Towards sustainable research

Mickael Coriat







One of the greatest challenge in human history

Challenge of making human activities sustainable...

« Between social and planetary boundaries lies an environmentally safe and socially just space in which humanity can thrive » K. Raworth

What about research?

What is a sustainable research?





Research as a human activity

- knowledge
- In different ways, it has positive and negative impacts on the environnement
- How should we consider these impacts from a sustainability perspective?



• The specificity of research is to produce a common good: scientific

COMETS (Ethics Committee of the CNRS)

« Taking into account the environmental impact of research should be considered as part of **research ethics**, in the same way as respect for human beings or experimental animals »

A collective responsibility

- research topics and the ways of tackling them

• To minimise our negative impacts while enhancing the positive ones

• This concerns not only our **research practices** (day-to-day) but also



Reduce impact of research practices

- Energy consumption
- Travels
- Purchases of goods and services
- Use of digital technology...

of research.



=> understand and quantify the environnemental footprint



- It is essential to quantify and understand the carbon footprint of research, its determinants, uncertainties and heterogeneity.
- Implementing locally designed and deliberate solutions in research laboratories, to re-appropriate our laboratories as decision-making centres for the organisation of scientific work.
- Organising reflective work on the coherence, responsibility and ethics of research in relation to the low-carbon transformation of our societies.

A national cross-disciplinary collective of academic researchers/staff

Guiding principles





Research group



Think tank

Association loi 1901 > 500 membres

Réflexion

S'INTERROGER SUR LE RÔLE DE L'ENSEIGNEMENT SUPÉRIEUR ET DE LA RECHERCHE DANS LA CRISE CLIMATIQUE

Arts&Sciences

FAIRE COLLABORER SCIENTIQUES ET ARTISTES

~ 800 members in total



Research group

Groupement de recherche [GDR]



Footprint

Estimating and analysing the carbon footprint of research.

Transition

Supporting and studying ecological transition of laboratories

Teaching

facilitating the teaching of ecological issues in higher education and producing teaching content

Communication

Communicating and raising awareness of the collective's objectives



Digital tool by and for research

1 - Quantify GHG emissions



2 - Quantify reduction strategies





3 - Network laboratories



GES 1point5

- A free, open-source web tool \bullet
 - **Standardised methodology**:
 - Complies with international standards (GHG Protocol)
 - Incorporates elements specific to research laboratories \bullet
- Current scope: ${}^{\bullet}$

—

- **Buildings** (electricity, heating, cooling, water, construction) —
- Travels and commuting
- **Computing equipment**
- **Purchases** (goods and services) -
- Translated in english \bullet



https://apps.labos1point5.org/ges-1point5

J. Mariette et al., *Env. Res. 2022*



GES 1point5 - Community

GHG inventories creation evolution For the years 2019, 2020 and 2021



Data source: GES 1point5

Black carbon emissions

- 900 laboratories
- 1800 GHG inventories
- Data analysed (research group)



GES 1point5 - Results

Carbon footprint

- Analysis and diagnostic tools
- Decision-making support

RESULTS	
⊙ GHG Protocol	New
🏛 Regulatory inventory	Updated
📽 Carbon footprint & submis	sion

s and tradeoff self breakgation and adaptation the context of strengthening the global resp tainable development and efforts to eradicate is it necessary and even vital to maintai sche onse to warming of 1.5pC comprises transitio Black carbon emissions

Consystemity ou

an and infrastructure, and industrial symptotic impacts at 1.50 and 20, the syncroter an

-imate chang

CARBON FOOTPRINT OF THE LABORATORY 321.13 ± 35.76 t co2e

CARBON FOOTPRINT PEA CAPITA 12 420 ± 1 384 kg CO2e

CARBON INTENSITY 167 ± 19 g CO2e



Figure : Nombre de trajets pour les différents mode de transports en fonction de la distance parcourue. En rouge le cumul du nombre de trajets tous les modes de transport confondus. À noter qu'une mission est constituée généralement de plusieurs trajets (A/R, correspondances…).



reguere can operation contain non-pression non pointen or construction and and a conmoyerer devidents, se voire laborator end holyale also confin instalment consciler.

