Inria foresight seminar on "Earth, Environmental and Energy Sciences" of October 2023
Follow-up notes

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The Inria foresight seminar on "Earth, Environmental and Energy Sciences" took place on 4 october 2023. The event was the occasion to discuss some scientific issues related to this vast area.

Several members of the participating Inria project-teams, among which the authors of this note, consider that reflections on these themes, even in the scientific arena, can no longer be confined to purely technical considerations. This note is thus a preliminary proposal of additional issues and questions that are considered relevant in this context: they are listed in sections 5 and 6, after the first four sections which contain the text of the foresight synthesis proposed by the deputy scientific director in charge of this scientific theme.

1 Scientific work

The scientific challenges require multidisciplinary approaches, which does not exclude detailed work in the digital sciences, in order to arrive at tools/methodologies that will be adopted by end-users. Finding the right allies and collaborations greatly enhances the impact of the scientific results obtained.

There are many modelling and simulation needs: high resolution, sub-grid parameterisation, stochastic aspects, model coupling (e.g. ocean-atmosphere) but also simplified models for decision support and public policy.

The four scenarios developed by ADEME to achieve carbon neutrality by 2050 illustrate this need for modelling. Inria's modelling skills should be useful in reducing the uncertainty associated with the assumptions made. It should be noted that these scenarios need to be accompanied by stories to illustrate the resulting changes.

Models (mechanical, physical, biological) form the basis of much of the research carried out by the teams in this theme. But we are also seeing the emergence of work on AI and ML in particular:

- Numerical approximation and numerical analysis of PDEs (time and space schemes, Galerkin approximation, data assimilation, etc.) are revisited,

incorporating techniques from ML;

- the development of data-based models when mechanistic modelling is not available;

- the representation of neural networks by differential or partial differential equations.

2 Digital technology and the ecological transition

Ethical considerations in the environmental field are prompting us to question the validity of certain research projects. But at the same time, can we deny ourselves access to knowledge that could be useful for tomorrow's sustainable technologies?

Sobriety must play a greater role in digital analysis and HPC, and the performance of algorithms must also be assessed in terms of the energy cost of calculations. We need to think about the methodologies and tools we develop in a constrained world (energy, materials, etc.).

The issue of CO_2 storage was highlighted, raising numerous scientific, industrial, monitoring and acceptability questions. It should not obscure the need to reduce CO_2 emissions (one expert explained, for example, that the current foreseeable rate of development of these technologies makes it uncertain whether they will have a sufficient impact to limit global warming to 2 degrees).

The One Health concept aims to consider health not on the scale of an individual or a group of individuals, but in the broader context of environmental issues, and therefore at the interface between the health of animals, humans and ecosystems. At this stage, little research is being carried out at the Institute in this area.

3 Organisational aspects

The question of the influence of the work carried out by Inria has been raised in several ways. In order to increase the impact of the work carried out by the project teams, we need to clearly define the targets and the people we want to talk to. Who is listening to us? Who do we need to talk to? We need to ask: who do you want to listen to?

The dissemination of scientific culture and information is a major lever in the ecological transition. Scientists must give society the benefit of their expertise (which is not limited to their specific area of research) in order to increase the place of the environment in debates.

Many questions asked during this seminar on:

- ethics,

- Inria's contributions to societal issues,

- the role of digital research in the ecological transition

must also be addressed at the level of the entire institute, locally in the centres (for example within the local sustainable development commissions) but also during debates concerning the institute's strategic orientations (for example the COP).

4 Proposals

- CO_2 storage: this issue has recently come to the fore (IPCC report, ADEME scenarios 3 and 4, DGEC) and raises a number of scientific questions (modelling, simulation, monitoring, etc.). A number of initiatives are underway with IFPEN and ENPC, which will need to be put into practice. It should be noted that the possibility of storing CO_2 should not detract from the objective of reducing emissions.

- Scientific leadership: the digital and environment programme should organise cross-disciplinary foresight days. The themes are to be defined/proposed. Possible topics include: reducing the energy footprint of digital technology, hybridisation between physical/EDP models and data science. Hybridizing AI and numerical modelling is a theme that is present (current and/or future research) in many teams within the theme, but also beyond. Science days bringing together EPs working on data science (e.g. machine learning) and numerical modelling will be organised.

- Multi-disciplinarity: this aspect needs to be strengthened within the project teams. This can be achieved through joint project teams (e.g. with SHS laboratories), but also through close collaboration (co-sponsored projects, delegation visits, exploratory actions, Inria challenges, etc.).

- ADEME offers funding (projects, theses) for which Inria teams could apply. The expertise of Inria scientists could also be mobilised for ADEME studies.

5 Epistemological aspects

The presentations and discussions at the seminar touched on a number of epistemological issues.

- A position that has been expressed: as we cannot always know in advance whether research will one day lead to a useful application, it is difficult to recommend stopping a research activity. Also, "the more tools we have at our disposal, the better [in the event of a crisis, for example]". One example cited was the work on messenger RNA carried out by a recent Nobel Prize-winning researcher over 20 years ago, which was almost halted at the time, and which ultimately contributed to the development of vaccines against the flu during the pandemic.

