

The complementary power of extensive environmental monitoring programs and intensively instrumented observatories for supporting the “green transition” to Agenda 2030

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Swedish University of Agricultural Science & Swedish Infrastructure for Ecosystem Science.



Funder



Vetenskapsrådet

Partners






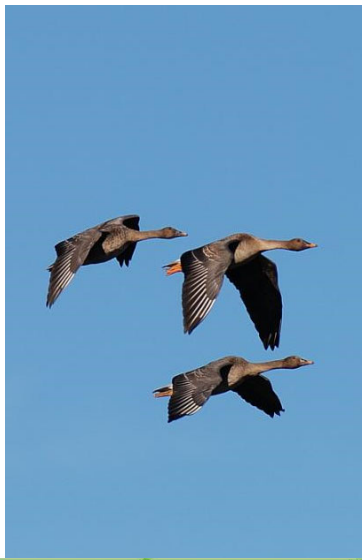

National Environmental Monitoring Programs

National, European and Global Goals






Evidence to sustainably meet human needs and conserve biodiversity

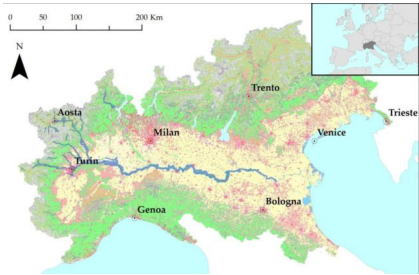


SITES



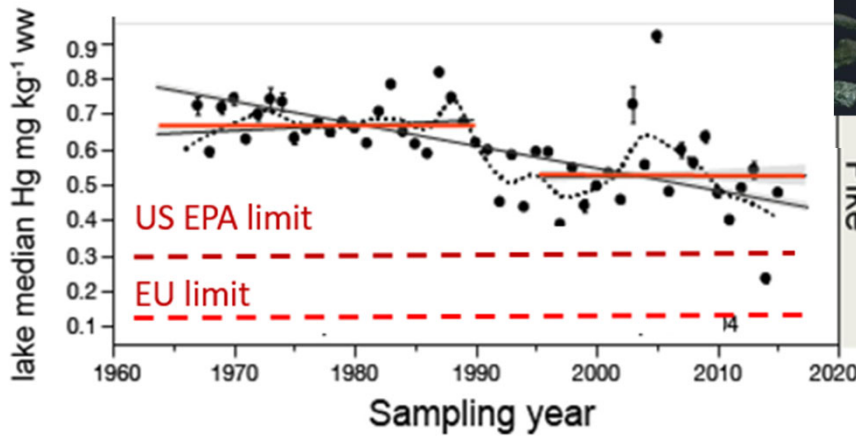
Po Valley: Flooding after Drought

What is “Normal” as climate changes?



Will fish mercury levels ever be safe?

How much does a 60-year Nordic time series actually tell us?



Veiteberg Braaten et al.,
Environ. Sci. Technol. 2019,

Evidence-base for the Green Transition

Research Observatories

+

National Environmental
Monitoring

= Better Evidence-base



THE GLOBAL GOALS
For Sustainable Development



SITES



Field-based ecosystem research needed to understand and predict



TERENO
OZCAR

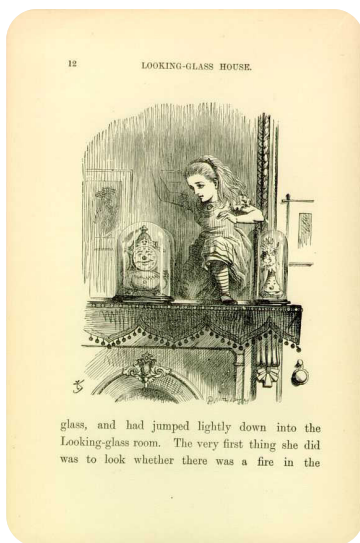
eLTER

Long-Term Ecosystem Research in Europe

ICOS

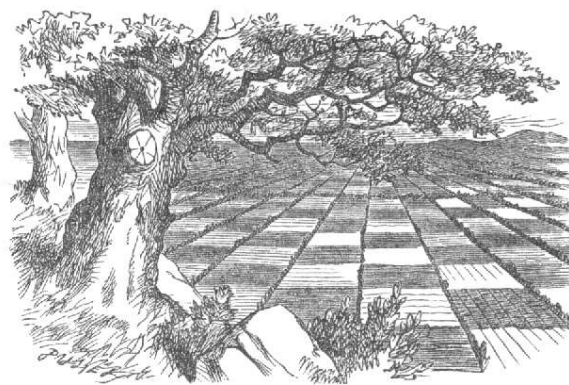
Integrated
Carbon
Observation
System

SITES



12 LOOKING-GLASS HOUSE.

glass, and had jumped lightly down into the Looking-glass room. The very first thing she did was to look whether there was a fire in the



