Nature as an asset

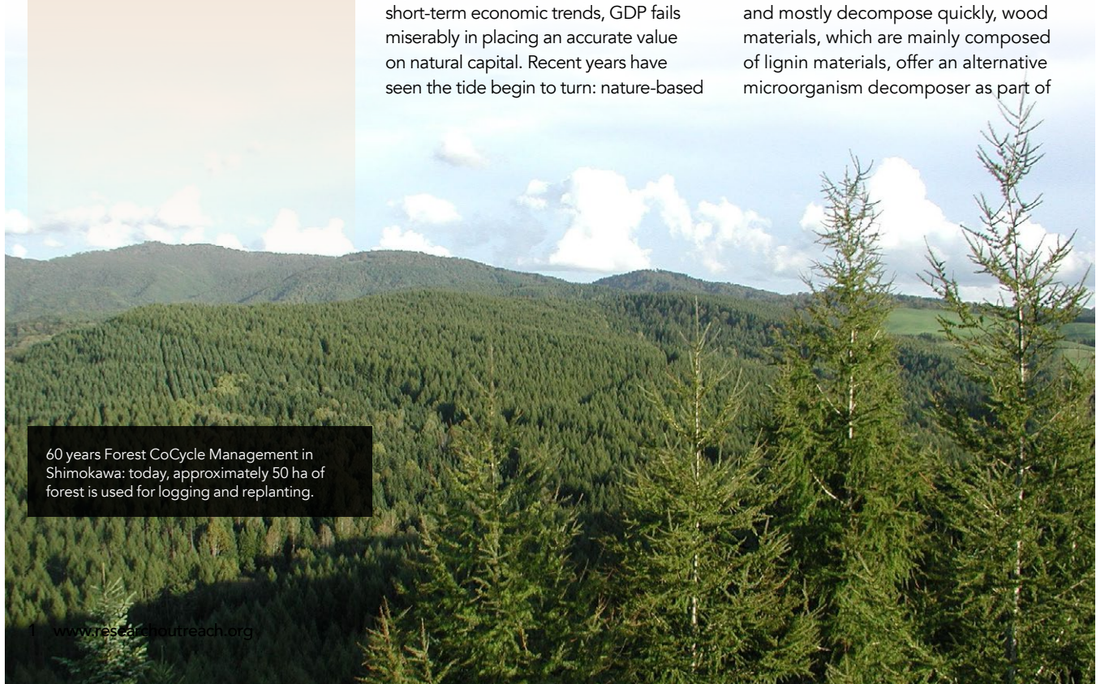
Natural capital in 'FutureCity' Shimokawa

Natural capital provides the goods and services that sustain humankind, but accurately quantifying it remains problematic. Professor Mitsuru Osaki (Hokkaido University) and Mr Takashi Kasuga (NPO FutureForest Institute) have addressed this issue by focusing on Shimokawa, a town in northern Hokkaido, Japan. Shimokawa aims to achieve economic stability by using its forest resources. Quantifying 19 variables related to agriculture and forests and assigning an economic value to each showed that the town's natural capital value dwarfs its yearly gross production, making the town carbon negative. The researchers have developed a new forest management approach, named Forest CoCyle Management, that further enhances the management of forest resources.

Natural capital refers to natural assets, including geology, soil, air, water, and all living things. In short, the natural world provides the food we eat, the water we drink, and the materials we consume in our pursuit of society and development. However, to the detriment of society as a whole, short-sighted mismanagement of natural capital, often in the name of economic benefit for the few, is widespread. Overexploitation not only impacts on ecology and biodiversity, but also reduces human resilience to extreme events like soil erosion, droughts or floods, while increasing social challenges such as diminishing food security, conflict over natural resources, and population displacement.

