

How is our environment related with our health?

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2019.1.23 4th NIES International Forum @Hanoi

国立環境研究所

National Institute for
Environmental Studies

(NIES)

Excerpt from Constitution

国立環境研究所は
今も未来も
人びとが健やかに暮らせる環境を
まもりはぐくむための研究によって
広く社会に貢献します

We shall contribute to the society through the research that will protect and nourish the environment in which humans can live safe and healthy now and in the future.

Talk outline

- Environmental pollutions
 - Typical pollutions
 - Contemporary situation
- Climate change & other issues
- environmental health to *planetary health*

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半世紀前の東京の大気汚染
Air pollution in Tokyo:
A half century back

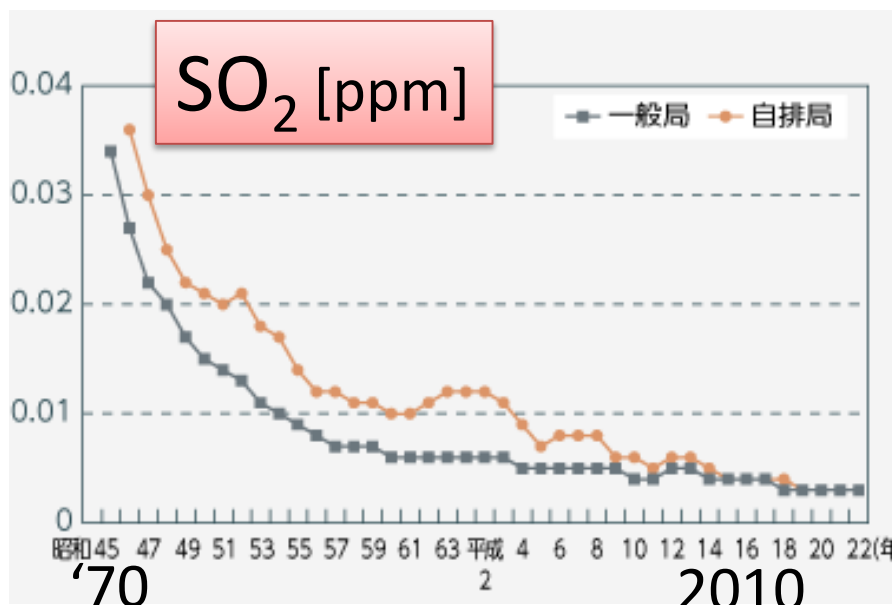
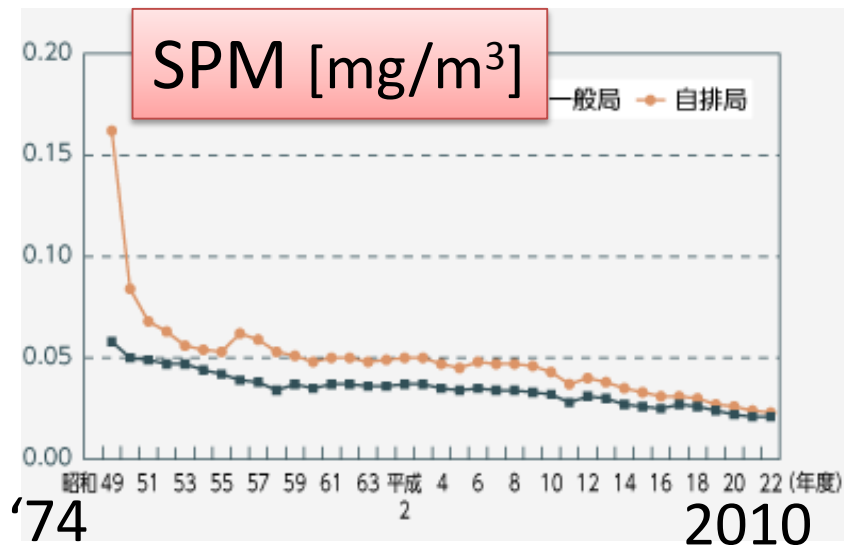
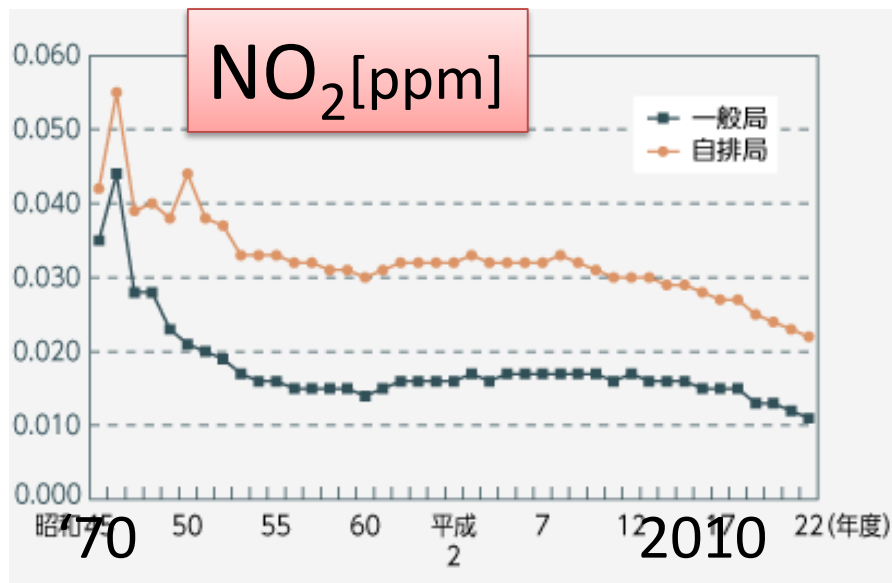


“光化学スモッグによる視界不良のためノロノロ運転(1967年11月29日. 時事通信)

“Cars are driving slowly due in bad visibility due to photochemicals smog” (Nov 29, 1967) [Jiji Tsu-shin]

日本における大気汚染の推移

Year trend of Air pollution in Japan: 1970-2010

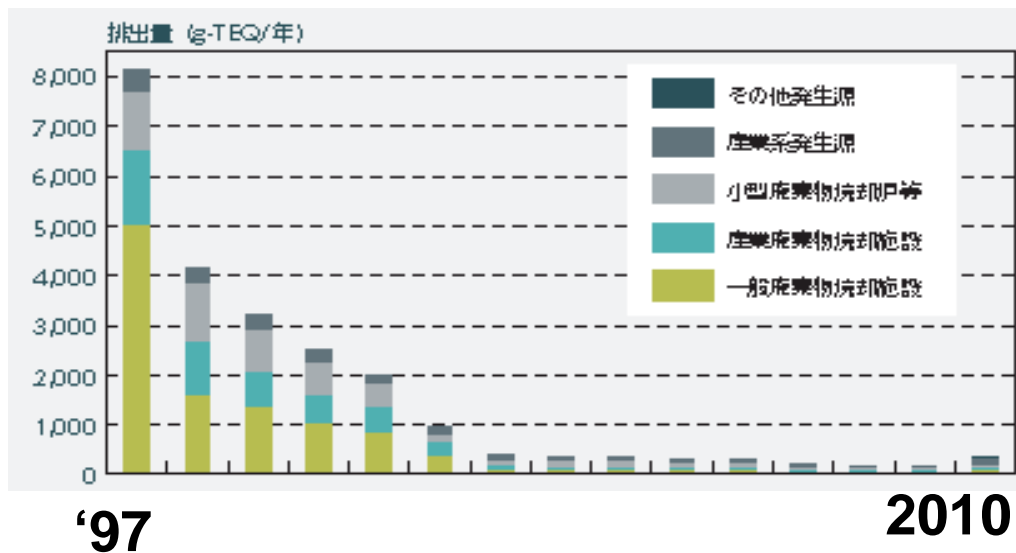


解決策: Solutions:

