

CARBONOPOLIS

A full-lifecycle carbon
monitoring and management platform
fr. Ecology to Construction to Operation



Carbon Neutrality



Sustainability



Smart, Green and
Resilient



BIM + AI

Story of San Tin

1940年代



An illustration showing three men in a wooden boat on a river. Two men are seated in the boat, wearing blue shirts and straw hats, holding long wooden poles. A third man, wearing a green shirt, straw hat, and black boots, stands on the sandy bank, handing a woven basket filled with flowers to the man in the boat. The background features large green trees and a hazy sky.



北部都會發展區

[illegible]

香港邁向 **碳中和** Carbon Neutral@HK

環保人士反對佔用濕地

水獺棲息地
新田將翻天覆地
科技城【生態走廊】被質疑非生態友善
環團憂危及水獺生存環境

“
「發展與保育並存」
Co-existence of
Development and Conservation
”

Co-existence of Development and Conservation

— Ms Bernadette Linn, JP
Secretary for Development

CARBONOPOLIS

Stakeholders & Key Challenges



Government

Leading the low-carbon development of the Northern Metropolis

Concern:
Policy Implementation, Public Trust



Developer & Tenants

Balancing economic growth with carbon accountability

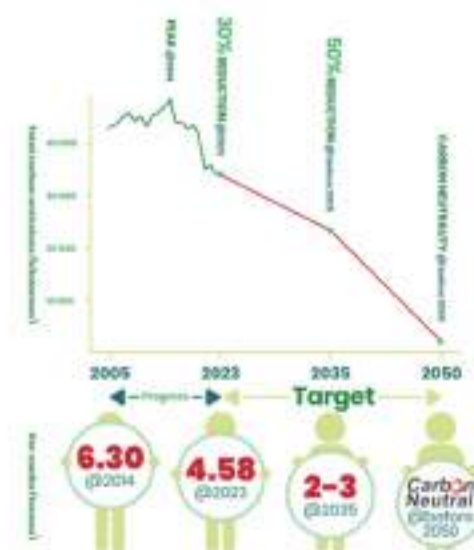
Concern:
ESG Pressure, Brand Responsibility



Town Planners

Turning policy into spatial, low-carbon solutions

Concern:
Design Trade-offs, Tool Shortage



香港通
向 **碳中和**
Carbon Neutral@HK



香港都市
節能藍圖
2015-2025+



2022

63% of carbon emissions came from power generation.



2023

Buildings in Hong Kong consume approximately **90%** of the electricity



Smart, Green and Resilient (SGR) Initiatives

CARBONOPOLIS

1 Initiative



+

1 Core Concept



1.0 t
Carbon

Our "Carbonopolis", carbon emissions from the life-cycle development into tokens, "Carbon Coins"

Initiative, embodies

Applications

A Digital Twin City-Building Game

“ Have fun as a real estate tycoon making San Tin a net-zero place. ”



