

Health and Science Crossroads (hascross) 14th Health Science Seminar  
Held on-line February 22, 2023  
Transcribed and translated version of meeting record released June 8, 2023.

Global Environmental Change and the Biodiversity Crisis.  
What do we know and how can we hold them down?



Guest Lecturer  
Professor Michael G Norton  
Environment Programme Director  
European Academies' Sciences Advisory Council (EASAC)



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(English Version)

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With Prof. Michael Norton (EASAC) as Quest Speaker

Table of Contents

Opening remarks	Hiroko Sasaki, PhC, Representative of Hascross	Page	1
Introduction	Toshiharu Matsumura, PhD, Co-Representative (Meeting host and the editor of meeting record) Prof. Michael Norton and the purpose of this meeting	Page	1
Section 1:	The global environmental and biodiversity crises	Page	3
1-1	Lecture Prof. Michael Norton Challenges for solutions referring to activities in the EASAC		
1-2	Supplementary slides from citizens' view points	Host	
1-3	Discussion and Q&A for Section 1	Discussants	
Section 2:	Science and policy interaction	Page	22
2-1	Lecture Prof. Michael Norton Science and policy interaction during Covid pandemic in the U.K.		
2-2	Comments UK-Japan comparison in the interaction	Host	
2-3	Discussion and Q&A for Section 2	Discussants	
Section 3:	Social ties between citizen and scientists	Page	32
3-1	Proposal Toshi Matsumura (Host speaker) An idea to strengthen ties between citizens and scientists		
3-2	Comments for Section 3	Discussants	
Section 4:	Post-conference information and comments	Page	35
4-1	Environmental impact indicators	Prof. Norton	
4-2	Additional comments	Discussant A	
4-3	Environmental impact indices on personal life	Host	
4-4	Ammonia as a fuel substance	Host	
Concluding remarks		Host	Page 44

## Opening remarks Hiroko Sasaki

Today we are honored and pleased to welcome Norton-Sensei (Prof. Michael Norton).

Many thanks for sharing your invaluable time during your stay in Japan this time.

Without you, Dr. Norton, we might not even think of having a seminar on the subject of global climate.

Thank you very much for all who join in this on-line seminar.

I am Hiroko Sasaki, representative and

secretary of Hascross. Hascross is a small science café in Yokohama. Usually, Matsumura and I do everything from responding customers' requests on health science, lunch making, cookie baking, and even working in a vegetable garden.

It is late in the evening, but I hope you all will relax and enjoy Dr. Norton's talk and discussion. To begin with, Matsumura will introduce Dr Norton, and the purpose of this seminar.

## Introduction Professor Michael Norton and the Purpose of this Meeting Toshiharu Matsumura

In the past Hascross seminars, we have selected topics that have been the subject of debate around us, and have tried to provide reference scientific information for citizens to make their own decisions.

As all of you may be aware of, climate changes have occurred frequently in many parts of the world. The overwhelming evidence in the scientific community is that this is due to global warming caused by human activity. However, there are other opinions, too, and countermeasures vary from country to country.

Measures have been compiled at international conferences attended by representatives of different countries, and brought back to their own countries for compliance, but the results appear to have been poor.

Citizens are suggested to, for example, replace beef with chicken, or plastic bags with shopping bags, but they are not always given sufficient information on how effective these measures are in preventing global warming and whether they are likely to solve the problem.

What are the scientists researching, what are their findings and ideas, and how do they contribute to policy or not? As a citizen, I want to know. I want to do what I can effectively do.

At that time, I happened to learn that a long-time personal acquaintance of mine, Mike (Dr Norton), is in a position to conduct extensive research and study on global environmental changes and to make recommendations for policy. On the occasion of his visit to Japan this time, I wondered if he could join us in a discussion meeting for myself as a layman and for all who may join in the meeting. He readily agreed, and the meeting was realized with several discussers and many audiences all on-line with fruitful discussion.

The video recording has been transcribed, and edited as a report in Japanese and its English translation, and they are released online from the office of Hascross. They are cordial gifts from Dr Norton and the discussants, as well as from us at Hascross, to you all of the citizens in Japan and in the world.

We wish you could find it worth reading.

It should be noted here that Prof. Norton made slides and spoke in Japanese, which was translated by the editor into English.

Although Dr. Norton briefly corrected wrong usages in the English version, any mistaking usages of English there are solely to the editor's responsibility.

## Prof. Michael Norton's Biography

Professor Michael G. Norton holds a BSc and PhD in Chemistry from the University of Bristol and worked in chemical research at Imperial Chemicals from 1970-74 before joining the UK Government's Science Service, particularly in marine pollution research, for eight years.

From 1982 he was Science Attaché at the British Embassy in the USA for four years, before joining the UK Department of Trade and Industry in 1986 and establishing the Science and Technology Directorate in the UK Parliament in 1989, where he provided advisory services.<sup>4</sup>

From 1998-2004 he was Science and Technology Counsellor at the British Embassy in Japan, where he contributed to exchanges in the field of life sciences and engineering and continued as Professor at the Tokyo Institute of Technology, where he was responsible for innovation and sustainable development (2004-6). In 2006, he became a professor at Shinshu University, and in 2012, a professor at Tohoku University. In 2015, he returned to the Tokyo Institute of Technology, where he was an adjunct professor in the Faculty of Environmental and Social Science and Engineering until 2018, contributing to research and education in this field in Japan.

## His Current Activities

Since 2015, he has been Director of the Environment Programme of the European Academies Scientific Advisory Committee (EASAC), where he has been involved in various research and analytical activities ranging from plastics to climate change. Once during this period, he gave us a talk in a Hascross seminar overviewing global environmental changes.

Recently, Prof. Norton mentioned in his e-mail to me the URL of a recording of his talk. This is: 'Bioenergy with carbon capture (BECCS) - a case of wishful thinking?' in 'Policy opportunities for reducing climate change and its impact on planetary and human health'. Seminar at the Royal Swedish Academy of Sciences in connection to EASAC Bureau and Council meetings, 2022-11-30. The Royal Swedish Academy of Sciences.

<https://www.kva.se/evenemang/policy-opp-ortunities-for-reducing-climate-change-and-its-impact-on-planetary-and-human-health/>.

