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REPORT

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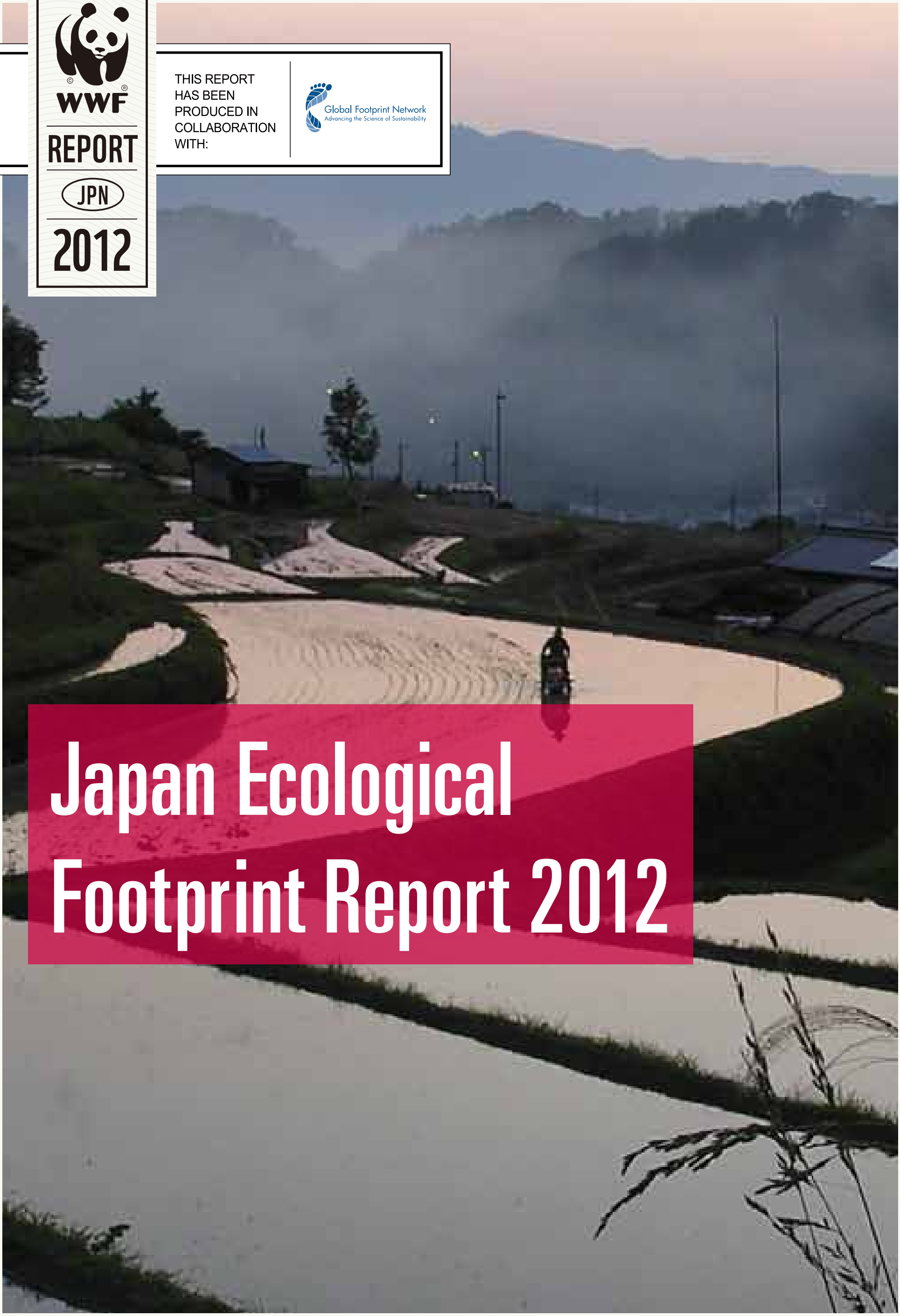

Japan Ecological Footprint Report 2012

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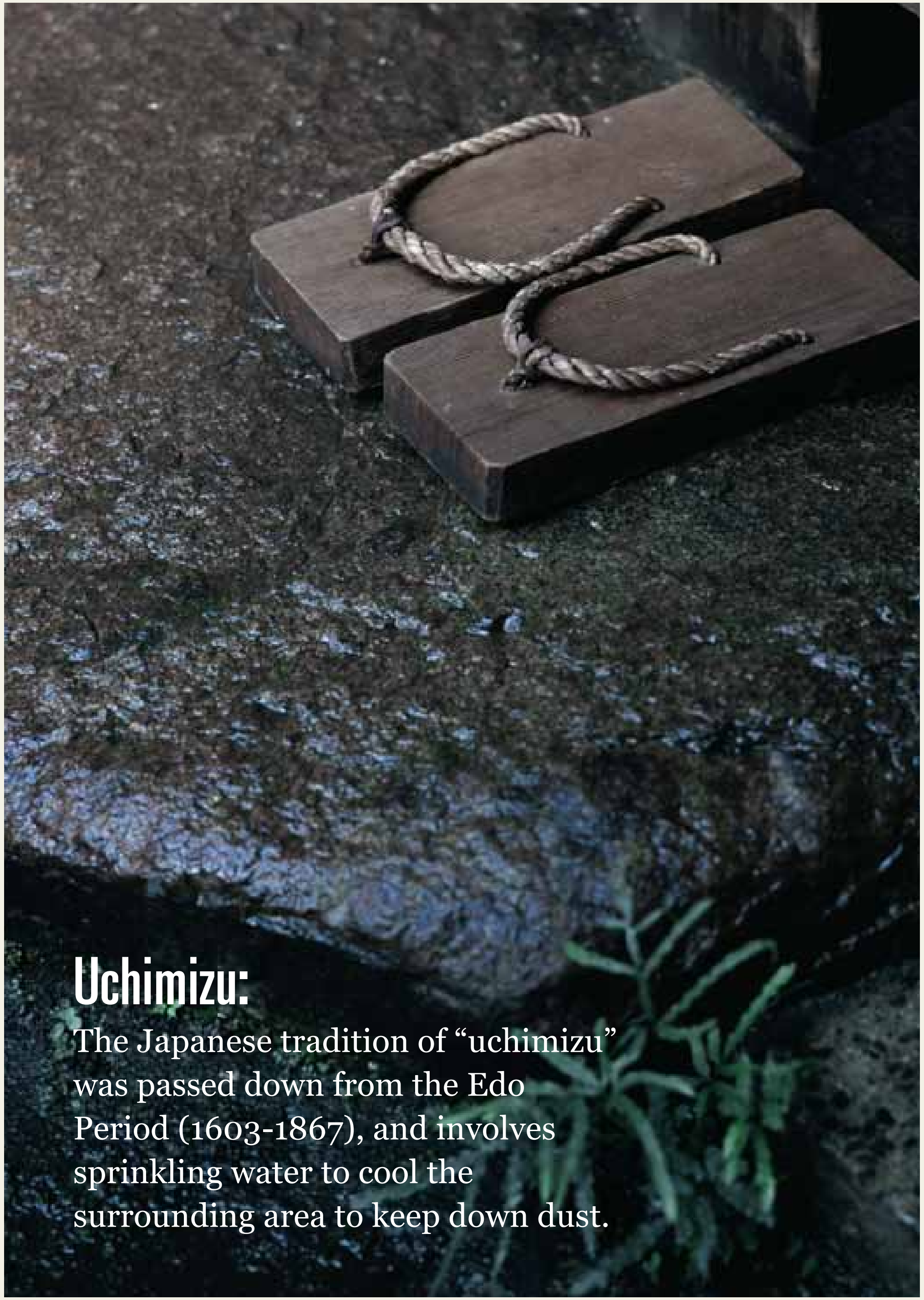


Uchimizu:

The Japanese tradition of "uchimizu" was passed down from the Edo Period (1603-1867), and involves sprinkling water to cool the surrounding area to keep down dust.

The goal of humanity living in harmony with nature is
in direct contrast to the goal of today's global economy.

No one can guarantee peace and prosperity
for all through their individual actions.
But, together, we can make a true,
and positive, difference in the world.

徳川恒孝

Tsunenari Tokugawa Chairman, WWF Japan

Biocapacity

All life on Earth rely on one basic biological relationship in the biosphere: Energy from the sun to the Earth. When this energy interacts with water and carbon dioxide, it is converted to photosynthetic organisms that fuel the growth and regeneration of our plants – the ecological assets that we rely on for basic needs, such as food, clothing and shelter, as well as the absorption of carbon. Thus, this biological process creates our "supply" of ecological services, the measurement of which we call "biocapacity".

→Please refer to Biocapacity in the Explanatory Note (General) for further information.

Ecological Footprint

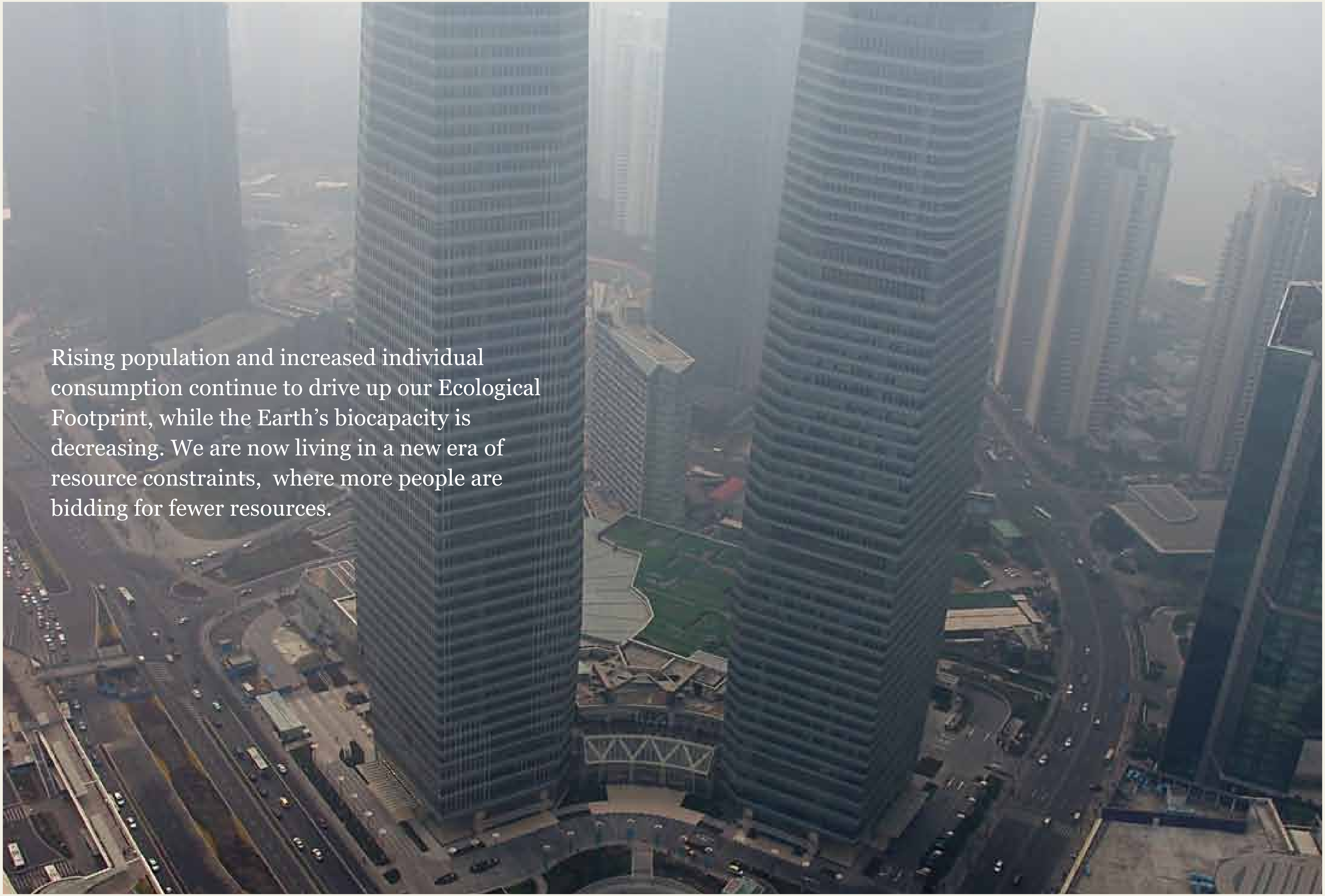
While biocapacity measures the supply of ecological assets, the Ecological Footprint measures humanity's demand. More specifically, it measures ecological assets that a population requires to produce all the renewable resources it consumes, and to absorb all the carbon it emits, in a given time period.

