which are inversely driving sustainable development [18,19]. An increased search for a remedy raises the importance of nature-based solutions for realising the SDGs [20,21].

In rapidly peri-urbanising savanna coastscapes of West Africa [22] and vast corridors of the world's coastal regions, including North America, India and the Arabian Gulf [23,24],

meeting 100% of the SDG targets to usher in sustainable futures is not possible without utilising climate-smart and nature-based solutions to wisely harness, enrich and sustain coastal bioresources, especially oysters. Oysters provide substantial restorative environmental benefits by removing nitrogen [25,26], thus, enriching reef habitats [27] and the daily filtering of 100–200 litres of water [28]. The harvesting and trading of oysters constitute a booming industry that furnishes food, employment, shelter and socio-cultural needs. Oysters are medicinal and nutritiously rich in protein, amino acids, Vitamin B12, magnesium and zinc [24,28–31] for combating acute malnutrition (SDG#2).

Balanced oyster diets (SDG#3) saved the lives of impoverished children who could have starved or died during COVID-19 mandatory lockdowns. Extreme climate change combined with the high utilisation of toxic chemicals considerably to alter ecosystem services by up to 70%, resulting in reduced oyster populations, ecological job loss, poverty, child labour and youth migration. At times, no oysters are harvested, thereby, limiting livelihoods [32]. Local divers often see dead oysters washed offshore (Figure 1b). In some communities, oysters have either gone extinct or migrated to deeper hydrospheres.

(**a**) (**b**)

Figure 1. (**a**) Freshly harvested oysters ready for head-carriage to a local market. (**b**) A scene of dead oysters washed offshore observed through a rapid action on an early morning at 7:45 a.m. (GMT) at Agorta Bay, near Soga City in the Lower Volta Basin.

Despite the fact that oysters have been academically studied for various scientific reasons—for example, being a vector for alien species [33], salinity [34], nitrogen reduction [35], usage as an ancient tool [36]—the sustainability and eco-entrepreneurship sides of the oyster value chain have been grossly neglected. The eco-enterprise mindset is muted about this in the literature and policy.

Recently, the GreenOyster Opportunities for Development (GOOD) integrated a GOOD Eco-Entrepreneurship Model (GEEM) into oyster conservation as a Sustainable Nature-based Solution (SNbS) to provide food and scientific ecotourism services to meet varying sustainability needs. GOOD's uniquely dynamic approach involves introducing green energy technologies and a carbon compensation scheme, digitalising and transforming the oyster economy, recycling oyster shells and rolling out a Community Sustainability Improvement Savings and Loans (CSISL) to connect local beneficiaries to a Sustainability Learning and Improvement Platform (SLIP).

In navigating the GEEM-SNbS theory of sustainable change, this paper uses realistic information from rapid action engagements, start-up actions and preliminary observations from the estuary of the Volta River in Ghana to outline the challenges, prospects and strengths associated with an enterprising SNbS start-up that integrates GEEM. New opportunities for enabling the GEEM-SNbS to intervene in climate emergency (SDG #13), poverty (SDG#1) and biodiversity loss (SDG #14 and #15) to accelerate massive socio-ecological improvements are highlighted, including trailblazing the computation of the sustainable capital value (SCV) of cash valued species (CVS) through CSISL. This stimulates

understanding, future research into the GEEM-SNbS nexus, SNbS financing and sparks fresh discourses into how GEEM can strategically refoster science–business–academic partnerships (SDG #17) towards maximising SNbS for sustainability and SDGs.

2. GEEM-SNbS Concept and Theory of Sustainable Change

In pre-industrial era, conservation was conceived as one-sided with no regard for sustainability. However, as the significant science of sustainability continues unstoppably rising [37,38] and the pressurised mission to achieve SDGs is mounting, the notion of conservation is changing universally. Now, the approach to biodiversity conservation and other nature-based solutions should be three-dimensional in order to be responsible, profitable and sustainable; where sustainable means all the three key components of sustainable development described in the Brundtland Commission Report are heeded and carefully streamlined into designing, planning, implementing and evaluating actions.

Here is where the GEEM-SNbS theory of sustainable change advantageously comes in. As brilliantly defined in [39] (p. 1), nature-based solutions are 'solutions to societal challenges that involve working with nature'. This easy-to-understand definition does not entirely differ from the meaning of the SNbS. In the sense of sustainability, the interest in SNbS is not only about the extent nature-based projects can lessen climate impacts or repair damaged nature but also in innovatively tapping income from within and for Extremely Low-Income Communities (ELICs) to sustain implemented SNbSs.

