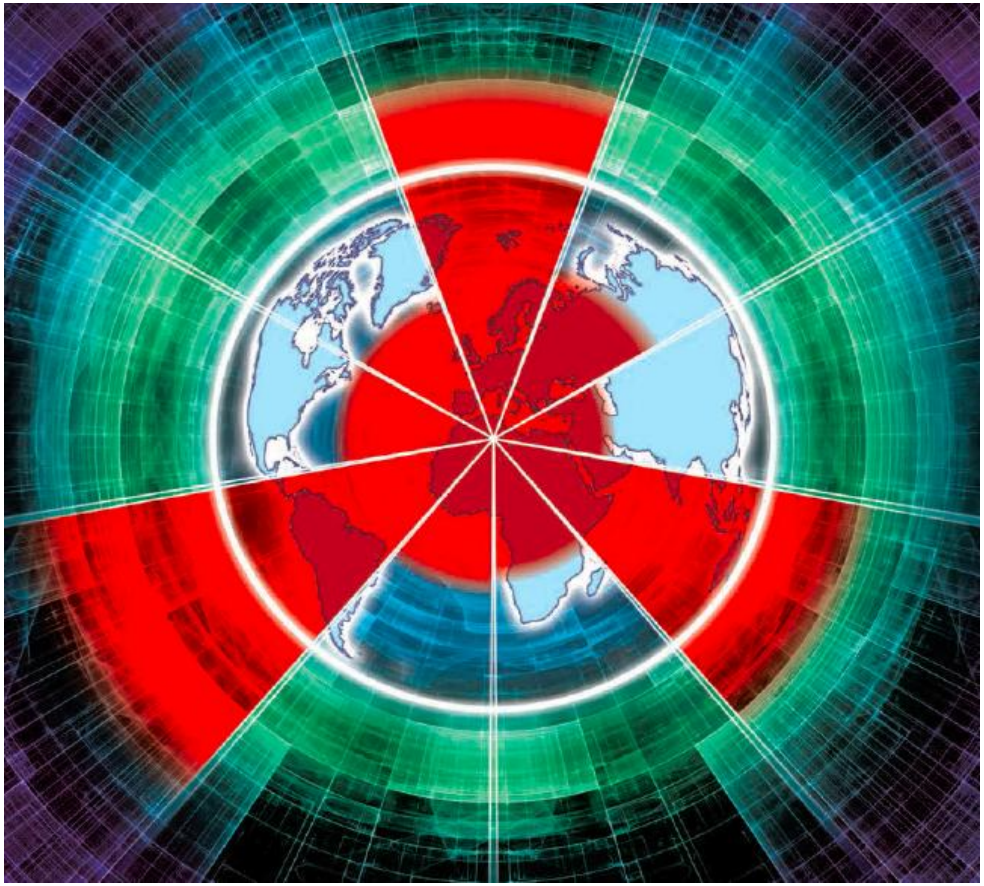


Image: © Edward Elgar 2014

Planetary Boundaries

Quality infrastructure for 'red alerts' for global sustainability?