→Please refer to Ecological Footprint in the Explanatory Note sections for further information.

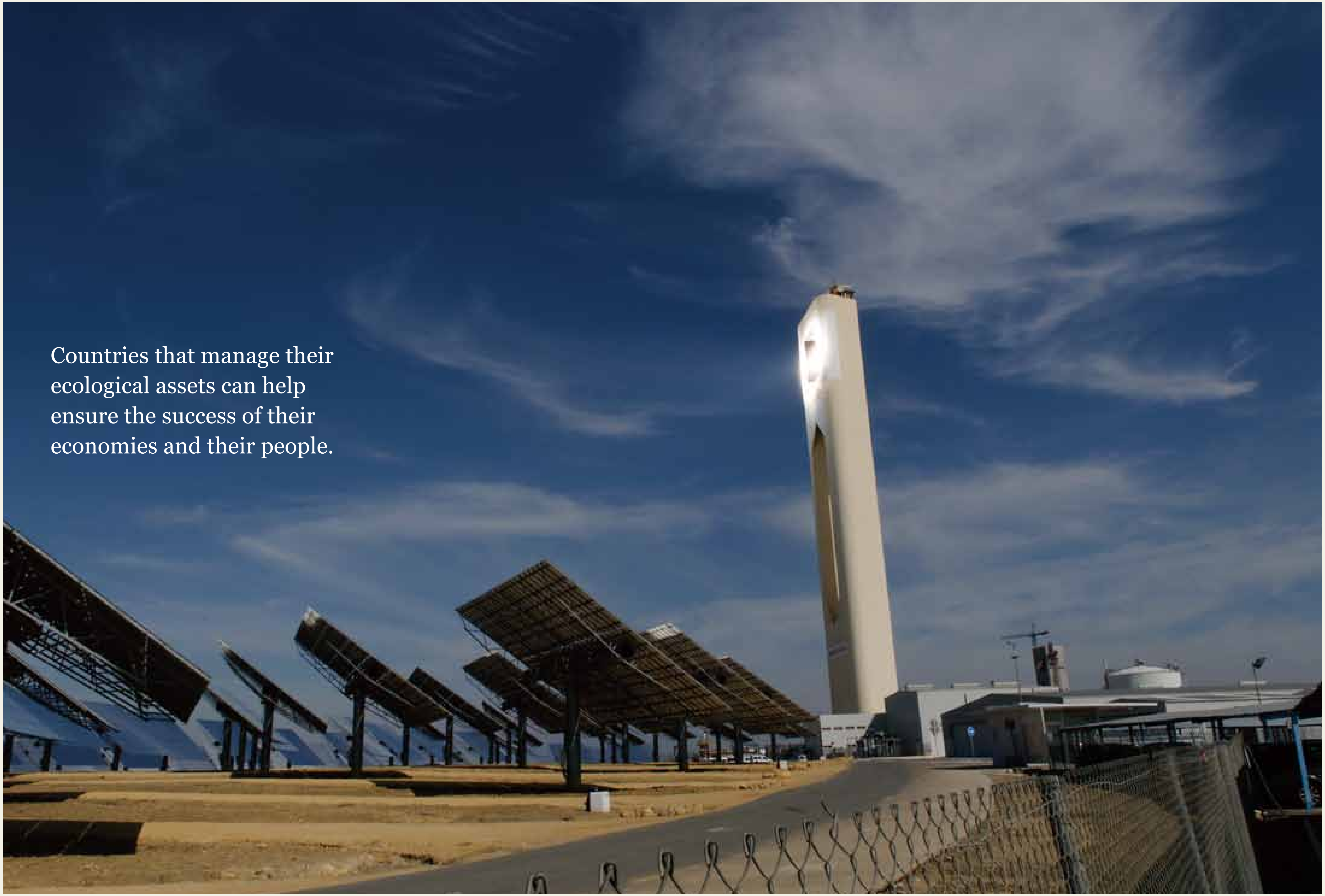
Ecological Overshoot

Since the 1970s, humanity has been in ecological overshoot, meaning that its annual demand on renewable resources exceeds what the Earth is able to provide in the same given year. This is the result of an infinite-growth economy running into a finite planet. Consequences of this “overspending” lead to the depletion of natural capital, and sign s of collapse, which can already be seen today through climate change, depleted fisheries and deforestation, among other major environmental challenges today.

→Please refer to overshoot in the Explanatory Note sections for further information.



Rising population and increased individual consumption continue to drive up our Ecological Footprint, while the Earth's biocapacity is decreasing. We are now living in a new era of resource constraints, where more people are bidding for fewer resources.



Countries that manage their ecological assets can help ensure the success of their economies and their people.

Japan is highly dependent on biocapacity from other countries to support its population's needs. If its trading partners are also in ecological debt, Japan is vulnerable to a disruption in its resource supply. This highlights the crucial need for governments to manage their use of ecological assets.

1. Historical Snapshot of Japan (1961-2008)

Japan's Ecological Footprint

Overview

- Since the 1980s, Japan's Ecological Footprint has grown increasingly dependent on the use of foreign biocapacity to meet its population's demands. This reliance exposes Japan to supply disruption and price volatility, and complicates its ability to implement policy in response to these risks.

- The main driver behind past increases in Japan's Ecological Footprint is carbon emissions. By the 1990s, Japan's carbon Footprint had grown to nearly 3 times higher than what it was in 1961.

- Japan has shown success in reducing its Ecological Footprint (both total and per capita) since the mid-1990s. However, the country's Ecological Footprint remains high – a situation that is ultimately not sustainable. Yet Japan has an opportunity to reverse this trend, achieve sustainable development, and serve as a model for the region and the world. Doing so will require leadership, pro-active decision-making by government officials and ministers, and aggressive environmental and economic policy shifts to manage its ecological assets and its contribution to climate change risk.

In three decades,
Japan tripled the size of its carbon Footprint

With each year,
the world continues to face increasing environmental challenges
– 2012 was no different.

Japan is taking action to mitigate these challenges and create a model of sustainable society by drawing on its unique historical knowledge, and combining it with today's technology and human resource.

Phases of Japan's Ecological Footprint trend

Phase 1 (1961-70s) : Rise and fall of Japan's Ecological Footprint

In 1961, the first year for which the Ecological Footprint was calculated, Japan was one of only a few countries that had already exceeded local biocapacity, meaning Japan's demand on its natural resources exceeded what was available domestically. Through the 1960s and 1970s, Japan's Ecological Footprint increased as quickly as its Gross Domestic Product (GDP). Its Footprint then declined in response to the oil and energy crises of 1973 and 1979.

Background: During the 1960s and 1970s, Japan experienced rapid growth at an average rate of 10 percent and 5 percent per year, respectively. In 1968, Japan became the second-richest country in the world in terms of total GDP. Its residents enjoyed subsequent improvement in their quality of life. The population expanded, with the majority living in, or migrating to, urban areas. The oil crisis encouraged Japan to shift to more efficient use of energy and other products.

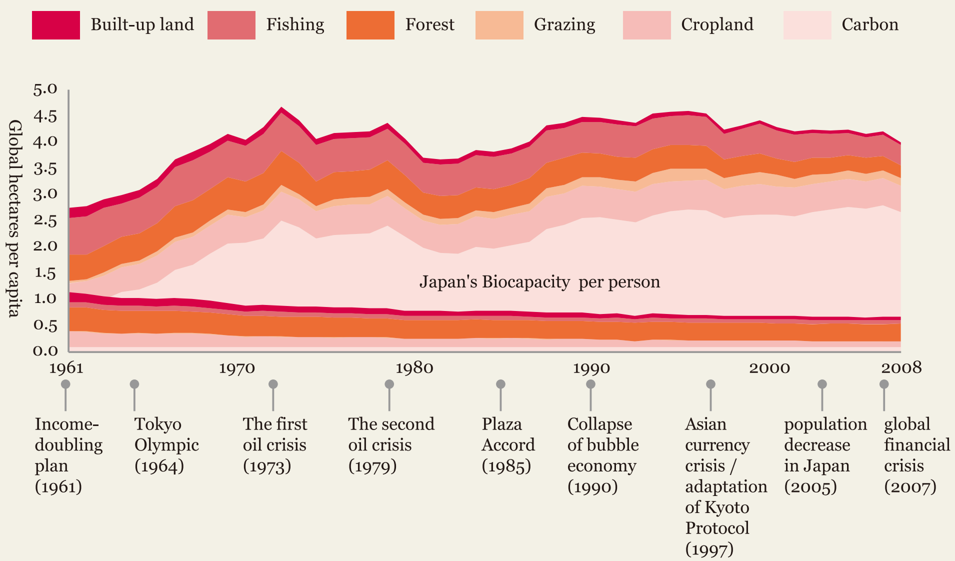
Phase 2 (1980s-early 1990s) : The second increase of Japan's Ecological Footprint

By the 1980s, Japan had already achieved national standards of living that met the basic survival necessities of its population -- including access to resources for food, shelter, health and sanitation. But, largely as a result of its growth, Japan's Ecological Footprint per person continued to grow, which led to a second phase of rapid increase in its total Ecological Footprint. To meet these resource demands, Japan became more dependent on foreign biocapacity, to the point that nearly 40 percent of its overall biocapacity consumption was met through trade.

Background: By the early 1980s, most of Japan's population had achieved a sufficient quality of life (called the "over 90 percent middle-class population"). However, consumption well beyond basic needs and poor investment during the late 1980s led to a collapse of the "bubble economy" in the early 1990s.

In the 1990s, Japan was dependent on foreign biocapacity for nearly 40 percent of its resource needs

Japan's Ecological Footprint per person



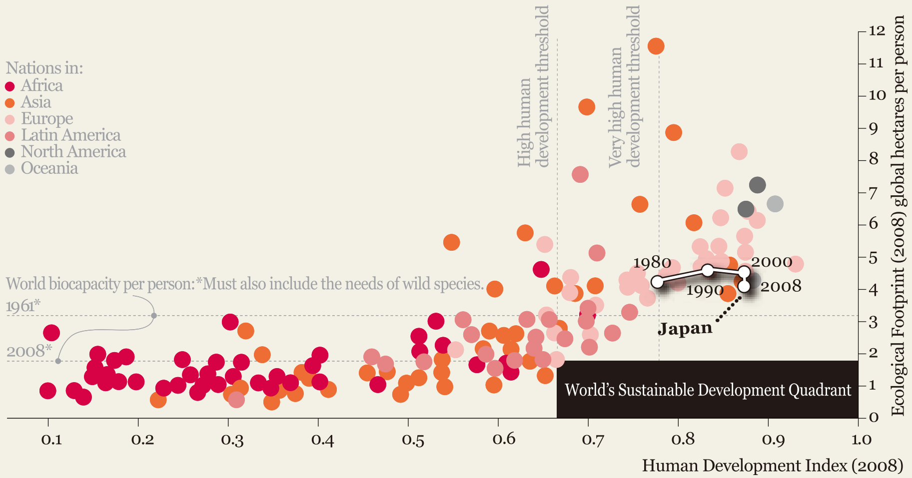
Phase 3 (1990s-current) : Reversing the course

Japan was able to reverse the trendof its Ecological Footprint after its per capita Footprint peaked in the mid-1990s. Since then, Japan has reduced its Footprint and its dependence on foreign biocapacity has also gradually declined. Japan can build on this progress by further reducing its Ecological Footprint through innovative policy shifts.