Hom Site Cl		Clanse	Surface other brote (m2)	Consonnation (kNds/m3/cm)	Emissi eCD2,	
81	Teulouse	8	4300	1		
50	Teulouse		2 000	100		
83	Teulouve	10 C	8 000	151		
80	Tarbes	5	250	540		
85	Teulouse	с.	952	126		
BG	Teulouse		445	0		
87	Auch	1	534	300		
88		1	1 000	890		
69	Tarbes	6	700	630		
Rodw	Teulouse	×.	2.000	2		

Include plane contrails in GES 1point5 calculations.

For air travel, the French regulation advocates to take into account the emissions linked to fuel combustion and u and to exclude emissions from **condensation trails**.

The **radiative forcing** of these contrails is **significant** even if its **magnitude** is still **uncertain**. Therefore, GES 1point to take these contrails into acccount or not in the calculation.

Submitted	Carbon footprint	Emissions in t CO2e S	hare of the total footprint			5
×	Carbon footprint of buildings	257.42 ± 28.76	80 %	la		● A
×	- Heating	80.34 ± 11.93	25 %		-	+ (
×	Electricity	95.90±9.59	30 %		гл parco	gune uru
×	Refrigerants	B1.18 ± 24.35	25%	_	đ	u'u
×	Carbon footprint of digital devices	16.44 ± 5.10	5 %	lat	۵	1
×	Carbon footprint of purchases	2.83 ± 0.63	1 %	[at	۵	1
×	Carbon footprint of travels	44.44 ± 20.62	14 %			
×	Commuting	3.97 ± 2.29	1 %	Jal	1	1
×	- Professional travel	40.47 ± 20.49	13 %	<u>hall</u>		
×	Vehicles	8.59 ± 3.93	3 %	Lat	¥	1
×	Business travel	31.88 ± 20.11	10 %	hit	£	1
×	T · · · · · · · · · · ·		100 %	<u>lat</u>	Ł	4
	FE free annumbers 2.43 : +022 FE ponsible 8.25 : +002 Figure : Engreding car bear des mot					
	Type ce matériel. Emissions (3 eCD2)	Part de l'empreinte du matériet info	omatique			
	Sarveur 5.20 # 2.50	i	32%			
	Éurer 1.34±0.79		10%			
	PC portable 9.20 ± 5.02		50%			
	PC five sersidoran 1.40±1.54		9.76			







Digital tool by and for research

1 - Quantify GHG emissions







3 - Network laboratories



Scenario 1point5



Black carbon emissions

- Simulating trajectories for changes in the laboratory's carbon footprint through the implementation of reduction measures
- **Sharing** these reduction scenarios with staff
- Quantitative guidance for decision-making
- **Encourage** actions







Digital tool by and for research

1 - Quantify GHG emissions



2 - Quantify reduction strategies







Carbon footprint of laboratories



T. Ben Ari, Nature Reviews physic. 2023

- Major differences between laboratories
- Purchase (40%) and travels (25%) dominate the carbon footprint
- Research Infrastructures not included

~1000 t CO₂e/yr per laboratories

~7.3 tCO₂e/yr per capita



Purchases footprint - reduction scenarios



Demand-driven mitigation strategies can achieve a 20% reduction in the total footprint (-40% in the footprint of purchase)