Stockholm Resilience Centre
Research for Biosphere Stewardship and Innovation

Stockholm University

Dr Sarah Cornell

Geneva, November 2014

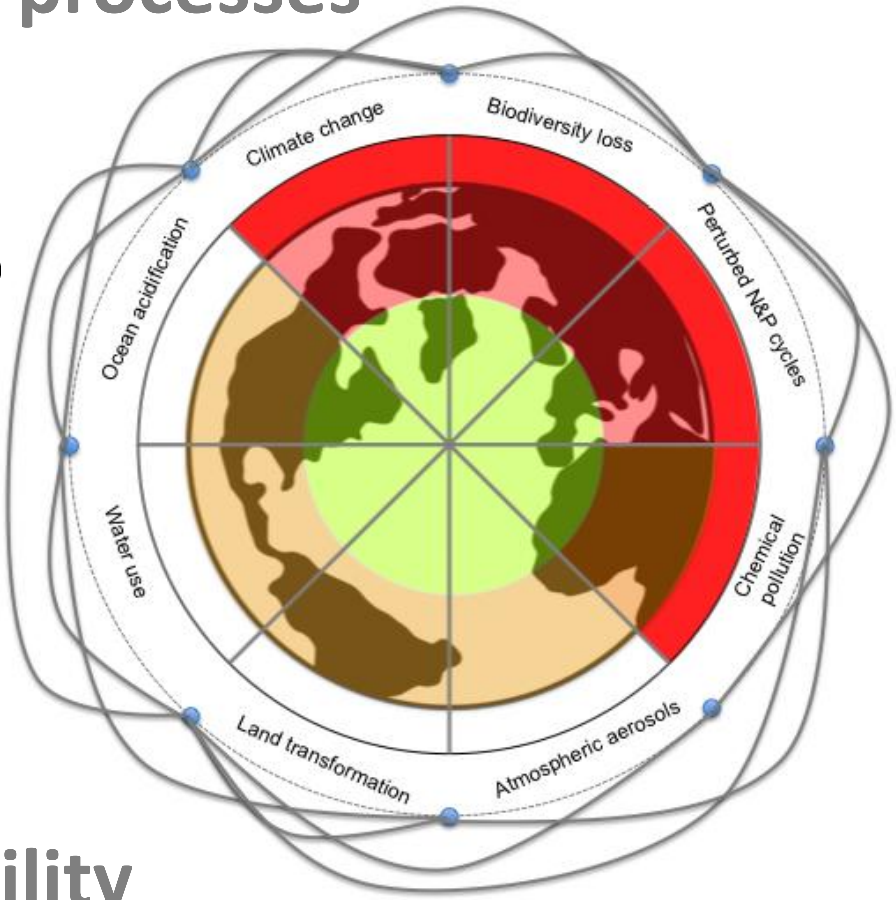
A PARTNER WITH
The Beijer Institute of Ecological Economics
Kungl. Vetenskaps-Akademien
The Royal Swedish Academy of Sciences

FUNDED BY
MISTRA
The Swedish Foundation for Strategic Environmental Research

Rockström and 27 co-authors (2009) 'A Safe Operating Space for Humanity': research article in *Ecology & Society*, discussion article in *Nature.*

Planetary boundaries mark precautionary limits for critical environmental processes

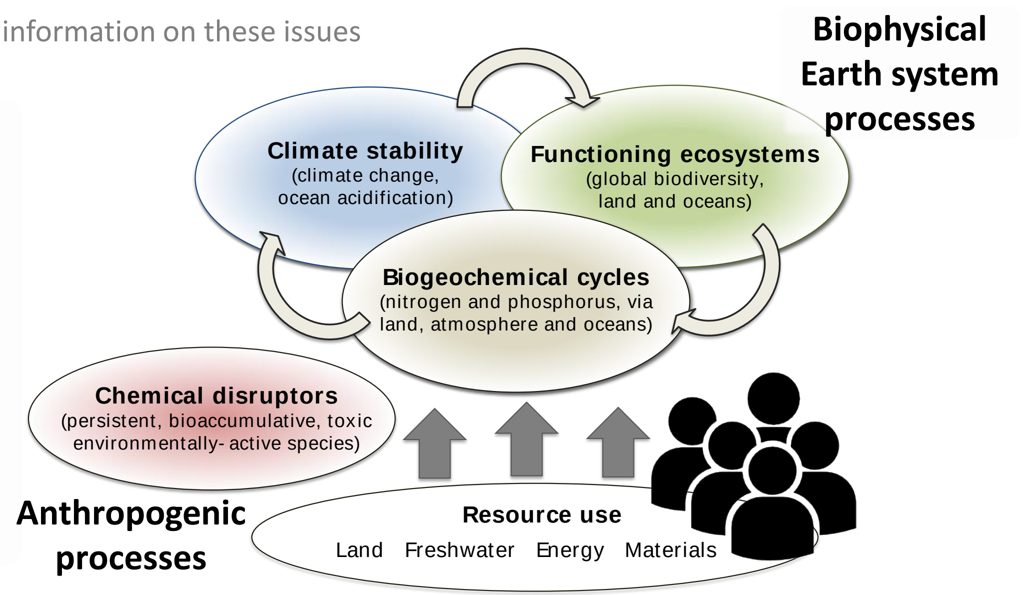
- ✓ **Climate change** & ocean acidification
- ✓ **Biodiversity loss** & ecosystem degradation
- ✓ Perturbed biogeochemical cycles (N and P)
- ✓ *Systemic* chemical pollution
- **Freshwater abstraction**
- **Land use and land cover change**
- Altered atmospheric physics & chemistry (aerosol loading, stratospheric ozone)



