

## DIFFICULTIES IN CONSIDERING “NATURAL CAPITAL” PRIMARILY THROUGH ECONOMIC INDICATORS

### — TOWARD CREATING A WORLD IN WHICH PEOPLE HAVE A SENSE OF SYMBIOSIS WITH NATURE (JAPANESE-STYLE RICHNESS) —

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#### SUMMARY

- It will be intriguing to observe if voters who prioritize swift economic measures will maintain their support for environmental policies in the 2024 election year.
- The conceptualization of natural capital as a metric for green policy is shaped by economic paradigms, particularly those rooted in modern Western thought.
- Natural capital, as understood through the lens of Japanese-style richness, is nurtured by the harmonious symbiosis between humans and nature.
- Why not reinterpret the term “natural capital” through the lens of contemporary rationalism, and strive to achieve a harmonious coexistence with nature?

#### 1. CLIMATE CHANGE MITIGATION (GREEN POLICIES) DURING AN ELECTION YEAR

In 2024, significant elections will occur globally, including such as the presidential election in the US and parliamentary elections across Europe. Attention is now centered on how the outcomes of these elections will influence climate change initiatives. This scrutiny arises amid concerns about whether nations can uphold their green commitments as outlined in the conclusions of COP28, the 28th conference of the parties to the United Nations Framework Convention on Climate Change (UNFCCC), concluded at the end of 2023<sup>1</sup>. Concurrently, there is a growing demand from the general populace for policies that deliver immediate improvements to their quality of life, as they grapple with high inflation and other economic challenges (Figure 1).

The Paris Agreement, which mandates CO2 emission reduction

**Figure 1: Elections in major countries and regions in 2024 and implications for climate change mitigation**

<b>Indonesian presidential election (February)</b>	Development of domestic emissions trading systems and reopening of international emissions systems Export constraints arising from the strategy transition towards higher value-added resources are impeding global decarbonization efforts
<b>Indian general elections (April-June)</b>	Advance the net-zero emissions target to the year 2070 Evolution of emissions trading systems, transitioning from energy conservation trading to comprehensive emissions trading
<b>European Parliament elections (June)</b>	Enact legislation mandating a 90% reduction in greenhouse gas emissions by 2040, relative to 1990 levels Implementation of EU ETS and EU CBAM has precipitated significant backlash from both businesses and consumers
<b>UK general election (July)</b>	UK ETS's response to the implementation of EU CBAM has led to an increase in UK ETS prices and a subsequent decline in industrial competitiveness Balancing oil development regulations with energy security considerations
<b>US presidential election (November)</b>	The Paris Agreement and the potential for withdrawal The Inflation Reduction Act (IRA) and the subsequent revision of industrial support mechanisms The Energy Transition Accelerator (ETA) and the subsequent decline in interest

Source: Compiled by MGSSI based on an article by Takashi Hongo published in the Nikkei Business Daily, March 1, 2024

<sup>1</sup> The agreement aims to reduce emissions further to achieve a net-zero society by 2050 and the 1.5°C target, by tripling renewable energy generation capacity and doubling energy efficiency by 2030.

targets for all signatory countries, has undeniably heightened global awareness of the natural environment, encompassing land, air, and water, among both public and private entities<sup>2</sup>. However, instances of greenwashing – where organizations and companies circumvent regulations by employing vague terms and slogans – have emerged. This practice has placed entities genuinely committed to environmental sustainability at a greater financial disadvantage than those less earnest in their efforts. This report highlights the issues inherent in the modern rationalist interpretation of natural capital indicators in green policies, referring to the writings of Professor Sian Sullivan of Bath Spa University in the UK<sup>3</sup>, who examines natural capital through the lens of the environment-culture nexus. Additionally, the report offers a contemporary rationalist solution by illustrating examples from Japan.

## 2. FORMULATION OF METRICS FOR ASSESSING NATURAL CAPITAL

To assist companies and organizations in proactively engaging with natural capital-related initiatives, the TNFD<sup>4</sup> has introduced a framework that recommends nine core disclosure metrics for dependencies and impacts on nature, structured around four recommendation pillars<sup>5</sup>. It also provides guidance on an integrated approach for identifying and assessing recommended disclosures, known as LEAP<sup>6</sup> (Figure 2). These indicators aim to recognize natural capital as an account item and manage it based on market logic. While it seems reasonable to interpret natural “capital” in accounting terms, there are unexpected pitfalls in this approach.

