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GreenPoints: A Gamified Platform to Democratize Carbon Credits for Small-Scale Plant Owners

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Abstract: ***Climate change mitigation requires participation beyond industrial-scale interventions. Traditional carbon credit systems emphasize large projects, excluding small contributors like farmers, rooftop gardeners, and plant enthusiasts. This paper proposes GreenPoints, a gamified platform enabling individuals to register plants, estimate their CO_2 absorption, and earn digital points. Agencies can aggregate these points for CSR reporting, while the model can evolve toward certified carbon credits for industries. The platform's goal is to increase awareness, incentivize plantation, and build a community-driven sustainability ecosystem.***

Keywords: Carbon Credits; Gamification; Sustainability; CO_2 Absorption; Digital Points; Community Engagement.

I. INTRODUCTION

Carbon credits emerged as market mechanisms to reduce greenhouse gas emissions by assigning a tradable value to emission reductions. However, access to verified carbon markets is limited for small-scale contributors. Despite the cumulative impact of community-level plantation, individual efforts remain invisible in formal registries. This work introduces GreenPoints, a digital platform that democratizes access by translating estimated CO_2 absorption into digital points, thereby motivating participation while creating a pathway to formal credit certification.

The main contributions of this paper are:

1) A role-based platform architecture connecting planters, agencies, and administrators;
2) A simple-yet-credible CO_2 estimation model mapped to points;
3) A data model suitable for scalable operation; and
4) A roadmap from awareness points to certified credits.

II. LITERATURE REVIEW

The global carbon credit system has matured significantly since the Kyoto Protocol (1997), yet accessibility for small contributors remains limited. Current literature highlights several approaches:

1) Pachama applies satellite imagery and machine learning for forest verification, but its scope is restricted to large reforestation projects [2].
2) Verra's Verified Carbon Standard (VCS) is one of the most recognized certification mechanisms; however, verification is costly and time-intensive, excluding small planters [4].
3) Climate Impact X, a global carbon exchange, provides a marketplace for institutional buyers but does not integrate micro-level contributors [3].

In addition to market mechanisms, technological interventions have been studied:

a) IoT-based monitoring: Low-cost sensors for soil, humidity, and growth have been demonstrated as effective for tracking plant health and carbon sequestration [10].
b) Blockchain: IBM and other research initiatives propose blockchain as a transparent ledger for carbon credit tracking [9].
c) Crowdsourcing: Platforms like iNaturalist demonstrate that distributed individuals can collectively create large-scale ecological datasets [11].

Gamification in sustainability is another relevant strand:

- Hamari et al. (2014) showed that gamification mechanics like leaderboards and points increased user motivation in eco-apps [6].
- Deterding et al. (2011) defined gamification as applying game elements in non-game contexts, emphasizing motivation and retention [5].
- Recent work in eco-gaming apps indicates that micro-rewards and digital tokens significantly increase participation rates, particularly among youth demographics.

From this review, it is clear that while strong verification systems exist at macro levels, there is no democratized framework that empowers individuals, small farmers, or gardeners to measure, validate, and monetize their carbon sequestration contributions. *GreenPoints* addresses this research gap through a gamified, community-centric platform.

III.PROPOSED SYSTEM

A. *Overview*

GreenPoints comprises three primary roles: Planter, Agency, and Admin. Planters, who may be individuals, farmers, or urban gardeners, register plants by providing details such as species, approximate age, photograph, and location. Admins review and verify these submissions to ensure accuracy and authenticity. Once validated, the system estimates the corresponding CO_2 absorption and awards points that are securely recorded in the Credit Ledger. Agencies, including NGOs or organizations, access aggregated dashboards to monitor program-level impact, enabling them to assess overall contributions and prepare sustainability reports.

B. *Architecture*

The *GreenPoints* platform is implemented as a web-based application designed for scalability and ease of access. Its core modules include user authentication, where planters and agencies log in with secure credentials; a plant registry, where users submit species, age, and photos of plants; and a verification workflow, where admins validate each submission before credits are assigned. Once verified, the points engine applies the CO_2-to-points formula and updates the credit ledger, ensuring transparency. Finally, reporting dashboards allow agencies to track aggregated environmental impact at community or regional levels. Fig. 1 illustrates the flow of data and interactions across these roles, showing how individual actions scale into measurable impact.

