Digital systems and sustainability

Martine Olivi

INRIA Sophia-Antipolis

23 April 2024
The 70s

Oil crisis in 73.
« En France, nous n’avons pas de pétrole mais nous avons des idées »

Amoco Cadiz oil spill in 78
How unsustainable is current human development?
CO2 emissions from fossil fluids
The great acceleration

The safe operating space for humanity\textsuperscript{1}

6 of the 9 planetary boundaries already overstepped!

\textsuperscript{1}Rockstrom, Steffen et al, 2009
Are digital technologies sustainable?
Global GHG emissions of ICT sector

- 2-4% of the world carbon footprint
- Annual growth: 6% (double every 12 years)

Projections of ICT’s GHG emissions from 2020, Freitag et al., 2021

All sectors of the global economy must keep their GHG emissions in line with the Paris Agreement.
What emits the most greenhouse gases

ARCEP-ADEME report (France)
Life cycle of ICT equipments

From D. Bol, S. Boyd and D. Dornfeld, Application-aware LCA of semiconductors [], in Proc. IEEE ISSST, 2011

ICT’s impact concerns at least 5 of the 9 planetary limits!
More and more!

The quantity of chemical elements in current technologies exploded!

Number of metals in phones:
Landline phone (1950): 12; First mobile phone (1990): 30; Smartphone: more that 50.
Supply of raw materials issue

- Tantalum, Indium, Gallium, Germanium, are critical elements:
  - Used in green and digital technologies
  - Recycling rate less than 1%
- Tantalum, Gold → Conflict resources
All that for just this!

Palabora copper mine (South Africa) and satellite view ©Dillon March.
Photographers raise awareness

Pollution: nickel mining waste, New-Caledonia
© Adam Dean/NYT-REDUX-REA 2022

Children labor: cobalt mining, DRC
© JUNIOR KANNAH AFP 2016

Health impact: gold mining, Burkina-Faso
© Olivier Girard for CIFOR 2013
Can digital science help us build a sustainable world?
5G: a shift toward green telecommunications?


Energy consumption/Gbit will be divided by 10 in 2025; 20 in 2030

→ Energy efficiency
Beware of the rebound effect!

- 5G users consume 2.7 times more data than 4G users. Opensignal, 2020

Positive feedback, Shift project (2018)

**Efficiency must go hand in hand with sobriety!**

- Growth of ICT’s carbon footprint due to 5G deployment in France\(^2\): 18% to 45% between 2020 and 2030.

\(^2\)Haut Conseil pour le Climat, 2020
5G what for?

- **Companies:**
  - Answer traffic increase
  - Save energy
  - Allow for new applications:
    - health, autonomous vehicle, connected objects
  
    This amounts to a choice of society!

- **The government:** progress and nation’s competitiveness

  Sobriety left to the responsibility of users

  Sobriety conflicts with the business model!
Are the environmental benefits of IA solutions well assessed?

Sankey diagram of parts of Rolnick’s paper references in terms of environmental evaluation. Ligozat & all, 2022

Half of them do not include any environmental assessment!
None of them take into account the impact of machine learning!
Very attractive field (scientific interest and funding)

The law of the instrument:

I suppose it is tempting, if the only tool you have is a hammer, to treat everything as if it were a nail. Maslow.

- Risk of wasting time on false solutions
  - Better assessing IA solutions
- Undone computer science
  - Funding Undone Computer Science$^3$

---

$^3$Undone Computer Science. Nantes, 5-7 Feb. 2024
Elephant in the room!

Image generated by ChatGPT 4.0 and DALL-E 3.0.
Our growth economy is unsustainable!

- Growth of the digital sector means more raw material, more equipment, more data centers, more submarine cables, ...
- Technological efficiency goes hand in hand with increased use
- We cannot only count on technologies
- Recycling in a growing economy does not help so much

→ Green growth is an oxymoron

---

Combaz & Bol, Le numérique dans l’anthropocène, JRES 2021
Shall we go for sufficiency?

An economic model that balances between essential human needs and planetary boundaries

- Provides an end goal for the transition
- Addresses the **systemic and global** character of the ecological crisis

A Safe and Just Space for Humanity. Kate Raworth.
Toward sustainable ICT

- Individual action: keep equipments as long as possible
- Laws: limit data consumption, number of screens, deployment of superfluous new technologies, advertising.
- Democratic ownership of technological choices
- Dematerialization → Lowtechization

From a course at UTC. Stéphane Crozat
Research is on the way!
We are not alone!

- **EcoInfo** - CNRS GDS
  - Reduce the (negative) environmental and societal impacts of ICT
  - Organize training weeks

- **Labos 1point5**
  - GDR CNRS, INRAE, ADEME, Inria, Sorbonne University
  - Understand/reduce the carbon footprint of research activities
  - Reflection team (monthly seminar)

- **Archipel**: community on the challenges of the Anthropocene
  - ... Atécopols, OTECCA,...

- **SEnS workshop**: a framework for a collective reflection (1 day-10 people)

Open positions in the field of sustainability digital sciences!