Rockström, Johan, & Gaffney, Owen. (2021). *Breaking Boundaries. The Science Behind Our Planet*. London, UK: Dorling Kindersley.

Summary

Breaking boundaries is a general-interest book. It may be compared with the famous *Limits to growth* book, published in 1972. It is not a scientific book; it is a meant as a conscious raising book. It is also not a history book, but a natural science book on very long-term changes in time (what historians would call *Big History* (Christian, 2018). It pleads for a safe operating space for our human life on earth. It's message is that there are planetary boundaries and we are crossing them. What we need is planetary stewardship to steer away from these boundaries.

The book has a clear structure. Apart from the introduction and conclusion it consists of three parts:

1) The first part is a mix of *Big History*, and (more traditional) long-term history since the agrarian revolution (mainly in chapter four);
2) in the second part the authors introduce their main concepts and way of thinking: Anthropocene, planetary boundaries, exponential growth and tipping points;
3) the third and final part is a mixture of policy recommendations and analysis: how to reach a safe operating space within the planetary boundaries? Are we already going in the right direction?
    a. In the chapters 10 to 15 they discuss six system transformations: lowering carbon dioxide emissions; transforming agriculture / food system; decreasing economic inequality; rebuilding cities; decreasing population size; and making technological change a positive force.
    b. In the chapters 16 and 17 they focus on changes in economic policy and in politics
    c. Chapter 18 is about social, political, economic and technological tipping points that are already going in the right direction.
4) Chapter 19 is their own conclusion of the book.

Part I. In the first part the authors tell the history from the beginning of the earth until the present. They distinguish between its earliest origins (Earth 1.0; 4.5 billion years ago), and the period of simple single-celled life (Earth 2.0; 3.8 billion years ago), followed by photosynthesis with oxygen (Earth 3.0; 2.5 billion years ago), to the period with complex life (Earth 4.0; 542 million years ago). After a long time in Earth 4.0, a pattern of ice-ages and warmer interglacial periods emerged. This alternation became rather regular since a million years ago: longer ice ages followed by interglacial periods of 10 to 30.00 years. In this alternate pattern it can be 5^0 C colder than today to 1^0 p. 32 /2^0 C p. 38. warmer. These temperature differences are largely caused by the level of carbon dioxide in the atmosphere: in ice ages the level dropped to 170 ppm (parts per million) and rose to 280 ppm in warmer interglacials. In the 1988 the level went beyond 350 ppm and in 2019 it was 415 ppm (p. 38). The authors warn that 350 ppm is a critical boundary.

In time hominids developed to become homo habilis some two million years ago and homo sapiens some 300,000 years ago, further developing to the kind of homo sapiens we are nowadays since 35000 years ago.

After having told the long history of the earth and humans, the authors introduce the history of our warmer interglacial: *the Holocene* that started some 12000 years ago. It is the story of nomadic people followed by agrarian societies with cities and states (pace Graeber & Wengrow, 2021), the creation of

one world under the aegis of merchant capitalism, next the industrial and urban world based on the use of fossil fuels and a gigantic use of natural resources which brought us, since the 1950s, into the *Anthropocene*.

Part II. The second part explains our contemporary situation: the Anthropocene and its problems: “Currently, we live on a planet with dangerously unstable life support systems. If we push the systems too far and set off more feedback loops, we will cross harmful tipping points and irreversibly start a transition from one state to another”. p. 66. The authors tell us that there are nine, quantifiable, planetary boundaries that we should not definitively surpass if we do not want to create, what they call, a new hot house earth – that is a climate system that existed before the icehouse earth – the alternation of ice ages and warmer interglacials. This new hot house earth would imply a climate system that will be completely different from the one that we have known since the beginning of the Holocene.

The three most important planetary boundaries are the climate system, the ozone layer and the ocean. Here the story of emissions of carbon dioxides plays a large role. Next are four biosphere boundaries: biodiversity, land use, fresh water and nutrients like nitrogen, phosphorus and potassium. These biosphere boundaries are important for themselves but also essential for the climate system, the ozone layer and the ocean. Finally, the last two boundaries are the use of novel entities (new chemical substances created by humans as well as artificial intelligence and genetic risks), and the release of aerosols in the atmosphere. These last two are not yet quantified at all; the other ones can be quantified in different degree of absoluteness. In summarizing this chapter, they give a bit different order of the planetary boundaries and call climate and biodiversity the core ones.

After this explanation of the boundaries, the authors tell us that nowadays some critical boundaries are already reached or will be reached soon, plus a cascade effect of causes and consequences could start leading to an unprecedented rise of the carbon dioxide level. Our situation has become more critical for two reasons. One – the pace of change is exponential, not linear; in other words very fast and a bit contradictory to human experience. Second - the change is not cyclical, like the ice age / interglacial alternation, but a tipping point to a new climate system. The exponential way of thinking should also guide how the problem may be managed. Intermediate goals should be formulated for the near future in order to decrease the pace of change and even alter the trajectory of the development.

Part III. In this part the authors explain what could and should be done. First, they identify six concrete transformations: 1) the Carbon Law Pathway; 2) agricultural and food-system transformation; 3) creating more economic equality; 4) building more sustainable cities; 5) decreasing the world population; and 6) taming the technosphere.

To reach these transformation goals a new economic set of policies is necessary more directed to resilience, regeneration and recirculation and to further develop the knowledge economy, the information economy, the digital economy, the service economy and the sharing economy. Politics in general should support these goals and be more effective due to new trust in politics and international coordination. When looking at contemporary social and economic developments the authors show themselves rather optimistic.

In their conclusion the authors state that the goal of a planetary stewardship and the protection of the global commons is realistic. They once again stress that their programme and diagnose are not meant for making us aware that we are living in a man-made environment or for the protection of the environment as such, but for creating and sustaining conditions in which human societies can thrive.