Figure 2: Framework of the Taskforce on Nature-related Financial Disclosures (TNFD) recommendations

Metric No.	Core disclosure indicators and metrics (for nature-related dependencies and impacts)	Overview
C1.0	Total spatial footprint	Total spatial footprint (km <sup>2</sup> ) (sum of): total surface area controlled/managed by organization, total disturbed area, and total rehabilitated/restored area
C1.1	Extent of land, freshwater, ocean-use change	Total extent of ecosystems (km <sup>2</sup> ) (sum of): changes in use by type of ecosystem and business activity, conservation or restoration voluntarily or mandatorily by statutes or regulations, and sustainable management by type of ecosystem and business activity
C2.0	Pollutants released to soil split by type	<b>Pollutants released to soil by type (metric tons), referring to sector-specific guidance on types of pollutants</b> Total amount of pollutants released to soil by type (metric tons)
C2.1	Volume of water discharged and concentration of key pollutants in the wastewater discharged	<b>Refer to sector-specific guidance for types of pollutants (metric tons)</b> Volume of key pollutants in discharged wastewater (m <sup>3</sup> ) and concentration in the wastewater
C2.2	Weight of hazardous and non-hazardous waste generated by type	<b>Refer to sector-specific guidance for types of waste</b> Weight of waste by sector (metric tons), weight of waste diverted from landfills (metric tons)
C2.3	Plastic pollution	<b>Total weight (metric tons) of plastics (polymers, durable goods, and packaging) used or sold</b> Total footprint as measured broken down into raw material content
C2.4	Non-GHG air pollutants by type	<b>Total volume of non-GHG air pollutants by type</b> PM <sub>2.5</sub> /10, NO <sub>x</sub> , VOC/NM <sub>VOC</sub> , SO <sub>x</sub> , NH <sub>3</sub> (metric tons)
C3.0	Water withdrawal and consumption from areas of water scarcity	<b>Amount of water withdrawn and consumed (m<sup>3</sup> or equivalent) from areas of water scarcity, including identification of water source.</b>
C3.1	Quantity of high-risk natural commodities sourced from land, ocean, freshwater	<b>Refer to type- and sector-specific guidance for high-risk natural commodities</b> Quantity of high-risk natural commodities (metric tons) split into types, including proportion of total high-risk natural commodities (YoY)



Metric No.	Core disclosure indicators and metrics (for nature-related risks and opportunities)
C7.0	Vulnerability to nature-related transition risks (B/S, P/L)
C7.1	Vulnerability to nature-related physical risks (B/S, P/L)
C7.2	Significant fines/penalties received/litigation action in the year due to negative nature-related impacts Description and amount of penalties, fines, and litigation measures
C7.3	Refer to a government or regulator green investment taxonomy or third-party industry or NGO taxonomy Amount of capital expenditure, financing or investment deployed towards nature-related opportunities
C7.4	Increase and proportion of revenue from products and services producing demonstrable positive impacts on nature with a description of impacts

Source: Compiled by MGSSI based on the Recommendations of the Taskforce on Nature-related Financial Disclosures

<sup>2</sup> A voluntary carbon credit market is being developed, with credits managed and issued by private entities.

<sup>3</sup> Sian Sullivan – Bath Spa University

[The Natural Capital Myth and Other Stories – Essays on Nature, Finance and Value\(s\) – by Sian Sullivan \(the-natural-capital-myth.net\)](http://the-natural-capital-myth.net)

<sup>4</sup> Acronym for Taskforce on Nature-related Financial Disclosures, a task force launched to shift global financial flows from negative to positive outcomes for nature.

<sup>5</sup> The four pillars refer to governance, strategy, risk and impact management, and metrics and targets.

<sup>6</sup> LEAP stands for locate, evaluate, assess, and prepare.

## 2-1. Considerations for interpretation of natural capital within accounting frameworks

In the TNFD's recommendations, first of all, the C7.0/C7.1 core disclosure indicators are predicated on the assumption that nature-related transition and physical risks can be quantified by measuring the stock of natural capital at a specific point in time, akin to a balance sheet (B/S) and the change in natural capital over a defined period, similar to a profit and loss statement (P/L). However, there remains a significant lack of sensors and other equipment necessary to provide consistent and accurate observation of natural capital both at the time of measurement and throughout the measurement period.