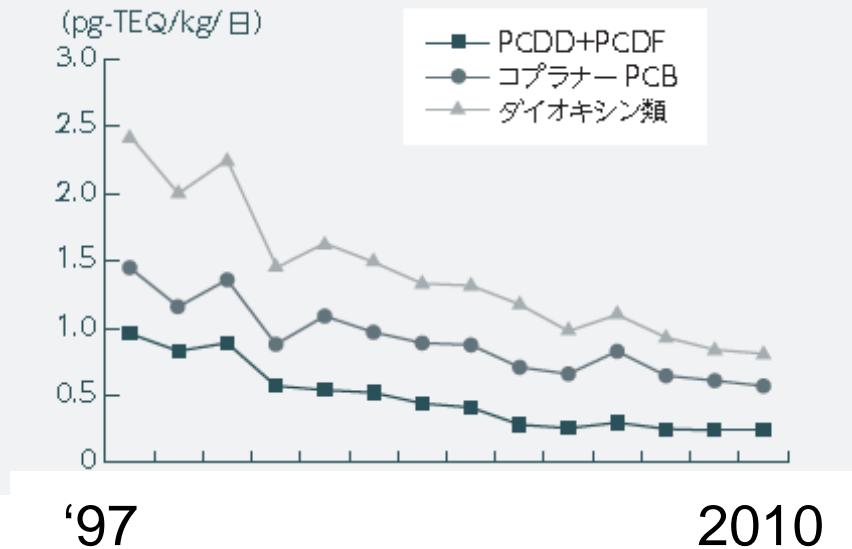
- 環境政策 (規制)
Regulatory actions
(emission/exhaust) discharge
- 工学的技術
mitigation technologies
- *Ozone is still problematic.*

ダイオキシン対策の効果

Effects of anti-dioxins policy



Total emission [g-TEQ/yr]



Human consumption [pg-TEQ 1kg BW/day]

Countermeasures

- reducing emission/exposure by improving *waste incineration* process

Transition of environment-health issues in Japan

- '50-' 60s : typical 'Environmental Pollution' (公害)
Minamata diseases (Kumamoto'56 - Niigata'64),
Itai-itai disease ('55-socially disclosed), Yokkaichi asthma ('60s);
cf. air pollution in Los Angeles ('30s-'40s)
→ '67 Basic Law for Environmental Pollution
'71 Environmental Agency
- after '80s:
Endocrine Disrupting chemicals (EDCs), Dioxin ('80s)
Global Environmental Issues ('92 Rio Summit)
"Planetary health" (Lancet, 2015)
Worldwide environmental pollution (Lancet, 2017)
→ '93 Basic Environment Law
'01 Environmental Agency > Ministry of Environment
- '90s: Social epidemiology

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'Revival' of Environmental Pollution



Re-emergence of 'environmental pollution' issue

大気汚染の世界的インパクト Lelieveld et al. (2015) Nature

More people die from air pollution than Malaria and HIV/Aids, new study shows

More than 3 million people die prematurely each year from outdoor pollution and without action deaths will double by 2050



Chinese parents hold their young children receiving treatment for respiratory illness caused by smog in Hangzhou city. Photograph: Imaginechina/Corbis

More than 3 million people a year are killed prematurely by outdoor air pollution, according to a landmark new study, more than malaria and HIV/Aids combined.

様々な要因による死亡数の推定

Pollutions kill a lot of people

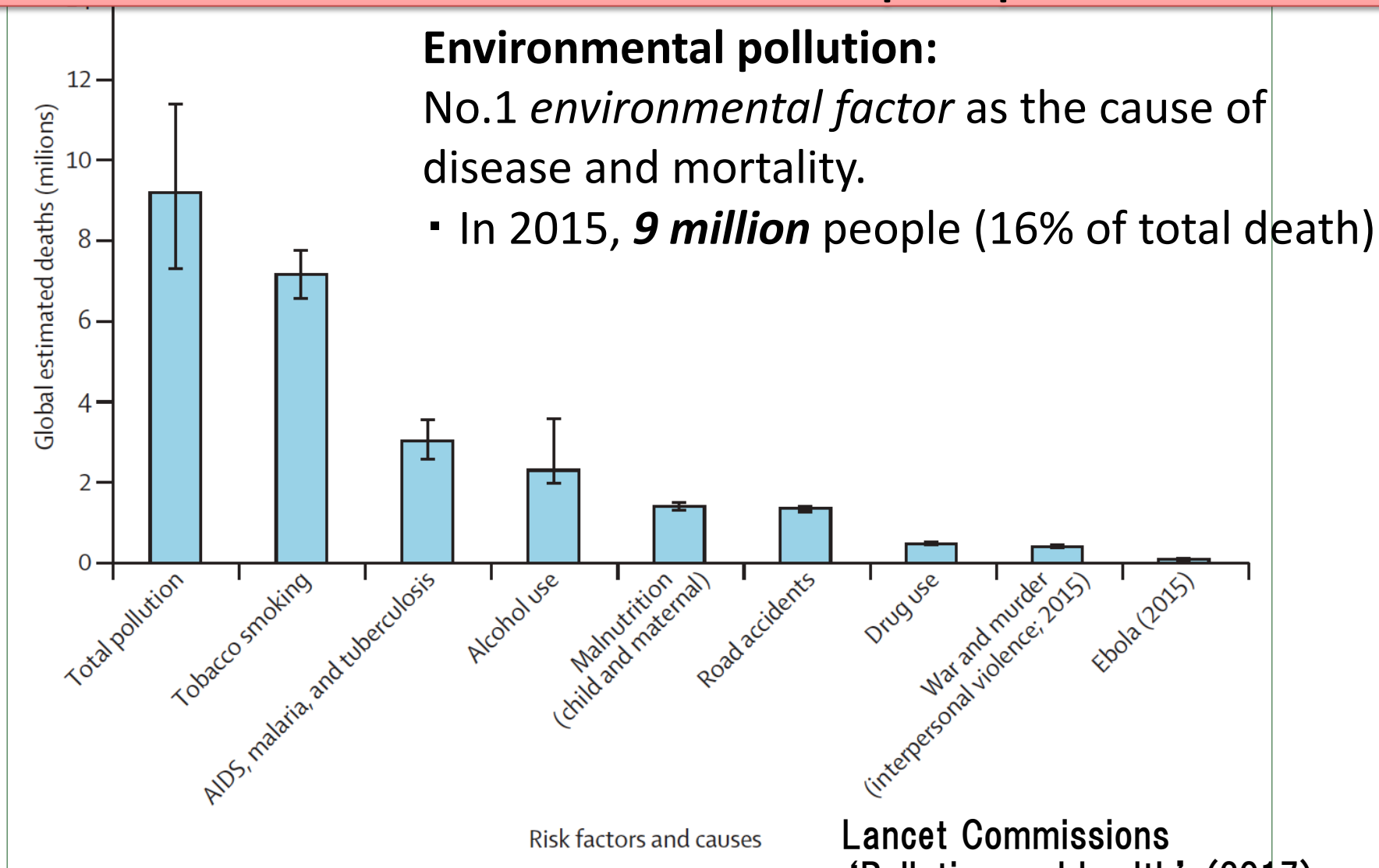


Figure 5: Global estimated deaths by major risk factor and cause, 2015
Using data from the GBD Study, 2016.⁴¹

Regions where pollution matters.