The overexploitation of natural capital is linked to society's tunnel-vision focus on economic growth, most commonly represented by metrics such as the gross domestic product (GDP). However, we generally fail to recognise the intricate relationship between GDP and natural capital. Moreover, as a measure of short-term economic trends, GDP fails miserably in placing an accurate value on natural capital. Recent years have seen the tide begin to turn: nature-based solutions (NbS) are increasingly promoted and alternatives to GDP have been developed – for instance, the inclusive wealth index (IWI), which includes three capital types: physical (infrastructure and building), human (education and health), and natural (forest, land, water, and fuel). Political, industrial, economic, and social initiatives are increasingly taking into consideration social and environmental impacts, aiming for carbon neutral/negative status has become mainstream, and 'ethical consumers' represent an increasingly powerful voice.

Recently, the World Economic Forum and partners launched 1t.org, a multi-stakeholder initiative to support efforts to grow, restore, and conserve 1 trillion trees around the world. The '4 per 1,000' initiative (www.4p1000.org), launched by the French government at the COP21 Paris climate summit in 2015, aims to boost carbon storage in agricultural soils by 0.4% each year to help mitigate climate change and increase food security. While organic fertilisers and composts are limited and mostly decompose quickly, wood materials, which are mainly composed of lignin materials, offer an alternative microorganism decomposer as part of



60 years Forest CoCycle Management in Shimokawa: today, approximately 50 ha of forest is used for logging and replanting.

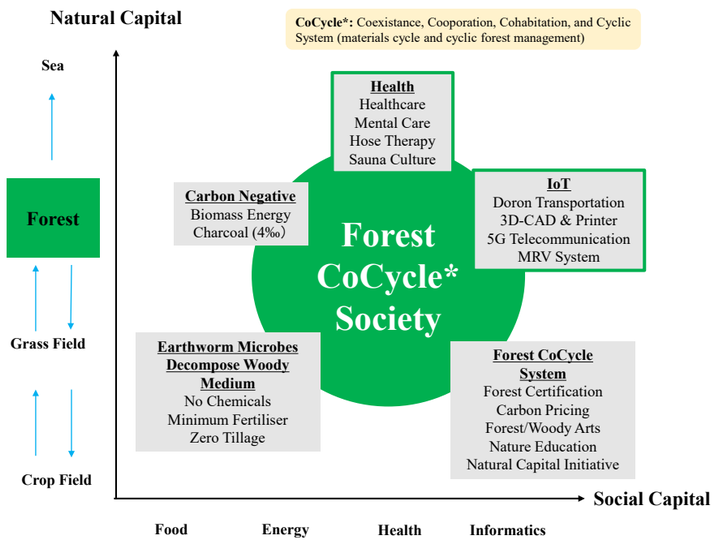


Figure 1. Elements of the Forest CoCycle Society.

the new Forest CoCycle Management System, mentioned in this article. The Intergovernmental Panel on Climate Change (IPCC) provides an approach for estimating mineral soil organic C stocks from biochar amendments to soils; biochar has matrix functions on microorganisms and contributes not only to carbon sequestration, but also to effective microorganisms' activity, which supports the co-existence with plants and microorganisms.

Despite these steps forward, accurately evaluating and quantifying natural capital remains problematic, with no standard practices agreed. At Hokkaido University and the NPO Shimokawa Research Institute for Forest Future Society (now NPO FutureForest Institute) in Japan, Professor Mitsuru Osaki and Mr Takashi Kasuga have been attempting to address this issue. In particular, they have developed a carbon-negative model for forest-based natural capital. Forest CoCycle Management is a forest management approach based on Coexistence, Cooperation, Cohabitation, and Cycles of energy, materials, cash-flow, and stock. The system helps to produce renewable wood energy, biochar for carbon sequestration and improved plan growth, microorganisms-decomposed wood materials for agriculture as organic composts, and economic timber products. To test their model, the researchers have focused their efforts on Shimokawa town, where they have applied cash-based methods to evaluate carbon and energy flows.