From the lecture, I understood clearly that EASAC is not just an advisory body to the EU, but is a globally influential advisory body influencing the UN, and that Prof. Norton is at its core. I also learnt that a representative report of EASAC has been translated into Japanese as well.

You can search for a number of achievements using Michael Norton or EASAC as keywords. Among them are 'Key Messages from European Science Academies for UNFCCC COP26 and CBD COP15', a set of recommendations from EASAC to two international policy-making conferences, COP26 and COP15, as well as the publication of a book by Prof. Norton, which seems to have been the basis for the dissemination of these recommendations. One of Prof. Norton's influential papers: Norton M et al. Serious mismatches continue between science and policy in forest bioenergy, *Bioenergy*. 11 (2019) 1256-1263. can also be found on the internet.

Prof. Norton is fluent in Japanese and made the slides for this Japanese presentation himself.

## Section 1: The global environmental and biodiversity crisis

### 1 – 1 Lecture Prof. Michael Norton Challenges for solutions referring to activities in the EASAC

As Matsumura said, I direct an environmental programme that explains the implications of important scientific issues to policy makers. We have covered issues related to plastics and pesticides.

But mostly we have covered issues related to climate change.

Last year, major conferences (conventions) were held on each of the two crises: 'climate change' and 'biodiversity loss'. We prepared papers on the two issues and submitted them to two important conferences - the Climate Convention and the Convention on

Biological Diversity, respectively. These are called COPs, which stands for Conference of the Parties, bringing together the majority of the world's countries.

Both conferences have been running for a long time, but separately. We noted how this has led to poor outcomes. Some of them were called losing-losing results.

We advised conference delegates to consider both climate change and biodiversity at the same time when developing policies.

Slide 1-1-1. Climate change and biodiversity losses: Twin crises

気候変動と生物多様性  
二つの危機

Prof Michael Norton  
Environment Programme Director, EASAC

European Academies Science Advisory Council-  
Science advice for the benefit of Europe

commentary

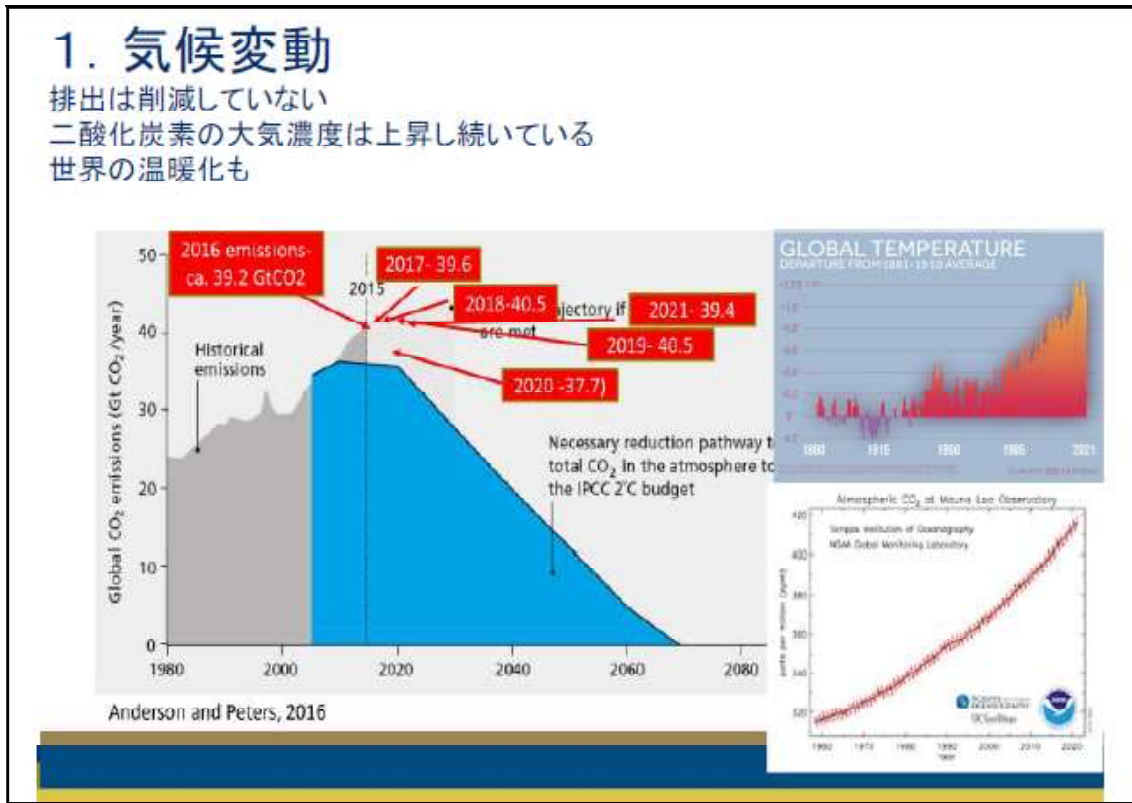
Key Messages from European Science Academies for UNFCCC COP26 and CBD COP15

The urgency of the climate and biodiversity crises requires closer coordination between UNFCCC and CBD

Editor's note: The two conferences were the 26th Conference of the Parties (COP26) to the UN Framework Convention on Climate Change and the second part of the 15th Conference of the Parties (COP15) to the Convention on Biological Diversity.

The messages from EASAC to these two conferences are quoted in Prof. Norton's introductory article. The UN news article on COP26 also documents the incorporation of EASAC's perspective.

Slide 1-1-2. Climate change: One of the two crises



One of the two crises is climate change. Increases in carbon dioxide and other greenhouse gases are accelerating warming in the atmosphere.

The bottom right shows the increasing atmospheric concentration of carbon dioxide.