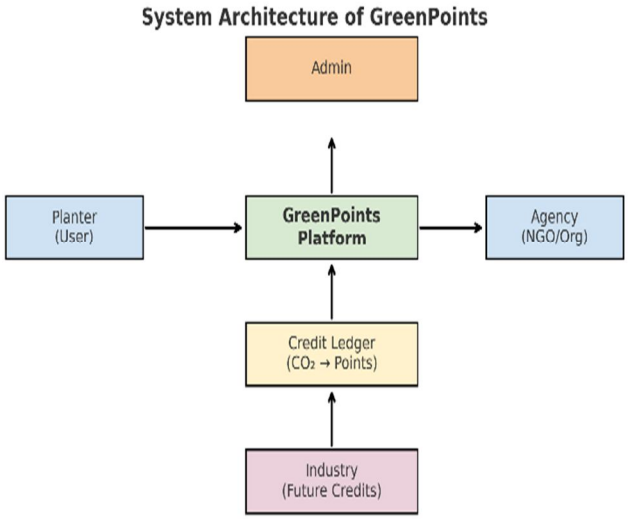

Fig. 1. System Architecture of GreenPoints.

C. *Data Model*

The system follows a structured relational model as illustrated in Fig. 2. The main entities include Users with their associated Profiles, which capture personal and location details; Plants, which store species, age, and verification status; and the Credit Ledger, which maintains the CO_2-to-points mapping for each plant. Additional entities such as Agency Notes allow organizations to record observations or CSR-related usage, while Admins manage verification and oversight. The relationships are designed to be simple yet scalable, with a 1:N link between Users and Plants, ensuring that each user can register multiple plants, and a 1:1 mapping between each Plant and its Credit Ledger entry, maintaining accountability and preventing duplication.

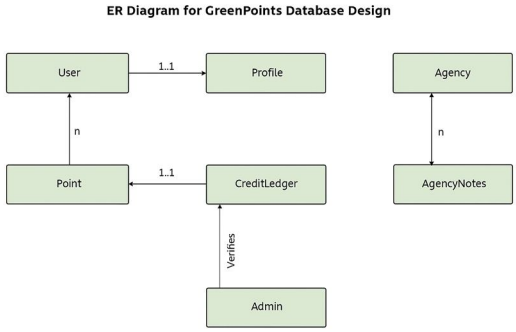

Fig. 2. ER Diagram for the GreenPoints database design.

D. User Flow

The end-to-end journey (Fig. 3) begins with user registration and plant logging, followed by admin verification to ensure authenticity. Once verified, the system applies the CO_2-to-points conversion, rewarding users with digital credits. These points are then stored in a secure ledger, allowing both individuals to track their contributions and agencies to view aggregated community data. Finally, reports generated from this ledger can be used by agencies for CSR documentation and, in the future, for industry-level credit purchases.

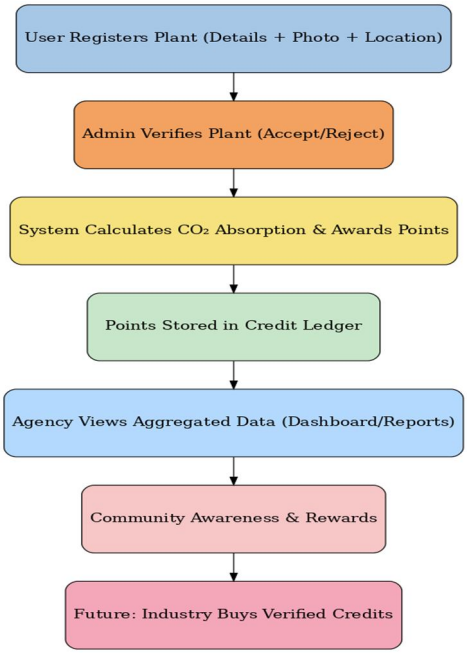

Fig. 3. User journey flowchart for GreenPoints.

E. CO_2 Estimation to Points

A simplified baseline: Tree (20 kg CO_2/year), Shrub (5 kg/year), Small plant (1 kg/year). We compute: CO_2abs = BaseRate × min(1, Age/3) × Days/365; Points = round(CO_2abs in kg). This provides transparent, gamified feedback while allowing future replacement with certified methodologies.

IV. RESULTS

We simulate a pilot with 100 users, each registering five plants (60% trees, 25% shrubs, 15% small plants). Assuming average age scaling of 0.6 for the first year, expected annualized absorption approaches ~10,000 kg CO_2. Engagement is amplified via points, badges, and leaderboards. Agencies obtain exportable summaries for CSR documentation.