Next, regarding the C7.2-C7.4 nature-related impacts, value is assigned on a fiscal year basis. However, unlike human activities, which can be segmented annually, or by the Earth's orbital cycle, natural activities must be understood independently of these units. For example, cicadas emerge in prime number cycles of 13 or 17 years<sup>7</sup> to evade predation. Similarly, the EU taxonomy for sustainable activities (EU Taxonomy or EU Green Taxonomy) endeavors to standardize definitions concerning the environmental considerations of economic and investment activities. Nevertheless, it remains challenging to directly correlate environmental impacts with a human fiscal year.

Core disclosure indicators related to dependencies and impacts, which form the basis for risks and opportunity assessment, vary significantly across regions due to differences in pollutant types and waste categories, influenced by the level of industrial development and population density. For instance, urban expansion has, in some cases, converted former industrial zones with soil contamination into residential areas. Additionally, pollution standards have evolved over time across different countries, complicating the application of uniform global standards. Even in the context of water resource utilization, which is anticipated to become increasingly scarce, the prioritization of industrial water use over agricultural water use based solely on the higher unit cost of industrial products compared to agricultural products is overly simplistic. There are numerous scenarios where natural "capital" cannot be adequately addressed through the lens of the economic growth ideology alone.

## 2-2. Can natural capital indicators be effective metrics for economic impacts and returns?

Economic indicators have been developed to achieve the policy objectives related to economic growth and market enhancement. Additionally, these indicators have historically been designed to determine taxable amounts and statutory requirements for taxation, thereby increasing tax revenue (Figure 3). Consequently, when striving to ensure objectivity and reproducibility of data, there is a tendency to prioritize the accumulation of tangible, collectible material objects. However, natural capital, such as air and water, are neither "material things" created by humans nor are they regulated in the marketplace by the "invisible hand of God".

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<sup>7</sup> For instance, predators and parasites with a 3-year development cycle will coincide with 13-year cicadas only once 39 years and with 17-year cicadas only once 51 years, thereby significantly reducing the likelihood of predation.

**Figure 3: History of the development of economic indicators**

Major indicators	Indicator-focused era	Background of indicator development
Real estate and vessel	The feudal era leading to absolute monarchy	William I (William the Conqueror), renowned for conquering England and inaugurating the Norman dynasty in 1066, commissioned the Domesday Book, a comprehensive record of land ownership that served as the foundation for land taxation. This ledger enabled the king to monitor land values and levy appropriate taxes, thereby establishing the feudal system in England and consolidating royal authority. The ships of the Age of Exploration carried wealth from overseas and became important as taxable assets.
Population	The Connecticut Compromise (aka Sherman Compromise) reached at the US Constitutional Convention in 1787	The compromise facilitated equal representation for each state in the upper house, while the lower house adopted proportional representation based on state populations. This arrangement streamlined the process of determining state populations and enabled the imposition of a per-capita tax.
Unemployment rate	Great Depression of 1929	To augment the working population and enhance tax revenues through job creation, the government undertook a comprehensive survey to ascertain the number of factory workers and white-collar employees.
Gross Domestic Product (GDP)	Establishment of the Bretton Woods System in 1944	The system was promoted to emerging nations via the United Nations to illustrate the superiority of capitalism. By excluding domestic labor and leisure activities—integral components of economic production—and periodically aggregating quantifiable data, the maximum potential war funds were calculated and subsequently used to justify deficit financing.
Rate of inflation	1970s oil crisis	Economist Professor Milton Friedman utilized the surge in consumer prices as a foundation for his critique, subsequently developed it into an economic indicator. He posited that the increase in consumer prices was attributable to the money supply policies of governments adhering to Keynesian principles.
Fiscal deficit as a percentage of GDP	Free movement of capital	The government sector deficit was indexed by financial institutions to assess country risk, irrespective of the nationality of creditors, following the initiation of unrestricted cross-border flow of financial assets and investments.