3 Carbon Reduction Aspects



Ecology



Construction

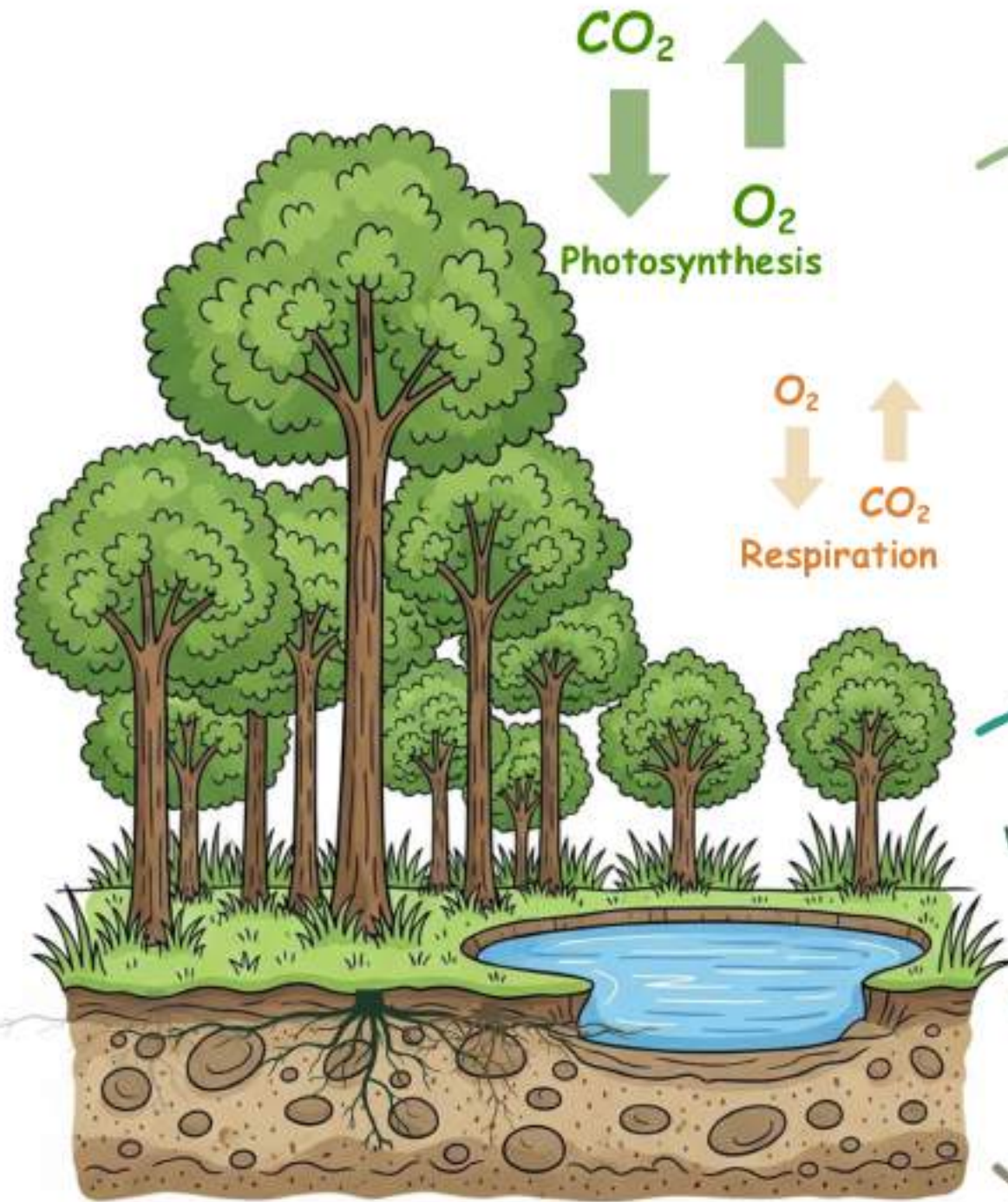


Operations



Source: Simulated City-Building Game at the Shenzhen Urban Planning Exhibition Hall

How much of the carbon stock vanished when turning undeveloped land into built?



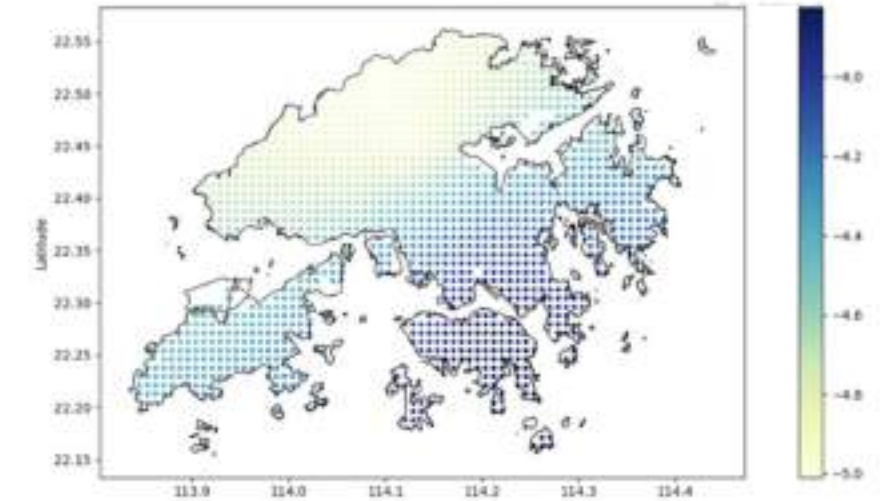
Long-term Loss

Net Ecosystem Exchange (NEE)

$$\text{NEE} = \text{Reco} - \text{GPP}^*$$

NEE is the net exchange of CO_2 between an ecosystem and the atmosphere. When NEE is negative, the ecosystem absorbs CO_2 .