Through the looking glass,
It was sort of, but not really
like chess

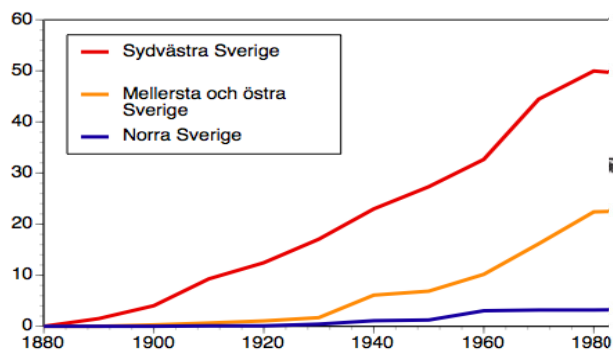
Full disclosure:

Providing opportunities for field research is personal



Acidification in Sweden - 1986

Percentage of Swedish lakes that were acidified





Environmental Goal: Only Natural Acidity

(i.e. acid due to natural organic matter)



MILJÖMÅL

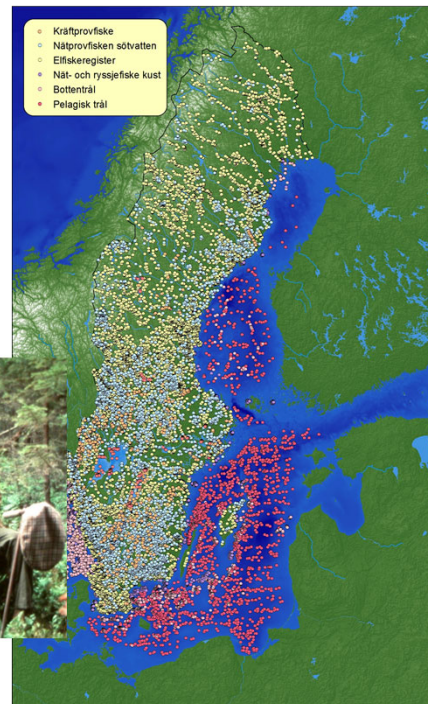
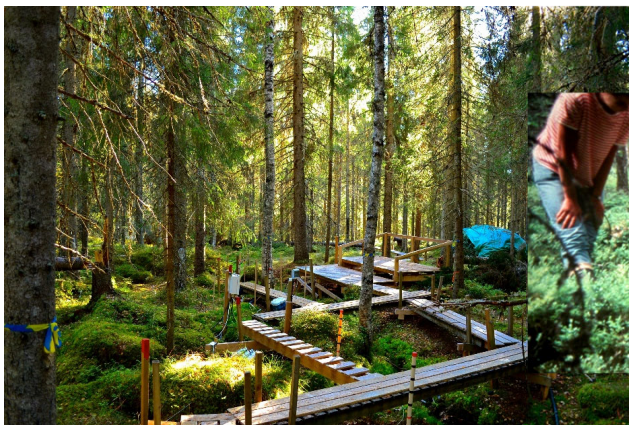
vägen till ett hållbart samhälle



Cambridge Acid Rain Expedition

From ten years on a hillslope to national water monitoring

(Some nations apparently value in-depth hydrological knowledge.)



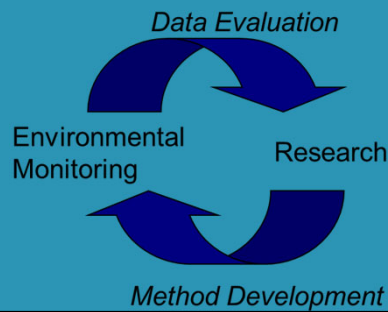


Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Aquatic Sciences and Assessment 1997-2010 ...2016-



Finding, understanding and resolving human impacts on water



SITES Director 2023-



SITES



- 8 Stations & 1 Associated station +
- > 500 Projects / year
- > 1000 Unique users / year
- > 200 Publications / year
- Yearly budget: 39.2 MSEK (50% VR)
- SITES III Funding 2023-2028
- Coordinated by SLU (5 stations)
- Secretariat based at SLU Uppsala

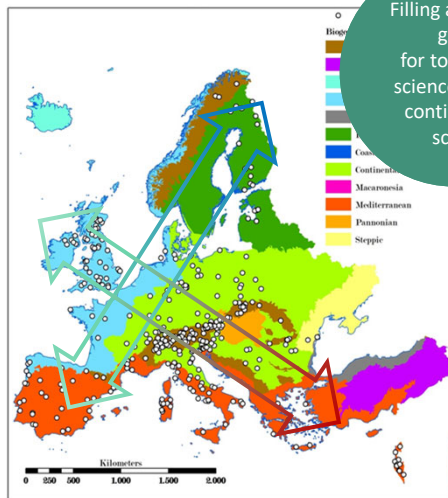
National infrastructure for field-based ecosystem research available to all users since 2013





Long-Term Ecosystem Research in Europe

From ESFRI vision to European Research Infrastructure Consortium (ERIC)