→ Strong policy interest in 'absolute' global sustainability

UN GSP's '*Resilient People, Resilient Planet*' (2012), UN Rio+20, UNEP GEO5 (2012), national assessments (Sweden, South Africa, Germany), EEAC discussions, UN Sustainable Development Goals (PB issues shown in bold = focus of proposed goals 6, 13 and 15, others are included in targets for goals 3, 11, 12, 13 and 14)

The planetary boundaries concept depends critically on **the quality of knowledge** about global processes that *already* present global risks



Issue	Global assessments	Policy structures
Climate change	IPCC AR 1990, 1995, 2001, 2007, 2014; SRES; UNHDR…	IPCC, UNFCCC SBSTA Many conventions
Ecosystem change	MA 2005; CBD GBO1-3; TEEB; UNEP GEO1-5; FAO…	IPBES and CBD SBSTTA CBD, CITES, other conventions
Biogeochemical change	UNEP GPNM 2013; WMO/IAEA/UNEP GESAMP	INI, GPNM, WHO, FAO, WMO, IPCC, GPRI. Several conventions.
Chemical pollution	UNEP AMAP and other regional	SETAC, SCI, WHO-IFCS Many conventions.

See the SRC/PTB *Environment, Absolute* Discussion Paper for more information on these issues

QI for global Sustainable Development:
Metrology • Standardization •
Conformity assessment • Quality management

QI needs change as we move from 'pure' science to societal decision-making and action

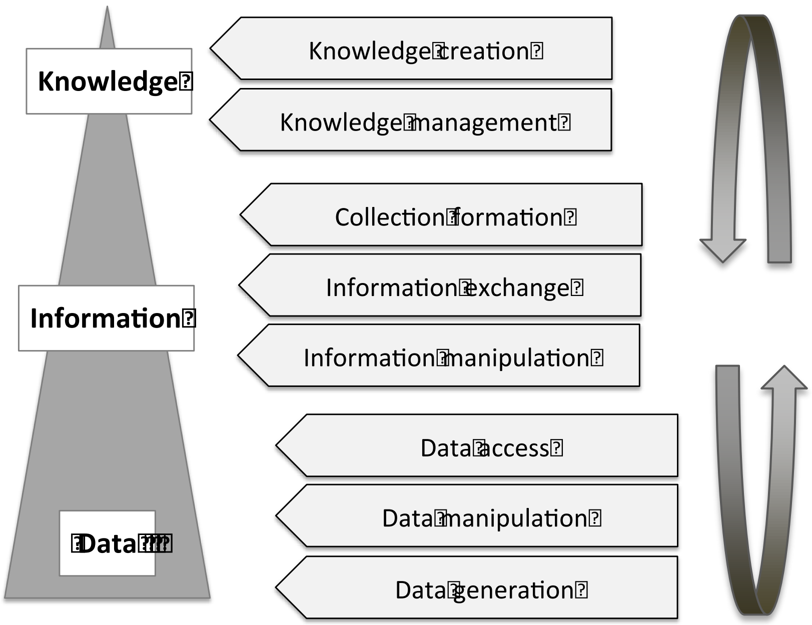


Diagram adapted from R.W.Moore, 2013, with input from PTB QI-Tage discussions.
https://www.icsu-wds.org/files/interoperability-building-blocks.pdf

Providing appropriate stewardship (monitoring)