The GEEM model, published [poster format] by the Nature-based Solutions Initiative based at the University of Oxford in July 2020 (see Figure 2), is conceptualised and meticulously packaged to function on the premise of a "sustainable value chain" of species with an existing cash value in deprived rural areas, informal settings and communities emerging from natural disasters, pollution, locust invasion, hazards, displacements, climate conflicts and humanitarian emergencies. Since the species in question are cash valued, the (in)direct emissions of greenhouse gases (GHGs) either through transportation, manufacturing or land-use is inevitable.

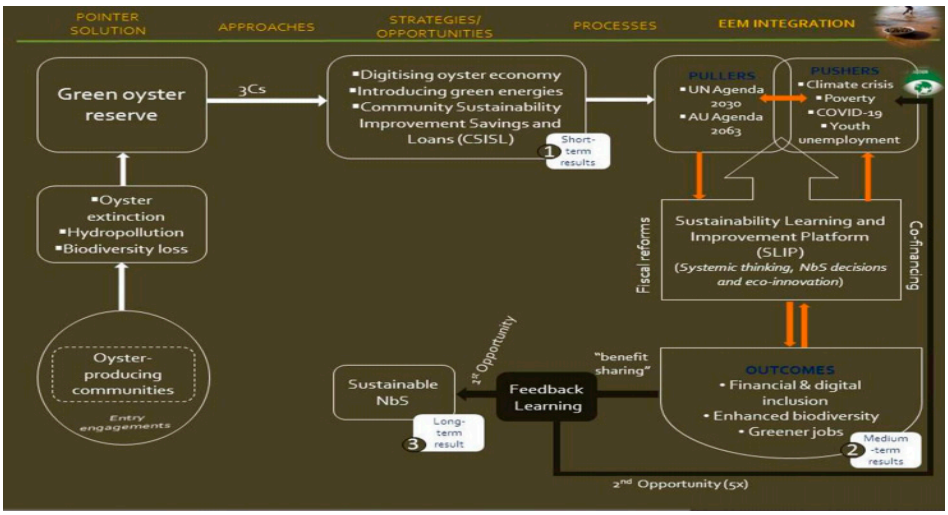

Figure 2. A diagram of the GEEM-SNbS nexus.

As a result, this model is formulated with a community-based oyster reserve as a pointer solution in mind for greening oyster ecologies, industries and empowering ELICs to minimise extinction, GHGs and to decouple microplastic pollution from oyster production and consumption. GEEM works by mobilising local resources, groups and institutions to implement varied interventions, including shifting attention from biomass energy to prevent mangrove deforestation. GEEM triangulates the SNbS knowledges generated from the SLIP to inspire active participation in oyster conservation, SDG action, awareness creation against child labour and the removal of microplastics from estuaries.

Normally, biodiversity conservation and other green projects at the grassroots level depend 100% on external funding. Most of the external project-based finances may be too restrictive or suddenly removed [40] as recently suffered under the period of COVID-19. The coronavirus pandemic negatively affected the sustainability of SNbS on the ground. Among countless challenges, a 'lack of finance is widely recognised as one of the main barriers to the implementation and monitoring' of nature-based solutions globally [41] (p. 8). Contextually, the GEEM is motivated to scan, diagnose and change this situation by removing barriers to create conducive conditions for local beneficiaries of SNbS to self-raise and spend at least 2% of net profit through a well-structured CSISL and associated sustainable investments to co-finance, sustain and own 'green shares' in conserved ecosystem services.

The central requirement of the model, therefore, is that the beneficiaries must be capable to earn income from a supportive ecosystem in sustainable means. In other words, a functional GEEM must generate greener revenue to create sustainable prosperity for all. GEEM is suitable for fauna and flora species that already have cash value (see a brief exposition in Section 3.3) in the natural or organically cultivated agri-environmental systems.

The examples of CVS are Theobrama cacao, Mangifera indica, Vitellaria paradoxa, Manihot utilissima, Anacardium occidentale, Elaeis guieneensis, mangroves, Citrus spp., tillapia, cotton, Cocos nucifera, Musa spp., Oryza sativa, snail, crab and shrimp. Hunting or harvesting of any species legally declared a crime is excluded. GEEM can also be applied in aggregate renewable ecosystems (i.e., combination of species in heritage and RAMSAR sites, parks, etc.) that support paying for ecosystem services, such as ecotourism. This means that the GEEM is replicable in marine and mixed terrestrial ecosystems at different places.