Background: Japan tightened and improved its environmental legislation in the 1990s. The OECD's Environmental Performance Review of Japan in 2002 stated that "the mix of instruments used to implement environmental policy is highly effective." Economically, Asian countries became increasingly important trade partners, a trend beginning in the late 1980s. Demographically, Japan currently faces a low birthrate and an aging population.

After the collapse of the 1980s "bubble economy," Japan reversed its Footprint trends

HDI : Development and biosphere demands



Japan ranks among the top countries in HDI

National progress toward meeting development goals can be assessed by using the United Nations' Human Development Index (HDI), which aggregates education, longevity and income into one number. UNDP defines an HDI score of 0.7 as the threshold for high development. The biocapacity available on the planet is calculated as 1.8 gha per person. Combining these two thresholds gives clear minimum conditions for globally sustainable human development. Countries in the lower right-hand box represent high levels of development within globally replicable resource demand.

Japan has shown much success in the area of human development. It ranks among the top countries in HDI over the last 30 years, with a healthy population, widespread education, and high income per capita.

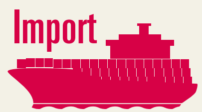
Additionally, Japan has been able to increase its residents' HDI with minimal growth in its per capita Ecological Footprint, suggesting an increase in the efficiency of delivering welfare. This is a major achievement, as most countries today do not meet both minimum requirements.

However, Japan's consumption of natural resources is demanding more biocapacity per person than is globally available, and the world's growing population is increasing that discrepancy.

It is not enough for Japan to look back on its prior success in increasing development; it needs to look forward to an increasingly biocapacity-constrained future and how best to maintain the well-being of its economy, environment and its people.

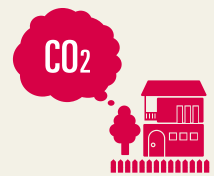
A summary of Japan's 2008 Ecological Footprint

•In 2008, the most recent year for which data is available, Japan's per capita Ecological Footprint was 4.17 gha. Japan was ranked 37th highest at the global level, with its Footprint about 1.55 times the world average of 2.7 gha. In comparison, the average per capita Ecological Footprint in the BRIICS countries (Brazil, Russia, India, Indonesia, China, and South Africa) was 1.74 gha, and the average in ASEAN countries was 1.54 gha. Those averages were 42 percent and 37 percent of Japan's Ecological Footprint, respectively. At 64 percent, Japan's carbon Footprint was the largest component of its overall Footprint, followed by cropland (12 percent) and fishing grounds (9 percent).



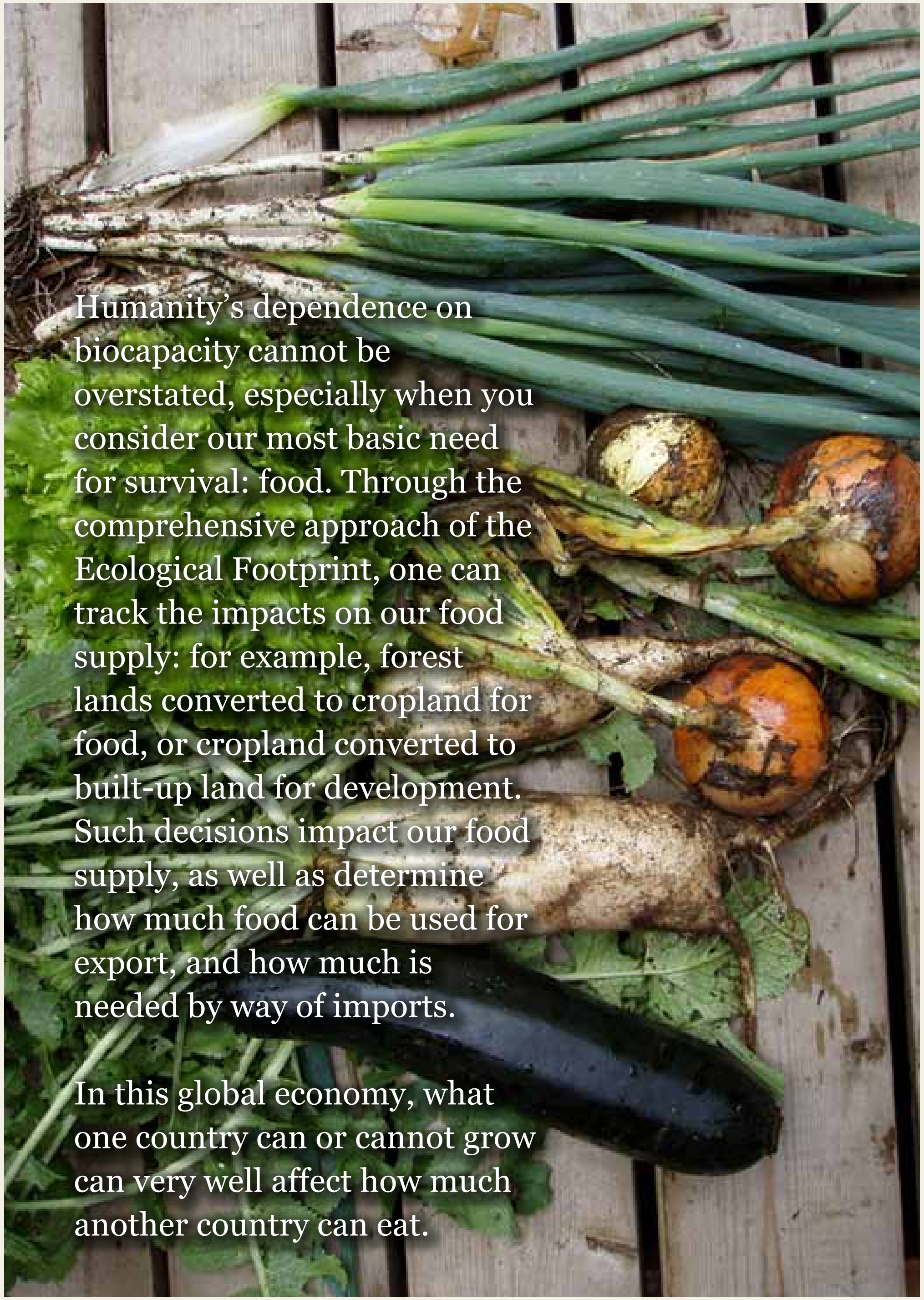
•Approximately 36 percent of Japan's total demand on resources (domestic and imported biocapacity) relied on the biocapacity of other countries. Nearly half of Japan's imported Ecological Footprint is in carbon (47 percent), followed by cropland (24 percent) and forest land (11 percent).

•If everyone in the world lived the same lifestyle as the average Japanese citizen, we would need the equivalent of 2.3 planets.



•At the final demand category level, household consumption is the main contributor, which accounts for approximately 66 percent of Japan's total Ecological Footprint. This means decisions made at the household level can greatly impact the country's overall Ecological Footprint. Among the household components, the food Footprint is the major driver (see 3-2 for further detail).

If everyone in the world lived as the average Japanese citizen, we would need the equivalent of 2.3 planets



Humanity's dependence on biocapacity cannot be overstated, especially when you consider our most basic need for survival: food. Through the comprehensive approach of the Ecological Footprint, one can track the impacts on our food supply: for example, forest lands converted to cropland for food, or cropland converted to built-up land for development. Such decisions impact our food supply, as well as determine how much food can be used for export, and how much is needed by way of imports.

In this global economy, what one country can or cannot grow can very well affect how much another country can eat.

2. Food Footprint.

Overview

The demand for, and availability of, biocapacity is critical to many aspects of the lives of the Japanese people, particularly their food. In this time of increasing resource constraints, the security and integrity of any country's food supply is one of the most dominant concerns of their population and policy-makers. Food shortages around the world have often led to social unrest, and rising food prices affect everyone, especially those on low and/or fixed-incomes, such as the elderly.

Historically, distribution of food among the world's population has been a dominant concern. But while progress has been made in these distribution efforts, the amount of overall food supply has become a growing challenge due to increasing resource constraints.

Japan's food supply is highly susceptible to movements in the global market and other nations' agricultural policies

Countries that produce a lot of food domestically can be somewhat shielded from risks to food supply. Policies such as agricultural export restrictions can partially safeguard countries from rapidly rising food commodity prices, yet exacerbate the problem in countries to which they usually export.

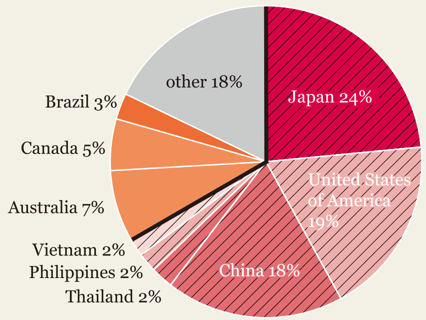
Nearly 20 percent of Japan's Ecological Footprint is associated with the consumption of food. Since Japan's biocapacity is only 14 percent of its Ecological Footprint of consumption, even if the whole productive base of the country were given over to food production, it would still be unable to supply its own demands.

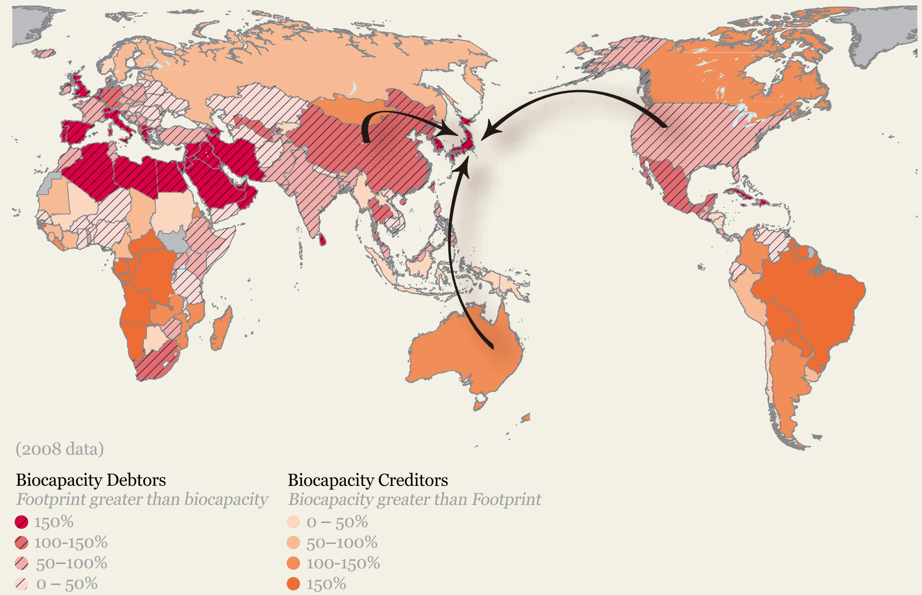
Consequently, Japan's food supply is highly susceptible to movements in the global agricultural market and the agricultural policies of other countries; the supply is at risk unless steps are taken to minimize demands and maximize the resilience of supply.