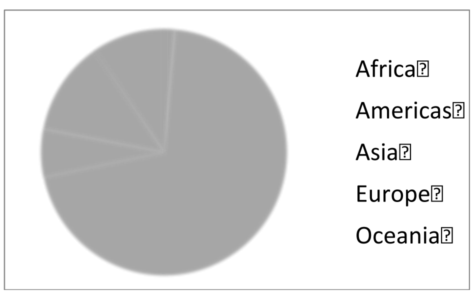
Responding to changes

Establishing assessment & prediction capacities

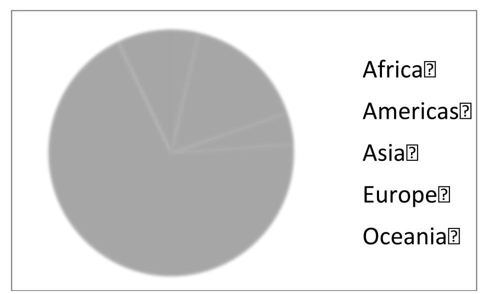
Fundamental research (state, trends, processes)

	Science	Policy	Decision landscape
Climate	Earth system (global) knowledge, local gaps	Global agreement on targets and metrics	Big science, big government
Biodiversity	Local knowledge, system gaps	Global agreement on targets and metrics	Concerned coalitions
Biogeochemistry	Gaps in local and system knowledge	Partial regional agreements, emerging issue	Many different players
Chemical pollution	Local knowledge, system gaps	Partial agreements, weak metrics	Big business

Different approaches to QI
Ad hoc implementation of QI → **Challenges: data 'patchiness', *global* information management, diverse and dynamic contexts**



GMD NOAA-ESRL sites for climate and chemistry observations



Locations of the world's protected areas, IUCN/UNEP

State of the science?

- Abundance of data, but often tricky to find information
  - GEO ICSU WDS, CODATA, specialist data networks, Future Earth
  - NOAA (GMD, NESII), PCMDI-CMIP; ICES, ILTER; GEIA, FAOSTAT
  - Supporting resources – inadequate or inefficient
- Coordination efforts focus on parts of the problem
  - Climate, some bgc: GCOS ECVs, MIPs, lab intercomparisons.
  - Biodiversity: EBVs?? (GEOBON), GBIF, WDPA
  - Chemicals: transport, labelling – but not use, release, hazard response…
- Serious knowledge gaps even for known risks (e.g. pH)
- Global extrapolation often does/can not work (e.g. air quality)
- Poor basis for precaution
  - Tension between standards (comparability) and responsiveness to change
  - Snapshots not dynamic understanding

e.g., www.futureearth.org/sites/default/files/Future-Earth-Design-Report_web.pdf, www.codata.org/uploads/CODATA_Strategic_Plan-2013-2018-FINAL.pdf

State of the world?

* UNEP GEO5, CBD GBO3, IPCC AR5, UNEP GCO 2012…

- **Implementation gaps are widespread*** (reporting, transparency, attribution)
- **Drifting targets, untethered metrics**
  - Humanity is getting very good at tracking its own decline
  - QA in education, data consolidation, oversight capacity for policy implementation, but…
  - Uptake is low for formal certification, accreditation and auditing of env scientists/labs (climate, ecosystem change, biogeochemistry)
- **There is no substitute for real engagement**
  - An equity issue: global coverage, participation, verification
  - Expanded remit for professional institutes as forum for QI debate?

Standardization presents big opportunities and big problems in a rapidly changing world

‘Technology is good, people are more important’

– Chandler, JGOFS 2005

Distributed verification? DIY data?

Adaptive responses to changing environment

Versus?* or *For?

