Epimetron[1,2]

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Yesterday my seven-year old daughter asked me: "what are humans for?". "What do you mean?" I replied. "Mum told me that bees pollinate flowers; mosquito feed frogs; so what are humans for?" Kids are usually very good at asking tough questions, and I must confess I had to pose a minute on this one (wouldn't you?). Physicists avoid asking what something is *for*, and prefer answering what something *does*. However, physiologists, ecologists, anthropologists—in fact everyone in everyday language—admit that things can have a function. Bees have a function because they fit into a global system, a global metabolism in which materials are recycled and signals are emitted and recognised. Do humans?

Struck by the urgency of the question, I answered my daughter that humans have not really found their place yet. Their population is still expanding, using more resources, and have not fitted a global, stable network of interactions with their environment.

On a second thought, though, history gives us plenty of examples of reasonably perennial societies. French have invented the beautiful, earthy word of "terroir". It conveys the powerful idea of an alliance between human traditions and the cycles of Nature. In it one can feel—smell!—how the Bordeaux grapes, the chestnut trees of the Cévennes, the Pyrenean dogs exchanged services with the monks, farmers and shepherds who needed them. It is all about food, lives, and cycles. Can we ever imagine a global-scale terroir? This could be the motivating question of this book.

Chapter after chapter, we have seen the Pleistocene as the theatre of mankind birth. After billions of years of history which saw the fabrication of enzymes, organisms, ecosystems, the production of the human brain was a new instalment in the rise of complexity on Earth—another level in the capacity of living beings to process resources and extract energy in an ever-changing environment. Humans have provided the material for yet higher organisation levels: the tribe, the city, the civilisation, and now the global economy.

It seems to be a lesson of history that any developing system is exposed to phases of contraction

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2 The title "Epimetron" is an idea of the book editor. It has meaning in Greek language. Metron has the meaning of fairness as opposed to excessive action. The expression "metron ariston" means that fairness (impartiality) is the best (choice in our acts). Epimetron is the addition to previously written to achieve fairness among various views. (This footnote is not published.)

and reorganisation. As reminded by Middleton (cf. Chapter 13), citing Tainter, the crisis is "a rapid, significant loss of an established level of sociopolitical complexity". Or, as summed up by Lucero and Tarmon (cf. Chapter 8), kings lose power—enacting a societal transformation—but farmers remain and reorganise themselves.

Climatic events such as long droughts have sometimes triggered crises and even societal collapses. Scholars are careful not to see the climatic event as their deep cause: the crisis is the sudden revelation of an imbalance accumulated over time, such as the increased reliance on a rarefied resource.

As time went on the mechanisms and the natures of interactions between humans and the environment evolved (Karpouzoglou and Mao, Chapter 18). Crisis after crisis, technological progress, trade, animal domestication, the discovery of fossil energy resources and information technologies have generated increasingly complex societies. With large scale transformative projects such as dams and cities, societies improved their resilience to local climatic conditions, but they increased their reliance on a global network.

In a sense, the complexification of societies has changed the rules which determine their evolution. Paleolithic and neolithic civilisations exploited ecological niches, which varied over time (cf. Sala, Chapter 15). Climatic events kept having acute consequences on populations even well into the industrial era. Wagner and Zorita (Chapter 5), for example, explain to us how in 1820 the Tambora eruption caused famine all over the world. Nowadays, a global food network protects the richer countries against a bad summer, but that network is not serving everyone on Earth fairly. It might also turn out to be vulnerable.

Indeed, the technosphere in which an ever-increasing fraction of the human population live should not let us forget that humans run on food, and, schematically put, industrial food is the product of oil and phosphorous (Cordell, Drangert, and White 2009). Oil supplies the energy needed for the production of nitrate fertilisers, farming, fish boats, food transport, plastic packaging, and processing; phosphorous is used as a fertiliser. Not only are these resources exhaustible, but the waste products of the whole human industry built on the top of agriculture has leveraged its pressure on the environment, causing serious threats to the functioning of natural ecosystems: climate change, fish stock depletion, eutrophication of coastal ecosystems, etc. (Rockstrom et al., 2009).