Life and health



M. De Paepe et al., *Biorxiv 2023*

Travels footprint - reduction scenarios

		No modal shift policy	375km (~2h30)	600km (~4h)	In mainland France	900km (~6h)	1000km (~6h40)	1200km (~8h)	1500km (~10h)
No moderation policy -		0	0.3	3	8	12	15	18	21
Reduce air travel number for conferences	20% fewer trips -	8	8	10	13	17	20	23	26
	50% fewer trips -	19	19	21	24	27	29	32	34
	1 trip/3 years -	13	13	14	17	18	19	21	22
	1 trip/4 years -	18	18	19	22	22	23	24	23
	20% fewer trips -	13	14	16	21	26	28	32	35
Reduce long-haul	50% fewer trips -	32	33	35	40	45	47	51	53
air travel number	1 trip/4 years -	28	28	31	35	40	43	46	49
	1 trip/6 years -	37	38	40	45	50	52	56	59
Reduce air travel mileage	20% decrease -	20	20	22	26	30	32	34	37
	50% decrease -	48	49	50	52	54	56	57	59
	5800km/year-	38	38	39	41	42	44	45	46
	4500km/year-	47	48	48	50	51	52	52	53
Reduce air travel number	20% fewer trips -	19	20	22	25	29	31	34	36
	50% fewer trips -	48	48	49	52	54	55	57	58
	1 trip/year-	36	36	33	32	29	28	27	27
	1 trip/2 years -	61	61	58	57	51	50	46	44

Minimum Allowable Distance (in distance or approximate duration) for Air Travel Clearance

Europe : 50% reduction by 2030 (Paris agreement)

- 50% reduction in the number of long-• haul flights + minimum allowable distance of 1,500 km for aviation
- Quota of 4,500 km per agent + • minimum distance for aviation
 - -50% in the number of missions

•

T. Ben Ari, G. Lefort et al., Subm. to Environmental **Research letters**



Use of plane by discipline



Blanchard et al., PLOS Climate 2022



Use of plane by status



Blanchard et al., PLOS Climate 2022

Differences in footprint by laboratories

French Astrophysics Labs



Courtesy A. Santerne





Evolutions of the tools

- Research infrastructures (CERN, astronomy, computing infrastructures)
- **University** version
- International versions (US, Germany, Switzerland, \bullet UK)
- **Environmental** footprint:
 - Broadening the current climate focus
 - Other planetary boundaries (biosphere, pollution, water...)
 - Material footprint

Black carbon emissions



FLOWS

zone of uncertainty (increasing risk yond zone of uncertainty (high risk)







Research topics and ways of tackling them

• **Short term impact** (energy consumption, pollution etc...)

computers, computer modelling, field surveys

- Foreseeable effects in the longer term (= impact that the use of the produced knowledge could have) **negative or positive**
 - Propose new representations of the world,
 - Support a particular model of society,
 - Guide the choices made by public and private players,
 - O Underpin technological or conceptual innovations.

• Use of large-scale equipment: telescopes, satellites, oceanographic vessels, super-

Including research infrastructures

French Astrophysics Labs

- Including large research infrastructures
- 1760 persons with ~35% astronomers
- Average ~20 t CO2eq. / cap.



Research topics and ways of tackling them

• **Short term impact** (energy consumption, pollution etc...)

computers, computer modelling, field surveys

- Foreseeable effects in the longer term (= impact that the use of the produced knowledge could have) **negative or positive**
 - Propose new representations of the world,
 - Support a particular model of society,
 - Guide the choices made by public and private players,
 - O Underpin technological or conceptual innovations.

• Use of large-scale equipment: telescopes, satellites, oceanographic vessels, super-

Research topics and ways of tackling them

Mitigate "short term" impacts

- Favour collaboration instead of competition
- Maximise use (scientific return) of existing infrastructures, data...
- Reduce the pace! (slow science): improve quality and creativity
- Can we sometimes consider that we know enough?

Research topics and ways of tackling them Longer term impacts: effect of the knowledge itself

« The aim is to integrate impacts into the very process of developing knowledge, to explain the reasons behind the choice of a particular subject, to imagine possible futures, etc. »

COMETS (Ethics Committee of the CNRS)

Research topics and ways of tackling them Longer term impacts: effect of the knowledge itself

- What **needs** does the research address? => Social utility
- What could be the effects of the knowledge that will be produced?
- How might the research change today's reality, and in what ways?
- Is it likely to support a particular model of unsustainable consumption or production?