*GPP: Gross Primary Productivity



One-time Loss

Above- and Below-Ground Biomass Carbon Stock

- **Above-ground carbon** is stored in living plant parts above the soil surface (stems, branches, leaves, bark).
- **Below-ground carbon** is stored in living plant parts below the soil surface (roots, rhizomes, tubers).

Soil Organic Carbon Stock

The total amount of carbon stored in soil organic matter within a specific depth and area.



Organic Matters

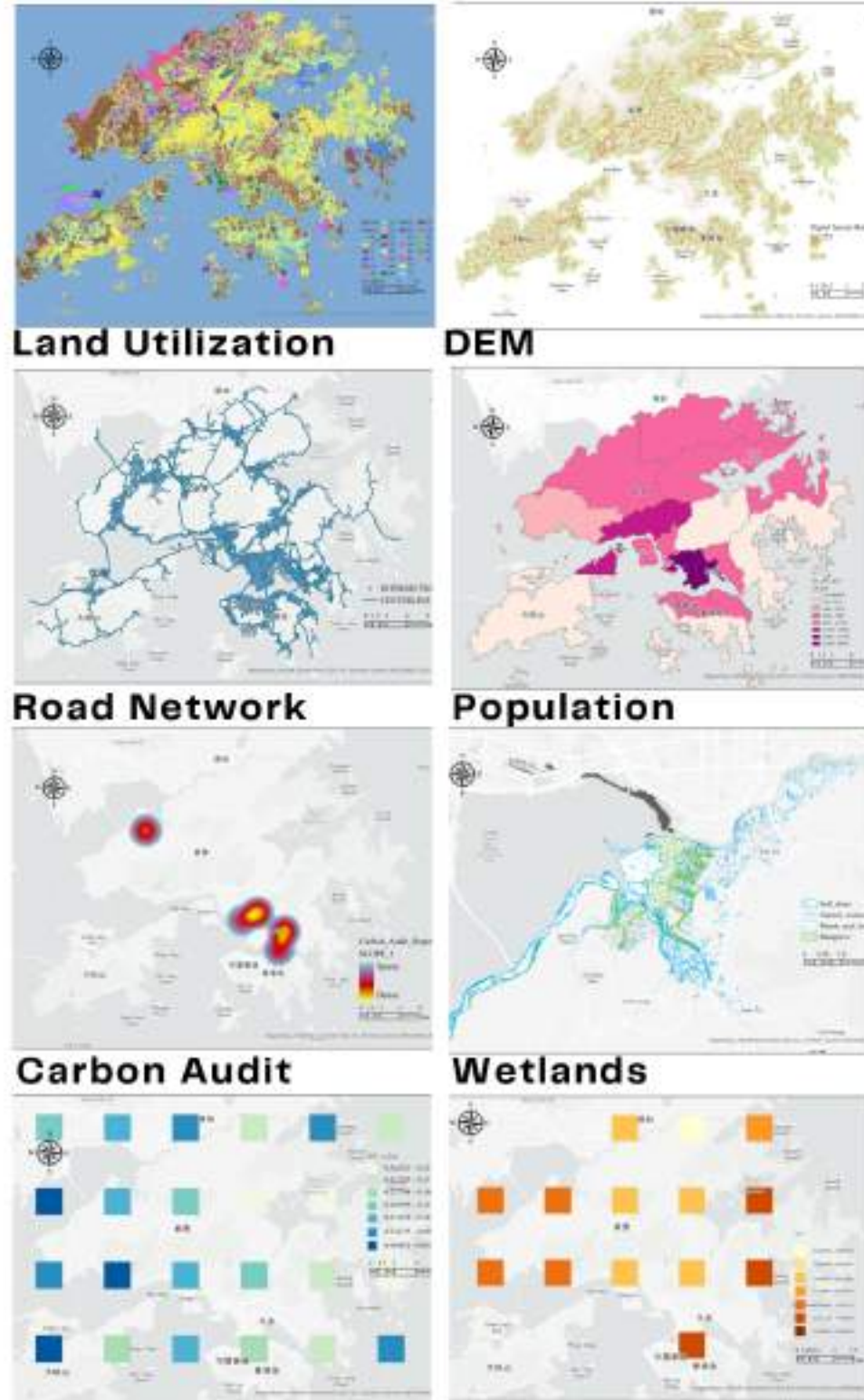
Land Acquisition: Carbon Stock in Raw Land