- One speaker suggested that the finiteness of resources (typically in terms of working time and money) should lead to choices being made in the research topics to be explored.

- One presentation tried to show that the same subject of study can be approached from a wide variety of angles, leading to a wide variety of approaches, disciplines and criteria [and possibly to very different conclusions]. That the choice of angle of study should be a conscious choice on the part of the researcher.

We think it would be interesting to explore this subject in greater depth, and that it would be a good idea to do so in conjunction with a discussion of the notion of the neutrality of science and scientists (a notion that is very well studied in the sociology of science, for example) and a look at the more general question of research ethics.

The presentation of the Transition2050 scenarios by Ademe was very much appreciated. It is an enormous and rigorous piece of work. It is also an excellent example of a more in-depth discussion of what is involved in choosing scenarios and telling the story of these scenarios: these two aspects are not neutral and involve choices that ultimately have a political impact. As with the epistemological elements above, it would be extremely interesting to exchange ideas between colleagues interested in this question.

6 Institutional aspects

In the run-up to and during the seminar, institutional aspects were raised by various participants. Organisational constraints did not allow sufficient time for a constructive discussion on these points, which would also be interesting to debate, in a framework to be found. Some of the issues raised and proposals made are listed below (non-exhaustive list).

The missions of Inria and its scientists.

- Is it Inria's role to work on environmental (and related socio-economic) issues?

- How can we obtain/demonstrate clear recognition of the legitimacy of doing research on these issues and approaching them in different ways, including not just 'technically'?

- What should I do as a scientist or teacher? A number of people have, broadly speaking, asked the question "What should I do as a scientist or teacher? [in the face of environmental challenges]. We think it would be interesting to think about ways of discussing this question and sharing experiences. One possibility would be regular 'inter-CLDD' meetings (a joint video of the Centres' sustainable development committees), another (more occasional) possibility would be to organise SEnS workshops. Other methods are also possible.

Taking a step back from Inria's actions in relation to environmental issues.

- Are the current research activities carried out by Inria in line with the issues at stake?

- What has been done since the creation of the post of ADS in charge of the environment, to facilitate the emergence and development of scientific activities on these themes (socio-environmental issues) within the institution? What forms of support? What institutional changes? What scientific policies, and in particular what research themes on these issues, have been promoted and highlighted? What resources?

- An assessment of the commitments made in the COP and the results obtained in relation to environmental issues. Examples of questions that might be asked:

  - What are the results of the CLDDs? What resources have been allocated to them?
  - What was the outcome of Céline Serrano's assignment as project manager for the implementation of a Corporate Social Responsibility (CSR) policy? What resources were actually allocated to her? Who replaced Céline Serrano following her departure?
  - What is the strategic assessment of the Institute's environmental policy (qualitative analyses and figures)?

Consult the institute's scientists.

- Setting up surveys or workshops to address questions such as those below. As researchers, would you like to get involved in research activities that tackle these issues more directly, their causes, or enable the emergence of alternatives (commensurate with the stakes)? Do you think it would be your duty to do so? What institutional barriers exist within the institution (Inria and possibly the EPSTs and universities more widely) that might prevent us from getting involved individually and collectively in these issues with the urgency and radicalism commensurate with the stakes? Have we so far identified and acted on the right levers for action? What taboos and fetishes need to be tackled?

- Suggest measures, alternatives and changes to be implemented within the institute to overcome or weaken these barriers.

- Are the changes to the institution moving at the right pace? Are they moving in the right direction? Are we doing enough? Are the messages from management clear, consistent, etc?

- How can proposals from the centres be discussed further and implemented?

- What concrete proposals would enable us to move forward?

Transdisciplinarity.

- Create forums where we can discuss the scientific issues that we wish to address individually and collectively at Inria, in a way that is both critical and sympathetic.

- Should civil society be involved in these choices, and how?

- The need for transdisciplinary research?

- How can we enable researchers to conduct truly transdisciplinary research?

- How can we carry out collective transdisciplinary and non-militant research into socio-environmental issues?

Changes in the political context.

- Framework: Risks for the institute, the research carried out and the researchers linked to the intrinsically political nature of research in a society in tension and political upheaval. Against a backdrop of polarisation in public debate and 'radicalisation' of players (activists, governments, etc.), a world of tension is taking shape.

- More and more researchers are getting involved in the public debate: there are countless collective articles in the major media. More and more researchers are also getting involved in groups such as "Scientifiques en rébellion" and "Labos 1point5".

- Tensions within our own institute: deep-seated disagreements over values and worldviews can generate conflicts within our institute itself. The example of what happened with tousanticovid could be just the beginning of future tensions linked to socio-environmental issues. For example, tensions, and even conflicts, are likely to emerge as a result of challenges to the ideologies of growth or the visions of 'sobriety' guiding current Western governments...

  - How can the social responsibility of research be considered in this context? What are the practical ways of doing this?

  - Can this context influence the Institute's strategy? Does it require us to redefine or rethink Inria's missions? To rethink the concepts and place of innovation? The nature and conditions of industrial partnerships? How can we 'reassure' teams working on issues that might conflict with the ideologies of current or future governments, etc.?