Lancet Commissions
'Pollution and health' (2017)

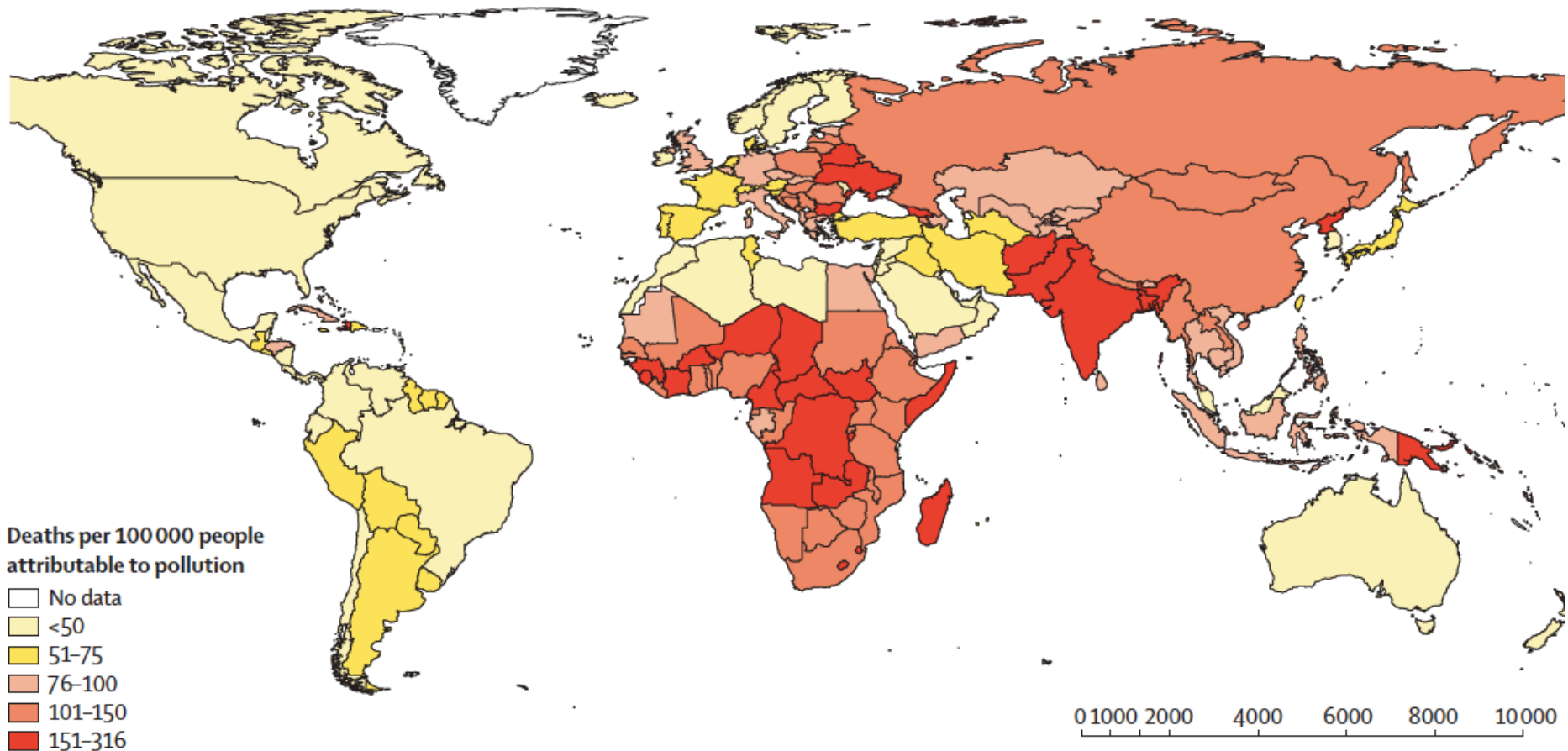


Figure 8: Number of deaths per 100 000 people that are attributable to all forms of pollution, 2015
3D Study, 2016.⁴²

Changing nature of the environmental risk issues

- **Impacts/effects**

Specific, overt → Non-specific, not overt (subtle)

- **Agents/exposure**

Single → multiple chemicals, multiple exposure route

→ chemicals + other factors (like social factors)

- **Causal relationship**

single agent – single outcome

→ multi factors - non-specific outcomes

‘factors’= chemical + nutritional + genetic + social etc

Real ‘effects’ largely unknown

> no appropriate statistical technique ?

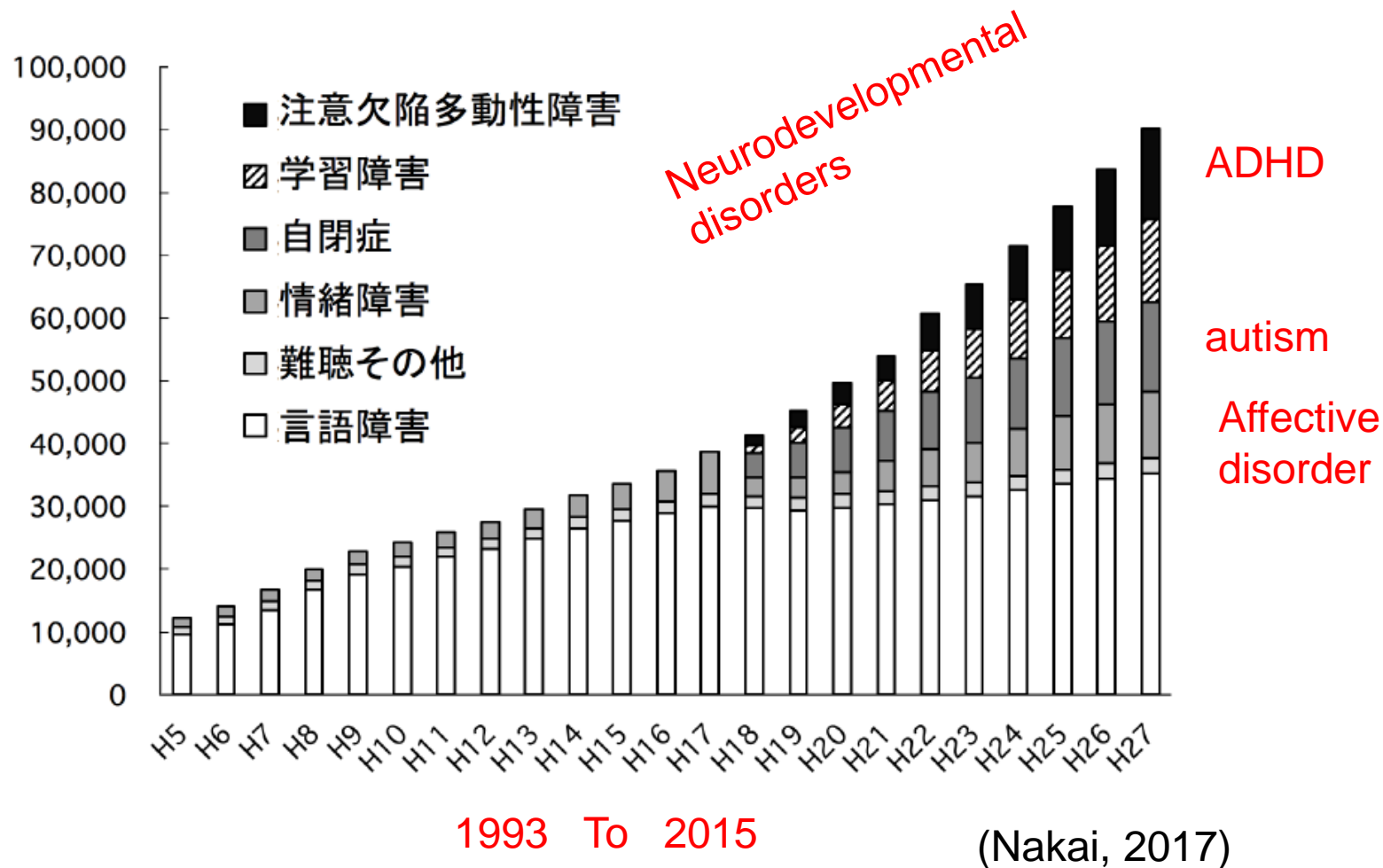
> potential approaches: Adverse Outcome Pathway,