Despite 25 meetings, global emissions have not decreased, atmospheric CO<sub>2</sub>

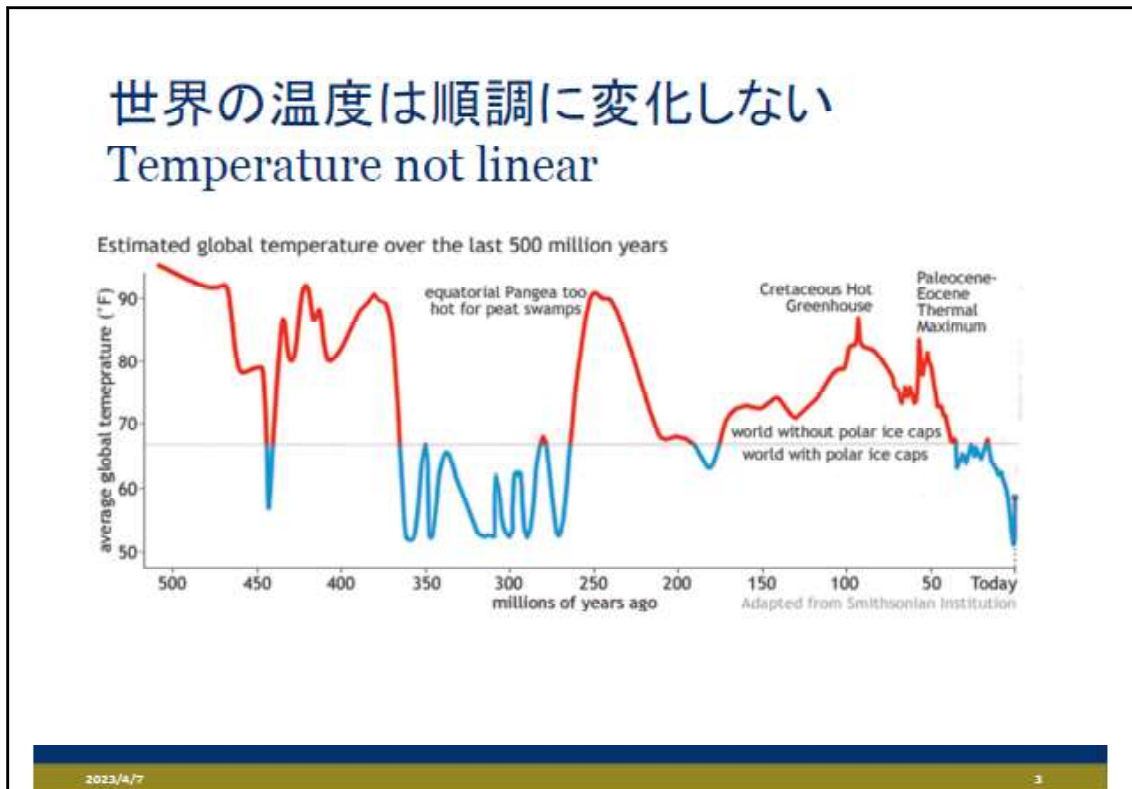
concentrations have accelerated and the atmosphere is heating faster than many models predict.

The blue areas on the slide are the paths that need to be reduced to limit warming to within 2°C. Each year we can see that we are moving further away from this target; annual emissions have not changed much since 2015.

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Editor' notes: In the meeting, every slide was originally explained by Prof. Norton in Japanese, which was translated into English in this English version of meeting record by the editor. The number and title shown over the frame of every slide are given by the editor.

Slide 1-1-3. Temperature has not changed smoothly



The long history of the Earth shows that temperature has not changed smoothly.

There have been periods of extreme hot and cold, and the temperature has not

been as stable as it has been over the last tens of thousands of years of civilization.

The concern is that we may now be causing a change to a hotter planet where humans cannot survive.

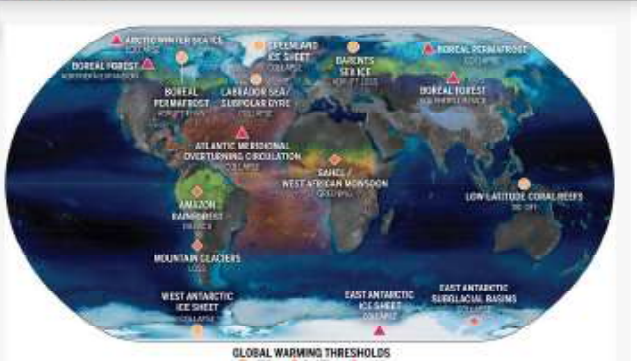




Slide 1-1-5. Tipping points to hothouse earth

## Tipping Points (転換点)

- もう戻れない
  - 山水河
  - グリーンランドの氷冠
- 転換中
  - 西南極
  - アマゾン枯れる
  - 大西洋子午線反転循環
  - 海の酸性化
- 状態はわかりにくい
  - 永久凍土などから壊滅的な CO<sub>2</sub> とメタンが放出されます。
  - モンスーン/干ばつ/生き残れない暑さ
  - 東南極氷床



The location of climate tipping elements in the cryosphere (blue), biosphere (green), and ocean/atmosphere (orange), and global warming levels at which their tipping points will likely be triggered.

GLOBAL WARMING THRESHOLDS  
■ <0°C    ■ 0-4°C    ■ >4°C

McKay et al., 2022. Science 377 (6611)

There are many tipping points towards a Hothouse Earth.

These are changes that will accelerate climate change and cannot be reversed.

Some of them have already passed the tipping point and will not return to the state of 100 years ago.

Examples include the melting of

Greenland's glaciers and mountain glaciers.

Antarctic glaciers and the Amazon are also undergoing conversion.

Others have catastrophic consequences. Therefore, the inability to significantly reduce emissions of gases that contribute to global warming is a serious concern.