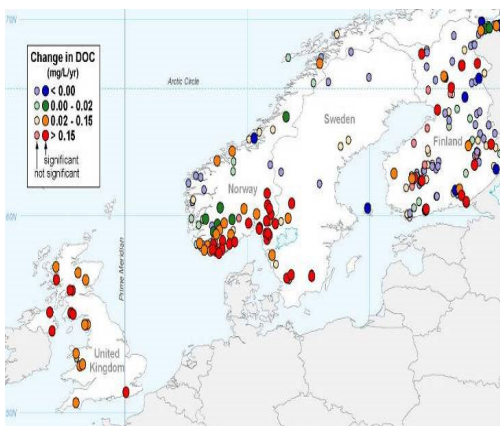


Filling a critical gap for top-class science at the continental scale

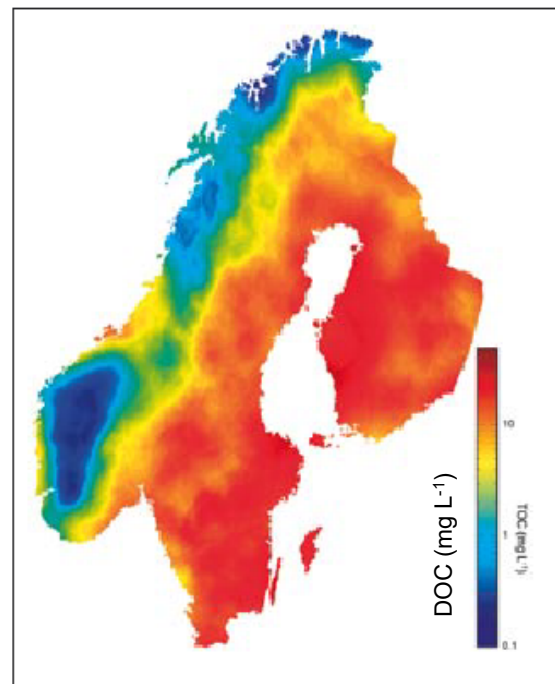


DOC has increased!

- 50%-100% increase 1990-2005
- Fennoscandia had a lot to start with



Monteith, et al. 2007 Nature

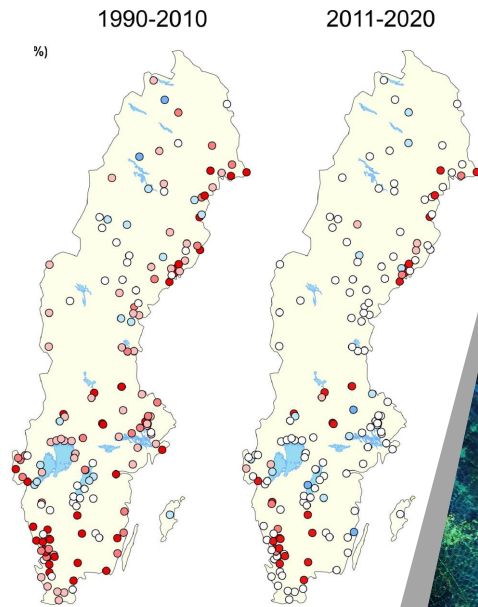
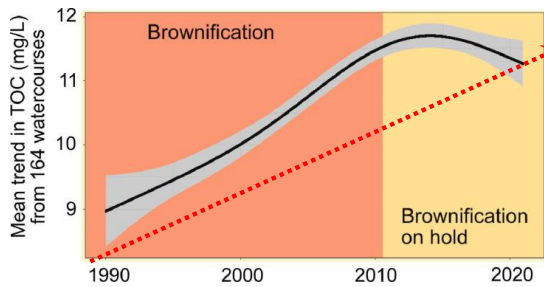
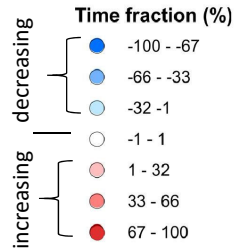


But as time series lengthen, the picture is more complex

Sulfate? Climate? Land Use History?
Drainage? LandRise?

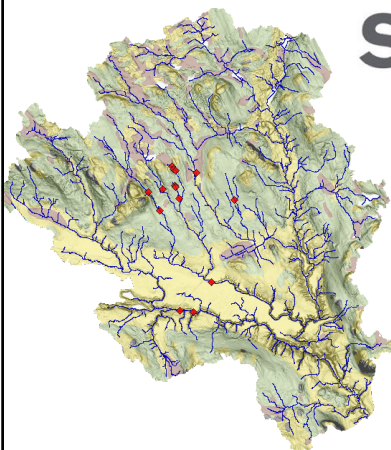
**Top-Down Statistical work
national data**