Source: Compiled by MGSSI based on various materials

It would be ideal to develop a natural capital index that facilitates objective comparisons of natural environments and biodiversity, which vary according to geographic and historical contexts. However, it is also evident that even within similar agricultural and pastoral regions, there exist myriad distinct environments conducive to plant growth. For instance, Japan, with its steep rivers, and Egypt, with its periodic flooding of the Nile river that enrich the soil, stand in contrast to the hot and humid climates of Southeast Asian countries and the steppe climate of Ukraine. The plantation agriculture<sup>8</sup> that emerged during colonialism is a consequence of human practices that prioritized international competitiveness while neglecting the importance of natural diversity.

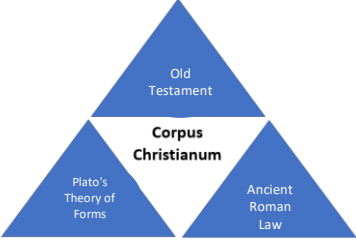
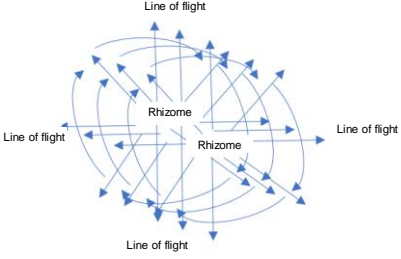
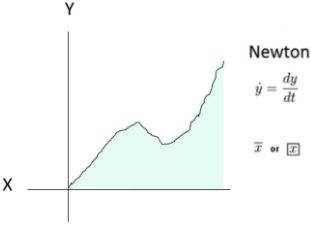
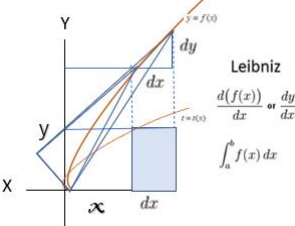
### 2-3. The emergence of economic indices marked a significant imprint of human domination over nature

Since the advent of the modern industrial revolution, human society has significantly augmented its economic power through the extensive exploitation of natural resources, particularly fossil fuels. The geometrical methods of mathematics have been extensively employed to comprehend physical phenomena and to facilitate invention and innovation. Foundational texts such as the Old Testament, which acknowledge human domination over nature, Plato's Theory of Forms, and ancient Roman law, underpin modern rationalism and economic metrics by integrating reconciling thought. However, contemporary rationalism also acknowledges the unpredictable aspects of reality (Figure 4<sup>9</sup>).

<sup>8</sup> A form of agriculture characterized by the large-scale cultivation of a single crop with high international market value, typically on extensive plantations. This practice has its origins in the British triangular trade, which involved the transportation of enslaved African to the West Indies for sugarcane production. Countries that produce commodity crops can generate foreign exchange through exports. However, this practice depletes soil fertility and can create an economically unsustainable structure, especially when these lands are also subject to natural disasters and other adverse factors. The challenges associated with agricultural land productivity are comprehensively examined in Eric Williams's book *Capitalism and Slavery*.

<sup>9</sup> In the 17th century, a significant dispute arose over the priority of discover calculus, a fundamental element of physics. This controversy involved Issac Newton, who formulated calculus based on the assumption of absolute time and absolute space from a divine perspective, and Gottfried Wilhelm Leibniz, who developed calculus under the premise of change among an infinite number of entities. Leibniz's mathematical philosophy is intrinsically connected to contemporary physics, encompassing theories such as relativity, which posits the equivalence of mass and energy, and quantum mechanics, which asserts stochastic nature of physical measurements. Philosopher Gilles Deleuze systematically critiques various assumptions of subjectivity and anthropocentrism. In

Figure 4: Differences between modern and contemporary rationalism

Comparative philosophy	Modern rationalism	Contemporary rationalism
Awareness of the environment	Harmonious	VUCA (volatility, uncertainty, complexity, and ambiguity)
Basic conceptual image	 <p>It is rooted in the dogmatic concepts prevalent in the Middle Ages, including the Old Testament's recognition of nature as an object of ownership under the doctrine of human dominion over nature; the philosopher Plato's Theory of Forms, which introduced 'Ideas' as the non-physical, absolute, and unchangeable essences of all things; and ancient Roman law, which delineated between divine law and natural law.</p>	 <p>It structurally interrogates the assumptions of individuality and anthropocentrism, while also challenging the Western construction of logos (language). This deconstruction extends across various disciplines, institutions, and economies, employing non-verbal methodologies. (Inspired by 'A Thousand Plateaus: Capitalism and Schizophrenia' by Gilles Deleuze and Félix Guattari)</p>
Mathematical insight	 <p>From a geometric standpoint, Newton situated the finite world within a hypothetical framework of absolute time and space, deducing complex phenomena from simplified models.</p>	 <p>From a mechanical standpoint, Leibniz posited that the universe is an infinite entity, with space and matter being inextricably linked. This perspective aligns more closely with the principles of relativity theory, quantum mechanics, and dynamic economic theory.</p>