Editor's notes: Word to word translation

もうもどれない

山水河  
グリーンランドの氷冠

Already have passed the point

Mountain glaciers melting  
Greenland ice sheet melting

転換中

西南極  
大西洋子午線反転循環

Passing the point

West Antarctic ice sheet melting  
Atlantic meridional reversal circulation change  
Ocean acidification

海の酸性化

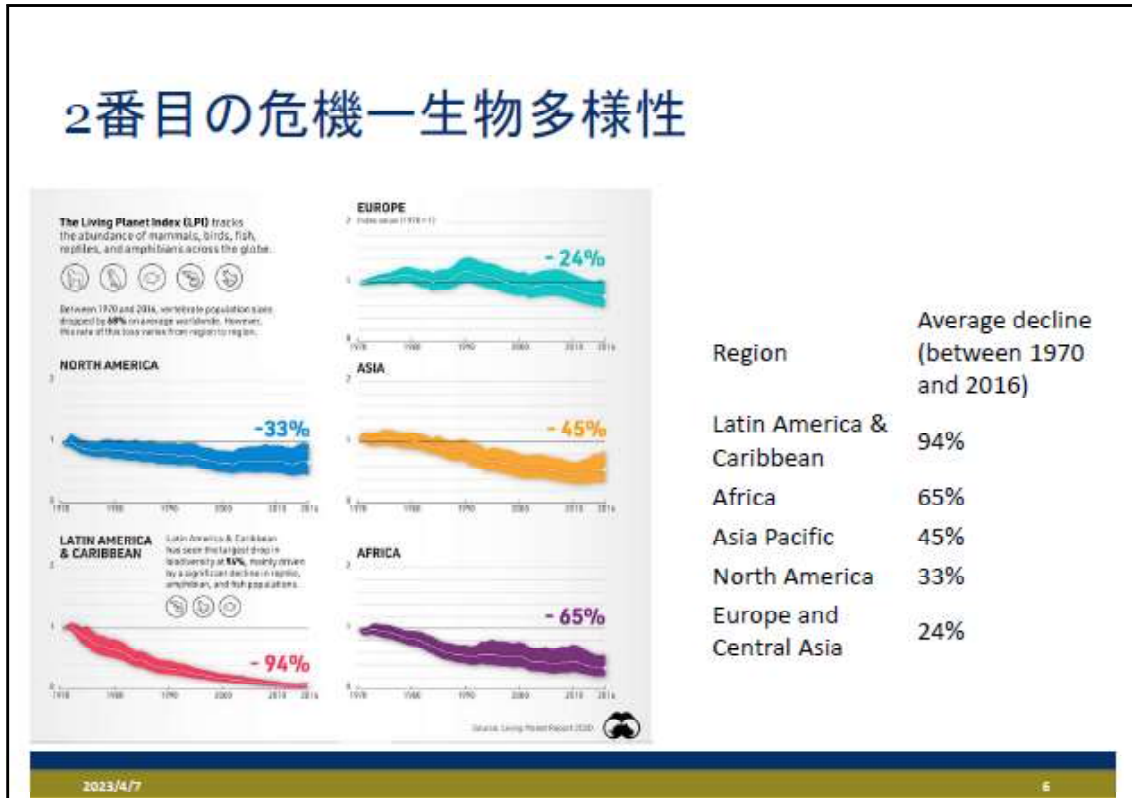
状態はわかりにくい

永久凍土などからの壊滅的な CO<sub>2</sub> とメタンの放出  
東南極氷床

Uncertain at this moment

Catastrophic CO<sub>2</sub> and methane emissions from permafrost and others  
East antarctic ice sheet melting

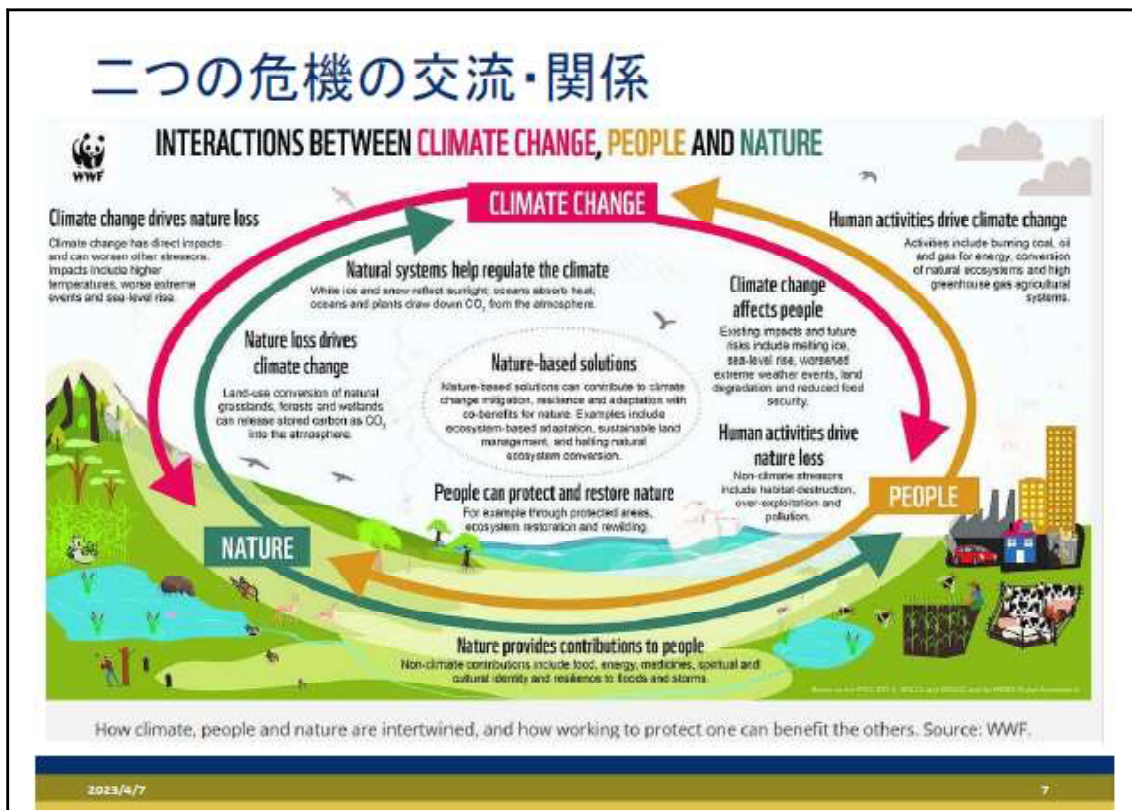
Slide 1-1-6. Biodiversity crisis: The second after climate crisis



A similar concern relates to biodiversity, with significant loss of species in some parts of the world.

These two crises are related, and it is time to start thinking about them together.

Slide 1-1-7. Interactions between climate change, people and nature



This diagram shows the different pathways through which biodiversity and climate interact. For example, healthy oceans and forests absorb large amounts

of CO<sub>2</sub>.

This diagram is shown in WWF (Worldwide Fund), 2019 Climate, Nature and Our 1.5°C Future.