**Bottom up Solubility study
Field station data**

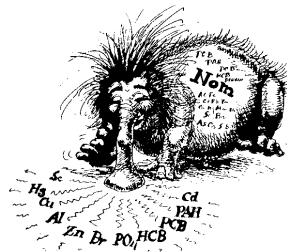


Eklöf et al 2021

**Natural Organic Matter Solubility
Field-station studies (bottom-up)**



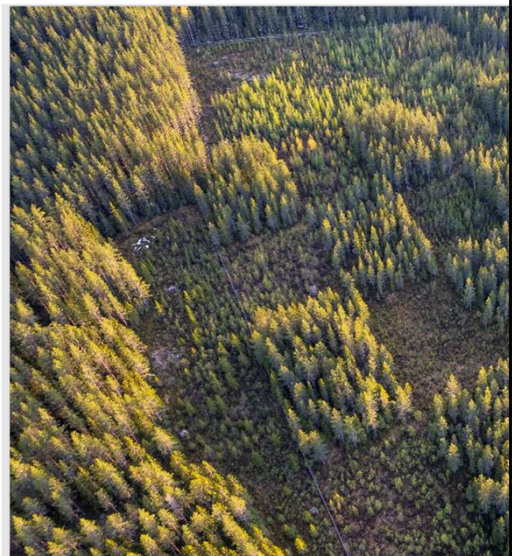
SITES



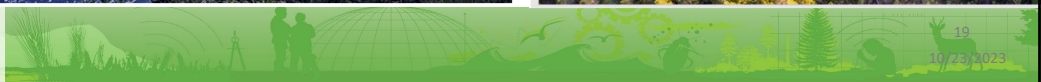
**Krycklan Riparian Observatory
2008-2011 and 2021-2023**



Boreal Forestry without clearcuts?

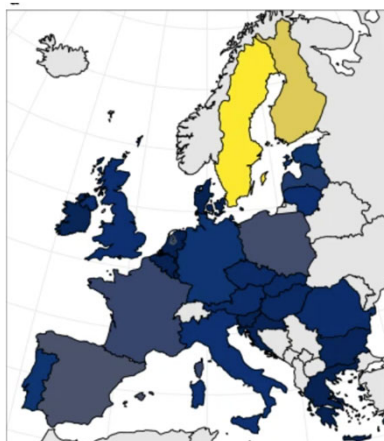


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When new a new remote sensing method conflicts with ground-based national monitoring: Dueling Nature papers

European harvested forest area.
(remote sensing based)

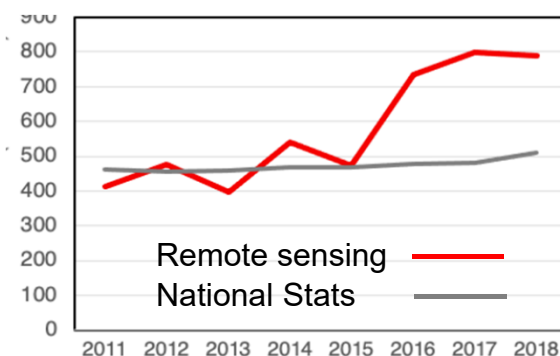


National contribution to harvested forest area 2016–2018 (%)

5 10 15 20 25

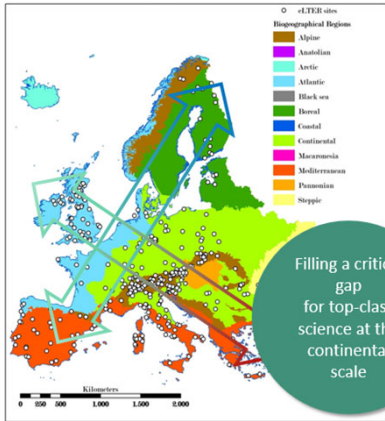
Ceccherini, G., Duveiller, G., Grassi, G. *et al.* Abrupt increase in harvested forest area over Europe after 2015. *Nature* **583**, 72–77 (2020). <https://doi.org/10.1038/s41586-020-2438-y>

Ground-based vs remote sensing



Wernick, I.K., Ciais, P., Fridman, J. *et al.* Quantifying forest change in the European Union. *Nature* **592**, E13–E14 (2021). <https://doi.org/10.1038/s41586-021-03293-w>

250 field stations across Europe : Groundtruth goldmine



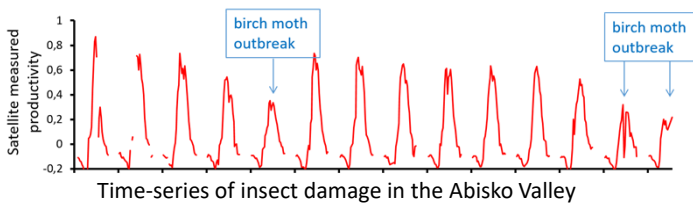
Filling a critical gap for top-class science at the continental scale



Long-Term Ecosystem Research in Europe



SITES Spectral: infrastructure for spectral ecosystem data



UAVs

Collecting multispectral images regularly over the growing seasons



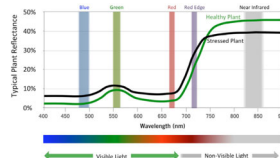
Multispectral sensors

Green, Red, NIR, SWIR Spectral Indices (e.g. NDVI)