空間數據共享平台
Common Spatial
Data Infrastructure

CARBONOPOLIS

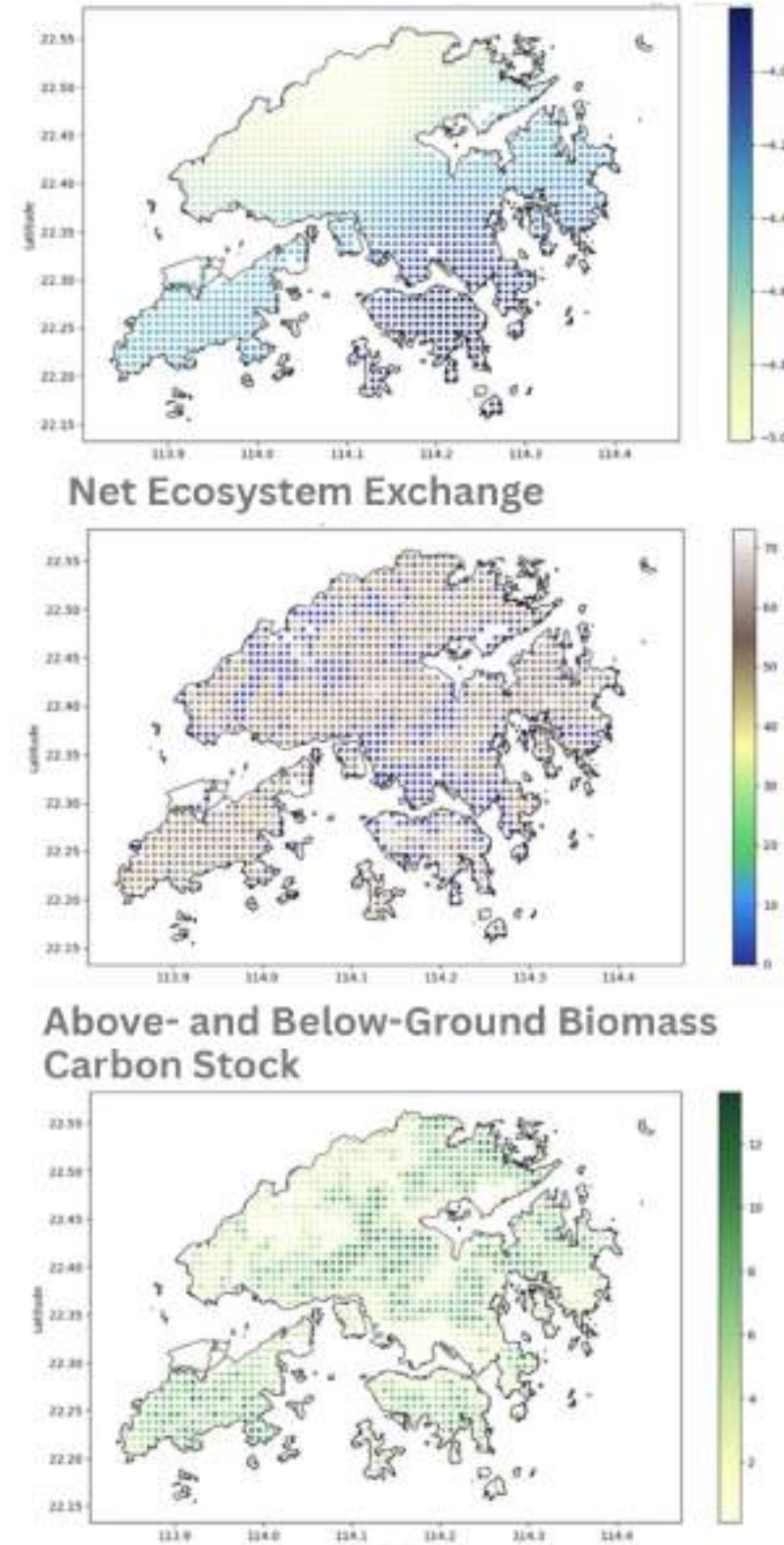
Input Features



ECMWF

ISRIC
World Soil Information

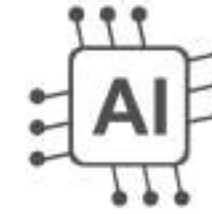
Target Variables



Training Set



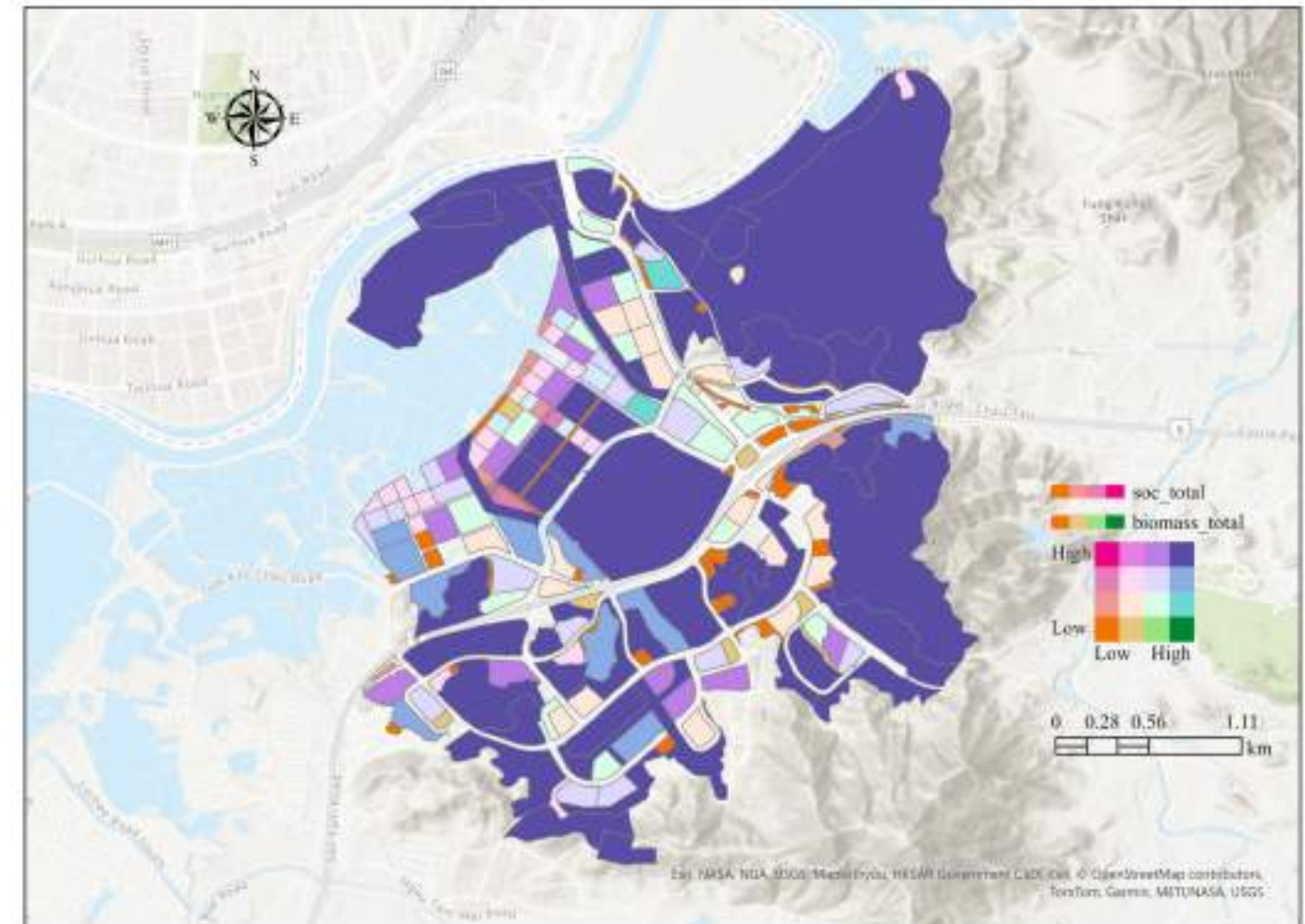
GeoAI CatBoost



Prediction Model

Model $R^2 = 87.4\%$

Results: Carbon stock of San Tin by block



Carbon Footprint: Model Buildings Energy Consumption

Referring to BEAM Plus and other global green building standards, we used the CIC Carbon Assessment Tool to evaluate 24 building types across six functions and four low-carbon development models, calculating their carbon consumption during construction.