THE FORESTS OF SHIMOKAWA

Shimokawa is located in boreal northern Hokkaido, Japan, and the town's land is heavily forested (64,420 ha, or 88% of the total area). More than a third of the town's economic output comes from forestry, wood manufacturing, and agriculture. Shimokawa is sparsely populated, and of the residents who remain, a third are over 65 years old. However, the town has avoided the fate of many others in a similar position (which are slowly disappearing) owing to its 2008 designation as a 'FutureCity'. The FutureCity programme, run by the Cabinet Office of the Government of Japan, designates model cities as test sites to tackle social issues, including rapid ageing and environmental degradation. According to the programme design, a FutureCity is one in which there is a self-sustaining socio-economic system, where 'everybody wants to live' and 'everybody has vitality'. In particular, a FutureCity places emphasis on creating social value (eg, healthcare, security, culture), environmental value (eg, low carbon, good waste management, biodiversity protection), and economic value (eg, stable employment, tourism, urbanisation).

The natural world provides the food we eat, the water we drink, and the materials we consume.

In Shimokawa, natural capital is concentrated in boreal forests and agriculture. In its capacity as a FutureCity, Shimokawa set out to achieve economic stability using its forest resources and the application of Forest CoCycle Management. Various initiatives have been introduced, with the town building on its existing strengths in its quest for sustainability. Forest management has been practiced in the area for generations; in the 1960s, between 40 and 50 ha of forest was planted and harvested each year. Today, via a 60-year tree nursing plan, approximately 50 ha of forest is used for logging and replanting. In addition, the town has embraced new technologies to optimise sustainable timber production (eg, a light detection and ranging [LiDAR] survey), instigated a zero-timber-waste policy (eg, the conversation of timber waste to wood biomass energy and biochar production), and installed wood biomass heaters and boilers.

To develop their method for quantifying natural capital value (NCV), Osaki and Kasuga took Shimokawa as a case study and focused on a single year, 2012. They chose 7 variables (ie, measurable natural capital aspects) related to agricultural land and 12 variables related to the forest. For each variable, they calculated a physical amount and an economic value. In terms of agriculture, they considered (1) farm and dairy product production by paddy and fields (which in 2012 yielded an economic benefit of 9,533 USD per hectare per year), (2) CO_2 storage by biochar (2 USD/ha/year), (3) water storage by paddy (5,046 USD/ha/year), (4) flood mitigation by paddy and fields (3,826 USD/ha/year), (5) soil erosion prevention by paddy (846 USD/ha/year), (6) organic waste recycling by fields (409 USD/ha/year),

and (7) recreation by paddy and fields (30 USD/ha/year).

The first forest measure was simply (1) the annual production of sustainable timber, which in 2012 yielded an economic benefit of 50 USD per hectare per year. Forests are an important store of CO_2; via the process of photosynthesis, trees store carbon in their trunks and branches as they grow. As such, many of the chosen measures were focused on CO_2, including (2) CO_2 sequestration by the forest (223 USD/ha/year), (3) CO_2 stored in harvested wood products (25 USD/ha/year), (4) CO_2 emission reduction owing to the use of timber over other materials (2 USD/ha/year), and (5) CO_2 emission reduction (1.3 USD/ha/year) and energy cost reduction (3.6 USD/ha/year) of using wood biomass over other fuel types. Next, water-related measurables were found to be significant, including (6) water storage by the forest (2,342 USD/ha/year), (7) water purification by the forest (4,971 USD/ha/year), and (8) flood mitigation by the forest (1,528 USD/ha/year). The most significant contributor to the town's NCV came from soil conservation, including (9) soil erosion prevention by the forest (10,358 USD/ha/year) and (10) landslide prevention by the forest (4,650 USD/ha/year). Finally, the cultural services of the forest were quantified, including (11) educational services (1.5 USD/ha/year) and (12) biodiversity protection by the forest (6.2 USD/ha/year).

The Ichinohashi Eco Village in Shimokawa uses wood construction materials, biomass energy, and woody medium decomposed by earthworm microbes with biochar for plant growth promotion (for agriculture, horticulture, and silviculture).