Phenological cameras

Monitor seasonal changes in vegetation/colour



Funder



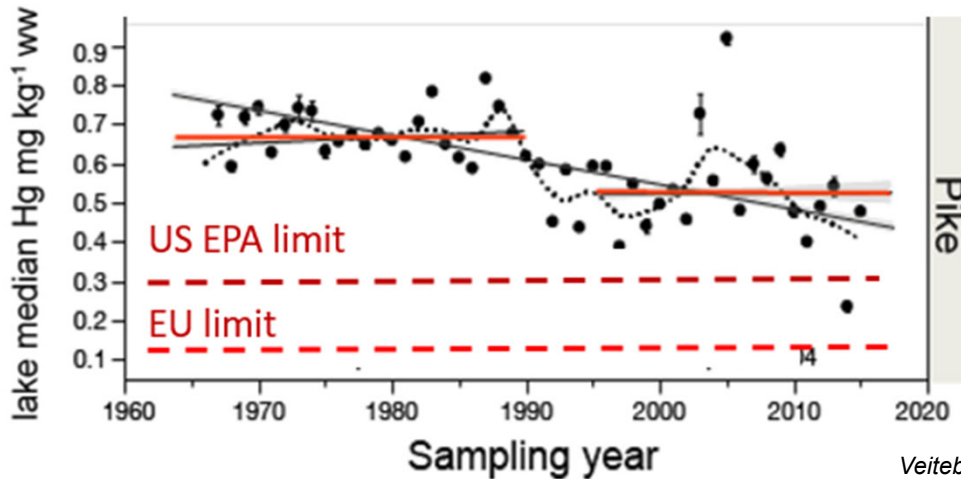
Partners



22

10/23/2023

So what does a time series mean?



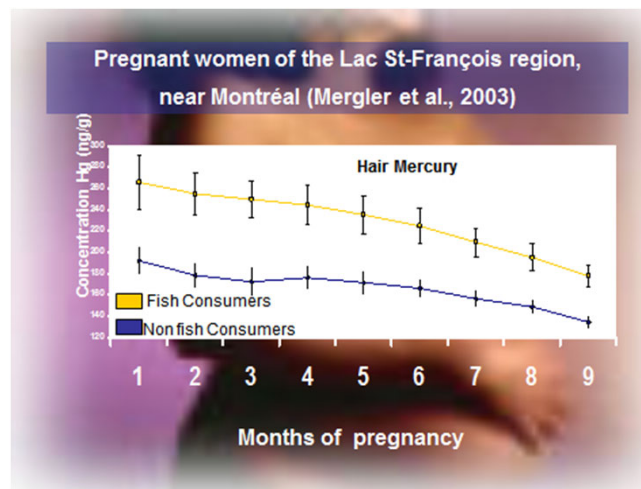
Veiteberg Braaten et al.,
Environ. Sci. Technol. 2019,

Fish, Mercury and the Fetus

Fetus takes up mercury from mother

Fish our biggest mercury input

Mercury is the main reason for the failure of good chemical status in over 30% of surface water bodies in the EU. (EEA 2021)



European Environment Report No 9/2021

Drivers of and pressures arising from selected key water management challenges: A European overview

How long will it take for emission reductions to make fish safe?
 ... but what if mercury could evade from peatlands, the major source? No good techniques....



Relaxed Eddy Accumulation System (REA)

→ Automated, long-term monitoring of Hg⁰ concentrations and Hg⁰ flux at landscape scale



Atmos. Meas. Tech. Discuss., 8, 1–45, 2015
 www.atmos-meas-tech-discuss.net/5/1/2015/
 doi:10.5194/amt-8-1-2015
 © Author(s) 2015. CC Attribution 3.0 License.

Atmospheric
 Measurement
 Techniques
 Discussions

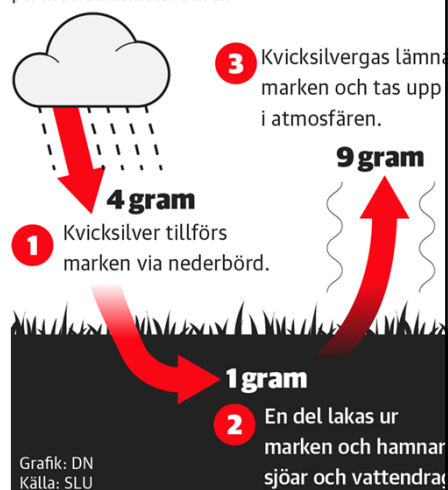
This discussion paper is/has been under review for the journal Atmospheric Measurement Techniques (AMT). Please refer to the corresponding final paper in AMT if available.

A dual-inlet, single detector relaxed eddy accumulation system for continuous quantification of mercury land-atmosphere gas exchange

S. Osterwalder¹, J. Fritsche¹, M. B. Nilsson², C. Alewell¹, J. Sommar³, G. Jocher², M. Schmutz², J. Rinne^{2,5}, and K. Bishop^{7,8}

Flödet av kvicksilvergasm från myren till atmosfären är dubbelt så stort som inflödet av kvicksilver via regnvatten.

Siffrorna anger gram kvicksilver per kvadratkilometer och år.