=> broaden the vision of the relevance of research work

Research has also positive environnemental impacts!

Collective responsibility to **act as a sentinel**

- Alert on the existence of risks
- Inform public decisions by a rigorous assessment
- Help to discern miracle solutions, false promises



Atécopol



Atécopol Political ecology workshop

Paris, Rennes, Dijon and Bordeaux working on the many aspects linked to ecological crisis.

- Expertise
- Action research
- Art-science explorations
- Institutional, academic training

- The Atécopols are interdisciplinary groups of local scientists in Toulouse, Aix-Marseille, Montpellier,
 - - Scientific events
 - Conferences and public debates
 - Intervention in media

https://atecopol.hypotheses.org/



A manual for intellectual self-defence



- Sustainable agriculture
- Anthropocene
- Biodiversity
- Compensation
- Eco-responsible construction
- Green growth
- Dematerialization
- Sustainable development
- Eco-citizen
- Circular economy
- Ecopsychology
- Decarbonised energy
- Green finance

A collective work from 35 scientists

- Green nationalism
- Human nature
- Carbon neutrality
- Nuclear
- Public policy
- Awareness
- Corporate Social Responsibility
- Tourism
- Transition
- Clean vehicles
- Sustainable cities



Research topics and ways of tackling them

Positive environnemental impacts

Find new knowledge to help us under and the solutions to meet them

- Strengthen interdisciplinary bridges to face major systemic issues
- Include **other stakeholder** in the choices of **research orientation** (citizen, associations) and **carrying out research itself** (post-normal science)
- Favour research programs targeted to « priority issues »

Find new knowledge to help us understand socio-environmental challenges



An alternative research program to Horizon Europe written by students, researchers and associations

A public contribution to propose new research directions that break with the predominantly technical proposals, which dramatically underestimate the scale and nature of the changes that need to be made.

together for responsible and committed research











ORIZON TERRE

SANTÉ

SANTÉ ET ÉNERGIE-HABITAT-MOBILITÉ

AGRICULTURE

AGRICULTURE ET SANTÉ

ÉNERGIE - HABITAT - MOBILITÉ

ÉNERGIE-HABITAT-MOBILITÉ ET AGRICULTURE

mais également...

ÉPUISEMENT DES RESSOURCES NATURELLES

USAGES DU NUMÉRIQUE ÉCONOMIE DE LA TRANSITION ÉCOLOGIQUE

DÉMOCRATIE DANS LA RECHERCHE

É BILITÉ

Health

Agriculture

Energy - housing - mobility

Natural ressources depletion -IT usage - Economy - Democraty



There are no ready-made or universal answers to these many questions, which involve different visions of the world and, for the most part, a complex hierarchy of priorities.

=> Multiply spaces for discussions at all level of research from lab to international community and also and out of research community

Thank you

Action research is a research method that aims to simultaneously investigate and solve an issue.

In other words, as its name suggests, action research conducts research and takes action at the same time. It was first coined as a term in 1944 by MIT professor Kurt Lewin.A highly interactive method, action research is often used in the social sciences, particularly in educational settings. Particularly popular with educators as a form of systematic inquiry, it prioritizes reflection and bridges the gap between theory and practice. Due to the nature of the research, it is also sometimes called a cycle of action or a cycle of inquiry.

Action research cycle



Post-normal science

It is a problem-solving strategy appropriate when:

"facts are uncertain, values in dispute, stakes high and decisions urgent"

Such constraints are typical of environmental problems, from climate change, through the dumping and contamination of toxic waste, to the installation of nuclear power stations.

In those situations, post-normal science recommends the participation of an "extended community of peers", made up not only of scientists, but also of other legitimate players, i.e. all the people involved in the problem, who will help to ensure the quality of scientific reflection.