TABLE I
Conceptual impact estimate for a 100-user pilot cohort.

Category	Count	Base Rate (kg/yr)	Age Factor	Estimated CO_2 (kg/yr)
Trees	300	20	0.6	3600
Shrubs	125	5	0.6	375
Small Plants	75	1	0.6	45

These results are indicative. With verification, IoT sensing, and standardized methodologies, values can be refined and certified for integration into recognized credit registries.

V. DISCUSSION

The *GreenPoints* model differs from existing carbon credit platforms by prioritizing inclusivity, gamification, and community engagement. Unlike Pachama or Verra, which focus on industrial-scale verification, *GreenPoints* values micro-contributions.
A comparative analysis is presented in Table II:

TABLE II

Feature	Pachama/Verra	Climate Impact X	GreenPoints
Target Users	Large-scale projects	Institutional	Individuals + NGOs
Verification Method	Satellite/AI	Certified Audits	Admin + IoT (future)
Accessibility	Low	Moderate	High (Web/Mobile)
Gamification	No	No	Yes (points, leaderboards)
Cost of Participation	High	High	Minimal/Free
Community Awareness	Low	Low	High (social, gamified)

A. Strengths of GreenPoints

- Inclusivity – empowers farmers, rooftop gardeners, and urban plant enthusiasts.
- Motivation – uses gamification to sustain long-term user engagement.
- Scalability – can aggregate thousands of micro-contributions into meaningful carbon impact.

B. Limitations

- Reliance on user honesty in initial stages.
- CO_2 absorption formula is simplified; scientific validation requires certified methodologies.
- Agencies may initially treat points as awareness tokens rather than official credits.

C. Opportunities

- Integration with IoT sensors for automated validation.
- Use of blockchain-based ledgers for transparency.
- Partnerships with NGOs for CSR-backed adoption.
- Alignment with India's Net Zero 2070 and UN SDG 13 (Climate Action) targets.

Thus, *GreenPoints* stands not as a replacement but as a complementary model, democratizing participation in carbon markets while fostering environmental awareness.

VI. CONCLUSIONS

GreenPoints democratizes carbon credits by turning micro-sequestration efforts into measurable points, creating a bridge between individual action and institutional reporting. The architecture, data model, and gamified mechanics provide a scalable foundation, while a staged pathway supports eventual certification and trading.

VII. FUTURE SCOPE

Near-term enhancements for *GreenPoints* include the integration of blockchain-backed ledgers to ensure transparency and immutability of records, as well as AI-based species detection to minimize fraudulent entries by automatically identifying plants from uploaded images. The system can further be strengthened through IoT-enabled growth tracking, where inexpensive sensors monitor plant health and validate long-term carbon absorption. A mobile-first user experience is planned to improve accessibility for rural users with limited digital literacy. Finally, partnerships with NGOs and official registries are envisioned to support phased validation, community engagement, and eventual recognition of points as tradable carbon credits.