‘*exposome*’ (involving big data, AI?),

endpoint-based approaches

Attributable to (Endocrine Disrupting) Chemicals?

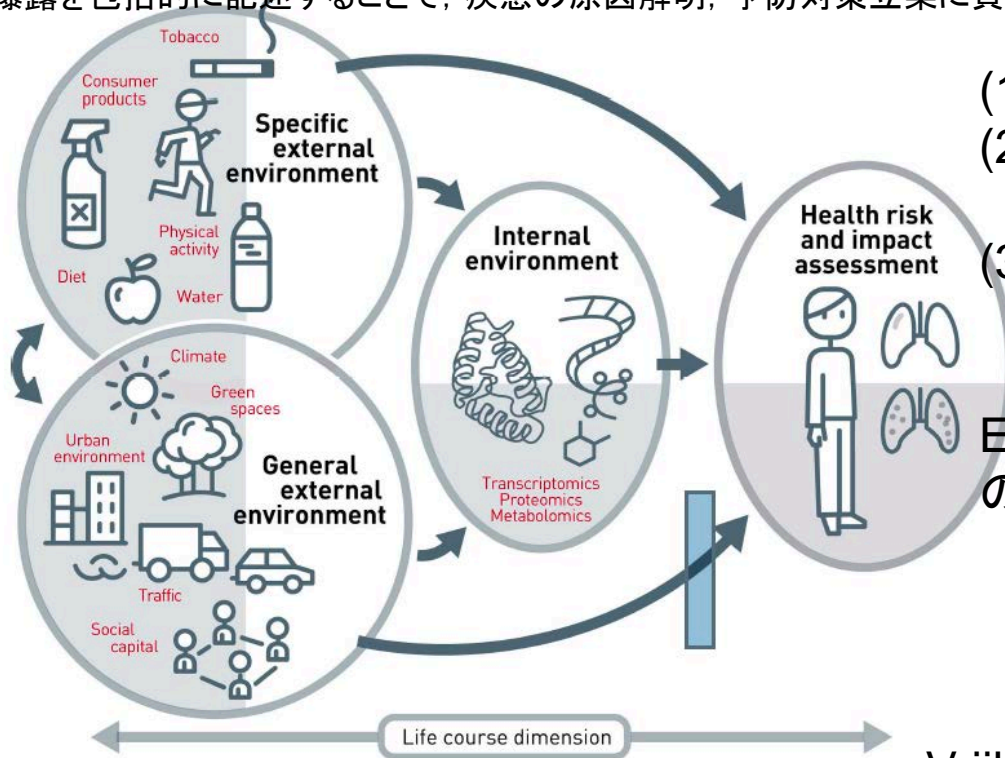
Concerns: The high incidence and the increasing trends of many endocrine-related disorders in humans;



Simple one to complex one “Exposome” (Wild, 2005)

- 複合曝露問題へのアプローチとして、Wildが提唱
Proposed by Wild as an approach to tackle with multiple exposure issues.
(Cancer Epidem Biomarkers Prev, 2005)
- Genome に対応する環境側 (exposure側) 要因の総体。
Aggregate of exposures to various environmental factors; corresponding to Genome

曝露を包括的に記述することで、疾患の原因説明、予防対策立案に貢献する。



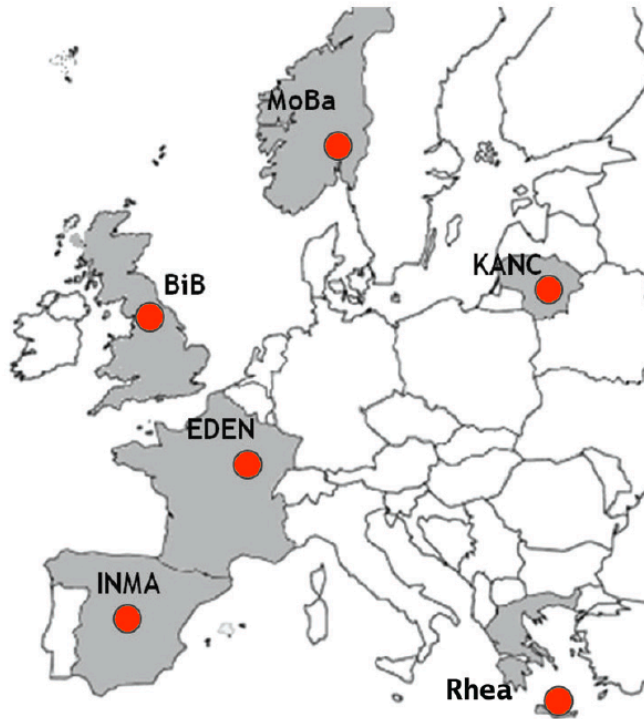
- (1) external measurement
- (2) Internal measurement
生体の反応 (omics)
- (3) Dynamic aspect
時間的な変化

Exposome と 健康アウトカム
の関連: 統計的手法の開発

Simple one to complex one

Human Early-Life Exposome (HELIX)

Figure 1. HELIX conceptual framework and interactions between research areas.



Cohort	Enrollment years	n subjects (total 32,000)
BiB—Born in Bradford, UK (Wright et al. 2013)	2007–2010	14,000
EDEN—Study of determinants of pre- and postnatal developmental, France (Drouillet et al. 2009)	2003–2006	2,000
INMA—Environment and Childhood, Spain (Guxens et al. 2012)	2004–2006	2,500
KANC—Kaunas Cohort, Lithuania (Grazuleviciene et al. 2009)	2007–2009	4,000
MoBa—The Norwegian Mother and Child Cohort Study, Norway (Oslo region) (Magnus et al. 2006)	1999–2009	8,000
Rhea—Mother–Child Cohort in Crete, Greece (Chatzi et al. 2009)	2007–2008	1,500

Existing 6 cohorts
 既存の6コホート
 N=32,000

Effects of perinatal environmental exposure
 周産期の環境要因

Effects at 6-9 years of age
 6-9歳時の影響

<http://www.projecthelix.eu>

- Response profile would be associated with exposure profile.