Regulatory cooperation & standardization

Why not join… jellywatch.org, www.rspb.org.uk/birdwatchbbc, Tea Bag Index www.decolab.org/tbi, mappiness.org.uk, www.juegos.com/juego/climate-chaos

Image: www.earthday.org/takeaction

Thank you

sarah.cornell@su.se

Selected figures and tables from the SRC Discussion Document, *Environment, Absolute?*

(S. Cornell and A. Downing 2014)

Some information resources on quality infrastructure for global sustainability policy:

Education, scholarship and qualifications

European Commission (2014) Report on progress in Quality Assurance in Higher Education.http://ec.europa.eu/education/policy/higher-education/doc/quality_en.pdf

European Union (2011) Directive amending Directive 2005/36/EC on the recognition of professional qualifications. PE-CONS 57/13 http://register.consilium.europa.eu/doc/srv?l=EN&f=PE%2057%202013%20INIT

UNESCO/OECD (2005) Guidelines for quality provision in cross-border Higher Education.http://unesdoc.unesco.org/images/0014/001433/143349e.pdf

World Bank/UNESCO Global Initiative for Quality Assurance Capacity (now in third grant period). www.unesco.org/new/en/education/themes/strengthening-education-systems/higher-education/quality-assurance/giqac

Data consolidation

UN Statistical Commission (2012) Report of the Secretary-General on national quality assurance frameworks. http://unstats.un.org/unsd/statcom/doc12/2012-13-NQAF-E.pdf; see also work in progress on methods: https://unstats.un.org/unsd/pubs/gesgrid.asp?method=meth

Eurostat (2012) Quality Assurance Framework of the European Statistical System. http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/QAF_2012/EN/QAF_2012-EN.PDF

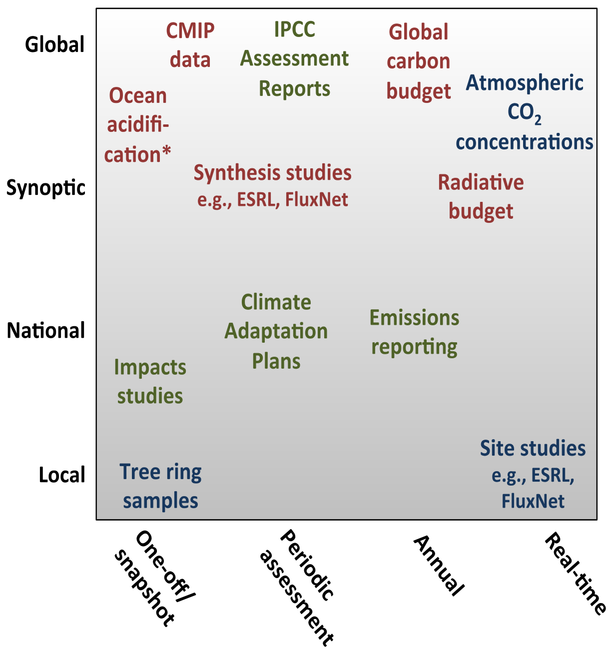
Oversight capacity for monitoring and evaluation

UN Environment Programme (2014) Medium-term strategy 2014-2017. (Section 5: Business strategy) www.unep.org/gc/gc27/download.asp?ID=4119 and www.unep.org/QAS

UN Development Programme (2012) Programme and operations policies and procedures. (Section: Results and accountability) https://info.undp.org/globl/popp/rma/Pages/introduction.aspx

MDG Task Force/OPM: Carraro et al. (2004) Monitoring the Millennium Development Goals. http://ipcc-wg2.gov/njlite_download.php?id=7356

climate



Key:

Blue text – primary data, mainly for research purposes

Red text – information collation for community exchange

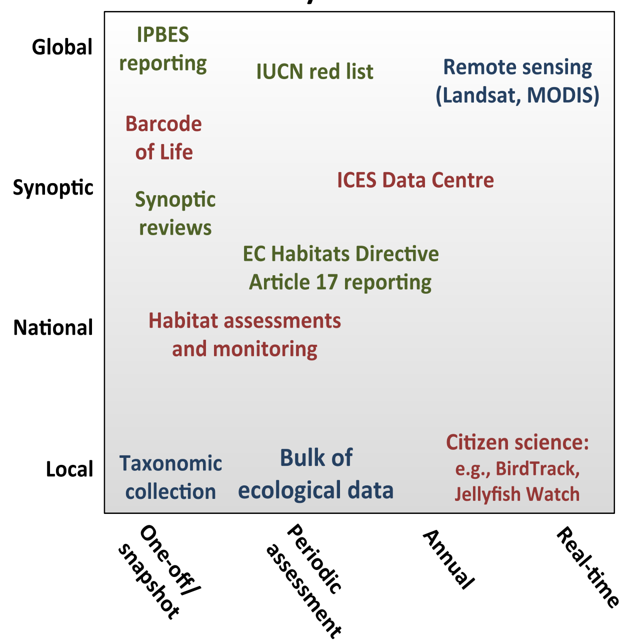
Green text – knowledge resources informing social decision-making

Acronyms:

CMIP = Coupled Model Intercomparison Project

ESRL = NOAA's Earth System Research Laboratory

biodiversity



Key:

Blue text – primary data, mainly for research purposes

Red text – information collation for community exchange

Green text – knowledge resources informing social decision-making

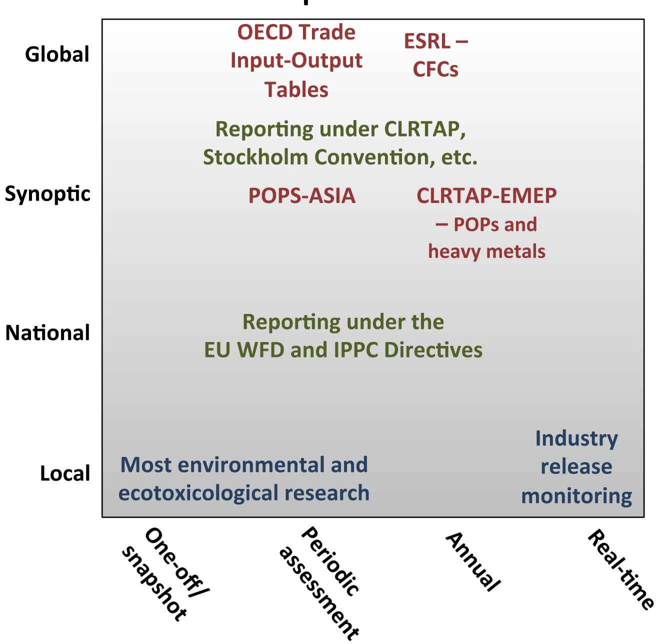
Acronyms:

IBPES = Intergovernmental Platform on Biodiversity and Ecosystem Services

IUCN = International Union for Conservation of Nature

ICES = International Council for the Exploration of the Sea

chemical pollution



Key:

Blue text – primary data

Red text – information collation

Green text – knowledge resources for policy/practice

Acronyms:

EMEP = European Monitoring and Evaluation Program

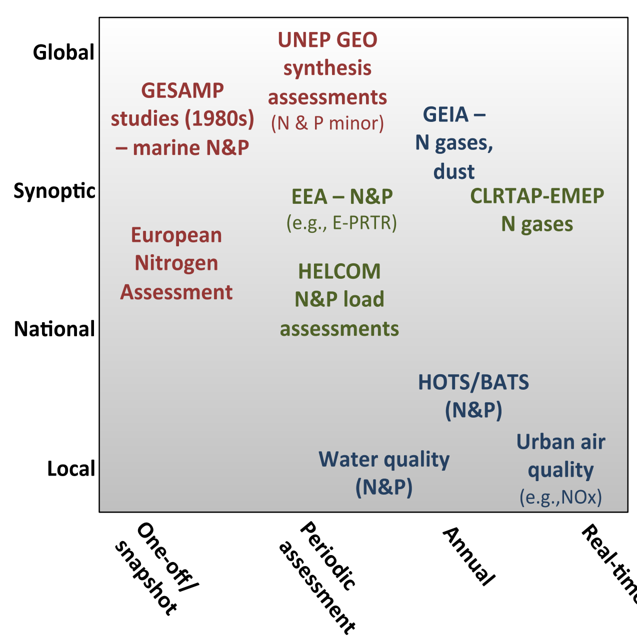
ESRL = NOAA's Earth System Research Laboratory