Importing biocapacity for food consumption

Input biocapacity for food consumption

Figure 1. The breakdown of biocapacity inputs into the Japanese food economy by country. Of these inputs, 99 percent is consumed domestically, while 1 percent is exported. Each country is colored by its creditor-debtor status: red = Ecological Footprint of consumption greater than biocapacity; orange = Ecological Footprint of consumption less than biocapacity.





Japan's top three sources of food are all in biocapacity deficit

Japan produces only about 24 percent of the biocapacity required for its food consumption, with 76 percent reliant upon imported biocapacity. Japan's top three sources biocapacity for food, the United States (19 percent), domestic production (24 percent), and China (18 percent), are all in biocapacity deficit. Although a biocapacity deficit does not directly imply that these sources will be unable to supply food to Japan in the near future, the reliability of the supply will likely be under greater constraints than in countries with an ample biocapacity remainder. This is especially true should mechanisms to restrict carbon dioxide emissions be put in place, as this will greatly impact resource trade flows. Restrictions on carbon emissions, as well as a rise in fossil fuel and increased production costs would likely lead to a rise in the cost of imports. Countries' and citizens' ability to pay these higher costs will also be a determining factor in whether they can secure these resources.

Japan's next three major sources of food biocapacity imports — Australia (7 percent), Canada (5 percent), and Brazil (3 percent)— currently have a biocapacity remainder. Brazil has the largest total biocapacity available of any country in the world; however, it is almost exactly on the opposite side of the planet to Japan, with obvious substantial carbon Footprint implications for transporting food to Japan.

On average, the shipping distance of food imported into Japan is about 4500 miles, approximately the direct distance between Tokyo and Moscow. Since Japan imports over 50 million tonnes of food per year, carbon dioxide emissions just from the maritime shipping of food (ignoring the transport of food to and from sea ports) into Japan corresponds to an Ecological Footprint of about 800,000 global hectares.

Japan is highly unlikely to ever become self-sufficient in food production; even increasing production from current levels could risk domestic resource degradation. However, close regional sources of food imports, such as China, are rapidly increasing their own domestic consumption. The maintenance of a secure supply of food is thus likely to become ever more challenging in the future.

Adequate nutrition in a resource-constrained world

The per capita Ecological Footprint associated with demand for food varies greatly across the world. Austria leads the world in the quantity of calories available for each resident (3,800 kcal), which is closely followed by the United States (3,700 kcal). Conversely, Haiti and a number of countries in sub-Saharan Africa have significantly less than 2,000 kcal available per person. Japan has 2,700 kcal available per person.

The nature of the diet (especially the amount of meat consumed) and the amount of food consumed per capita are also important in determining the demand on the biosphere.

On average, on an equal calorie basis, consumption of animal products has an Ecological Footprint about 14 times greater than consumption of vegetable products (on an equal protein basis, this diminishes to 4.5 times greater). The combination of differing caloric quantities, diet composition, and indirect biosphere demands leads to a wide divergence in the Ecological Footprint associated with food consumption across the world, from 0.3 gha per capita in Mozambique, to more than 2.0 gha per capita in Denmark. Japan's food Footprint is mid-way between these two extremes – at approximately 0.8 gha per capita.

It is important to note that in many countries, a small food Footprint reflects widespread undernourishment. In Mozambique, for example, 38 percent of the population is estimated to be undernourished. Figure 2 shows the relationship between the food Footprint and caloric supply.

While countries with a very low level of food supply have a small food Footprint, there is wide variation in Ecological Footprints among countries with high supply, implying there is room for improvement. For example, Costa Rica has less than 5 percent undernourishment, but a dietary Ecological Footprint of 0.6 gha per capita (less than one- third of that of Denmark). Some countries still exhibit potential issues with internal distribution of food; China, for example, has more than 3000 daily kcal available per person but 10 percent of Chinese residents get less than the required 1800 kcal.

Japan's food Footprint falls toward the middle of countries with very low levels of under-nutrition, suggesting there is still potential for improvement. However, the relatively low average kcal available per person, 2780, highlights an egalitarian distribution of nutrition among the population.

Diet and the amount of food consumed per capita are important in determining demand on the biosphere

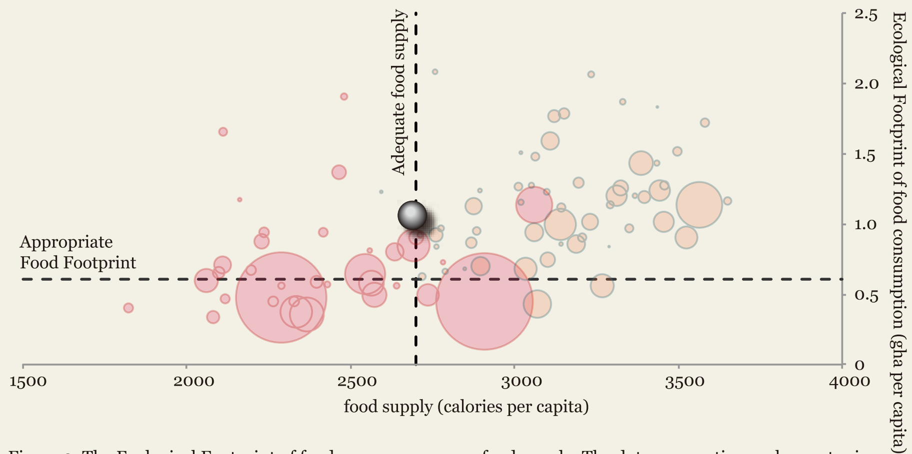
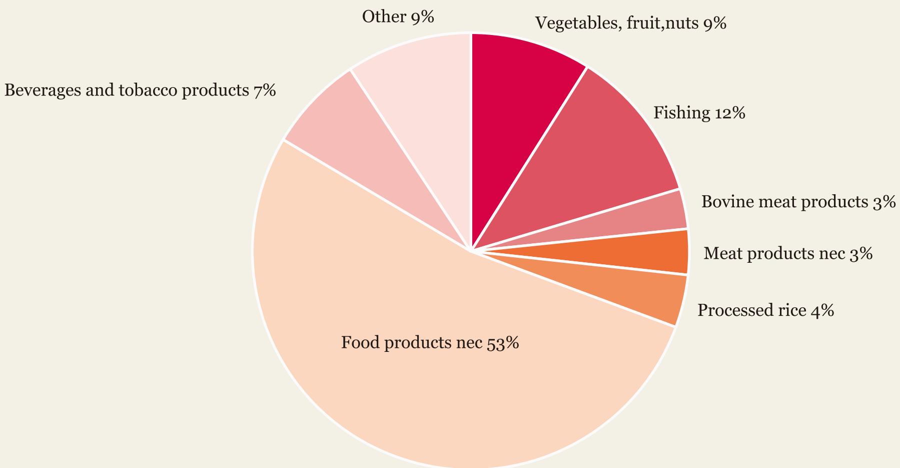


Figure 2. The Ecological Footprint of food per person versus food supply. The dot representing each country is sized according to its population and colored according to its prevalence of undernourishment [Orange: less than 5 percent of the population has less than 1800 kcal per day; red: more than 5 percent of the population has less than 1800 kcal per day]. Japan is highlighted in grey. The dotted lines represent i) the current minimum average caloric supply required for less than 5 percent undernourishment across all countries; ii) the Ecological Footprint of food in Costa Rica.

BOX

Marine Stewardship Council (MSC) is an independent, non-profit organization set up to find a solution to the problem of overfishing. It is a leading certification programme for sustainable seafood in the world, and WWF is promoting the uptake of this certification scheme. Consumer demand for certified sustainable seafood can act as an extremely powerful incentive for better fisheries management.

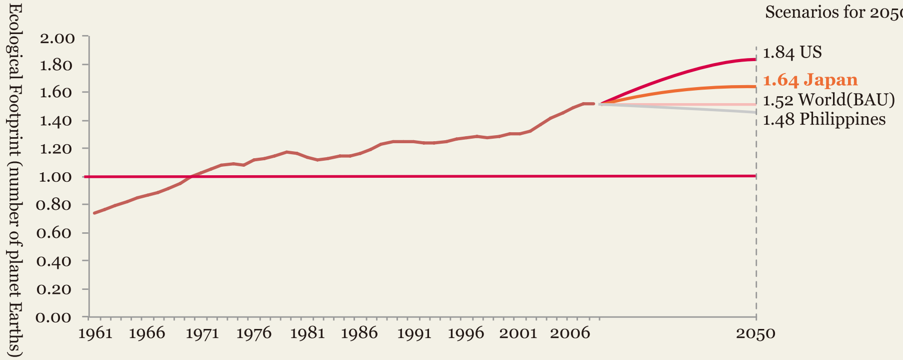
Commodity level analysis for food consumption



The majority of Japan's food Footprint (with regard to output from a specific sector) is associated with the "fishing" sector (11 percent). Large contributions also come from the "vegetables, fruit, nuts" sector (9 percent) and the "beverages and tobacco" sector (7 percent). The percentage breakdown by each sector into demands for various land-use types varies widely across sectors: The outputs from the "dairy products" and "sugar" sectors are each composed of about 30 percent demands for carbon uptake land; demands for the output from the "cereal grains" sector are only comprised of 2 percent demands for carbon uptake land.

If everyone had a diet the same as an average Japanese citizen's diet, the global EF would be unsustainable 1.64 planets.

Food scenario : If everyone had the same diet as an average Japanese citizen



The use of scenarios helps us understand what the world in the future "might" look like based upon changes to assumptions. Here, we investigate the different pathways of the global Ecological Footprint by focusing on food consumption patterns in Japan, the United States, and the Philippines.

The scenarios show that if everyone in the world had a diet the same as an average Japanese citizen's diet, the planet's global Ecological Footprint would be an unsustainable 1.64 planets, which is 8 percent higher than the (also unsustainable) current world average diet (1.52 planets). By comparison, the equivalent of the diet of an average Philippine resident would need just under 1.48 planets.

As wealth increases, people consume more calories, especially from animal- based products. If everyone in the world had an average American diet, a projection of the global Ecological Footprint would reach 1.84 planets by 2050, which would be12 percent higher than if based on an average Japanese diet; 21 percent above the world average; and 20 percent higher than for an average Philippines diet.

A range of possible outcomes from different diet assumptions shows that whichever pathway we take, our present track is unsustainable, and more and more pressure is being placed on the planet. However, we can mitigate the risks shown in these scenarios by reducing demand on biocapacity, particularly through our diet choices. Managing ecological assets and investing in increasing the quantity and quality of current biocapacity will also help ensure a sustainable existence.

Ensuring Food Security

Japan’s food supply is highly dependent upon imported biocapacity from other countries, and, like Japan, many of these countries are also in a state of biocapacity deficit. Additionally, Japan’s domestic production of biological resources alone (excluding demands for waste absorption) exceeds the country’s biocapacity. Together, these factors increase the risk of food supply disruption.

Encouragingly, Japan does not have a large food Footprint relative to similarly well-nourished countries. Among countries reported by the UN’s Food and Agriculture Organization as having less than 5 percent undernourishment, Japan requires the fewest calories per capita. However, Japan relies heavily on the consumption of fish products.

Eliminating food waste alone could help reduce Japan’s dietary Footprint by about 25 percent

Steps that can be taken to ensure food security includes bolstering domestic production through careful land management and avoidance of degradation; diversification of food imports within the local region; and reducing food waste. Eliminating food waste alone could help reduce the Japanese dietary Ecological Footprint by approximately 25 percent.