Slide 1-1-8. Common drivers/risks

## 共通点 Common drivers/risks

- 熱帯林を農地に置き換えると、生物多様性が減少すると同時に、貯蔵された炭素が放出されます
- 気温の上昇は、農業の生産性を低下させるだけでなく、種を移動させ、場合によっては絶滅に至らせます。
- 海洋の温暖化と酸性化は、海洋が大気から CO<sub>2</sub> を除去する能力を低下させ、生態系を劣化させます
- 生物多様性と気候変動には、相乗的に負の相互作用があります。例えば。2019 年のオーストラリアの火災 (10 億から 30 億の動物と、オーストラリアの森林の 21% が破壊された); 6億 5000万から12億トンのCO<sub>2</sub> が排出された

2023/4/78

There are also cases where both climate change and biodiversity can act simultaneously.

For example, if we replace tropical rainforests with agricultural land, stored carbon is being released at the same time as biodiversity is being reduced.

Rising temperatures not only reduce agricultural productivity, but also reduce species, in some cases leading to their extinction.

Warming and acidification of the

oceans reduce the ability to remove carbon dioxide from the atmosphere, degrading biological ecosystems.

In 2019, you may all remember. The fires in Australia had a synergistic negative effect on biodiversity and climate change.

The examples shown here are examples of simultaneous negative impacts, both from the climate change side and from the biodiversity side.



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Editor&s note: Literal translation of the fourth point is:

There is a synergistic negative interaction between biodiversity and climate change. For example, the fires in Australia in 2019 destroyed between 1 billion and 3 billion animals and 21% of Australia's forests. They also emitted between 650 million and 1.2 billion tons of CO<sub>2</sub>.

Slide 1-1-9. Attempted innovation to protect the earth

## Examples

		Climate	Biodiversity
 <p style="margin-top: 10px;">Amazon</p>		X	X
 <p style="margin-top: 10px;">Carbon offsets</p> <ul style="list-style-type: none"> <li>- Fail to grow</li> <li>- Replace good habitat</li> <li>- Just a scam 詐欺</li> </ul> <p style="margin-top: 10px;"><a href="https://www.youtube.com/watch?v=AW3gaelBypY">https://www.youtube.com/watch?v=AW3gaelBypY</a></p>		X	X

2023/4/7
=

Under the climate change treaties various innovations have been created.

One of them was to create a carbon offset market. This was called a climate change solution. This is for organizations, such as companies, to pay to plant trees rather than to lower their own CO<sub>2</sub> producing activities, if they needed to remove CO<sub>2</sub>.

Unfortunately, however, offsets are not very effective. Unfortunately, this rarely works, and in fact, there have been

several cases where it was a genuine scam.

There have also been cases of bad results after national elections. In the Amazon, for example, during the period of Bolsonaro's election as president in Brazil, there was significant forest loss and fires released large amounts of carbon dioxide. As a result, the forest's ability to absorb CO<sub>2</sub> has also weakened further, and the Amazon no longer removes CO<sub>2</sub> from the atmosphere, but instead emits it.


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 Editor's note: What is offset?

Offset means 'make up'. It is a policy to prevent the increase of carbon dioxide emissions by compensating for emissions of carbon dioxide by planting trees in their place (which are intended to absorb CO<sub>2</sub> as they grow).


In reality, however, there have been a number of cases where forests have been logged and planted, but then left unattended, resulting not only in green spaces, but also in further devastation.

Slides 1-1-10. Biomass for energy


## Biomass for energy



Public Image 建前  
- green, renewable



Reality 真実



Bad for climate  
and biodiversity

2023/4/7 10

Another example is the rationale that it must be environmentally friendly to use wood as fuel instead of fossil fuels, as it is a carbon resource that is circulating from the atmosphere during the lifetime of the tree.

But burning wood instead of coal to

generate electricity was another failure.

This is because deforestation has exacerbated climate change and destroyed biodiversity in the cleared forests.

So this issue is one of the failures of having considered the climate issue and the biodiversity issue separately.

Slide 1-1-11 UNFCCC and CBD

## UNFCCC and CBD

- UNFCCC- Convention in force 1994, now on COP27, IPCC 6 cycles of analysis
- Highly likely to miss Paris Targets
  
- CBD- Convention in force 1993, now COP15
- Have they worked together, have they worked against each other?

2023/4/711

So EASAC asked the respective treaty headquarters whether these two conventions could be better coordinated.

At two meetings last year, as you can see on the slide, this issue was recognized

and some steps were taken for coordination.

So now we are looking at these two issues together.



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Editor's note: Ref. to Slide 1-2-2 in Page 16 for more information on UNFCCC and CBD,

Slides 1-1-12. Ecosystem Restoration

## 生態系の回復

- 生態系の回復は、食料不安、気候変動の緩和と適応、生物多様性の損失に対する自然に基づく解決策を提供する最も効果的な手段の 1 つです。これを認識して、2021 年から 2030 年 が国連生態系回復の 10 年と宣言されました。
- 生物多様性と気候危機の両方に対処する上で、「再野生化」には大きな役割が見られます。UNEP (2021) は、政府に対し、2030 年までに少なくとも 10 億ヘクタールの土地を回復し、海洋についても同様の約束をするよう求めています。
- これには、自然界への年間投資の 4 倍が必要です

2023/4/712

One of the key common themes of the two conventions is that of ecosystem restoration.

This helps both biodiversity and climate.

It is about protecting the remaining natural ecosystems and initiating the

recovery of those that have already been destroyed.

This requires a lot of international investment.

The sources of this money were examined in detail under the recent Convention on Biological Diversity.

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Editor's note: A direct word to word translation of the slide contents may be as follows:

- Ecosystem restoration is one of the most effective means of providing nature-based solutions to food insecurity, climate change mitigation and adaptation, and biodiversity loss.
  - Recognizing this, years from 2021-2030 have been declared as United Nations Decade of Ecosystem Restoration.
  - United Nations Environment Programme (UNEP, 2021) calls on governments to restore at least 1 billion hectares of land by 2030, and to make similar commitments for the oceans.
- This would require four times the annual investment in nature.