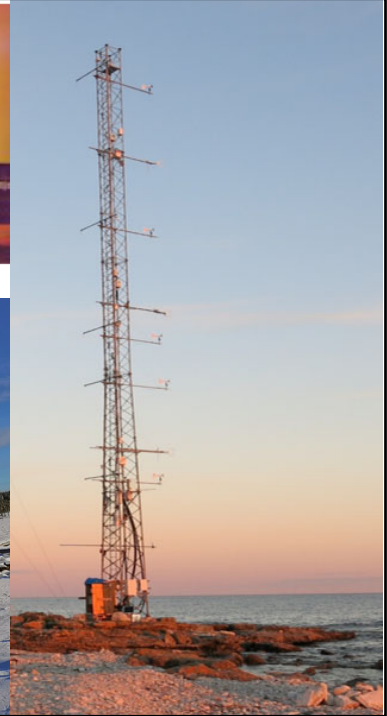
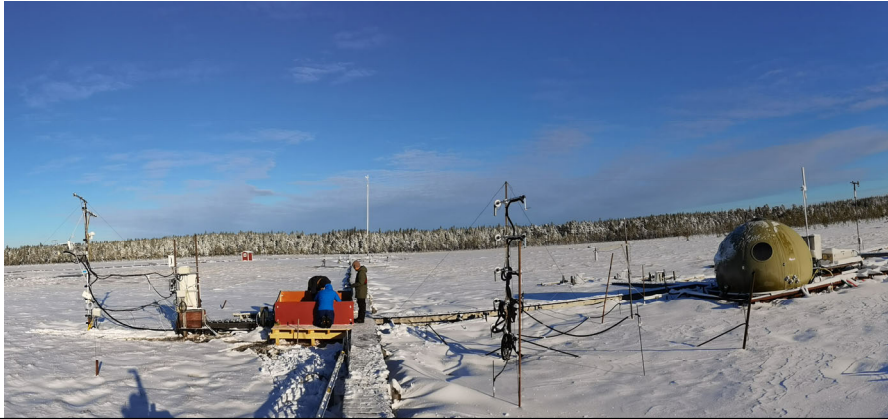
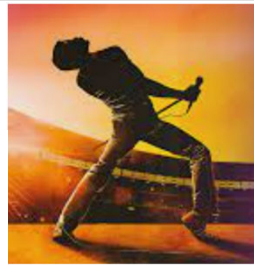


Land-Atmosphere Exchange starring Eddy Mercury

and

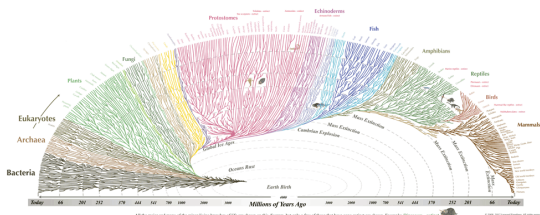
ICOS


National
Network
Sweden



New techniques to trace the changing Global Hg cycle

- Micrometeorology (what)
- Isotopes (how)
- Genomics (why)



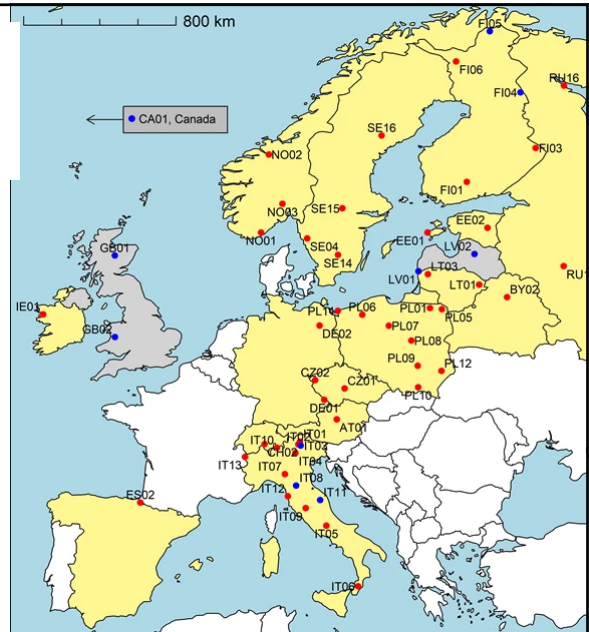
Science & Society Picture library, as shown by J. Sonke CNRS



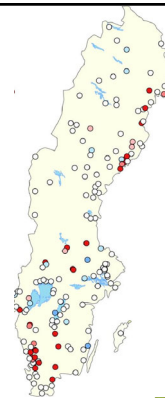
Photo: S. Osterwalder

Mercury researcher needs
litterfall across climate and
air pollution gradients:

**International
Cooperative
Program
on Integrated
Monitoring of
Air Pollution
Effects on
Ecosystems**



**Field Research
Stations
and
National
Environmental
Monitoring**

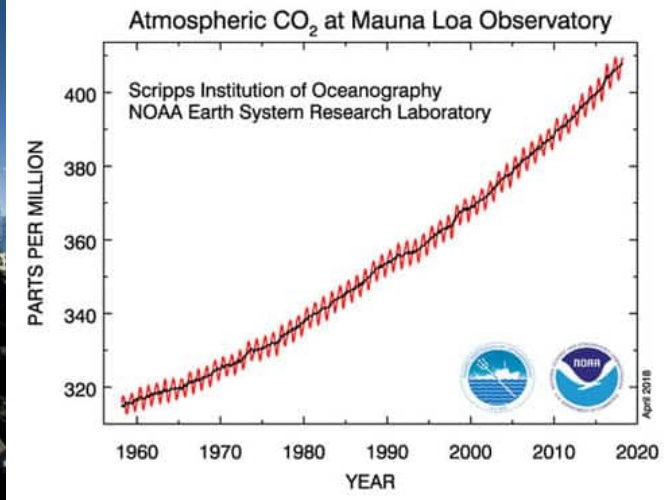


Two cultures divided by a common mission?
“Two countries divided by a common language”