In an ever-more resource-constrained world, ensuring the supply of food is of growing concern to countries around the world. Japan has the potential to increase its security of food supply, and thus ensure the future well-being of its citizens, by taking concrete steps to improve the reliability of supply and reducing the Footprint associated with the consumption of particular types (and quantities) of food.

3. CLUM comparison

What is the CLUM analysis?

As human impacts on the natural world increase — that is, for food production and trade — there are increasing calls to understand the driving forces behind these impacts and ways to reduce them. The Consumption Land Use Matrix (CLUM) approach can translate land-based Ecological Footprint results into three specific final demands: household consumption (HH), government consumption (GOV), and gross fixed capital formation (GFCF). The household component is further broken down into five categories: food, housing, transport, goods and services.

The CLUM approach provides the basic data to identify Ecological Footprint hotspots, which enables government and private sector decision-makers to focus on potential areas and strategies to reduce overall Footprints.

Average CLUM :
World, G7, BRIICS, ASEAN, and Japan

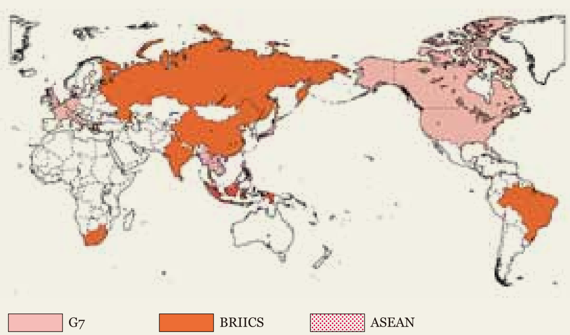
Japan's per capita Ecological Footprint is 55 percent higher than the world average, 140 percent higher than BRIICS and 171 percent higher than ASEAN countries. However, Japan's per capita Footprint is 27 percent less than the average G7 countries', of which Japan is a member. This is mostly due to the United States' high per capita Ecological Footprint and its relatively large population size, which drives up the G7 average.

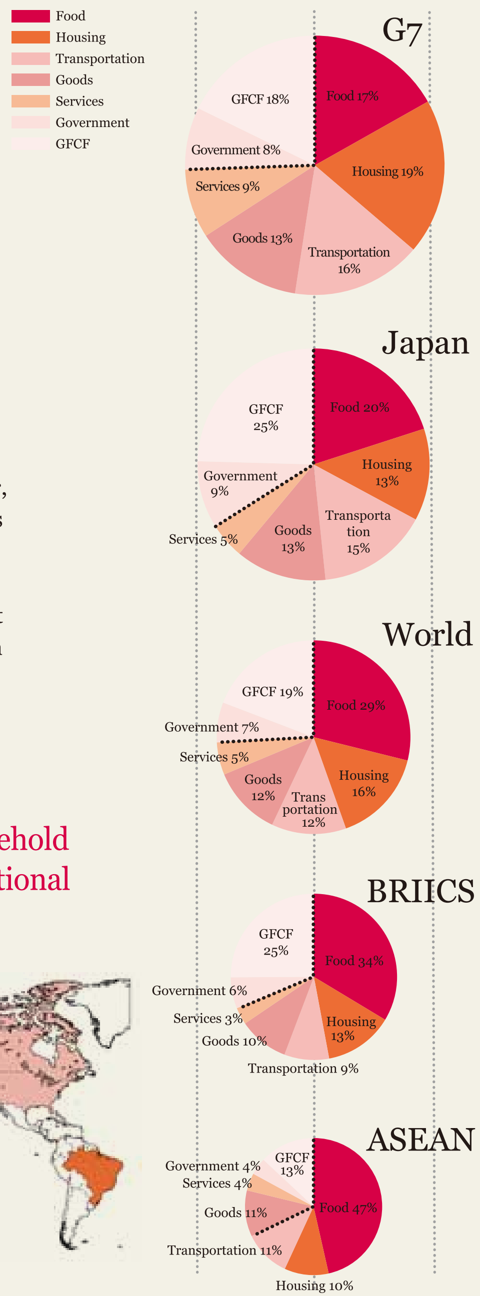
The rapid economic expansion and high population growth among BRIIC countries, along with an increasing average consumption per person, are also exacerbating challenges for global sustainability.

By looking at the final demand category level, the main contributor of the Ecological Footprint among all regions comes from household consumption, accounting for 66 to 83 percent of countries' total Ecological Footprints. This means that daily decisions made at the household level have the power to change the course of national Ecological Footprint trends.

In a breakdown of the household component, the food Footprint is a major driver of the total Ecological Footprint. The food Footprint percentage of the total Ecological Footprint for BRIICS and ASEAN countries are much larger compared to Japan and G7 member countries. In the absolute values, however, G7 and Japan have higher food Footprints than BRIICS and ASEAN countries: 0.96, 0.84, 0.59, and 0.71 gha, respectively. As described in Chapter 2, the food Footprint is a key component for the transformation toward a sustainable future for Japan. Strategies to leverage this opportunity should vary depending on regional status.

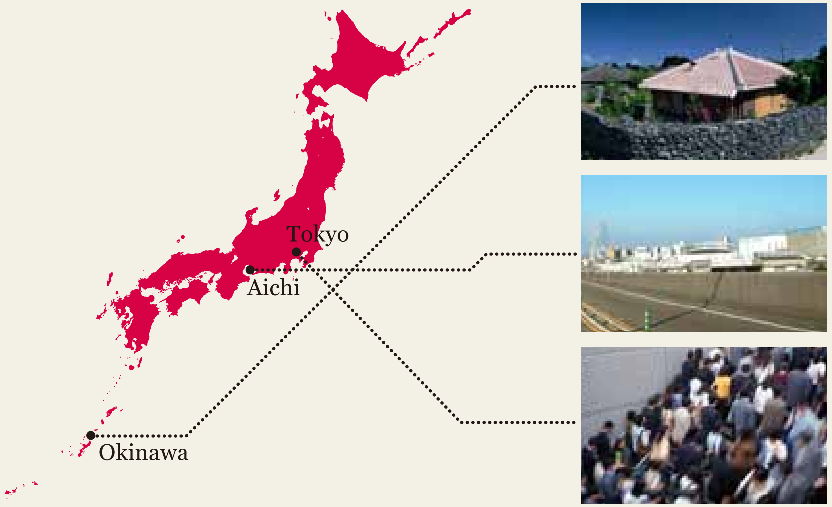
Daily decisions made at the household level can change the course of national Ecological Footprint trends





Regional CLUM : Tokyo, Aichi, and Okinawa prefectures

Japan's Ecological Footprint can be analyzed on a regional basis, which shows considerable variation between different provinces. Differences in lifestyle, economic structure, and the carbon Footprint required to generate each unit of electricity (called the electricity Footprint intensity), as well as geographical and cultural differences, affect the Ecological Footprint. To illustrate these differences, Figure # shows Japan's per capita Ecological Footprint, as well as the provincial per capita Footprints of Tokyo, Aichi, and Okinawa prefectures.



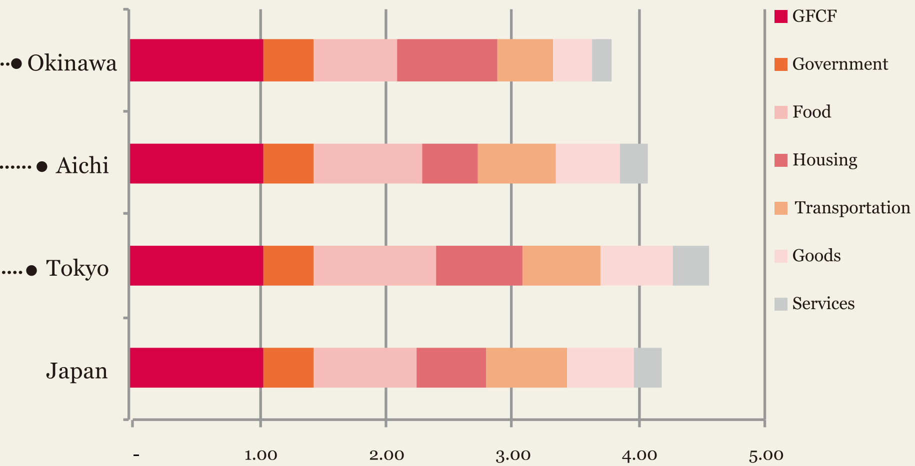
Tokyo has the highest per capita Ecological Footprint, which is approximately 9 percent higher than Japan's average. Aichi has a per capita Ecological Footprint 2 percent below the national average. Okinawa's per capita Ecological Footprint is 9 percent below the national average, but, significantly, its housing component is higher than that of both the other two prefectures and of the national average.

Okinawa's high energy intensity is the main driver behind its high housing Footprint, approximately double that of the other provinces. The variation in housing Footprints are largely influenced by each province's level of nuclear power dependency. As mentioned above, a province's Ecological Footprint is largely impacted by the carbon Footprint required to generate its electricity. (In 2011, nuclear power provided 12 percent of Aichi's total electricity, and 27 percent of Tokyo's. Okinawa had no dependence on nuclear power.).

Tokyo's food Footprint is 17 percent higher than the national average.

All three prefectures have a higher total Ecological Footprint than the global, BRIICS, and ASEAN averages.

To reduce regional Footprints, it is important to understand the complex connections between international and inter-provincial supply chains and consumption patterns. Unique provincial features, such as geographic conditions and culture, also play an important role. These variations demonstrate the need for the adoption of regionalized Ecological Footprint assessments to wisely manage ecological assets. Maintaining and enhancing biocapacity— especially at a regional scale — is critical for achieving sustainable standards of living and food security.



Managing biocapacity at a regional scale is critical for achieving sustainable standards of living

4. A Case study : Impact on Biocapacity by Fukushima Nuclear Power Plant Accident

Overview of the 2011 nuclear disaster

When addressing the Ecological Footprint and biocapacity of Japan, especially in terms of future scenarios, the 2011 Fukushima nuclear disaster cannot be ignored. Through data and analysis, which is described in this chapter, this report highlights the impact that The disaster has caused on biocapacity in Japan. It is important to remember, however, that the impact on biocapacity shortly after the event is only a snapshot of the potential long-term effects of the disaster. We have yet to realize the true impact on biocapacity over time, which further underscores the need to incorporate ecological limits into policies, decisions and investments made today.

To understand the true fragility of our natural assets, one need only look at the rapid sequence of events on March 11,2011. The Tohoku region of Japan was hit by a powerful earthquake at 2:46 pm, followed by enormous tsunami waves. Huge areas of the country, including the Kanto region, were severely affected.

The Tokyo Electric Power Company' s Fukushima Daiichi nuclear power plant had six reactors, four of which faced serious problems due to a failure in cooling systems and spent fuel storage pools. Meltdown and melt-through, followed by reactor explosions, took place. A large amount of radioactive particles has been released from the reactors since the disaster, and large areas of Japanese land and water have been contaminated.

© Air photo service

The Ecological Footprint can be useful in measuring the impact that Japan's nuclear accident had on its biocapacity. It will also be a useful tool in developing and benchmarking policies and investments as Japan considers its way forward.

Impacts to biocapacity due to the Fukushima nuclear disaster

A number of serious ecological and social impacts have been recorded as being associated with the Fukushima nuclear disaster. Ecological Footprint calculations can capture the impact on biocapacity—that is, the area of land that can no longer be considered usable and/or biologically productive due to the contamination of radioactive fallout released from the reactors.