Slides 1-1-13. Common Solution-Transformative Change

**Common solution-transformative Change**

- 1 Introduction
- 2 Why the need for transformative change?
  - 2.1 Planetary boundaries
  - 2.2 Climate change
  - 2.3 Biodiversity and ecosystem services
  - 2.4 Population and consumption
  - 2.5 Economics' compatibility with sustainable development
    - 2.5.1 GDP as an indicator and GDP growth as a policy objective
    - 2.5.2 Cost-benefit analysis and the discount rate
    - 2.5.3 Placing an economic value on environmental impacts
    - 2.5.4 Dealing with non-linearity of climate change
    - 2.5.5 Energy and resource decoupling
    - 2.5.6 Finance
    - 2.5.7 More sustainable economic models
- 3 What should transformative change involve?
- 4 Points relevant to post-COVID-19 priorities
  - 4.1 The COVID-19 pandemic and transformative change
  - 4.2 Insights from the analyses of transformative change for the EU
    - 4.2.1 Replacing GDP with indicators of human well-being
    - 4.2.2 Overcoming the excessive influence of special interests
    - 4.2.3 Public awareness
    - 4.2.4 Industry engagement
    - 4.2.5 International actions
- 5 A final word

07/04/2023 13

However, this alone will not solve the problem. Without transformative change (Ref. to notes), the current policy cannot make sufficient progress.

The objectives and interests that drive the behavior of people and companies must change.

The approach so far has been incremental change. That doesn't work very well. That is why transformative change is needed.

This is to mitigate further increases in

population and consumption, reduce demand for resources and energy, and move towards stable, sustainable lifestyles.

The EASAC proposals discussed here have been translated into Japanese.

Japanese author Saito Kohei has recently published a popular book on the subject.

Having explained the above briefly, I will now join in the question and answer session.

For now, I will return to Matsumura-San.

Editor's notes:

(1) Kohei Saito. 'Karl Marx's Ecosocialism: Capital, Nature, and the Unfinished Critique of Political Economy Paperback. Monthly Review Press (October 24, 2017). and Kohei Saito. 'Marx in the Anthropocene. Cambridge University Press; (February 2, 2023).

(2) The report translated into Japanese is: EASAC 2020 Toward a sustainable future: transformative change and post-COVID-19 priorities.

<http://susdi.org/doc/mvc/easac2010covid.docx>.

(3) The word 'transformative' is an adjective meaning 'powerful enough to cause a transformation'. So, 'transformative change' would mean a change that triggers a conversion. As far as the editor knows, the originator of this phrase seems to be Sandra Dias and others (Science 366 (2019) 1327).

1-2 Supplementary slides from citizen's view points Host

Slide 1-2-1 Reference papers quoted in Prof. Norton's lecture

Hascross online seminar 20230222

**Response to Global Environment and Biodiversity Crisis:  
 Current Status**

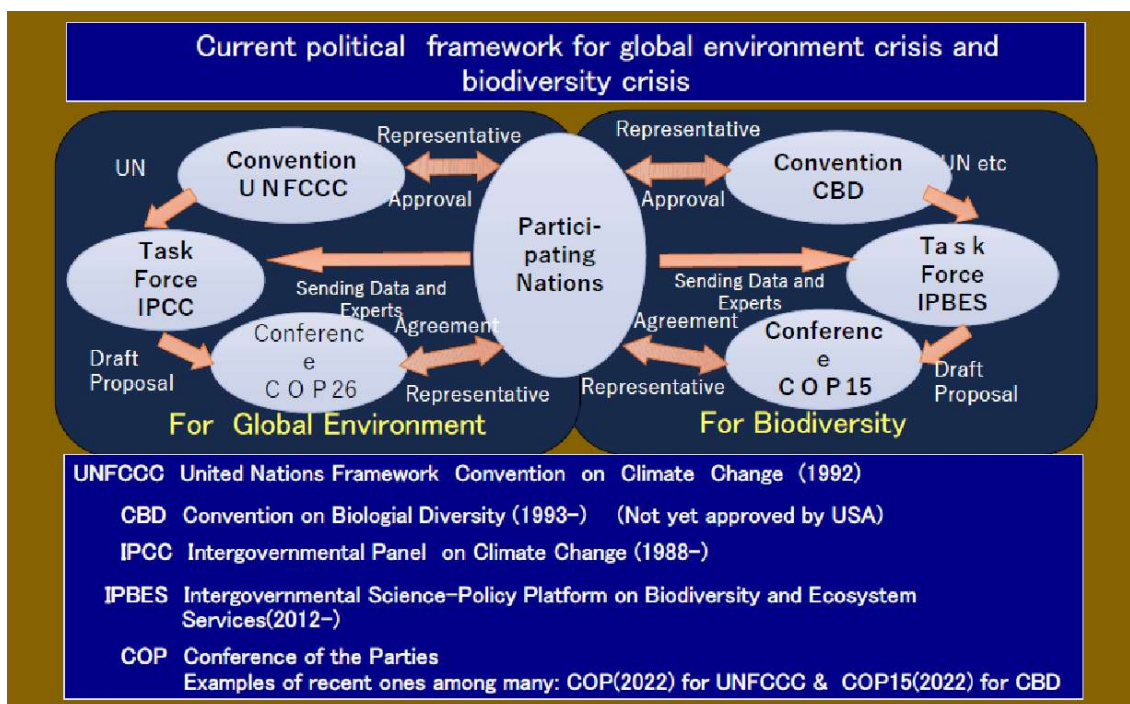
**Professor Michael G Norton,  
 Environment Programme Director, EASAC**

Seminar organizer's understanding of and comments for his lecture and EASAC's papers. Toshi Matsumura, Health and Science Crossroad (hascross)

**References**

- 1) Towards a sustainable future: transformative change and post-COVID-19 priorities. A Perspective by EASAC's Environment Programme. EASAC October 2020
- 2) Key Messages from European Science Academies for UNFCCC COP26 and CBD COP15. The urgency of the climate and biodiversity crises requires closer coordination between UNFCCC and CBD. EASAC. August 2021
- 3) Climate change and biodiversity – common drivers, common solutions. Professor Mike Norton, Environment Programme Director EASAC. Plenary lecture at EASAC symposium on policy opportunities for reducing climate change and its impact on planetary and human health, Stockholm, Sweden 2022-11-30. <https://www.kva.se/avenemang/policy-opportunities-for-reducing-climate-change-and-its-impact-on-planetary-and-human-health/>
- 4) Transformative change. A brief introduction by IPBES secretariat: <https://ipbes.net/glossary-tag/transformative-change/>

Slide 1-2-2 Roles of functional bodies and their interrelationships



Slide 1-2-3 EASAC raises questions

**Are they right targets to achieve?**  
From scientific analyses EASAC raises questions to the targets in the current political framework.