First case of J-VER credit for forest CO_2 absorption certified by the Ministry of Environment, Japan, with partnership between Shimokawa and 'More Trees' in 2009.

The natural capital value exceeded the yearly gross production of the town by seven times.

NATURAL CAPITAL FOR A FUTURE OF SUSTAINABILITY

Armed with these data, Osaki and Kasuga assessed whether the town used its natural capital sustainably, the total economic value of the ecosystems, and the positive effects of natural capital on the economy and human wellbeing. The total NCV of the agricultural lands in 2012 was 19,692 USD/ha/year, resulting in a total economic value of 44 million USD/year for the town. The total NCV of the forest in 2012 was 24,161 USD/ha/year, equivalent to a total economic value of 1.326 billion USD/year for the town. Summed together, the natural capital value exceeded the yearly gross production of the town by seven times, with the forest providing the greatest capital – primarily because the area of forest (54,862 ha) greatly exceeded that of agricultural land (2,953 ha).

In addition to purely monetary values, the data show that annual tree growth in Shimokawa exceeded the annual harvest of trees. Moreover, the town is carbon negative, meaning that on balance, the trees provided a CO_2 sink to the tune of 107,249 t-CO_2/year, even when considering the CO_2 emitted from industries and households. As a result, the town is able to issue J-credits; that is, carbon credits managed through a central scheme of the Government of Japan. On a more human level, the forest management and timber industries created local jobs, became a focus for study tours that bought visitors into the community, and provided a basis for social welfare in the town.

The continued survival of Shimokawa in the face of a dwindling and ageing population points to the success of sustainable natural capital schemes in preserving communities and the environment. Through their work, Osaki and Kasuga were able to take this a step further by quantifying the values of natural capital in the town and its benefits. However, the researchers stress that this is just a first step. Their NCV accounting exercise needs to be repeated and updated to monitor the situation and facilitate effective land management.

The forest management and timber industries created local jobs and provided a basis for social welfare in the town.

Behind the Research

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Research Objectives

Professor Osaki and Mr Kasuga have developed a method for quantifying natural capital value.

Detail

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Bio

Mitsuru Osaki was Professor at the Research Faculty of Agriculture and the Graduate School of Agriculture, Hokkaido University, from 2006 to 2017. Currently, he is Professor Emeritus, Hokkaido University, president of the Japan Peatland Society (JPS), founded in 2014, and president of the NPO FutureForest Institute. He was trained as a plant physiologist and soil scientist and obtained his doctorate degree from the Faculty of Agriculture, Hokkaido University, in 1981.

Takashi Kasuga graduated from Takushoku University in political economy and worked on regional sustainability and development at Shimokawa Municipal Government, Hokkaido Prefecture, Japan. In 2021 he was assigned by the National Cabinet Office to Director of Shimokawa Environmental FutureCity Promotion Project. Subsequently he became a Researcher of NPO FutureForest Institute and a member of Shimokawa Town Council.

Collaborators

- NPO FutureForest Institute, which developed the concept of Forest CoCycle Management
- Mr Kunihiro Yamashita (previous President of Forest Owner's Cooperative of Shimokawa Town), who established the 'Forest Cycle Management' system
- Mr Tamotsu Anzai (previous Mayor of Shimokawa Town), who introduced the system of 'Forest-based Society'

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Personal Response

How have the demographics of Shimokawa changed since this initiative was launched? Has the population grown and/or become younger?

"The population of Shimokawa is still decreasing. Between 2015 and 2020, the population declined by 11.9% because of ageing – currently, 40.2% of the residents are over 65 years old. However, entrepreneurs, artists, planners, and cookers, who are creating a new lifestyle culture, are bringing new life to Shimokawa. Also, the town is becoming increasingly popular for visitors wanting to commune with nature, care about their health and mental wellbeing, and work in agriculture, forest, and animal husbandry in the short term."