IPPC = Integrated Pollution Prevention and Control

OECD = Organisation for Economic Cooperation and Development

WFD = Water Framework Directive

biogeochemical cycles (N&P)



Key:

Blue text – primary data, mainly for research purposes

Red text – information collation for community exchange

Green text – knowledge resources informing social decision-making

Acronyms:

EEA = European Environment Agency

E-PRTR = European Pollution Release and Transfer Register

GEIA = Global Emissions Initiative

EMEP = European Monitoring & Evaluation Program for CLRTAP

HOTS/BATS = Hawaii Ocean and Bermuda Atlantic Time-series Stations

Summary: state of climate change quality infrastructure

Metrology	understanding assessing responding stewardship
Standardization	understanding assessing responding stewardship
Conformity assessment	understanding assessing responding stewardship
Quality management	understanding assessing responding stewardship

Issues
Basic science and scientific synthesis systems are robust (e.g., SI and IUPAC standards; peer-review systems). Specialist measures are developed by community consensus (e.g., definition of plant functional types and traits, new remote sensing products). Assessment processes (e.g., IPCC) are globally inclusive and transparent. Major gaps exist in global data coverage for science, policy implementation, and monitoring and verification. Gaps coincide with regions where biophysical impacts of climate change are projected to be most severe. Gaps correlate with places where national technical and institutional capacity are low. Systems are not being re-evaluated to enable more precautionary and adaptive responses in light of the progress of climate change.
Basic climate research uses model intercomparisons for various purposes; laboratory intercomparisons are less common (although key networks, such as Fluxnet, have good quality systems), and systematic data-model comparison is relatively uncommon. IPCC reports (especially WGII, on climate impacts) continue to flag the difficulty of compiling and comparing data. The climate policy process gives high priority to worldwide technical standards, and institutions and instruments are in place for capacity development, technical cooperation.
Globally, there is fairly low uptake in climate science of formal systems for certification, accreditation and auditing of scientists and research labs, compared with other science and technology fields. Participation in state-of-the-art assessments provides impetus for worldwide coordination and harmonisation. The open and transparent processes of expert nomination by governments serve as a form of accreditation. Despite international agreement on climate policy, and the availability of detailed technical information, institutions and instruments for climate mitigation and adaptation action, systems assuring conformity and compliance are weak. A growing focus on stakeholder engagement and transparency serves as an auditing mechanism for some processes.
In many academic climate research contexts, professional accreditation/registration and quality management is not given the same emphasis as it is in commercial and public organisations, nor as in other fields of environmental science (e.g., atmospheric science, chemical pollution). Public interest has ensured that the processes of information gathering have evolved notably over time (e.g., improvements in process, inclusiveness, and output communication in the IPCC assessments). Climate policy is not reducing the climate change problem. This can be framed as a failing in quality assessment and assurance at the global level. A precautionary approach that accepts biophysical absolutes' would seek to strengthen the quality infrastructure for climate to halt CO_2 emissions in the near term, rather than simply reprofiling missed targets to later in the future.