VIII. ACKNOWLEDGMENT

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APPENDIX

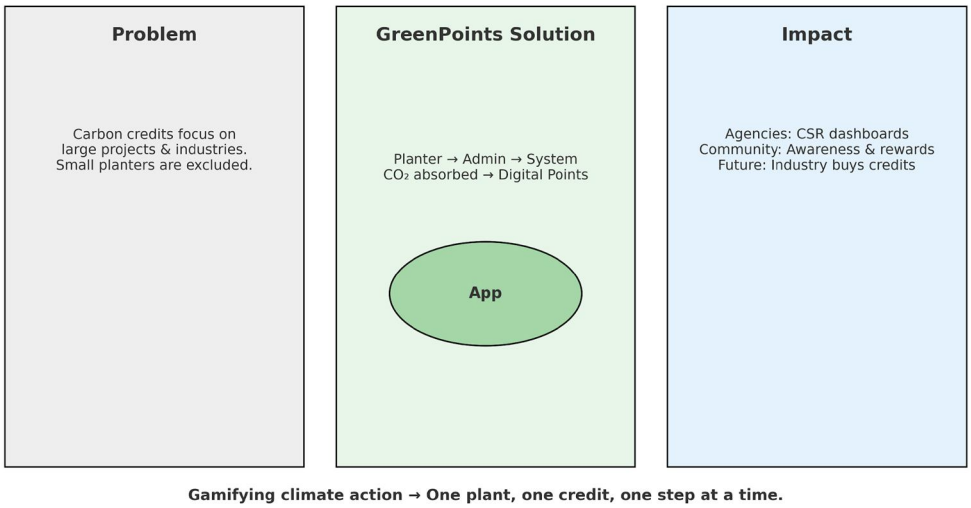
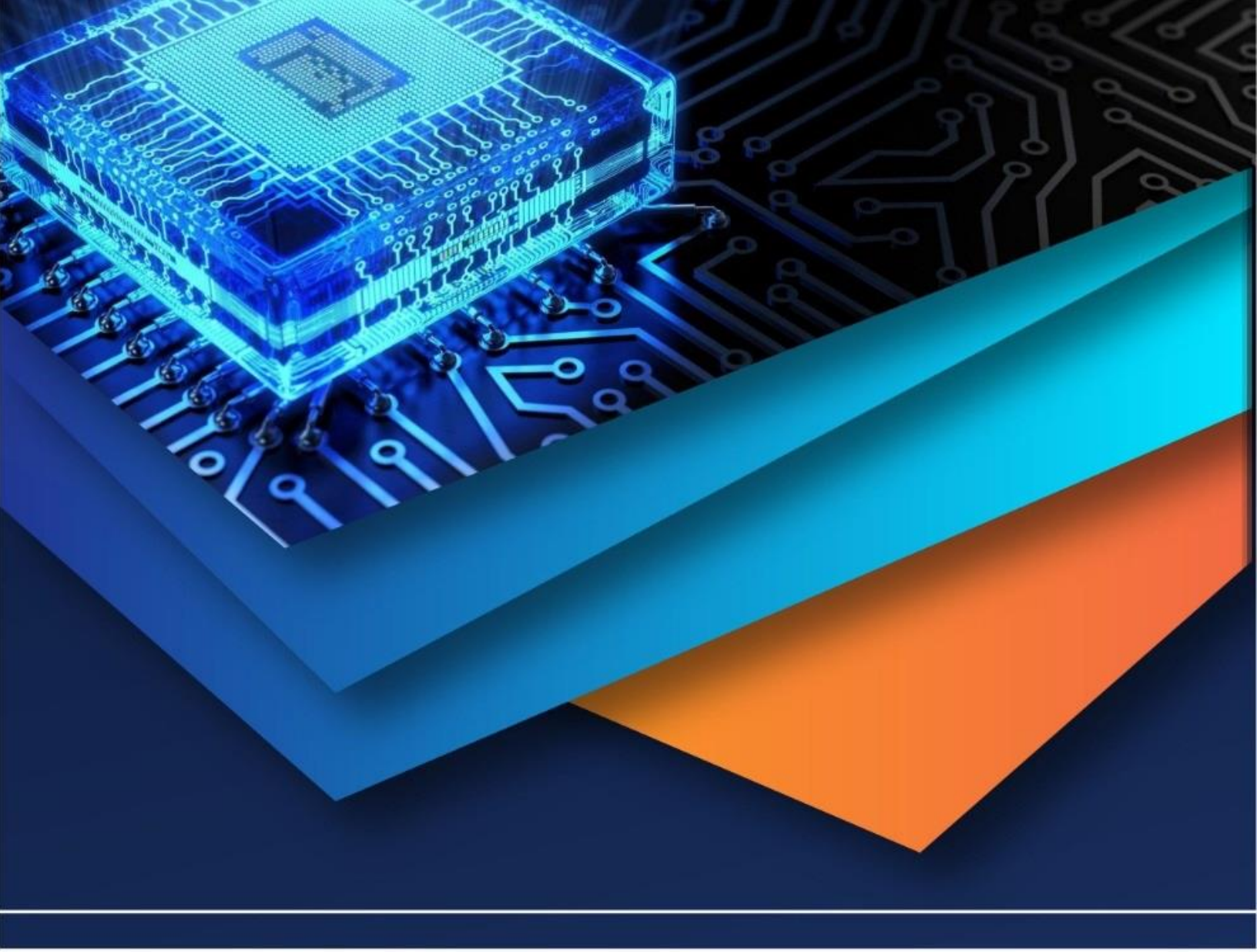


Fig. 4. Graphical abstract summarizing the GreenPoints concept (infographic style).



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