Vrijheid *et al.*
 (Environ Health Perspect
 2014)

Simple one to complex one Exposome and Adverse Outcome Pathway

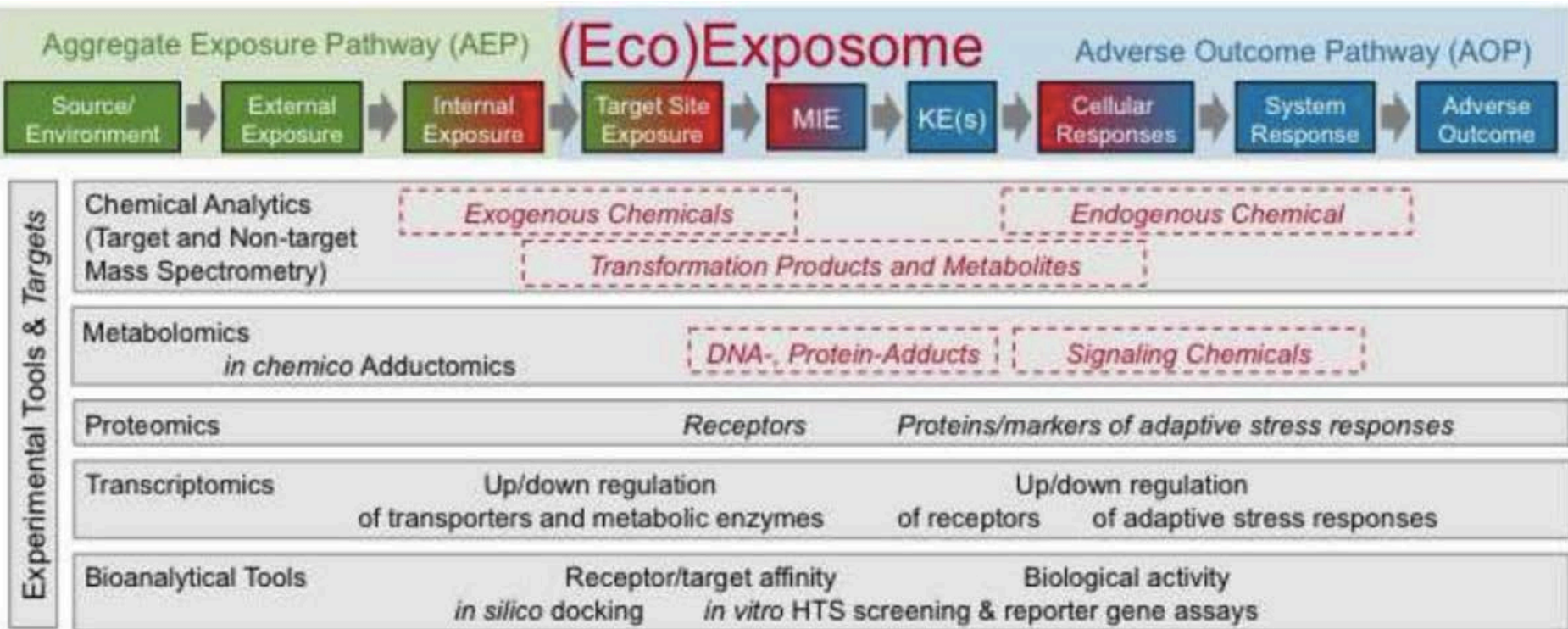


Figure 3: Interface between the (eco)exposome (in red), the aggregate exposure pathway (AEP, green) and adverse outcome pathway (AOP, blue). The red dashed boxes represent chemical

Escher et al. (2018) *Env Int*

“Pollutome”

“the totality of all forms of pollution that have the potential to harm human health.”

Quantitative data Rich

Previous miss

Numbers of pollution-related deaths included in GBD estimates by zone

Zone 1: 9.0 million

Zone 1

Well characterised health effects of well studied pollutants. Data are included in GBD estimates and in this report.

Ex. Increase in NCDs due to air pollution

Zone 2: none at present

Zone 2

Emerging, but still unquantified, health effects of known pollutants. Data are not included in GBD estimates or in this report.

PM_{2.5}—Diabetes, CNS development etc.

Zone 3: none at present

Zone 3

Inadequately characterised health effects of emerging pollutants. Data are not included in GBD estimates or in this report.

EDCs.
This class of chemicals are detected in most of the participants.

Mostly Qualitative data

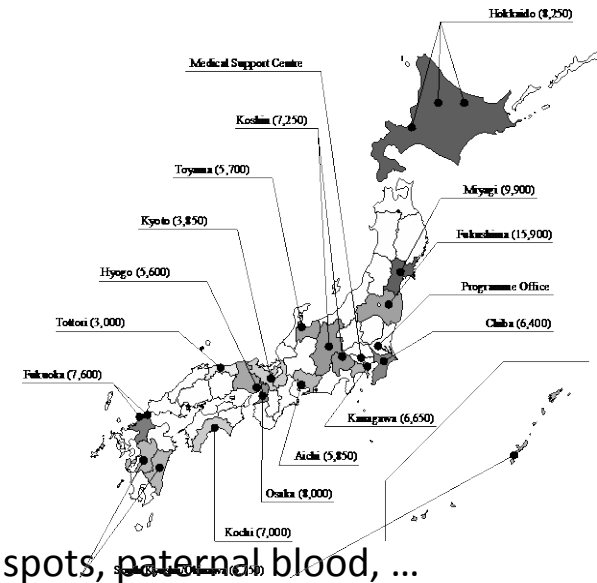
Figure 3: The pollutome

Lancet Commissions
‘Pollution and health’ (2017)

Japan Environment and Children's Study (JECS)

エコチル調査 (全国10万組の母子cohort調査)

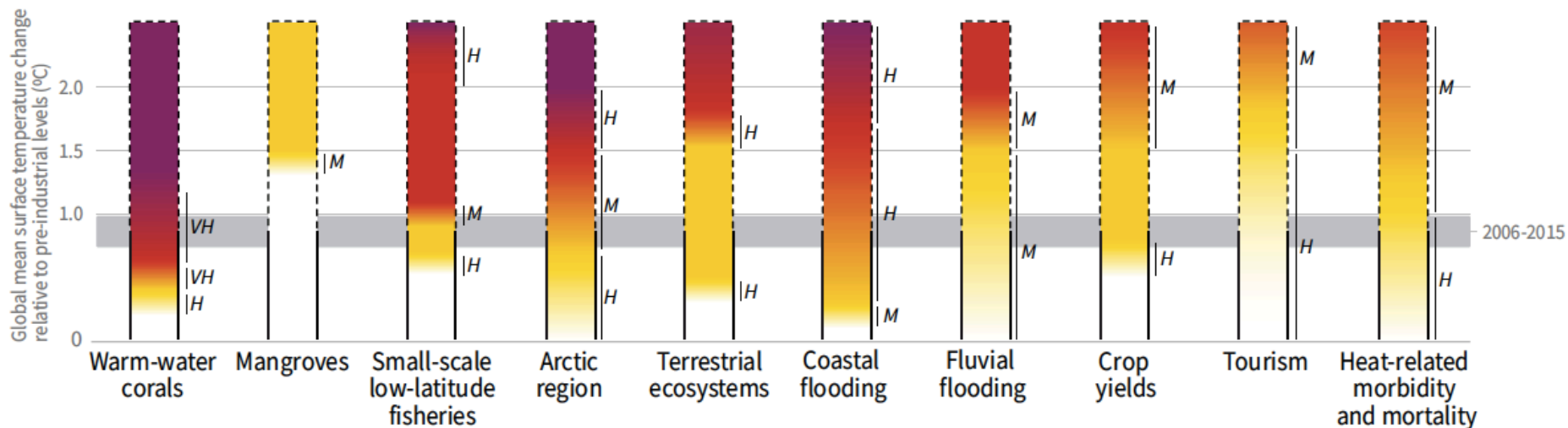
- JECS is a longitudinal birth cohort study (**early pregnancy–13 years old**) to investigate **environmental factors that affect children's health and development** and help decision makers design better risk management strategies, i.e. prevention and intervention
- Recruitment completed in March 2014
- **Mother: 103,103** (~80% consent rate)
 - Father: 51,943
 - **Birth: 100,169**
- Questionnaire
 - Through pregnancy to 5 years old (every 6 months)
- Biological samples > 4,000,000 tubes
 - Maternal blood, urine, breast milk, cord blood, hair, blood spots, **paternal blood**, ...
 - **Metal analysis (Hg, Pb, Cd,...)** will be completed for all mother blood samples this year
- Sub-Cohort Study (n = 5,000) started in November 2014
 - Home visit (1.5 and 3 y/o): **VOCs, aldehyde, PM, house dust, dwelling observation**
 - **Developmental test**, physician's exam, blood (2 and 4 y/o) and urine collection (4 y/o)
 - **Home (social) environment, genetics**