	Residential Block	Business Block	Commercial Block	Public Building Block	Green Space Block
Plot Size (m × m)	100*150	150*200	100*200	100*100	75*100
Building Height Limit (m)	150	75	25	15	10
Building Area(m ²)	180k	120k	40k	10k	2.5k
Zero-Carbon Demonstration	 76K 1200 2,500 R4	 33K 900 2,500 B4	 10K 700 2,500 C4	 6.4K 600 2,500 P4	 0 500 2,500 G4
Advanced Low-Carbon Development	 82K 1050 2,500 R3	 38K 750 2,500 B3	 12K 600 2,500 C3	 6.8K 500 2,500 P3	 0 500 2,500 G3
Basic Low-Carbon Development	 90K 1000 2,500 R2	 40K 700 2,500 B2	 13K 450 2,500 C2	 7.2K 350 2,500 P2	 1K 100 2,500 G2
The Baseline Development	 98K 700 2,500 R1	 42K 500 2,500 B1	 15K 300 2,500 C1	 8K 200 2,500 P1	 2K 20 2,500 G1

Assessment Method

Business Block Design Parameters

Plot Size (m × m)	30,000	FAR	4.0
Building Height Limit (m)	75	Building Area(m ²)	120,000
Green Space Ratio	20%	Average Number of Floors	10



Baseline Development

Estimation of Main Material Usage

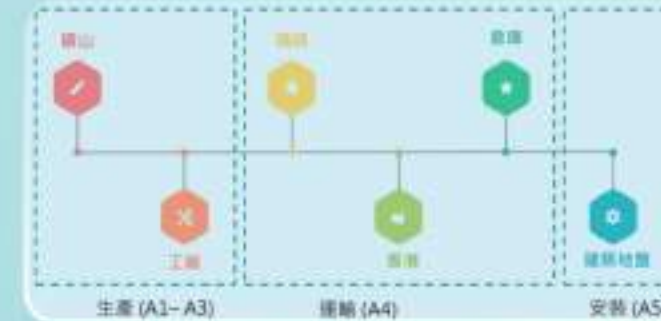
Reinforced Concrete *0.35-0.45 t/m ² of building area	48,000t
Steel *0.05-0.08 tons/m ²	8,400t
Earthwork Excavation Volume *10 kg/m ² of external wall area	25,200m ³
Glass Usage *10 kg/m ² of external wall area	360kg
Paint/Coating *Approximately 0.5 kg /m ² of building area	60kg



CIC Carbon Assessment Tool
建造業議會碳評估工具



Result



Life Cycle Carbon Emissions (LCA)



Total Carbon Emissions
42127.83 (tCO₂e) ≈ 42k

On-Site Renewable Energy Integration

Geopolymer Concrete Green Roof Materials

Solar Photovoltaic Integration Aggregate

Reclaimed Wood Dynamic Glazing Technology

Heat Pumps Low-Carbon Cement

Bio-Based Insulation Modular Construction

Cross-Laminated Timber Off-Site Manufacturing (OSM)

Prefabrication

Robotic Construction

Bamboo Aerated Concrete

Recycled Steel Energy-Efficient HVAC Systems

Building Carbon Reduction Technologies

Game Design | Everybody embraces the low-carbon San Tin

CARBONOPOLIS

In this city-builder game, you will play the role of an eco-responsible developer who can purchase a block of land, build buildings, and also involve in the operation of your properties. Your performance is marked in several dimensions.

Step 1 – Purchase Land

LAND ATTRIBUTE

Land Use: **Innovation & Technology**

Floor Area Ratio: **3.0**

Building Height Restrictions: **75 m**

One-time Carbon Stock Loss: **221**

Long-term Carbon Stock Loss: **5/year**

Key Ecological Resources:

Loss of pond and other wetland habitats

Key Impacts:

Direct loss of pond habitat that is utilised by high diversity and abundance of avifauna

BACK

BUY



Step 2 – Construction

SELECT YOUR BUILDINGS



Back

Select

Step 3 – Operation

LAUNCH A CAMPAIGN TO NUDGE

Renewable Energy

- Wetland Restoration
- Solar PV Systems
- Solar Water Heaters
- Biodiesel Systems
- Transparent Solar Windows
- Photovoltaics