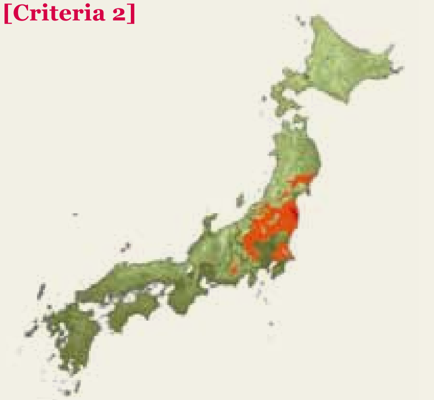
[Criteria 1]

The degree to which biocapacity was affected over one year differs greatly depending on what kind of criterion is employed to determine the impact on land productivity. A minimum impact estimation was calculated by employing: (1) the Japanese government criterion of Warning Zone (a circle within 20 km from the Fukushima Daiichi nuclear power plant (NPP)) and Planned Evacuation Zone (radiation exposure level will be equal or greater than 20 milli-Sv/year). These zones are the most contaminated areas, and were designated as "evacuation zones" by the Japanese government. Since April 2012, the restriction of entry into some areas of these two zones has been relaxed. Even in these areas, however, an overnight stay is still prohibited. Agriculture and forestry activities also still have conditional restrictions.

Thus, for the purposes of calculating the impact on biocapacity, it was assumed that no resources could be used from all cropland, grazing land, and forests within these two zones, and thus yields were assumed to be zero. We have estimated the impact on biocapacity within these zones to be 1,752,078 gha. This area corresponds to approximately 2.7 percent of total biocapacity of Japan (which was 65,467,638 gha in 2008).

At least 2.7 percent of Japan's total biocapacity was impacted by the Fukushima disaster

[Criteria 2]



Another estimation of the impact on biocapacity is more theoretical, but is worth considering. This second estimation was conducted by applying a tougher criterion: Areas where the level of radiation exposure is expected to be greater than the Japanese legal level of allowable radiation exposure for ordinary citizens in normal settings. According to this law, radiation exposure must be equal or lower than 1 milli Sv/year. The measure of biocapacity affected using this criterion was estimated to be 6,554,200 gha. This corresponds to approximately 10 percent of Japan' s total biocapacity.

The above two estimated figures of biocapacity impact do not account for biocapacity imapact of fishing grounds within and surrounding the Japanese archipelago.

BOX

There are more varieties of environmental and social impacts associated with the nuclear disaster other than biocapacity impacts, which would be captured by the Ecological Footprint method. For example, energy costs of removal and storage of contaminated topsoil and regeneration of topsoil, or the costs of the disposing highly contaminated products in agriculture, forestry, fisheries, and construction industries. Another example would be the costs of the relocation of population and building houses and facilities.

In the wake of the devastating nuclear accident, Japan has the opportunity to rebuild – not just infrastructures that have been destroyed, but outdated systems that worked against nature's limits, rather than with them. As Japan once proved, it is a country that can not only live within nature's budget – but prosper.

5. Discussion
– How things move forward?

From the first analysis in 2009 to the present in 2012

During the 11th Conference of the Parties to the United Nations Convention on Biological Diversity (CBD) in India on October 20, 2012, the world's governments agreed to double resources for biodiversity protection by 2015. Japan is expected to be a key player in honoring this commitment, as the previous chair of the CBD parties.

Of course, biodiversity is part of a larger ecosystem, and has the potential to impact biocapacity. Understanding the impacts of its resource consumption through monitoring, and mitigating these impacts is especially crucial for Japan, which is heavily dependent on outside biocapacity, to ensure a sustainable supply of resources.

WWF Japan and Global Footprint Network published "Japan Ecological Footprint Report 2009" in August 2010, precedent to the CBD COP10 in Nagoya, from the above perspective. Since then, however, Japan has faced increasing challenges.

During 1980s, Japan's Ecological Footprint had kept relatively low, with a majority of Japan's society achieving a sufficient quality of life by the beginning of the 1980s;
The trend of Japan's Ecological Footprint shows a second phase of rapid increase starting in the late 1980s, especially in the Footprint associated with carbon grounds;
Japan was able to reverse the course of its Ecological Footprint after its per capita Ecological Footprint peaked in the mid-1990s. Since then, Japan has reduced its Ecological Footprint and its dependence on foreign biocapacity has also gradually declined.

Over the past decades, Japan's economy has constantly weakened in comparison to other countries, such as China, while the emerging economies of BRICS countries have been steadily increasing. It is obvious that the second phase of Ecological Footprint increase detailed in this report, did not result in a GDP increase , which differs from the first phase. The relationship between the Ecological Footprint and GDP is a rich and crucial area of exploration, especially when considering that the value of natural capital decreased significantly as a result of a simultaneous increase in the Ecological Footprint and decrease in the GDP increase.

On top of this, the Great East Japan Earthquake occurred on March 11, 2011, followed by the Fukushima Daiichi Nuclear Power Plant accident, impacting its biocapacity, as cited in this report.

While the long-term impacts of these economic, social and environmental challenges have yet to be determined, it is likely that they will negatively impact Japan's human development and Ecological Footprint. Japanese government can change the country's course, however, by introducing innovative policies and land-use plans guided by resource accounting, and recognizing the economic and social impacts of the country's ecological deficit.

Unique feature of the relationship between Japanese nutrition and Japan's Ecological Footprint

Food Footprint was further analyzed in this report , revealing that Japanese people eat the fewest calories per capita with sufficient nutrition, and that their diet composition is rich in variety, with relatively high reliance on fish and vegetables. Its health benefits, quality and diversity may be among the reasons why the Japanese diet has increased in popularity around the world.

To maintain a sustainable food supply and reduce Ecological Footprint , however, Japan must implement policies informed by the following key findings in this report:

1. It is likely that Japan's domestic biocapacity will never be sufficient to support its food Ecological Footprint;
2. Two of Japan's largest food suppliers, the Unites States and China,

Okinawa may serve as a model for sustainable development

are in biocapacity deficit;

3. A quarter of Japan’s food Footprint is caused by food waste;

Food waste reduction remains the most important, yet easiest to decrease, element of Japan’s Ecological Footprint. I At the same time, the fishing sector may play a significant role in improving Japan's food footprint. Further investigation is needed to identify possibilities.

Because of Japan’s remote location, its carbon Footprint associated with food import could be a key issue when politicians consider long-term energy and food security policies. However, Japan’s decreasing biocapacity make it difficult for the country to reduce its food imports significantly. Therefore, priority should be placed on reducing Japan’s carbon Footprint by lowering domestic energy consumption, where there is a variety of alternatives to replace fossil fuels.

Future Scenario: learning from a regional model and adopting an ambitious national energy policy

How can Japan improve its sustainability under these difficult circumstances, and how will the country look like in the mid-century? The scenario analysis from the Japan Ecological Footprint Report 2009 labeled “Redefined Priorities” is the best way forward to reduce Japan’s Ecological Footprint by 2050. However, even in this scenario, Japan’s ecological overshoot would remain at 150 percent, meaning it would still be heavily dependent on outside biocapacity.

On the other hand, some other scenarios suggest additional potential of consumption reduction.
WWF Japan had developed “Energy Scenario for Decarbonizing Japan by 2050”, which aims at a Zero Carbon Footprint of internal energy consumption by 2050. This is worth simulating with Redefined Priorities Scenario for the reduction of Ecological Footprint.
The regional CLUM comparison suggests that even without a nuclear power plant, Okinawa maintains the lowest Ecological Footprint, 18 percent lower than Tokyo. In addition, the carbon Footprint of energy,

Renewable energy

which increases the household Footprint in Okinawa, can be replaced by renewables, suggesting further reduction of its Ecological Footprint. The Ecological Footprint, with the exception of carbon in Okinawa, must be far smaller than other regions, and further analysis is required to understand their low-Footprint lifestyle.

Okinawa may serve as a model for sustainable development, if there are areas of policy and daily consumption patterns that can be applied to the national level. What are policies that enable lower consumption for Okinawa’s population? How has Okinawa managed to develop without increasing its Ecological Footprint? These are questions worth exploring for Japan’s government.
If Japan wishes to be a champion in the world on sustainability, with rich biodiversity on the ground, Okinawa's case study may offer valuable insight, as Japan's remote location in the world is similar to Okinawa’s remote location in Japan.

The results in this report may be challenging, but it is still within Japan’s government to reverse these trends and change the course of the country’s future. We are living in a new era, one in which resources are becoming increasingly scarce, while the global population continues to rise. In this new era, countries’ economies will determine their ability to secure resources.
Clearly, managing our resources is not just an environmental issue, but one that can enable the long-term success of our country’s economy and human development.

BOX

The most important thing we can do for our planet is to drastically reduce our CO_2 emissions. WWF’s work promotes to supply supports all the energy we need from renewable sources by 2050. This will solve majority of the problems of carbon footprint.

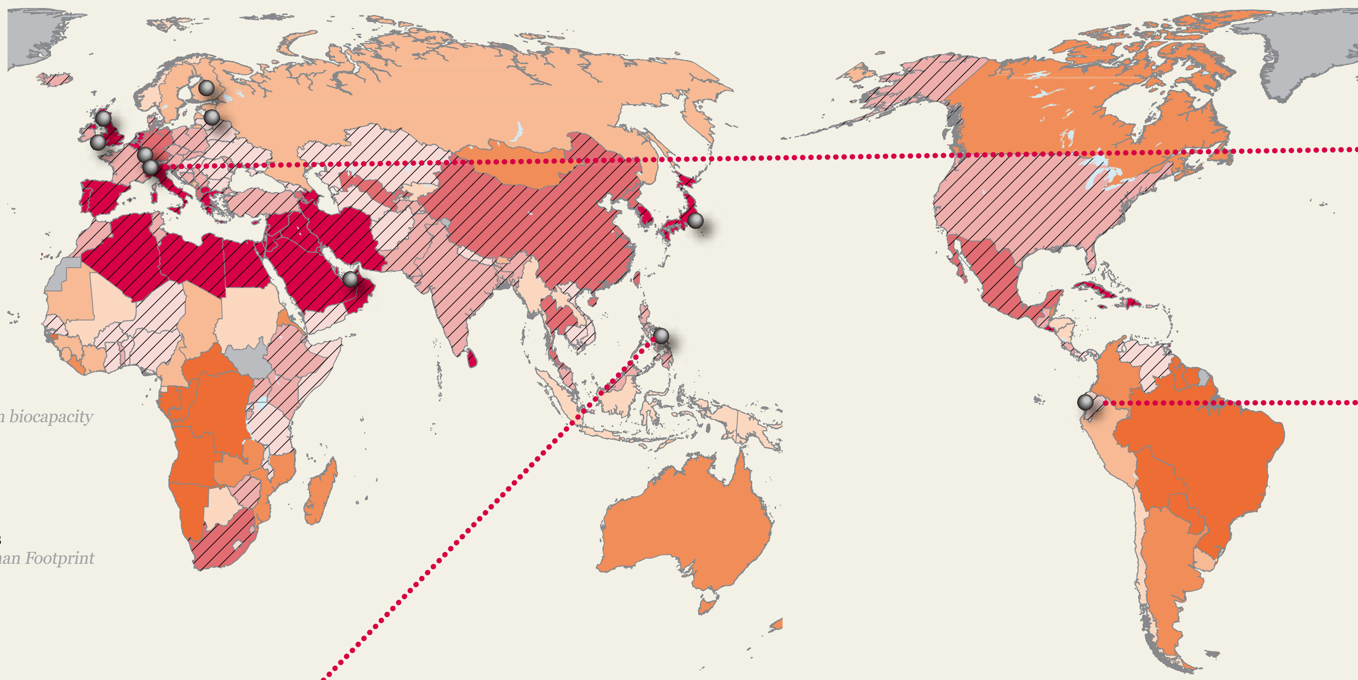
6. History of Ecological Footprint studies

From adoption to action (World)

Ecological assets are becoming arguably the most decisive competitive factor in global affairs. Nations that effectively manage their ecological assets will ncrease their chances of economic success. By 2012, more than 57 nations have engaged with Global Footprint Network directly, and 20 have completed reviews of their national Ecological Footprint. Japan, Switzerland, UAE, Ecuador, Finland, Latvia, Luxembourg, Scotland, and Wales have formally adopted the Ecological Footprint as a national planning or accounting mechanism.