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Impacts and risks for selected natural, managed and human systems



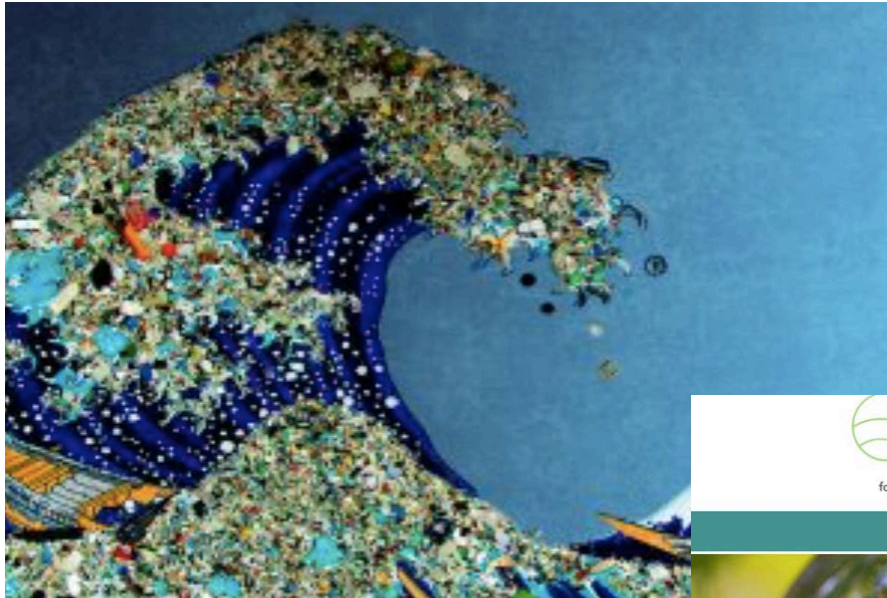
Confidence level for transition: L=Low, M=Medium, H=High and VH=Very high

IPCC “Global Warming of 1.5° C” (2018)
WMO/UNEP

“Adaptation plans for Climate Change” in Japan (Cabinet, 2015)

Endpoint	Pathways	Countermeasures
Heat: direct effect	Death due to background diseases. Heat stroke. Working capacity, efficiency	Hazard forecast, Early warning Dissemination of know-how on countermeasures Utilization of engineering and ICT to reduce work load
Infectious Diseases	Vector habitat (mosquito etc.) Water-born, food-borne diseases	Large uncertainty. Need more data accumulation. Monitoring vector organism.
Other Health effects	Combined with air pollution Vulnerable population Sub-clinical impacts	Reduce environmental pollution (air, water, and food). Need more data accumulation.
Daily activity	Combined with ‘heat island’ phenomena (in urban area)	Increase vegetation and water surface Low energy housing/building Improved public transportation, shift of cargo transportation from car/truck to railroad/ship.

Ecosystem crisis....



Blue Ocean Network
Art-Bonnie Monteleone

<https://blueocean.net/plastic-ocean-pollution/>



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A glass globe containing a small, self-contained ecosystem of green plants and grasses, symbolizing nature and ecosystem services. The globe is set against a blurred green background. Navigation arrows are visible on the left and right sides of the globe.

Correspondence in "Nature" about Ecosystem Services and Nature's Contributions to People
Biodiversity: United by a Common Goal – Four letters in Nature about unity in the wider IPBES community.

[Read more](#)

IPBES

<https://www.ipbes.net>

生態系へのダメージと人間の健康のつながり方

Links between ecosystem damage and human welfare

Environmental changes

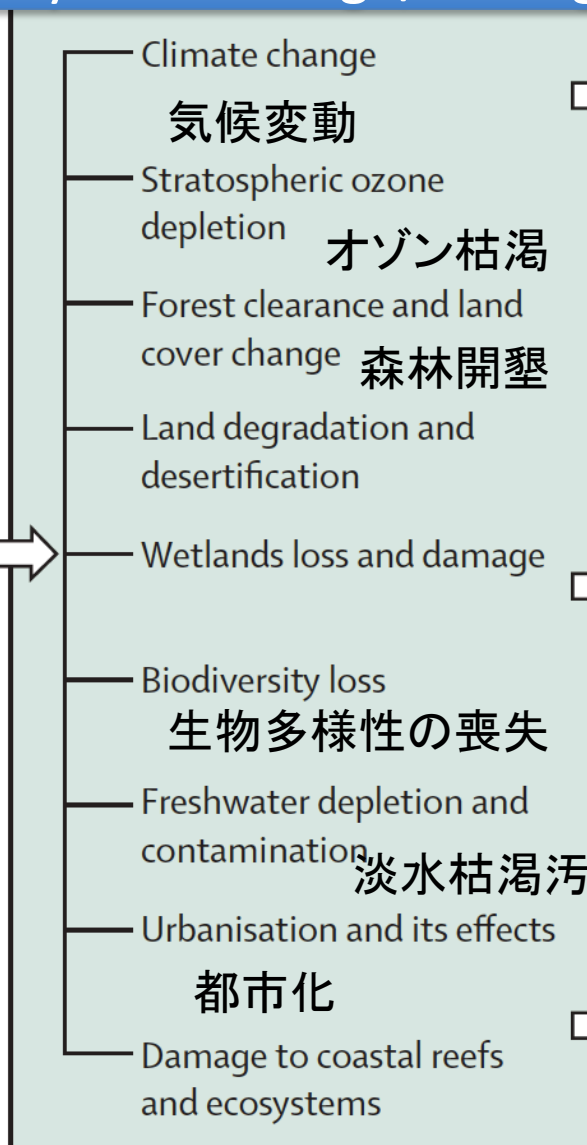
直接影響: 熱波, 洪水など

Examples of health effects

Ecosystem change/damage

Escalation of human pressure on global environment

Millennium Assessment



Direct health effects

Floods, heatwaves, water shortage, landslides, exposure to ultraviolet radiation, exposure to pollutants