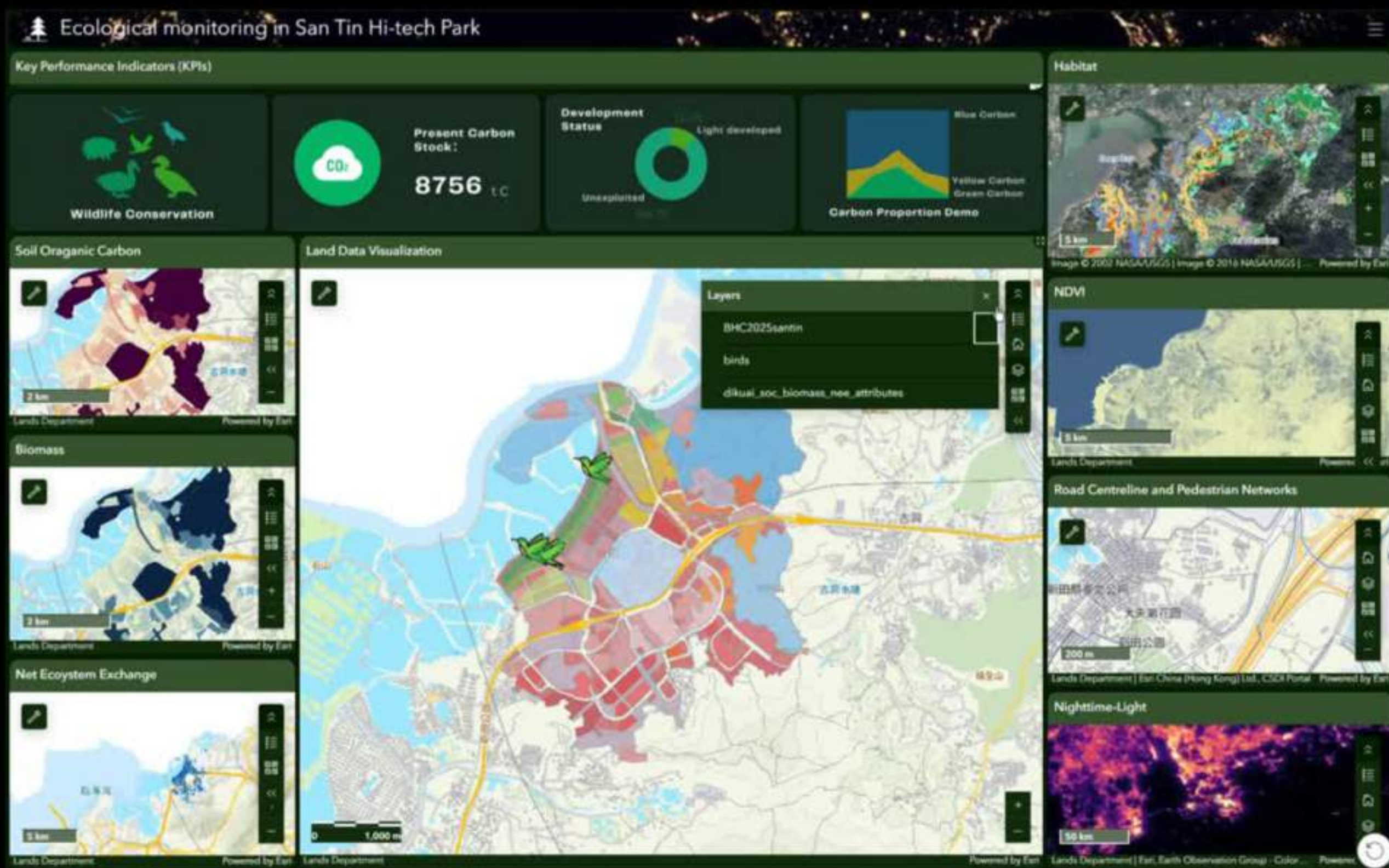
Occupant Engagement

- Educate Staff on Energy-Saving
- Promote Cycling
- Waste Segregation
- Paperless Offices



Back

Select



空間數據共享平台
Common Spatial
Data Infrastructure



scientific **data**

Google Earth Engine



ECMWF | 50

HKMS 2.0

Smart Dashboard for Carbon Neutrality

CARBONOPOLIS

It will help me find more cost-effective ways to go greener and boost profits.



Developers & Tenants

Support low carbon management; Monitor resource consumption across the entire portfolio.