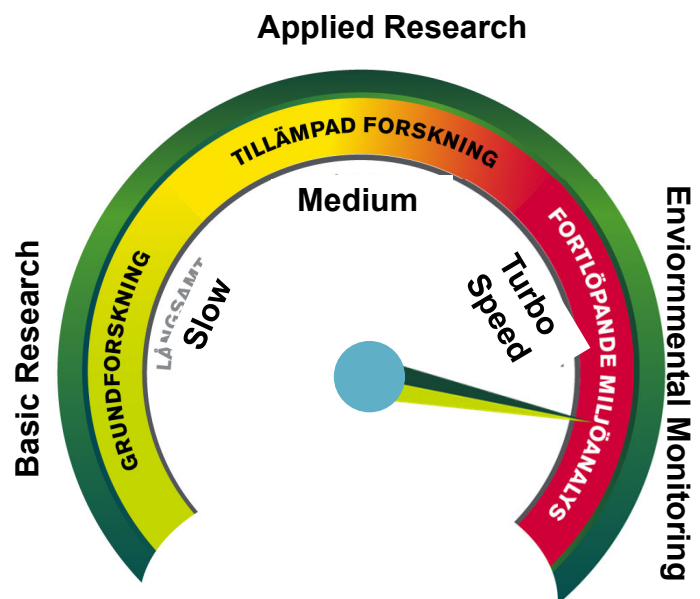




Environment Monitoring: Not Second Class Science!



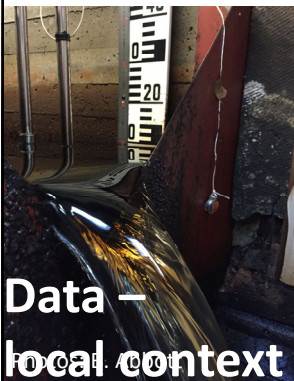
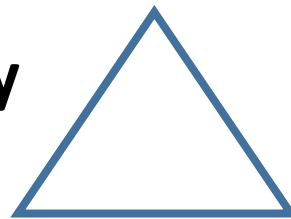
Environmental Monitoring and Assessment (EMA) must work **FASTER** than even applied science



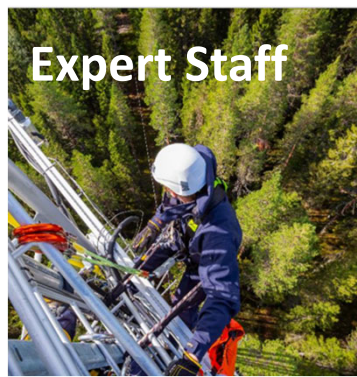
Field stations matter! Infrastructure, Expertise & Measurements



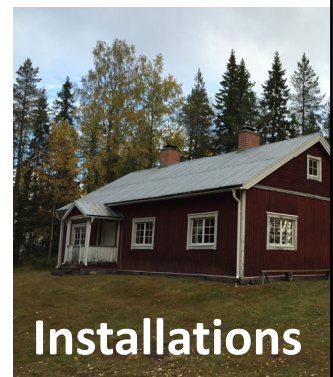
The field station's 3-way resource split/squeeze (remember the visiting researcher!)



VS



VS



SLU ARDATABANKEN

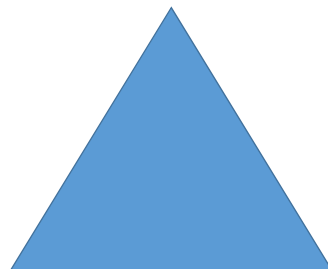
Big, Open Data

SITES

The 3-way data curation split/squeeze

Station Measurements (Context)

Legacy
Data



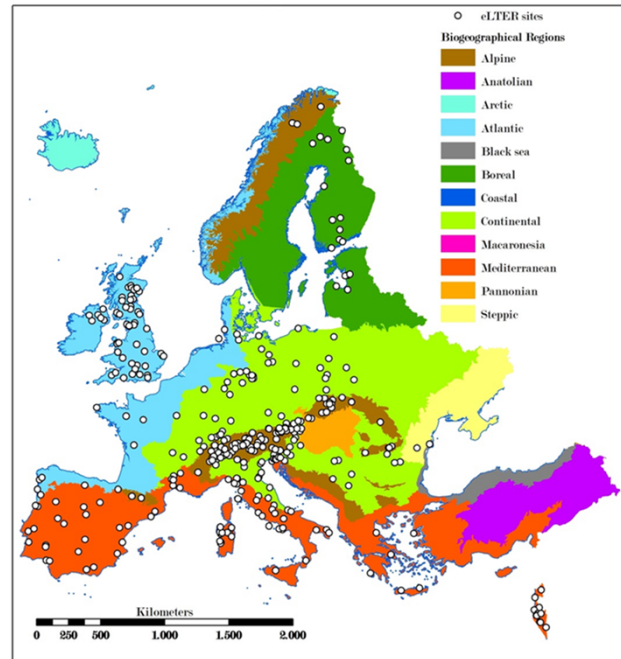
Researcher
Data
(Creativity)