Source: Compiled by MGSSI based on various materials

Modern rationalist thought, which presupposes the freedom of the individual's inner mind (spirit)<sup>10</sup>, conceptualizes human existence in opposition to God and establishes a social contract based on the general will, amalgamating the rational will of each individual. This is merely a hypothetical representation of the ego's integrity<sup>11</sup>. In reality, our interactions with the natural environment and our interpretations of language are as diverse as the myriad individuals who engage with them. For instance, Johann Sebastian Bach's exquisitely balanced church music arrangements<sup>12</sup> and YMO's<sup>13</sup> innovative synthesizer compositions, though

essence, contemporary rationalism directly engages with concepts that had previously remained unarticulated. Furthermore, Leibniz derived the binary principle from the I Ching, an insight that would eventually underpin the digital society characterized by binary code.

<sup>10</sup> In his *Discourse on the Method*, the philosopher René Descartes famously asserted "I think, therefore I am." Within the mechanistic worldview of his time, which included Galileo Galilei's astronomical observations, Descartes demonstrated that "I" existed prior to the objective structure of internal and external worlds, forming the foundation for humanity's confrontation with God and introducing the concept of the spirit's absoluteness. Building on this notion of "I," or ego, philosopher Immanuel Kant later developed his doctrines of transcendental idealism and empirical realism.

<sup>11</sup> French political philosopher Jean-Jacques Rousseau conceptualized the general will as a synthesis of individual and collective wills, advocating for the establishment of a government system grounded in a social contract that upholds this general will.

<sup>12</sup> Johann Sebastian Bach integrated *basso continuo* and counterpoint into church music, which traditionally consisted solely of harmonies, and thereby creating compositions that sustain emotional harmony through the interplay of tension and release with the inclusion of inharmonic notes. Political scientist Masao Maruyama employs the term "insistent bass" to describe the colorful repetition of the main melody in *basso continuo*, identifying similar elements within Japanese culture, which has assimilated influences from Chinese and European traditions.

<sup>13</sup> Yellow Magic Orchestra. The music, formed in 1978 by Haruomi Hosono, Yukihiro Takahashi, and Ryuichi Sakamoto. saw Sakamoto utilizing synthesizers to create sounds beyond the scope of Western chords. Influenced by composer Claude Debussy's innovative use of scales and harmony, as well as Erik Satie's incorporation of unconventional sounds such as pistol sounds into



unconventional, are widely appreciated. Contemporary philosopher Richard Rorty emphasized the importance of a spirit of tolerance towards diverse treatments and interpretations, rather than imposing one's own opinion, and highlighted the confusion within Western rationality between these concepts<sup>14</sup>. By extending this spirit of tolerance to nature, we can foster a partnership with the natural world, enabling sustainable coexistence and growth.

#### 2-4. Debunking the myth of “natural capital”

Professor Sullivan, as previously mentioned, highlights the issue that the term “natural capital” evokes the capitalist framework that we subconsciously internalize. The use of this term should be reconsidered, as it may influence subconscious perceptions when defining natural capital. The underlying premise is that we must re-evaluate the “ontological richness” inherent in the true essence of life and cultivate an appreciation for a broader spectrum of expressions that integrate cultural values.

### 3. INSTANCES IN JAPAN OF EXPERIENCING AND LIVING IN HARMONY WITH NATURAL CAPITAL, CONCEPTUALIZED AS “ONTOLOGICAL RICHNESS”

Japan, an island nation encircled by the sea, features a topography where approximately 70% of its land area is mountainous. The country is endowed with four distinct seasons, fostering a cultural ethos that deeply values nature, as evidenced by the integration of gardens and borrowed landscapes into daily life. During the Meiji era's industrialization and the post-World War II economic boom, traditional landscapes of white sand and green pines along the coastal areas were often supplanted by industrial sites and harbors. Similarly, *satoyama*-undeveloped woodlands near populated areas, which provided firewood and wild small animals for food before industrialization, were transformed into residential districts and golf courses. Despite these changes, numerous elements of traditional culture have been preserved.