The model does not promote conservation by conventionally held business-as-usual wisdom. For that reason, GEEM relies on the sum of eco-innovation, system rethinking and SNbS decision-making interlinking 3Cs approaches (conservation, co-restoration and consumption) as explained in Table 1. The eco-innovation blends best practices, human values, digital technologies and new sciences through SLIP to enable primary and secondary beneficiaries to learn, decide and act on the sustainable use of oysters.

Table 1. GOOD 3Cs approaches.

3Cs Approaches	Understanding the Processes
Conservation	Conservation means enriching, conserving and protecting oysters and their ecosystems, including water and immediate land resources to increase and sustain benefits for people.
Co-restoration	Co-restoration means inclusive engagement and sustainable empowerment of all actors, social groups and authorised leaders for rehabilitating and repairing destroyed oyster habitats.
Consumption	Consumption means using low-carbon methods and technologies to commercially produce organic oysters, greenly process and distribute fresh oysters, shells and other by-products through approaches that are not harmful to human health and the coastal environments.

Source: Author.

3. Sustainability Learning and Improvement Platform (SLIP)

GEEM drives best on an immersive learning and practising wheel called SLIP. SLIP is a pivotal heart of the GEEM innovation. It creates a rotational circuit that function 24 h within the GEEM framework to reconcile and deal with trade-offs, risks and gamut of socio-planetary boundary issues ranging from extinction, child labour, gender inequality, behaviours, benefit-sharing to conflicting synergies until sustainability improves and synchronises across systems, institutions and sectors to move forward the SDG agenda. Here is where the SLIP highlights changing contents, evidence and services of the SNbS to be thoroughly discussed and assessed and therein ensures that confusions are clarified to repel disinformation about conservation issues, beliefs and bylaws. How to support child labourers back to school and to prevent future school dropouts are collectively deliberated.

A stronger basis why seeding trust, soft and positive human values among beneficiaries is treasured by SLIP component of the GEEM.

The key reasons underlying SLIP are to improve relationships between humans and nature, expand opportunities, nurture cooperative spirit and identify system change needs for incorporating in empowerment and coaching of individuals and youth groups with less capacity to efficiently integrate *Brundtland principles* into implementing low-carbon livelihoods and oyster conservation activities. The activities are intended channels to bring-in better well-beings and to network with and mentor young actors to actively participate in oyster habitat enrichment—for example, replanting mangroves. To succeed, SLIP provides new skills, competencies and instruments to equip beneficiaries to become agents and stewards of the oyster ecosystems.

This is done by gathering appropriate knowledge from indigenous and scientific domains and translating this into meaningful actions [42], such as boosting oyster restoration. For strengthening social inclusivity, women and diverse actors regain their voices from the SLIP learning subspaces to freely exchange new ideas and inventions with scientists, leaders and all actors on pressing climate matters, prices, access to finance or input regulations. In the exchange processes, helpful tools could be adopted to monitor and evaluate oyster conservation progress. Thus, SLIP relies on organically blended layers and levers of sustainability strategies and actions (see Figure 2) to enable SNbS to intervene in biodiversity, climate and COVID-19 crises.

The SLIP allows for the transfer of greener energy technologies and friendly web tools to transition from fossil-fuel to renewables, promote good health, digital inclusion and literacy in support of the six major transformations and the six social tipping interventions comprising norms and values necessary for realising the SDGs and Paris Agreement [4,18]. (Re-)setting goals regarding real-life issues is the shared responsibility of the participants in the CSISL and SLIP, which permit peer-learning and aligning the GEEM services to all the 17 SDGs.

3.1. Community Sustainability Improvement Savings and Loans

CSISL is an add-on savings and lending strategy of the GEEM targeting over 4500 oyster processors (women), retailers (girls) and divers (men) in the initial phase. The major feature that differentiates CSISL from other local financial networks is the sustainability criteria added at the SLIP—for instance, SNbS decisions and removal of emissions from land-uses. Another merit is that the CSISL flexibly insists on low-carbon sources of incomes. In practice, the CSISL promotes only SNbS services, which are deliberately designed for decarbonising the oyster economy and fostering the transition out of all land-use GHG emissions, broadly estimated between 2007–2016 to be '12.0 $\pm$ 3.0 Gt CO_{2e} yr^{-1}, includes CO_2, CH_4 and N_2O' with a 'net emissions of 5.2 $\pm$ 2.6 Gt CO_{2e} yr^{-1}' from deforestation [41].