Long-Term Ecosystem Research in Europe

Filling a critical
gap
for top-class
science at the
continental
scale

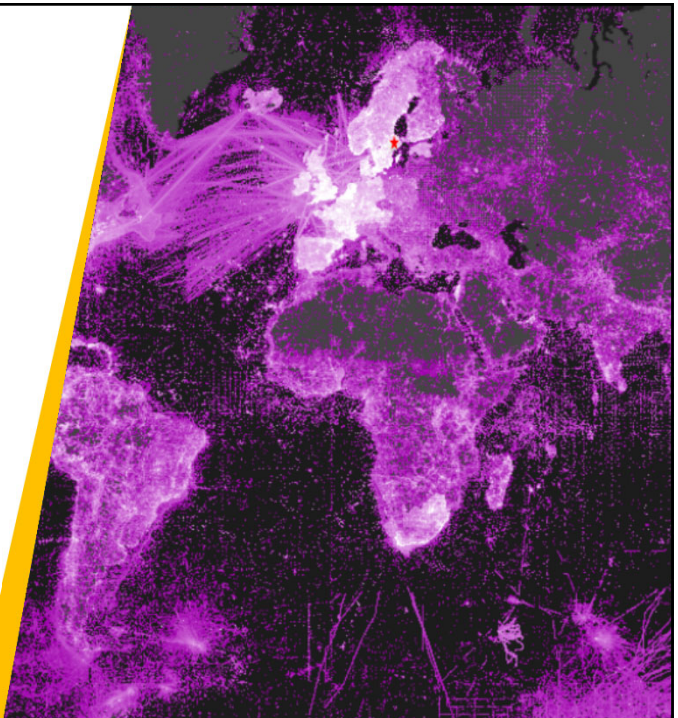
250 eLTER stations



Metadata Catalogs: The Key to Open Data

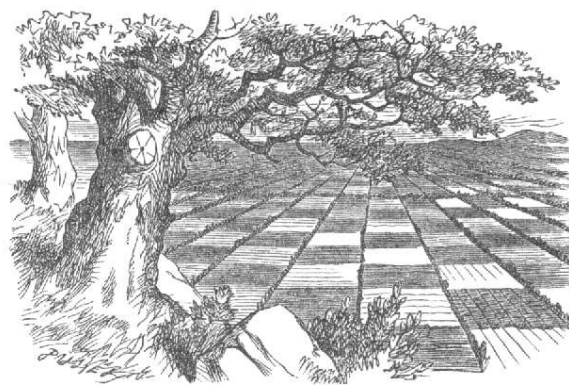
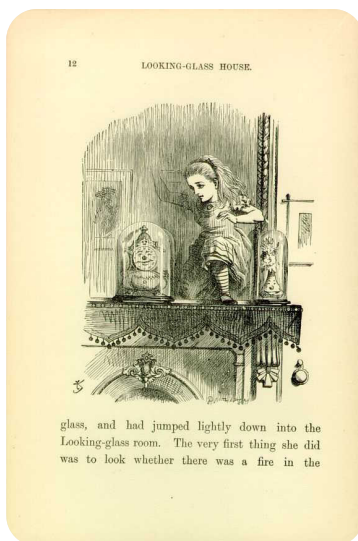
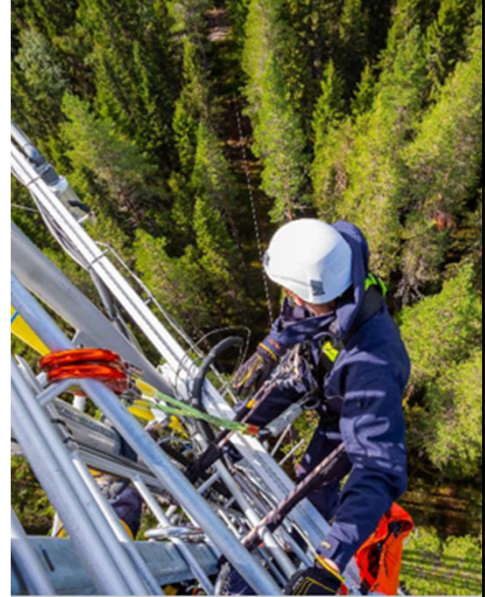
In Sweden
National Monitoring
and Research have
different metadata catalogs

SITES



“Sustainable Field” Stations

Can Research Infrastructures offer appealing careers?



Through the looking glass,
It was sort of, but not really
like chess

Evidence-base for the Green Transition

Research Observatories

+

National Environmental
Monitoring

= Better Evidence-base



THE GLOBAL GOALS
For Sustainable Development



Evidence-base for the Green Transition

Research Observatories

multiplied by

National Environmental
Monitoring

= **Much** Better Evidence-base



THE GLOBAL GOALS
For Sustainable Development





Thanks for
your attention,
and the
invitation!

(kevin.bishop@slu.se)

SCIENCE AND
EDUCATION
FOR
SUSTAINABLE
LIFE