These are obviously global issues. As humans became globally interconnected, with food and raw material travelling worldwide, and the values propagated by marketing reaching an ever-increasing fraction of the population, individuals have developed dependence to a system organised at the global scale. Yet, this global system is in a state of overshoot: it consumes more resources than is sustainable and, worryingly, it seems to have remained largely blind to this notion of overshoot. Global markets keep working as if resources were infinite.

But we, individual humans, should not be blind. As long demonstrated by the paintings,

sculptures and engravings of the paleolithic, humans have since long grasped the ability to think, picture, discourse about the different levels of organisation they are embedded in. The realisation of the dangerous position in which global civilisation has put itself must be for us a call for action. Science, art, and politics are the mechanisms humans can use to favour the emergence of global awareness and anticipation at the global scale. This is a tough challenge.

The agreements adopted in the Convention of Parties in Paris (December 2015) to hold "the increase in the global average temperature to well below 2°C above pre-industrial level and to pursue efforts to limit the temperature increase to 1.5°C above pre-industrial levels" are a political fact. As reminded by Guillemot (2017), a survey published by the British newspaper The Guardian in 2009 suggested that 85 % of climate scientists did not believe, however, that it would be possible to limit warming to 2°C. Reasons for such scepticism are easily found in current assessments about climate change: about two thirds of the available budget of emissions for keeping warming to below 2°C have already been emitted (Rogelj et al. 2016; Kriegler et al. 2018).
In other words, the 1.5°C target will be pulverised unless we replace about 85 % of our current primary energy needs by carbon-neutral alternatives in the next decade or so, or if the next generation finds a way to remove carbon dioxide from the atmosphere (Chapter 17). The latter is a dangerous bet indeed: however bright our kids may be, they will have to cope with the laws of thermodynamics (Hansen et al. 2017). The Paris agreement has therefore caused some turmoil among climate scientists, some applauding the political recognition of the risks of climate change (Schellnhuber, Rahmstorf, and Winkelmann 2016), other expressing scepticism or even anger about talks unsupported by a consequent action plan (Le Page, 2015).

As scholars swiftly observed (Hulme 2016; Guillemot 2017), this is the relationship between knowledge and policy which is highlighted here. The proliferation of scientific articles, special issues, and the IPCC being commissioned for the preparation of a special report "on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways" show that the scientific production system has absorbed the political shock. Scientists feel they need to remain actively publishing (publish or perish), but they also wonder to what extent climate researchers and research funders should bend their research agendas, programmes and projects towards short-term policy-oriented questions (Hulme 2016). Researchers from developing countries, on the other hand, remind that their populations are on the forehead in the coming environmental crisis, and urge to envisage all options, including geo-engineering (Cao 2018).

In fact, climate scientists' attempts to predict how the Earth system will evolve over the next century under this or that scenario will be of limited value unless historians, archaeologists and anthropologists put as much wisdom to understand who millennial societies can adapt, migrate, morph in each other in the face of rapid changes. Together, we need to develop the tangible elements that might help humanity to solve the difficult puzzle of reducing its global energy and resource needs without crashing. Is a soft landing scenario actually possible ?

Perhaps the bigger question is whether global politics and economy can ever be moulded into a sustainable relationship with the Earth system. Karpouzoglou and Mao (cf. Chapter 18) present society as a "self-adaptive system". Others have used similar words. Kim and Mackey (2013) describe environmental law as a "complex adaptive system". The concept of self-adaptive system appeared in the research on emergence and organisation of living systems developed around the buzz of the Santa Fe Institute in the 1980s. These concepts may be connected to a deeper epistemological movement focusing on relations, causal pathways, and anticipation—in a word, complexity. Hence, while we witness a knowledge gap between science and politics, bridges appear between the 'two cultures' of sciences and humanities. Our challenge will be to cross language barriers. Be this book a contribution in that direction.

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