CSISL was tried on a microscale with US$ 1000 (Lended Amount—LA) that remarkably yielded 89.5% Actual Recovery (AR) success within an agreed 180 days at GEEM Interest Rate (GEEM IR) of 5% (see Figure 3) as compared to an Open Market Interest Rate (Open Mt IR) of over 25% in the first half of 2021. Once sustainability has improved, it is expected that the 5% interest rate will further reduce [43], thereby, enabling more people, predominately vulnerable women to emerge out of SDGs #1 and #2. The remaining 9.5% of the loan was retrieved after 6 months.

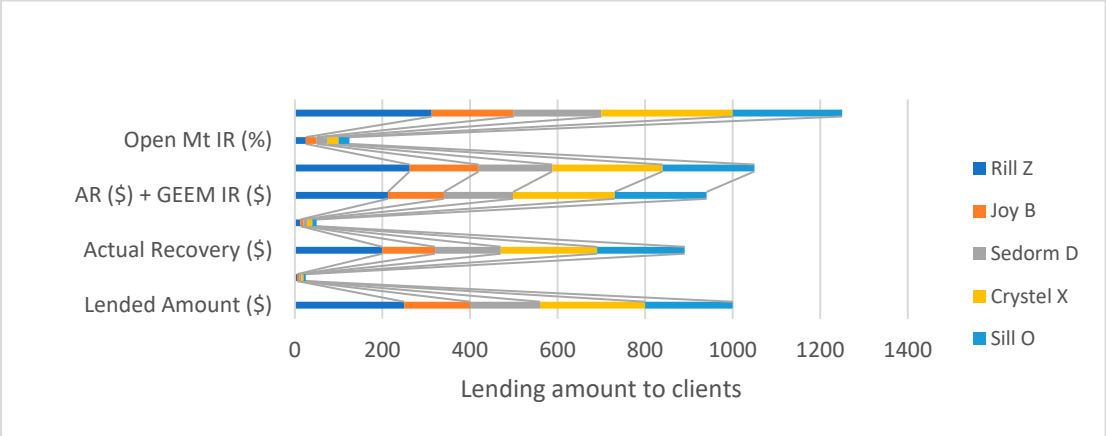

Figure 3. CSISL recovery outlook.

3.2. CSISL Grand Challenges

The CSISL was confronted with three top risks that tilted smooth piloting. First, the deadly COVID-19 pandemic shattered client engagements and field monitoring. Secondly, unstable microclimatic conditions spirally triggered by the West African monsoon disrupted water flows at the downstream of the Volta River that led to reduced oyster catch, thus, weakening the financial capacity of divers to willingly contribute to the CSISL. Thirdly, organising focus meetings as enshrined in the *green codes and ethics book* of the SLIP was halted because the oyster value chain was not digitalised to ease communication. Thus, digitalising the indigenous oyster economy was proposed and fed into feedback learning and backcasting (see Figure 1).

3.3. Determining Sustainable Capital Value (SCV)

SCV is imperative for assessing the extent that SNbS action can meaningfully improve the lives of people by reducing poverty and hunger and by helping CSISL members to mobilise finance to fully or co-run SNbS services. This is a strong basis for why it is advisable that the species underlying the SNbS action must have a cash value if the GEEM is to be successful.

$$\begin{aligned} \text{SCV (Aggregate)} &= \$SG_p \times C_1 \times C_2 \div (\text{RLC i.e.GH¢}/5.2) \times 12 \\ \text{SCVx Individual (Annually)} &= \text{SCV} \div (C_1 \times C_2) \\ \text{SCVy Individual (Monthly)} &= \text{SCVx} \div 12 \\ \text{SCVz Individual (Daily)} &= \text{SCVy} \div 30 \\ \text{Final value} &= \text{SCVz} \times \$1.25 \end{aligned} \quad (1)$$

where SCV = sustainable capital value; C_1 = number of CSISL members known here as 30, which ideally cannot be less than 20 due to operational and other costs initially; C_2 = number of CSISL groups, which is known here as 150; and RLC = recapitalised local currency, which is represented here as GH¢5.2 = $1 for Ghana. For other countries, substitute the GH¢).