Human demands on nature's regenerative capacity are usually measured separately in terms of climate change, land use, and food consumption. The Ecological Footprint translates these individual demands into a single aggregated number, the global hectare. This unique factor of the Ecological Footprint helps policy makers to understand their overall resource needs, limits, and dependencies.

Learning from this global experience, it is time for Japan to implement a realistic national action plan and stipulate concrete numerical goals that take into account natural capital accounting, and the nation's Ecological Footprint. A policy mechanism with a quantitative target will give Japan a clear indication of the state of the nation, highlighting where the nation is going, as well as how individual choices, institutional investments, and governmental policies will lead toward those goals.



(2008 data)

Biocapacity Debtors
Footprint greater than biocapacity
- 150%
- 100-150%
- 50–100%
- 0 – 50%

Biocapacity Creditors
Biocapacity greater than Footprint
- 0 – 50%
- 50–100%
- 100-150%
- 150%

Switzerland: Switzerland has made the Ecological Footprint an official national indicator, used in its sustainable development monitoring system and published annually by the Swiss Federal Statistical Office. The government's "Sustainable Development Report 2012." launched at the Rio+20 Summit, documented that Swiss residents consume three times more biocapacity than is available per person worldwide.

Ecuador: In 2009, Ecuador launched a program to keep its country in the ecological "black" as an ecological creditor. It has committed its National Plan to maintain its Ecological Footprint at a level that is within what its ecosystems can renew. It has also adopted a Presidential mandate to manage ecological assets by developing physical indicators such as the Ecological Footprint to track ecological supply and demand, and inform sound long-term decision-making.

Ecuador recently launched Yasuní ITT, an ambitious initiative to preserve one million acres (404.685 hectares) of the Amazon rainforest by keeping the country' s largest undeveloped oil reserve —846 million barrels worth —permanently in the ground. The plan will keep 407 metric tons of CO_2 out of the atmosphere, maintaining a key source of Ecuador' s natural wealth, and safeguarding the livelihood of indigenous cultures.

Nations that effectively manage their ecological assets will increase their chances of economic success

Philippines: The Philippines is on track to adopt the Ecological Footprint at the national level, making it the first nation in Southeast Asia to do so. The Ecological Footprint was incorporated into the Philippine's 2012 National Land Use Act, a comprehensive national land-use policy that protects areas from haphazard development and plans for the country's use and management of its physical resources. The Philippines Ecological Footprint report, which will include a foreword by President Bengigno Aquino III, will be launched in partnership with the Climate Change Commission of the Republic of the Philippines in November 2012.

From adoption to action (Japan)

At the government, business, and research levels since the late 1990s. The combined effect of these efforts may lead Japan from adoption to action in its progress toward sustainability:

Japan has been actively accumulating Ecological Footprint (EF) data

[1990] [2000] [2006] [2007] [2012]

Business

[2007] The WBCSD (World Business Council for Sustainable Development), an organization that represents many of the world' s most influential corporations, including the Sony Corporation, Toyota Motor Corporation, Tokyo Electric Power Company Inc. (TEPCO), and Osaka Gas Co., Ltd., has launched Vision 2050 to identify the pathways toward a one-planet economy. They used the EF as a tool to frame their approach toward resource constraints.
http://www.footprintnetwork.org/en/index.php/GFN/page/case_stories/#WBCSD

[2012]
The Kao Corporation presented EF analysis as a method of environmental accounting at Japan' s Institute of Life Cycle Development. They suggested using the analysis to visualize a company' s total environmental impact, not just its Carbon Footprint.
https://www.jstage.jst.go.jp/article/ilcaj/2011/0/2011_0_164/_article/-char/ja/

Research and NPO

[1990-1991]
EF was developed by Drs. William E. Rees and Mathis Wackernagel at the University of British Columbia in Vancouver, Canada.

[2004] "Our Ecological Footprint: Reducing Human Impact on the Earth"written by Drs Mathis Wackernagel William E. Rees was translated into Japanese by Yoshihiko Wada and Mari Ikema, which led to the prevalence of the EF concept in Japan.

[2005] Ecological Footprint Japan, a non-profit organization, was established to promote the research and application of the EF in Japan and Asia.

[2006] The report "Research on the Scientific Basis for Sustainability" (RSBS) used the EF to explain the concept of environmental carrying capacity in the context of life-supporting naturalcapital.
http://www.sos2006.jp/houkoku/index.html

[2007] Ecological Footprint Japan, with the support of the Hitachi Environment Foundation, created the personal footprint calculator for Japanese audiences.
(http://www.ecofoot.jp/quiz/index.html)

[2010] WWF Japan and Global Footprint Network collaborated to release the Japan Ecological Footprint Report 2009. In it, they identified leading areas of ecological demand, and offered policy recommendations to address each.

[2012] On June 17, Japan's Asahi Glass Foundation awarded the prestigious Blue Planet Prize to Dr. Mathis Wackernagel and Prof. Bill Rees in recognition of their work in developing the EF accounting system.

Government

[1996] "The Quality of the Environment in Japan" (White), published by the Ministry of Environment, first introduced the concept of the EF in an official government document.
http://www.env.go.jp/en/wpaper/

[2000] "Tokyo Metropolitan Government Environmental White Paper 2000" estimates the 125 time bigger area of Tokyo is requires supporting the life in Tokyo Metropolitan's EF.

[2003] Japan's Ministry of Land, Infrastructure, and Transport along with the National and Regional Planning Bureaus calculated Japan's EF from 1980, 1990, 1995, and 2000 and 48 prefectures' EF for 1995 and 2000.

[2006] After completing an extensive internal review of Japan's National Footprint Accounts research, the national government adopted the Footprint as part of Japan's Basic Environmental Plan.

[2008] Tsuyama city in Okayama prefecture introduces the concept of EF and its methodology in their City Planning Master Plan.

[2009] Sano city in Tochigi prefecture introduces EF Personal Calculator developed by NPO Ecological Footprint Japan in its Basic Environmental Plan.

[2012] "Tokyo New Development of Greenery Policy: Basic Policies for a Convention on Biological Diversity " mentions the EF as a demonstration of the pressure that Japan's activities put on the environment.
http://www.kankyo.metro.tokyo.jp/nature/plan/green_biodiversity.htm

Japan Ecological Footprint Report 2012

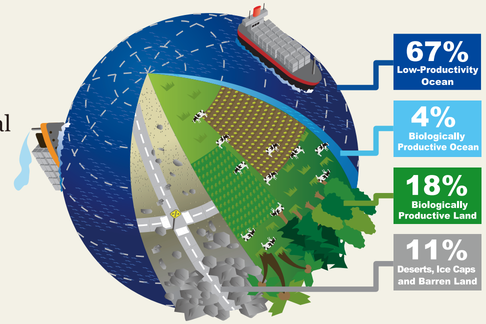
Explanatory note






Explanatory notes (General)

Biocapacity



Biocapacity tracks ecological assets available in each country and at the global level in a given time period (usually one year). It catalogues their capacity to produce renewable resources and absorb wastes (particularly carbon dioxide). A national biocapacity calculation starts with the total amount of bioproductive land and water available within national borders. “Bioproductive” refers to land and water that supports significant photosynthetic activity and accumulation of biomass.

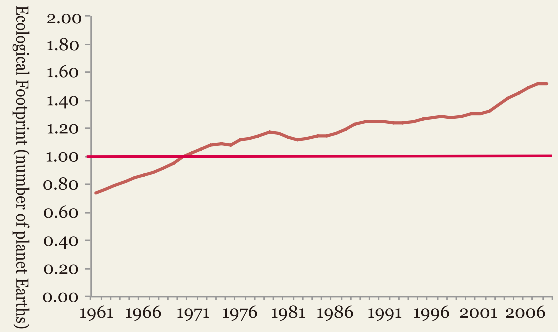
Ecological Footprint

Ecological Footprint measures ecological assets that a given population requires to produce all the resources it consumes and to absorb the waste it generates, in a given period of time (typically one year). This covers plant-based food and fiber products, livestock and fish products, timber and other forest products, sequestration of waste (CO2 from fossil fuel burning), and space for urban infrastructure.

Both measures are expressed in global hectares (gha)—globally comparable, standardized hectares with world average biological productivity. Actual areas of different land use types (in hectares) are converted into their global hectare equivalents by using yield factors and equivalence factors. Yield factors account for differences between countries in the productivity of a given land type. Equivalence factors allow for the comparison of different land types (such as cropland and forest) by accounting for relative differences in their world average biological productivity.

Overshoot

Overshoot is the relative amount by which the Ecological Footprint of a given area exceeds biocapacity in that same area, and thus violates a basic criterion of sustainability. Global overshoot occurs when humanity's total world demand on nature exceeds the globe’ s supply, or regenerative capacity. Such overshoot leads to a depletion of Earth's life supporting natural capital, and a buildup of carbon dioxide waste (causing climate change). Local overshoot is often overcome by importing resources from abroad. At the global level, this is not possible, since there is essentially no net-import of resources into the planet.



$$EF_C = EF_P + (EF_I - EF_E)$$

Ecological Footprint of Consumption

Ecological Footprint of Production

Net Ecological Footprint of Trade

The Ecological Footprint of consumption (EF_C)

The Ecological Footprint of consumption (EF_C) indicates the consumption of biocapacity by a country's inhabitants.EF_P does not give an accurate indication of the quantity of resources consumed nationally. An accurate assessment is important, since this consumption is directly related to domestic well being In order to assess domestic consumption of a population, the Ecological Footprint of consumption (EF_C) is used instead. EF_C accounts for both the export of national resources, and the import of resources used for domestic consumption. Since it is based on consumption instead of industrial production, individuals can change EF_C more easily than EF_P by changing their purchases and other resource uses.

The Ecological Footprint of production (EF_P)

The Ecological Footprint of production (EF_P) indicates the consumption of biocapacity resulting from domestic production processes. The one exception is carbon Footprint, because the demands placed on the environment by a country through the emission of carbon dioxide are mostly dispersed throughout the globe. Otherwise, this measure is produced similar to the way economists calculate gross domestic product (GDP) – adding up the monetary values of all goods and services produced within a country's borders.

The net Ecological Footprint of trade

The net Ecological Footprint of trade (the Ecological Footprint of imports minus the Ecological Footprint of exports) shows the international trade of biocapacity. If the Ecological Footprint embodied in exports is high, domestically available biocapacity may be reduced since resources are essentially being traded away. If the Ecological Footprint embodied in imports is high, then the country may be very susceptible to global resource constraints because it depends on so many resources from abroad.