Summary: state of biodiversity quality infrastructure

QI element	Context	Issues
Metrology	☺ understanding 😐 assessing 😐 responding 😐 stewardship	Long-established, well-tested and widely accepted techniques have been developed for understanding ecology at local scales. However, these are poorly suited for application at the global level, both for global change research and for society's responses to ecosystem change. Global synthesis reports highlight geographic, taxonomic, and theoretical gaps. Progress is being made on indicator development and correspondence assessment between large-scale observations and on-the-ground ecological reality.
Standardization	☺ understanding ☺ assessing ☺ responding 😐 stewardship	The term 'biodiversity' embeds many concepts and meanings, and is applied in different ways in different research and policy contexts. This presents challenges for overall standardization. The definition of the CBD sets the scope for global assessments and a major strand of society's response to ecosystem change, and serves as a standardization mechanism enabling coordination and cooperation among partners. However, this scope is not adequate for the long-term stewardship of the biosphere, as the missed 2010 targets show.
Conformity assessment	😐 understanding 😐 assessing 😐 responding ☺ stewardship	As for climate, uptake is low for formal certification, accreditation and auditing of scientists and research labs, except for public labs providing commercial services, where ISO certification is widespread. Policy processes (mainly CBD) are improving flows of technical information, and scrutiny systems for national reporting, etc. Systems assuring conformity and compliance are weak. The CBD has a strong focus on stakeholder engagement, and this higher transparency serves as an auditing mechanism for some processes.
Quality Management	☺ understanding ☺ assessing ☺ responding ☹ stewardship	Quality management developed for local-level ecology research is strained in the global context. The creation of the IPCC-like IPBES is an effort to improve science-policy processes, inclusiveness, and output communication. Global state-of-play assessments and policy are supported by effective multi-stakeholder, multi-national networks (e.g., CBD Secretariat, FAO, UNEP-WCMC). Environmental protection policy is not reducing the problem, and baselines are repeatedly shifted – a clear failing in quality assessment and assurance at the global level.

Summary: state of biogeochemical cycles quality infrastructure

QI element	Context	Issues
Metrology	☺ local scale, N & P 😐 regional and global assessment, N ☹ regional and global assessment, P	Established and tested techniques are in use for multiple measures of biogeochemical processes and air and water quality at local scales, e.g, EMEP/EEA air pollutant emission inventory handbook, EC Directive on technical specifications for chemical analysis and monitoring of water status. Europe has produced a regional N assessment (www.nine-esf.org/ENA-Book), *encountering measurement inconsistencies*. Analytical methods and data resources are not well-developed for global assessment of biogeochemical processes of N and P.
Standardization and **Conformity assessment**	☺ local and regional policy contexts, N & P ☹ regional and global scientific assessment, N & P	Criteria and standards exist for air and water quality (e.g., US National Ambient Air Quality Standards, WHO water quality requirements). ISO standards for pollution prevention, waste minimisation and laboratory competence are important in controlling environmental N and P release at local level. Public and environmental health laboratories have generally good uptake of formal certification, accreditation and auditing. Calls have been made for global N assessment, but heterogeneity of issues and policies will make a global synthesis difficult to carry out and validate.
Quality Management	😐 global N ☹ global P	Quality management developed for local pollution responses is poorly suited to informing and supporting responses to global dynamics of both N and P. Emerging risks (links between N and P and global energy and food security) highlight knowledge and governance gaps, especially for P. General awareness of the issues is low for both N and P. For N, dialogues have begun to link knowledge communities (industry, policy, science) and enable policy integration (climate, biodiversity, pollution).

Summary: state of quality infrastructure on chemical pollution

QI element	Context	Issues
Metrology	😐 Industrial production and supply ☹ Environmental assessment	Established and tested techniques exist for chemical substances of high concern. Globalised and concentrated industry means much of the world has adequate metrology at the production end. Number of substances and lack of knowledge about new chemicals, mixtures and environmental pathways presents measurement challenges. Quality issues hamper management of legacy and emerging chemicals.
Standardization	☺ Industrial production and supply 😐 Environmental assessment	Chemicals and industrial production sectors apply international standardization for many relevant processes and environmental management systems. Chemicals associations are present in most regions. Multiple contexts and changing suite of substances of concern mean that environmental assessments may lack comparability, consistency and interoperability.
Conformity assessment	☺ CLRTAP region ☹ Most of the rest of the world	Global conformity agreements exist for transport, labelling, and classification. Apart from selected chemicals in the northern hemisphere, conformity agreement and assessment are very weak for use, release, hazard response, and many other aspects of environmental risk.
Quality Management	😐 Policy is reactive, not proactive	Quality management developed for local pollution responses is poorly suited to informing and supporting responses to global dynamics and emerging risks. Society's access to global information and lower tolerance of chemical pollution is an important force for positive change. Dialogues between knowledge communities (industry, policy, science) are fragmented and show power imbalances.