To calculate a SCV, a Green Share Price (GSp) must be chosen in US$ to reflect the cash value of the species in question. The GSp should be equivalent to an amount a beneficiary is likely to invest in SNbS as a "share" (here, an Oyster Reserve). For example, to obtain GSp for oysters, $2000 was chosen. How much can it take to reduce poverty and, at the same time, help the CSISL members to give a token (an accruing "GSp") towards securing and sustaining an oyster reserve towards an ultimate goal of conservation?

The GSp must be recapitalised in a local currency for X, Y and Z values if an individual beneficiary subscribe to the CSISL and SLIP. Using Equation (1), the result of the GSp (i.e., $2000) gives a SCV in local currency as GH¢12.82. The GH¢12.82 must be multiplied by $1.25 to internationally standardise at $16.03, which is higher than the international poverty line and the national minimum daily wage of many developing countries. In

all circumstances, the final value for SCV must be positive, advisably higher than the international poverty line to be acceptable. A negative SCV is not advised.

3.4. GEEM-SNbS Start-Up Prospects for SDGs and Futures

- GEEM can enable 4500 divers, processors and retailers (i.e., 150 CSISL groups) to mobilise US$3,994,082.85 annually to co-finance oyster conservation assets.
- GEEM enables recycling of 1250 metric tonnes of oyster shells for utilisation as substrates in manufacturing eco-friendly products to enhance resource use efficiency.
- GEEM encourages deployment of renewable energy technologies to increase access to affordable and cleaner energy in the ELICs. It decouples air pollution and mangrove forest degradation from oyster value chain by shifting beneficiaries' focus from burning fuelwood and charcoal to solar energy. Thus, GEEM fights deforestation to boost biodiversity and is, thus, compatible with the REDD+ and biodiversity treaties.
- GEEM can deliver SDG and conservation messages to reach 1.5 million people.
- GEEM can support 600 divers to produce 1.68 billion organic oysters by 2030, translating into 300 decent jobs and an expanded green-blue economy.

3.5. Opportunities for Future Research

1. Assessing and responsibly digitalising the oyster economy to become a commercially inclusive and capable to accelerate biodiversity information sharing.
2. Researching how sustainable eco-entrepreneurship, legal and financial market regulations can be positively leveraged to aid fiscal flows and choices by the SNbS start-ups. How can youth-led SNbS start-ups access and transparently utilise funds?
3. Investigating the potential of GEEM in empowering SNbS start-ups to financially transform beyond pitching for $1000 into vibrant institutions capable to support the SDGs and other developmental agendas, such as the UN Convention on Biological Diversity.
4. Re-examining parameters for calculating SCV (see Equation (1)) for cash-valued species to inform scientific definition, planning and reframing conservation actions.

4. Concluding Remarks

The power of eco-entrepreneurship in enabling SNbS to be responsive and sustainable should not be undervalued. In this sense, the degree to which eco-entrepreneurship can decarbonise and transform the oyster value chain ought to be clearly comprehended and recognised in the context of the actual sustainable change needed to achieve the SDGs, poverty eradication, biodiversity richness and carbon neutral economies. Such a recognition should reflect the fact that a sustainable change is not an ordinary change. It is a nonlinear system change that exhibits precise characteristics of *Bruntland principles* or sustainability whether in the short, medium or long-term.

Thus, in connecting eco-entrepreneurial decisions through SNbS to sustainably conserve oysters within the larger coastal landscapes, the financial, social and environmental modes for turning around system change towards sustainability must be equally prioritised. GEEM illuminates this character by redefining and promoting sustainable finance of climate solutions, SDGs and ensuring consistent flows of financial and ecosystem services. While further investigation into how GEEM-SNbS can lead to long-term sustainable change and the sustainability of large-scale SNbS is strongly recommended, this model is relevant for incentivising and galvanising international public–private partnerships and sustainability actions from and for ELICs to catalyse socio-environmental transformation.

This is envisioned as a rapid transformation driven by science and partnership that continually supports the functioning of oyster ecosystems in greener and eco-inclusive manners for SDG advancement and sustainability. The striking sustainability milestones of the GEEM were its success in (i) raising the gender equality ratio in oyster conservation from zero to 60% in 1 yr and (ii) creating public awareness of oyster conservation, SDGs and extending socio-ecological sustainability knowledge to reach over 50,000 people. In sum, this article shines light on the GEEM-SNbS theory of sustainable change by re-echoing

that the model is indispensable in mobilising people and connecting eco-entrepreneurial innovations to successfully implement oyster conservation and SNbS towards advancing local and global efforts to achieve SDGs, biodiversity and climate action in sustainable ways.

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