#### 3-1. Case study of Ise Jingu Shrine, dedicated to Amaterasu, the Sun Goddess and mythical ancestress of the Japanese Imperial House

In principle, every 20 years, the main buildings of the two primary shrine complexes (inner and outer) and all 14 annex structures are meticulously reconstructed. This ancient Japanese custom is rooted in the wisdom of preserving traditional carpentry skills and ensuring the availability of suitable timber for the shrine's renewal. The ceremonial relocation of the shrine necessitates over 10,000 cypress trees, whose cultivation is intrinsically linked to the centuries-old forestry industry in the mountains surrounding the inner and outer shrines. The Ise Jingu Shrine thus exemplifies a harmonious coexistence with natural capital.

#### 3-2. Management of *satoyama* and other common land areas<sup>15</sup>

orchestral music, Sakamoto employed synthesizers to enrich chordal textures and integrate non-instrumental sounds (see NHK E-television's program, “Schola: Ryuichi Sakamoto's Music School”).

<sup>14</sup> American pragmatist and philosopher Richard Rorty distinguished among three types of rationality: (1) the capacity to effectively navigate one's environment, (2) exceptional human abilities that are presumed to be inherent, and (3) the capability to remain unperturbed by differences and to avoid aggressive reactions to such differences. He argued that Western tradition inadequately differentiate among these three forms of rationality.

<sup>15</sup> A right founded on joint ownership and collective labor, ensuring equal rights of all its members. [History of Common Land Membership and Membership Rights \(in Japanese, Masato Goto, 2019\)](#)

Figure 5: *Shikinen Sengu* at Ise Jingu Shrine



Source: [The Origin of Ise Jingu Shrine: How to Visit the Place of Spiritual Power and What is \*Shikinen Sengu\*? \(kyoumi.click\)](#)

In Japan's diverse topography, where rivers cascade from steep mountain ranges to the sea, forests have been meticulously cultivated. Rainwater traverses through layers of decaying leaves and soil before reaching the ocean, fostering a thriving fishing industry. This natural interplay has nurtured a cooperative ethos within communities, encompassing those in and around the mountains, forests, and coastal areas. *Satoyama*<sup>16</sup>, or traditional rural landscapes, have been collectively and voluntarily managed by local residents across the nations, even in sparsely populated regions.

### 3-3. Establishing green infrastructure at a principal metropolitan transit hub

With the advent of industrialized society characterized by mass production and consumption, the development of ports and urban centers accelerated, and automobile culture permeated rural areas. Consequently, land use increasingly diverged from natural landscapes, with the proliferation of roads and parking lots. In redevelopment projects, such as those around Tokyo's Shibuya Station<sup>17</sup>, considerations of sunlight, wind flow and human movement have enabled the creation of integrated landscapes where stations are connected to high-rise buildings through pedestrian bridges, and rooftop gardens are situated like roadside parks. This approach fosters a culture of walking and cultivates a sense of shared identity among regions.

Figure 6: *Satoyama* conservation movement



Source: [Yatsuda Restoration Project, Certified Non-Profit Organization, Asaza Foundation \(asaza.jp\)](#)

Figure 7: Creation of green space in station-front redevelopment project



Source: [Shibuya Redevelopment Information Site | Tokyu Corporation \(tokyu.co.jp\)](#)

## 4. RECONCEPTUALIZING NATURAL CAPITAL

This report proposes three frameworks for examining examples from Japan through the lens of contemporary rationalism, aiming to uncover the “ontological richness” inherent in the concept of “natural capital”.

### 4-1. Temporal frameworks are adjusted to align with the inherent growth rates of natural systems

Plants and trees exhibit varying growth rates depending on their species. In the context of Ise Jingu Shrine, after allowing the cypress trees to mature in the surrounding hills, only a moderate number are harvested for the shrine's reconstruction. Globally, prior to the British land enclosure movement<sup>18</sup>, humans coexisting with nature did not adhere to an absolute time scale measurable by a clock, nor did they possess the concept of internal rate of return (IRR), which calculates the present value of returns, including final value, after a specified period. The present value of a tree cultivated over a century could be assessed within a relative time frame, independent of human intervention, and aligned with the temporal framework of industrial product manufacturing.