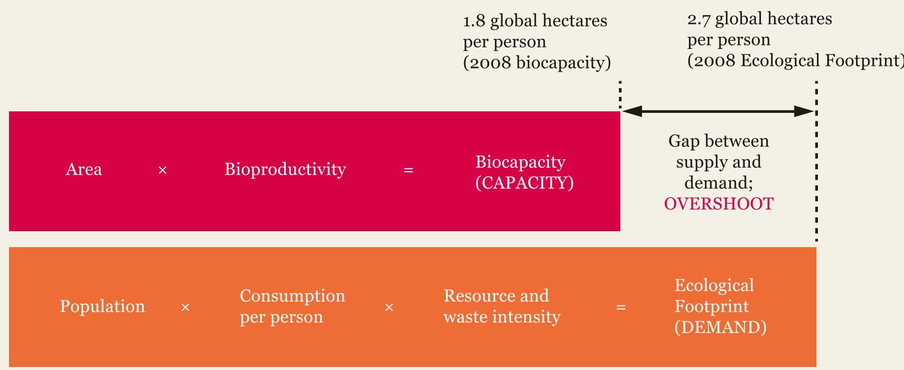
Ecological deficit / reserve:

The difference between the biocapacity and Ecological Footprint of a region or country. An ecological deficit occurs when the Footprint of a population exceeds the biocapacity of the area available to that population. Conversely, an ecological reserve exists when the biocapacity of a region exceeds its population's Footprint. If there is a regional or national ecological deficit, it means that the region is importing biocapacity through trade or liquidating regional ecological assets, or emitting wastes into a global commons such as the atmosphere. In contrast to the national scale, the global ecological deficit cannot be compensated for through trade, and is therefore equal to overshoot by definition.

The Five factors

The Five factors determine the degree of global overshoot, or a country' s ecological deficit.

Two Biocapacity Factors: The available biocapacity is determined by the amount of biologically productive area, and the productivity (yield) of each unit of that area. Three Ecological Footprint Factors: Ecological Footprint is a function of population, consumption per person, and resource efficiency (how much Ecological Footprint can be derived from each unit of a resource).



Explanatory notes (Chapters)

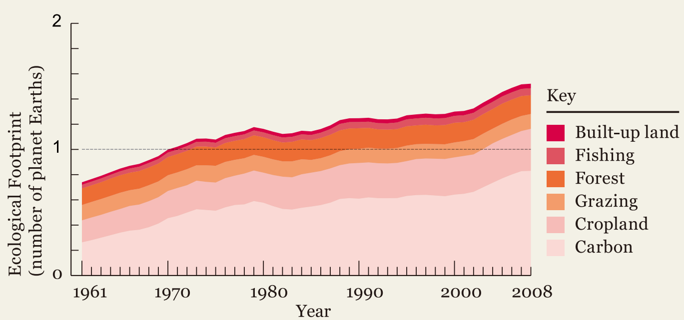
1. Historical Snapshot of Japan (1961-2008)

National Footprint Account (NFA)

Most of the Ecological Footprint and biocapacity results used in this report come from National Footprint Accounts (NFA), released by Global Footprint Network. The newest NFA (2011 Edition) provides data on more than 200 countries and regions, as well as global totals, for Ecological Footprint and biocapacity values from 1961 to 2008. This provides an assessment of how much of nature's biocapacity is demanded by people in each country or region each year. It is one contribution to our understanding of the sustainability of humanity's consumption.
The utility of the NFA is its ability to provide scientifically-based, transparent natural resource accounts to support resource use, conservation, and efficiency decisions and policies. In support of this, raw data for its calculations come from robust international sources, including: Food and Agriculture Organization of the United Nations, the United Nations Commodity Trade Statistics Database, International Energy Agency, and peer-reviewed journals. Global Footprint Network oversees a continuous process of methodological improvements, incorporating stakeholder input from partners actively using Ecological Footprint data in their work, and with all improvements approved by an independent National Footprint Accounts Review Committee.

Methodology and Source in GFN website
http://www.footprintnetwork.org/en/index.php/GFN/page/methodology/

According to the most recent NFA, in 2008 humanity's Ecological Footprint was 2.7 gha per person, while the Earth's total biocapacity was 1.8 gha per person. This means that humanity consumed ecological resources and services, and polluted carbon dioxide into the atmosphere, 1.5 times faster than Earth could renew them or absorb this waste. By looking at the breakdown of land type components, 54% of the total Ecological Footprint comes from carbon uptake land, followed by cropland (22%), forest land (10%), grazing land (8%), fishing grounds (4%), and built-up land (2%).



2. Food Footprint

Adequate Nutrition in a Constrained World

The graph of food Ecological Footprint against food supply was developed from two primary data sources: Global Footprint Network, 2012; and the United Nations Food and Agriculture Organization statistical database (FAOSTAT, 2012).

The food Ecological Footprint was defined as the total unadjusted Ecological Footprint associated with the final consumption of items within Division 01 of the United Nations Classification of Individual Consumption According to Purpose (COICOP): "Food and non-alcoholic beverages".

Food supply was measured as the grand total kcal per capita per day of all food items in 2008. While the United Nations defines undernourishment as an individual obtaining less than 1800 kcal per day, distributional issues and food waste mean that at least 2700 kcal of food supply is required to achieve low levels of undernourishment. This level and above is thus set as meeting the minimum requirement for food supply. Conversely, a "sustainable" food Ecological Footprint is set as the average food Ecological Footprint of the 10 lowest countries that still achieve low levels (<2.5 percent) of undernourishment.

A potential alternative measurement to calories would be one made using grams of protein available per capita per day.

Individual country points were weighted by the country's population in 2008, according to data from the United Nations Department of Economic and Social Affairs, Population Division.

Food Scenario

The food scenarios were made using the scenario calculator developed by Global Footprint Network, described fully in Moore et al. (2012). Within this scenario calculator, the consumption and supply of all items was held constant except for the total caloric consumption of food, and the percentage of calories obtained from each food type (cereals, roots and tubers, sugar, pulses, vegetables and oils, meat, milk and dairy, fish, and "other" food). These data were obtained from the United Nations Food and Agriculture Organizational statistical database (FAOSTAT, 2012) for the most recent year available, 2009.

3. CLUM Comparison

What is the CLUM Analysis? / Average CLUM in World, G7, BRIICS and ASEAN, and Japan

The Ecological Footprint has become an influential measure of global demand for biological capital. However, the current National Footprint Accounts (NFA) provides disaggregation only according to land use types, limiting their utility to government and private sector decision-makers. The information provided by the NFAs is extended by utilizing Environmentally Extended Multi-Regional Input Output analysis (EE-MRIO) through the Global Trade Analysis Project (GTAP) published by Purdue University, which provides data on 57 industrial sectors, 3 types of final demand, and a Consumption Land Used Matrix (CLUM), for 113 world regions, as well as trade data.

The Global Trade Analysis Project (GTAP)
https://www.gtap.agecon.purdue.edu/default.asp

Ecological Footprint of consumption contains three main components. The first is short-lived consumption by households. This component contains food, housing maintenance and operations, personal transportation, goods, and services. The second component is consumption paid for by government. It contains short-lived consumption expenditure such as public services, public schools, policing and governance, and defense. The third component is consumption for long-lived assets (called "gross fixed capital formation), which may be paid by households (e.g. new housing), firms (e.g. new factories and machinery), or governments (e.g. transport infrastructure).
In compassion of the world, G7, BRIICS, and ASEAN averages, Japan has the second highest relative Ecological Footprint devoted to gross fixed capital formation (24.6%) in the world, second only to the BRIICS (25.1%) nations. Wise investments in long-lived assets today will build the foundation for a green economy and lead to more sustainable lifestyle patterns for the next few decades. We call this investment strategy – prioritizing resource efficient, long-lived goods – “slow things first”.

CLUM in Tokyo, Aichi, and Okinawa Prefectures

In this regional Footprint analysis, sub-national CLUMs are developed through scaling procedures that take household expenditures (HHE) for the nation and each region and adjusted them by consumer price index (CPI) and energy efficiency data (the percentage of carbon dioxide emissions per unit of energy produced). Ecological Footprint by government consumption and gross fixed capital formation in each region are allocated the same as the national average due to data limitations and vague definitions of some national government spending and investment allocated to each prefecture (Ecological Footprint generated by U.S military bases in Okinawa, for instance, are not easily separated from Japanese consumption).

4. Impact on Biocapacity by Fukushima Nuclear Power Plant Accident

What is Sievert (Sv)

The sievert is an international unit of radiation exposure used to derive a quantity called equivalent dose. This relates the absorbed dose in human tissue to the effective biological damage of the radiation. Not all radiation has the same biological effect, even for the same amount of absorbed dose.

Equivalent dose is often expressed in terms of millionths of a sievert, or micro-sievert and thousandths of a sievert, or milli-sievert. To determine equivalent dose (Sv), multiply absorbed dose (Gy) by a factor called relative biological effectiveness (RBE) that is unique to the type of incident radiation. One sievert is equivalent to 100 rem. A recent study shows that an equivalent dose of 1.3 milli-sievert can seriously damage DNA, which may trigger cancers or other illnesses.

The Japanese laws and regulations which specify the allowable dose limit of radiation exposure in the areas where ordinary citizens live

The Japanese government designates the allowable dose limit of effective radiation exposure in areas where ordinary citizens typically live (i.e., outside radioactive control zones) to be 1 milli Sievert (Sv). The following laws, regulations, and notices specify the dose limit.

1) The Law of Regulation of Nuclear Reactors. The Notice of Regulating the Dose of Radiation during Installment and Operation of Nuclear Reactors for Practical Electric Power Generation, Ministry of Economy, Trade and Industry.
2) The Law of Preventing Health Hazards from Radiation Exposure. The Regulation of Preventing Health Hazards from Radioactive Isotopes and Radioactive Wastes. The Notice of Specifying the Volume and Mass of Radioactive Isotopes, Agency of Science and Technology.

Method for Determining Biocapacity impact from the Fukushima Nuclear Accident

Global Footprint Network typically provides yearly biocapacity figures, by land use type, for each of the countries tracked in the National Footprint Accounts. However, in order to determine the impact of biocapacity from a regional disaster, such as the Fukushima nuclear accident, it is necessary to estimate a country' s biocapacity with high spatial resolution.

In order to do this, the methods described here use Net Primary Production (Olson et al., 2001) as a proxy for yields. The rest of the analysis proceeded as follows, all calculations being done in ArcGis 10.0 with Spatial Analyst extension.

1) A Net Primary Production (NPP) map (Olson et al., 2001) and a global land use (LU) map (NASA, 2010) were restricted to the Japanese administrative boundaries (GADM, 2012).
2) The LU map categories were combined to match the classification of land uses in the National Footprint Accounts (cropland, grazing land, forest land, built-up land, water).
3) The NPP and LU maps were combined to create separate maps of NPP for each land use category.
4) The average NPP across all pixels for each land use type was calculated. Each pixel was then divided by this average value and multiplied by the Japanese yield factor and global equivalence factor for the specific land use type to get a measure of biocapacity density (global hectares per hectare). These maps were then combined together to get a comprehensive map of biocapacity density.
5) Maps showing areas of radioactive contamination were overlaid onto the biocapacity density map. The total biocapacity (sum of all pixels) underneath the contaminated areas was divided by the sum of all pixels within the Japanese boundaries (which was presumed to be directly proportional to the total biocapacity in Japan excluding fishing grounds). This ratio was then multiplied by the non-fishing ground biocapacity in Japan to get a final, normalized result for the area affected in global hectares.

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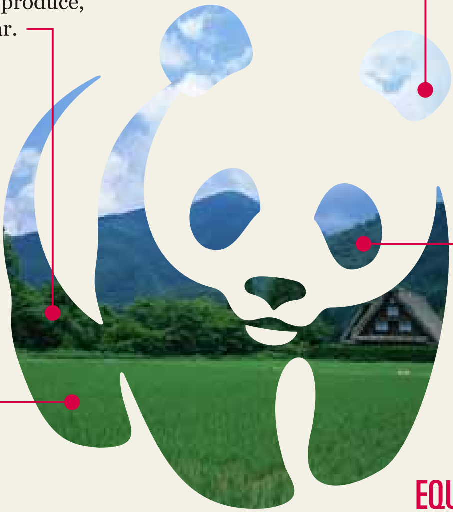

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