**Among them are:**

- Is 'carbon offset' an effective measure?
- Can 'sustainable growth' truly be a goal?
- Is an increase in 'GDP' a good indicator of the affluent lifestyle that we seek for?

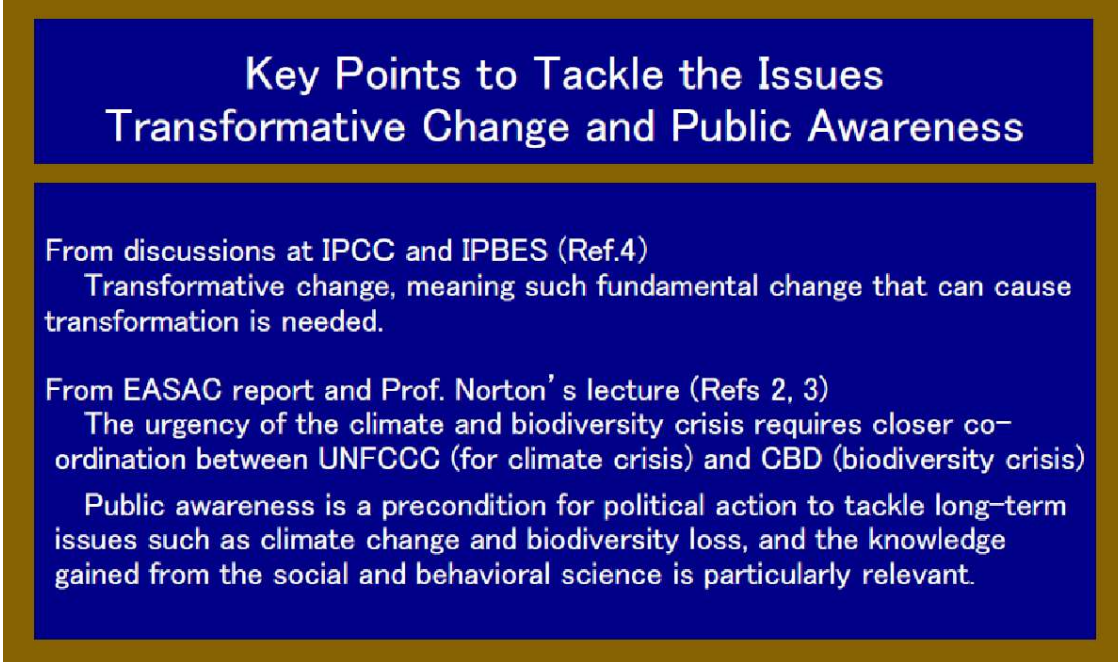
Detailed discussion and consideration are given on the above and other points in References 1) and 2).

Slide 1-2-4. Unattainable goals under the current political framework

**Why can't we achieve the goals being set under the current political framework?**  
From EASAC's reports and discussion with Prof. Norton

1. Unlimited population growth cannot be controlled in a significant number of nations where;
  - insufficient education is given to women.
  - social security is underdeveloped, so that the only remaining social security is children.
  - there is a strong religious belief in fertility.
2. Economic expansion is essential to maintain social stability in many nations, where earth resources (underground resources, water resources etc.) and labor power are more important for the stable increase of profitable cycles than those necessary for human life.
3. In nations where people are looking for the bread of tomorrow, their governments are unable to deal with future issues such as the prevention of global warming.
4. Nations with short-lived governments are unable to address long-term issues

Slide 1-2-5 Key Points to Tackle the Issues



**Key Points to Tackle the Issues**  
**Transformative Change and Public Awareness**

From discussions at IPCC and IPBES (Ref.4)  
Transformative change, meaning such fundamental change that can cause transformation is needed.

From EASAC report and Prof. Norton's lecture (Refs 2, 3)  
The urgency of the climate and biodiversity crisis requires closer co-ordination between UNFCCC (for climate crisis) and CBD (biodiversity crisis)

Public awareness is a precondition for political action to tackle long-term issues such as climate change and biodiversity loss, and the knowledge gained from the social and behavioral science is particularly relevant.

### 1-3 Discussion and Q&A for Section 1

Discussant A.

Thank you very much, Doctor Norton.

How do you perceive the gap between the imminent reality and public sentiment?

When I was listening to the discussion on the global environment, we have been discussing carbon dioxide emissions for about 20 years now, and although we discuss it, it has not led to any action, and carbon dioxide emissions are increasing every year.

I think we are emitting about 35 billion tonnes of carbon dioxide per year.

The top 20 emitters in the world emit more than 80% of the total, so I believe that unless the activities of those 20 countries change, we will not be able to reduce carbon dioxide emissions.

The question I keep thinking about is whether we, as consumers, would choose to reduce carbon dioxide emissions even if we had to change our own lives. For example, would we give up our four-seater cars for two-seater cars, or

would we go for motorcycles?

In short, we are doing something completely irrational, like carrying a one-tonne car to carry 60 kg of weight, so if we can't change this much, I wonder if we can reduce carbon dioxide emissions with that.

For example, it is not realistic to say that we can stop using smartphones. The servers consume a tremendous amount of energy, so first of all, cars consume a lot of energy, so can we change this?

Can we reduce consumption by switching from four-seater cars to two-seater cars, and hopefully even one-seater motorcycles, by making them lighter and smaller?

I wonder if consumers in developed countries will be able to make such a choice.

I'm happy to put that out there for now as a comment, thank you very much.

Prof. Norton.

Is that an explanation of what you mean by personal action?

That even if you do your best, it doesn't affect you from a global standpoint?

Discussant A.

The purpose of a company is to make a profit. The basic principle of capitalism is that you have to pursue profit forever, which is essentially contradictory because you are trying to do that on a finite planet.