<sup>16</sup> [Yatsuda redevelopment project, Mitsui & Co. Environment Fund](#)

<sup>17</sup> In the redevelopment of the area around Shibuya Station, design and development plans were meticulously formulated to incorporate rooftop greening on towering buildings and to account for wind impacts between structures. These plans align with the cityscape's natural slopes, originating from the station's valley location. This project aspires to create an urban environment that extends human sensory functions (refer to architect Hiroshi Naito's “*Environmental Design Lectures*”).

<sup>18</sup> Thomas More famously depicted the metaphor of sheep consuming humans in his 1516 work, *Utopia*. At the Industrial Revolution began, England's wool industry experienced significant growth, leading to a sharp increase in the price of sheep's wool. Consequently, feudal lords and landowners encroached upon and appropriated fields and common lands from tenant farmers. This displacement forced farmers to seek livelihoods as wage laborers in the burgeoning industrial handicraft sector.

## 4-2. Integrating advanced utilization of natural spaces with digital information systems

Following the dispute over the British Corn Laws<sup>19</sup>, international free trade in grains and industrial products expanded, leading to a decline in common land holdings alongside the land enclosure movement. While global food security increases food mileage and CO2 emissions, transportation costs as a percentage of GDP do not directly correlate with increased food production costs. It would be prudent to consider establishing a system that ensures a certain level of food self-sufficiency at the local and national levels<sup>20</sup>, fostering a multilayered, membership-like communal relationship. For globally utilized food ingredients, production management information, collected under diverse circumstances both at the time of measurement and throughout the measurement period, could be digitized and shared. By leveraging digitized knowledge, regional plant factories<sup>21</sup> could be established to cultivate globally popular foods in appropriate volumes, thereby reducing food loss and optimizing the use of natural space.

## 4-3. Development of urban social infrastructure that seamlessly integrates natural elements

Social infrastructure necessitating long distances travel or commuting for people and wide-area transportation of goods imposes significant maintenance and management costs on municipalities and results in substantial CO2 emissions. By reducing CO2 emissions through intermodal transportation<sup>22</sup> and preserving nature through the construction of high-rise buildings surrounded by parks, strategically located near workplaces and residential areas, alongside the development of infrastructure such as ports and stations, we can pave the way towards a sustainable and environmentally friendly world.

Professor Sullivan's assertion that natural capital is not merely a construct devised by accountants offers a welcome reprieve for contemporary individuals who still adhere to modern thought. This perspective deeply resonates with the Earth. By adopting the viewpoint that humans and nature grow together, rather than relying on indicators that measure how humans have dominance over nature, it becomes possible to ensure the richness of coexistence with natural world.

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<sup>19</sup> In the 19th century, economists Thomas Robert Malthus and David Ricardo engaged in a notable debate over the abolition of the Corn Laws, which regulated the import and export of grains. The core of their dispute centered on the distribution of wealth within both the international specialization system and the grain self-sufficiency system, as well as among different social classes. This debate ultimately paved the way for free trade to gain prominence, aligning with Ricardo's arguments.

<sup>20</sup> [https://www.maff.go.jp/j/zyukyu/zikyu\\_ritu/013.html](https://www.maff.go.jp/j/zyukyu/zikyu_ritu/013.html) In 2020, food self-sufficiency rates on a calorie supply basis exceeded 100% for Canada, Australia, the US, and France, and surpassed 50% for Germany, the UK, and Italy. However, Japan's rate was only 38% in FY2022, according to estimates by the Ministry of Agriculture, Forestry and Fisheries based on figures of the UN Food and Agriculture Organization.

<sup>21</sup> Plant factories, which systematically cultivate plants in closed or semi-closed environments using sensors to monitor light sources, temperature, humidity, and CO2 concentration, typically incur higher production costs compared to natural cultivation. However, there is potential of widespread adoption of such factories when considering the final demand location's prices, including transportation costs.

<sup>22</sup> Intermodal transportation refers to a system that seamlessly integrates multiple modes of transport, such as railcars, trucks, ships, and bicycles, to optimize the efficiency and effectiveness of moving goods and passengers.