生態系によって媒介される影響:

感染症の分布の変化, 農作物の減産など

Ecosystem-mediated health effects

Altered infectious disease risk, reduced food yields (undernutrition, stunting), depletion of natural medicines, mental health (personal, community), effects of aesthetic or cultural impoverishment

間接的影響: 生計の減少, 集団の移住, 争い……など

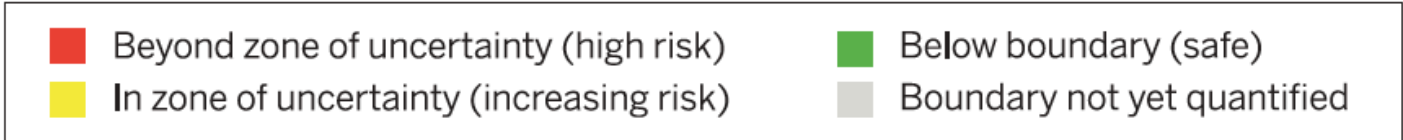
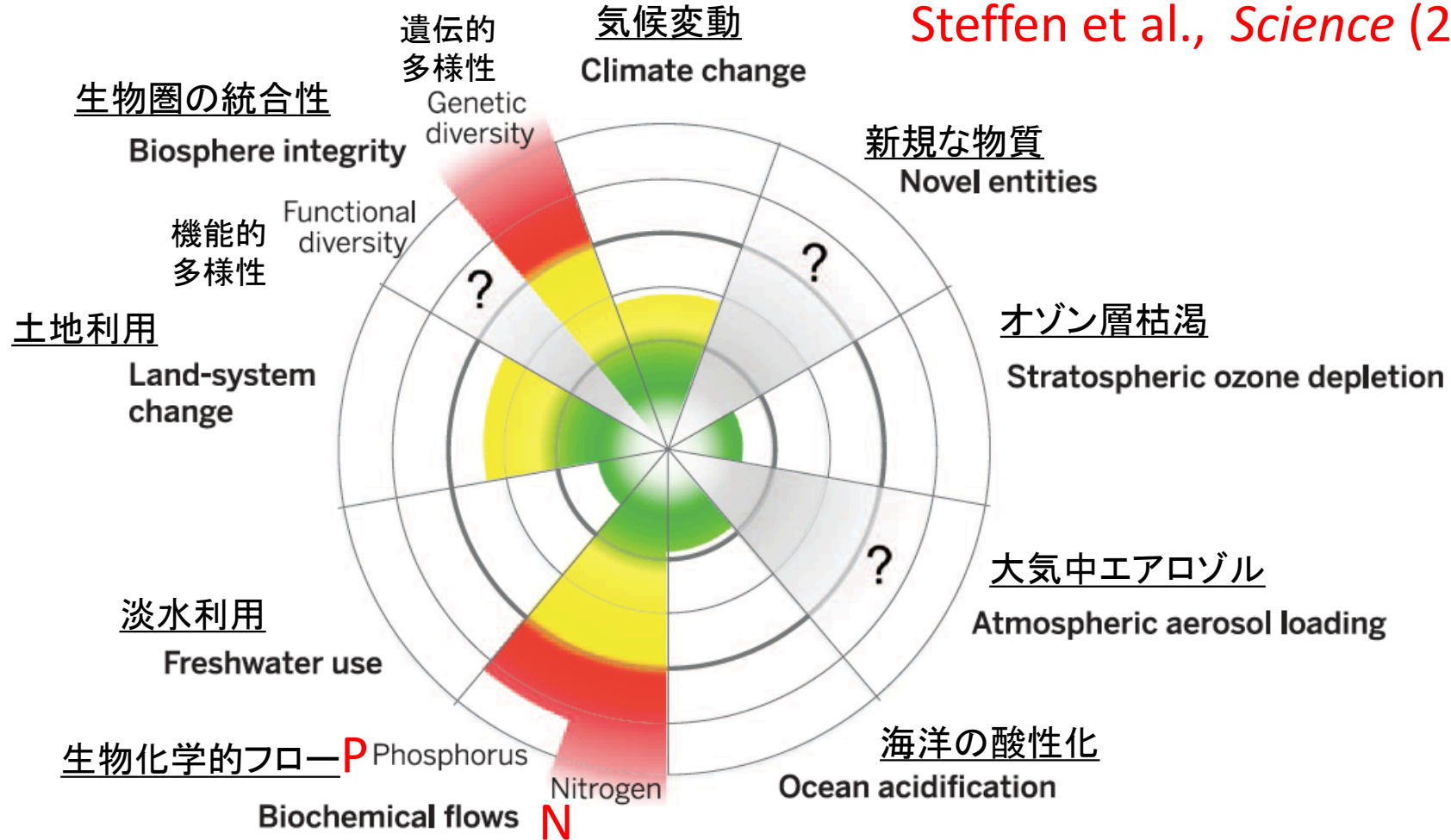
Indirect, deferred, and displaced health effects

Diverse health consequences of livelihood loss, population displacement (including slum dwelling), conflict, inappropriate adaptation and mitigation

'Planetary boundaries' Safe operating space

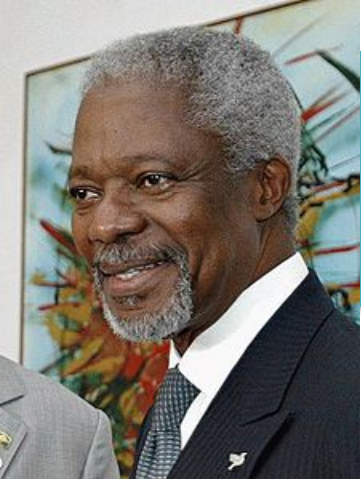
Rockstrom et al., *Nature* (2009)

Steffen et al., *Science* (2015)



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Millennium Ecosystem Assessment

(ミレニアム生態系評価)

A 5-year (2001-05) project evaluating the interrelationship between ecosystem change and human wellbeing in the latter half of 20th century. Called by late Cofi Annan (ex UN-SG). 1,360 experts participated in the project.

Ecosystem change \Leftrightarrow improvement of wellbeing and economics
 \Rightarrow *ecosystem service* for future generations may decrease.
 \leftarrow avoidable with *appropriate actions in the next half century*
 \leftarrow substantial shifts in policy and practice required

www.millenniumassessment.org "synthesis report"