Commentary

What can a historian comment to this book? The authors are serious scientists affiliated with the Stockholm Resilience Centre and the Potsdam Institute for Climate Impact. Johan Rockström belongs with Will Steffen and Carl Folke to the pioneers of this field of research and thinking. The book sometimes therefore takes an almost autobiographical approach of the remarkable developments in the last decades. The references to social and historical work are really limited. Some of the usual suspects are missing, like Harari (Harari, 2015; Harari, 2017) and McNeill (McNeill, 2000; McNeill & Engelke, 2016), sometimes a whole chapter (the one on politics) has only one reference! The book does demonstrate how much progress has been made in the historical research of the deep past, of the period, that not that long ago was called pre-history. Was it first archaeological research that broadened our time frame, now it is geological, climate and earth-system research that really scatter the time limits about which we get knowledge. The book is to be praised because it puts time processes in the centre of their research. It is all about transformations and transitions and cascades and interactions of change. Their idea to turn the exponential change that is going on, to a way of managing the climate change, is a *trouvaille*. At the same time, the book is less clear about time itself – about the differences in human time and geological time.

The authors are aware of the problems associated with the use of the concept *Anthropocene* (Kamel, 2022). They reject the concept *Capitalocene* – for them it is about consumption but also about the agency of governments. They discuss the unequal responsibility for the making of the Anthropocene – the one percent of very rich people with a colossal footprint, the colonizing parts of the world, the early industrialized parts of the world are mostly responsible - but conclude that a discussion about the extent of responsibility would distract from what is necessary: the problem needs to be tackled now.

It is interesting to see where the authors are optimistic and where they are not. Probably to convince their readers that the ambitious goal of a planetary stewardship is possible, they paint in their third part a rosy picture of change for the better. They show themselves overtly optimistic over mass civil movements in favour of change; of government policies, of corporate policies and of new technologies going in the right direction. But their arguments for this optimism are weak. Mostly they refer to the energy transformation, the population decline and the well-known example of the CFK's (McNeill, 2000). In the chapter concerned they frequently use the concept tipping point. But their social tipping points are more mere metaphors or wishful thinking rather than real game changers.

They are much more optimistic about changes in cities and the industry than about changes in agriculture. A heavy burden weighs in their book on agriculture. It has to improve its performance, with less acreage (because more land should be given to nature), with less use of fossil fuels, while feeding a still growing world population and while becoming more important as a storage for carbon dioxide. But even for this transformation they suggest that change is nearby.

Although the authors are critical on economic inequality, on government and economic policies and suggest sometimes radical changes, their general approach is rather technocratic and modernistic. They try to use an objective and neutral tone beyond one that demonstrates that it is aware of huge differences in the world and of more political discussions. They behave like engineers and claim that most of the boundaries are quantified without paying a lot of attention to the fact that some have a better scientific underpinning than others.

It is strongly a program from above. The book breathes the atmosphere of the Davos World Economic Forum or of the UN-world. Captains of industry, government leaders, world celebrities and scientists meet and discuss for the best of the world in general. They publish of course this book to reach a

general public, but it is only at the end of the book that the individuals who are reading the book are directly addressed and involved. That is a pity because their programme demands not only a change in policies of governments and corporations. Individuals will experience the transformations and will have to get along. That requires that individuals become aware and accept responsibility and accountability for the indirect (in time and space) and aggregate effects of their personal behaviour. In other words, it involves that individuals also take into account the effect of their personal behaviour on others and on the group as such, that we really become a reflexive society (Beck, 2016).

In general, one can say that the book gives a good and probing picture of the planetary problems; it gives a clear picture of the steps in time that have to be made; it sketches a very general picture of the necessary transformations and the current trajectories towards these transformations. In fact, very much in line with the really superficial and cursory sketch of the history of the Holocene – from which not much can be learned about process of social change, let alone of spatial differential processes and of transitions processes. More, and more diverse, social and historic research could support their program towards a planetary stewardship. In first instance this research would probably paint an even darker picture of the task ahead. Like many policy makers the authors have a clear idea of what they want to reach and where they come from, but are rather indifferent to the consequences of the transition process itself (except to measure whether they are already closer to their goal) (Judt, 2010). All kind of implementation and legitimation problems will become clearer because of real existing differences in the world with regard to the standard of living, life experiences and perceptions of the world and its problems. However, if these problems are taken seriously (like the authors start to do by connecting the climate challenge with the Sustainable Development Goals of the UN), if not only planetary problems are eyed but also day to day issues, and as long as this happens in a democratic environment with the help of scientific knowledge (open society), the endeavour to create a safe space for our earth could become a new uniting, challenging programme from which everyone involved could get a sense of pride and satisfaction.

Literature

Beck, Ulrich. (2016). *The metamorphosis of the world. How climate change is transforming our concept of the world*. Cambridge: Polity Press.
Christian, David. (2018). *Origin story. A big history of everything*. Allen Lane.
Graeber, David, & Wengrow, David. (2021). *The Dawn of Everything*. Allen Lane.
Harari, Yuval Noah. (2017). *Homo Deus. A brief history of tomorrow*. Harper Collins.
Harari, Yuval Noah (2015). *Sapiens: A brief history of humankind*. HarperCollins.
Judt, Tony. (2010). *Ill fares the land.* New York: Penguin Press.
Kamel, Lorenzo. (2022). The Anthropocene. History and Legacy of the Colonial Mindset. *Perspectives in History*, 60(6).
McNeill, John R. (2000). *Something new under the sun. An environmental history of the Twentieth-Century world*. New York: W.W.Norton.
McNeill, John R., & Engelke, Peter (2016). *The great acceleration*. Cambridge, MA: Harvard University Press.