I think it is necessary to change that, but that is a very serious problem. For the moment, I would like to think of the car as a car, and as a problem at the individual level.

Prof. Norton.

People are looking for growth. We use GDP to measure the results of growth.

When there is a big problem (e.g. a major disaster), GDP increases.

According to GDP, the Fukushima disaster is an achievement.

A major tsunami is another economic outcome.

So, GDP includes many different problems.

If there is a problem with the environment, then GDP increases. This is because money is needed to solve the damage.

So can't we use another indicator instead of GDP? People are working hard on this and considering it.

The debate has been going on for 30 years or more. Everyone agrees that GDP is bad, but there is no alternative indicator that everyone agrees on, so far.

In Europe, since 2009, there has been a special initiative to consider what indicators should be used instead of GDP. But we haven't yet come up with an indicator that everyone agrees on.

The British government is still saying

that they want to grow GDP by 2% next year. The same goes for the government in Taiwan, and the same goes for China.

Bhutan is often cited here as a good example. Bhutan does not use GDP; instead of GDP, it has erected six indicators, including happiness, health, jobs and environment. Bhutan has created an almost sustainable society (Ref. to Editor's note).

If Japan adopts the same indicators as Bhutan, the problem of climate change could be solved, but the reason why Japan cannot change to the Bhutanese method is that these indicators are easy for the government to understand and for citizens to understand, but the way companies are run is all about economic indicators (GDP).

So even though transformative change is required to solve the problem, it is also a problem that people don't really want to change!

Editor's note: About the Bhutan Indicators

In researching the Bhutan Indicators, it has been reported that recent changes in the lifestyle of young people in Bhutan have resulted in a less monolithic assessment of the Bhutan Indicators.

Discussant B.

Can we take an individual level approach?

When dealing with these issues, I always wonder where to look for quantitative data such as where CO<sub>2</sub> is being emitted and absorbed, or where energy is being used in how much amount.

If you don't know that, you can't use it as an indicator, and although you can economise a little bit on a personal basis, it may not make much sense. So I think we need more quantitative data, and we need to use it to make our case.

Prof. Norton

There are a lot of publications. UN organizations such as the IPCC, papers in scientific journals, the World Climate Programme, NOAA in the US, NASA in the US, WMO in the UN, JAMSTEC in Japan, a number of climate centres; most

countries have their own data.

Thanks to the UN organization, we have an international databank where each country's data is shared. So it is not a question of data accessibility. It is full of data.

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Editor's supplementation: Explanation of terms.

NOAA National Oceanic and Atmospheric Administration

NOAA Global Monitoring Laboratory provides a lot of basic data in this field, such as the perennial changes in atmospheric CO<sub>2</sub>.

NASA National Aeronautics and Space Administration

WMO World Meteorological Organization International Meteorological Organization  
(a specialized agency of the United Nations)

JAMSTEC Japan Agency for Marine-Earth Science and Technology

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Discussant B.

I see a lot of country-specific data here and there, but I have not seen much about how it is used in those countries.

biological data. This has been very well developed and allows for a variety of detailed calculations. How is the data related to energy and climate change maintained?

Prof. Norton.

You are talking about energy consumption. Carbon dioxide is produced from the energy sector. But it also comes from the agricultural sector, and there are different ways of calculating it internationally.

The other greenhouse gases, methane, nitrogen dioxide and fluorocarbons, are also calculated from the respective production data.

There is a set international method; there is a set international data collection method under the IPCC. Everyone uses the same method.

So the Chinese and UK indicators are collected using the same method.

Prof. Norton.

Data standardization is based on the International Harmonization of Statistics. I think this is the same as in the case of DNA, which was established 30 years ago for the determination of the human genetic sequence.

Each institute is supposed to collect and calculate data on the same basis. There will be errors of plus or minus 5-10%, but no errors of plus and minus 100%.

We are confident that the increase in these figures is not an error due to the way the statistics are done.

The Global Carbon Project (GCP) publishes the Global Carbon Budget every year as a scientific review (Editor's note: there will be no reduction in atmospheric CO<sub>2</sub> until the end of 2022).

Host

Mr B has been working on the basis of DNA sequence data and molecular

Discussant B

I think it's not that easy to calculate what would happen if all of us individually stopped using cars or stopped eating beef, because we know the emissions and so on, but what we need to do for our personal lives, what would happen if all of us individually stopped using cars or stopped eating beef?

Prof. Norton.

The emissions in each country are segregated into energy, transport, agriculture and industry, so we have a rough idea of how much the average person emits.

The trend now is moving away from IC engines using petroleum fuels towards using electric motors. But the most important thing is how the electricity is generated.

Host

Thank you very much. Due to time constraints, we will end this discussion for now and move on to the next statement by Ms C.

Discussant C. Ammonia as an energetic substance

My question is about ammonia and hydrogen, which are currently being considered as candidates for non-carbon dioxide-emitting fuels in Japan. Hydrogen is fine because it only turns into water

when it is burnt, but ammonia produces NOx when it is burnt.

Ammonia can be used as fuel for ships, aeroplanes and power stations. I am concerned because I have not seen any discussion on this point, because I believe that the use of ammonia has a very harmful effect on the environment.

When NOx dissolves in water, it becomes nitric acid. Nitric acid is a strong acid, so it ionises 100% in water, and I think it acidifies the seawater very much. When new technology is introduced to use ammonia as an energy source, how much of the negative effects will be assessed in advance?

Ammonia is a substance that has been around for a long time, so I think the results can be estimated. I have not seen any discussion on the negative effects of introducing ammonia as a fuel, so I am concerned about that. What are your thoughts on that?

Prof. Norton.

I know that ammonia is expected to transport energy, but I would have to look into the details.

Host

Thank you so much Dr. Norton. Let us discuss the matter separately, and shall we go to the next session?

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Editor's note 1:

As to the discussion with Mr. A and Mr. B, Prof. Norton sent me additional materials via E-mail after this meeting.

I also did some additional research after the meeting. They are appended as supplementary materials in Section 4 of this paper.

Editor's note 2:

In response to Ms C's question, a brief survey in literature was done after the meeting, and the results with editor's comments are appended in Section 4 of this paper.