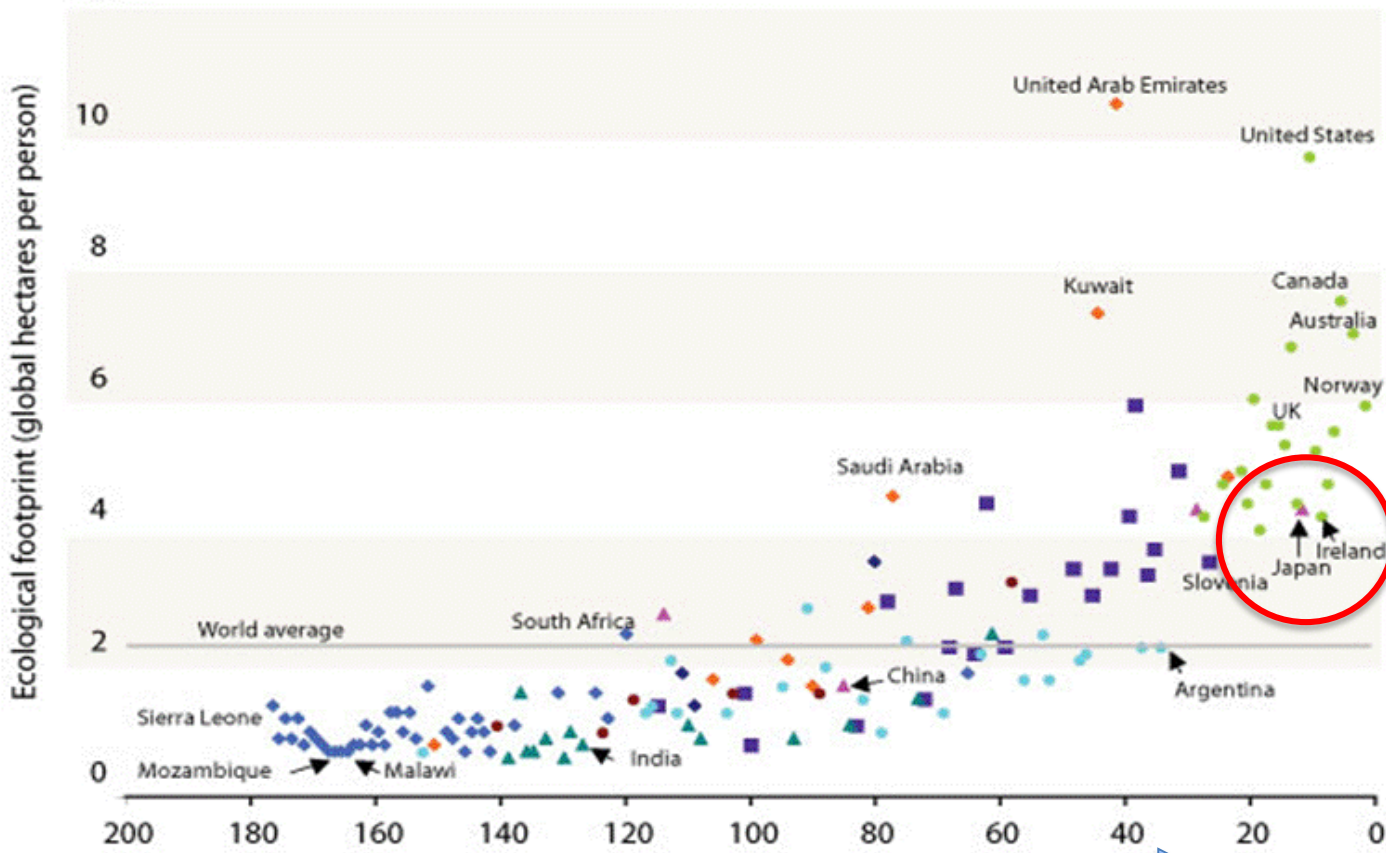
Wellbeing of people built upon environmental burden (cross-sectional/snap shot)

HIGH

LOW

↑

Environmental burden (ecol ftpt)



LOW

Wellbeing (human dev. index)

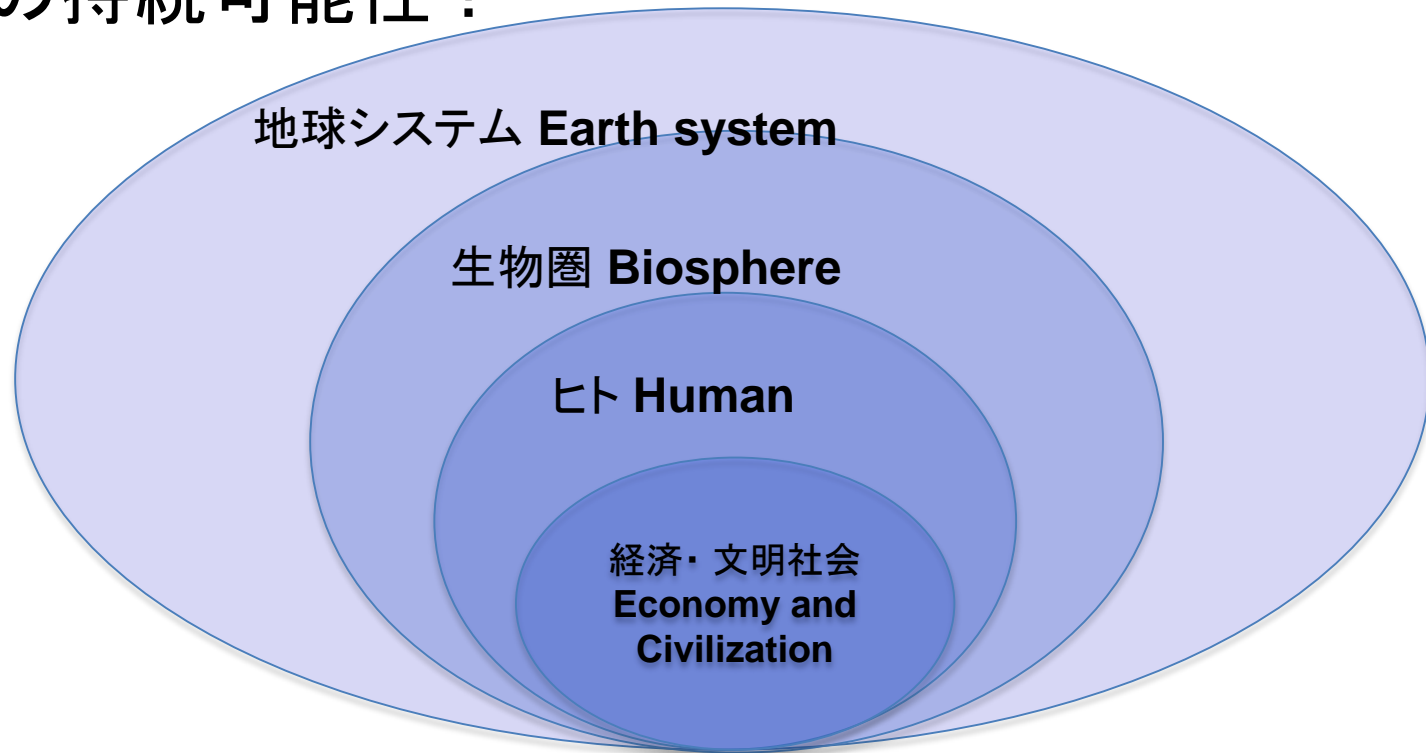
HIGH

- ◆ Central Asia
- ▲ East Asia
- Latin America
- ◆ Middle East
- North Africa
- ▲ South & Southeast Asia
- ◆ Sub-Saharan Africa
- The West
- Eastern Europe

↑

Human wellbeing should be the bottom line of sustainability

→ Sustainability of what?
何の持続可能性？



“Planetary health” (Whitmee et al., 2015. Lancet)

Human health and civilization can be achieved based on the flourishing natural system and wise management of it.

An aerial photograph of a vast, vibrant green field, likely a rice paddy, with a distinct grid-like pattern of furrows. In the lower foreground, a row of trees with light-colored foliage stretches across the width of the image. The text is centered within a white rectangular box that has a thin blue border.

ご静聴ありがとうございました！
Thank you for your attention!