Planners & Engineers

The system promotes transparency and credibility of green buildings for sustainable cities.

This provides refined carbon management and helps track policy outcomes effectively.

Government

For AI-Based Evaluation and Carbon Neutral Plan Report in San Tin Hi-tech District



Project Overview

1 Initiative + 1 Core Concept



Our Initiative, "CARBONOPOLIS", embodies carbon emissions from the life-cycle development into tokens, "Carbon Coins",

3 Carbon Reduction Aspects



Ecology

How much carbon is additionally produced if we turn a raw land into a built area?



Construction

To what extent does it work to utilise more eco-friendly materials and construction tech?



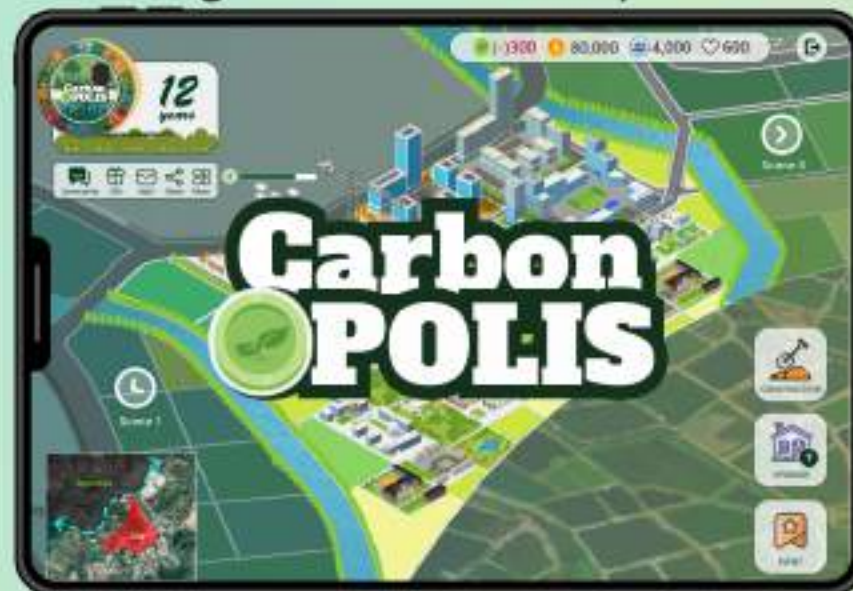
Operations

What can we do to reduce carbon just as ordinary people or new tenants in the San Tin?

2 Applications

City-Building Game

"Have fun as a real estate tycoon making San Tin a net-zero place."



Smart Dashboard

"See the sandbox, carbon stock, and energy consumption in one screen."



4 Stakeholders



- Alotaibi, B. S., Khan, S. A., Abuhussain, M. A., Al-Tamimi, N., Elnaklah, R., & Kamal, M. A. (2022). Life cycle assessment of embodied carbon and strategies for decarbonization of a high-rise residential building. *Buildings*, 12(8), 1203.
- Chen, Y., Feng, X., Fu, B., Ma, H., Zohner, C. M., Crowther, T. W., Huang, Y., Wu, X., & Wei, F. (2023). Maps with 1 km resolution reveal increases in above- and belowground forest biomass carbon pools in China over the past 20 years. *Earth System Science Data*, 15, 897–910.
- Hammond, G., & Jones, C. (2008). *Inventory of carbon & energy: ICE (Vol. 5)*. Bath, UK: Sustainable Energy Research Team, Department of Mechanical Engineering, University of Bath.
- Muñoz-Sabater, J., Dutra, E., Agustí-Panareda, A., Albergel, C., Arduini, G., Balsamo, G., Boussetta, S., Choulga, M., Harrigan, S., Hersbach, H., Martens, B., Miralles, D. G., Piles, M., Rodríguez-Fernández, N. J., Zsoter, E., Buontempo, C., & Thépaut, J.-N. (2021). ERA5-Land: A state-of-the-art global reanalysis dataset for land applications. *Earth System Science Data*, 13, 4349–4383.
- Shen, L., Ma, Z., & Liu, C. (2025). Study on life-cycle carbon emission of urban residential buildings: A case study of Xi'an. *Sustainability*, 17(4).
- Wong, J. K. W., & Kuan, K. L. (2014). Implementing 'BEAM Plus' for BIM-based sustainability analysis. *Automation in Construction*, 44, 163–175.