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Environing media and cultural techniques: From the history of agriculture to AI-driven smart farming

Adam Wickberg
KTH Royal Institute of Technology, Stockholm, Sweden

Abstract
This article presents the new theoretical concept of environing media, which is developed to offer critical insight into how processes of mediation affect how we perceive of, manage and use the environment. Building on the insight that the environment has been in a continuous slow process of change that is now escalating due to human impacts, the article sketches a history of how environmental change and mediation are intertwined. Taking the history of agriculture as a case for the theoretical development, it shows how the current digitization of farming and implementation of AI systems in precision agriculture is the last of a long series in which environmental mediation come to play a crucial role in the forging of human–Earth relations. The article thereby shows the complex interplay between knowing and changing the environment as media technologies produce new epistemologies that in turn produce new interventions.

Keywords
agriculture, Artificial Intelligence, cultural techniques, environing, environment, environmental data, media

Corresponding author:
Adam Wickberg, Division of History of Science, Technology and Environment, KTH, Stockholm, Sweden
Email: adam.wickberg@abe.kth.se

Environing and cultural techniques

This article introduces the new concept of environing media as a theoretical tool for analysis of how the environment is understood and changed by technological means, and unpacks the concept through readings of media and environmental history, with a particular focus on agriculture. The etymological roots of media and environment are in fact not so dissimilar. Environment, from the word *environ* historically meant 'in the middle of' or 'surroundings', while the strong nature connotation of this word is largely a modernist conception. Media is derived from the Latin *medius* meaning 'middle' or 'in between'. It shares etymology with 'milieu' that stems from *medius locus* – a place in the middle. Thus being surrounded by something and knowing and changing these surroundings go hand in hand in the history of human civilization.

As the scale of our knowing and changing our surroundings have reached a point of inaugurating a new geological epoch – the Anthropocene – there is a need for a better and more refined understanding of how and why anthropogenic environmental change happens. The Anthropocene names humanity as a species with the word *Anthropos*, although a particular form of Western human culture, associated with colonialism, capitalism and extractivism, is the primary driver of this stage of global environmental change. What then, are the conditions of possibility for the Anthropocene? What needed to be in place in order for humans to so profoundly alter the nature of the planet and how can we better understand this process? I suggest that the concept of environing media could be helpful to this end, referring to the cultural techniques of knowing and changing the environment at various scales, from the cellular to the planetary systems that support life. In this way, the analytical juxtaposition of media and environment can become an a gateway to study the varying expressions of ever-changing human–Earth relations beyond the separation of nature and culture. A significant body of critical work has contributed to overcoming this separation, which we may now on a conceptual level claim to have achieved, but we still lack a critical understanding of how and why humans are conflated with their surroundings (Wickberg and Gärdebo, 2020, 2022). Stating that the separation was a mistake thus cannot be enough, nor dissecting the mistakes that led us there or replacing separate concepts with a composite one like natureculture. Theoretically informed empirical studies of anthropogenic environmental change are thus needed, offering detail and depth to the long historical process that led us to the current situation, as well as informing the future environmental imaginaries which are now starting to occupy the top of the political agenda.

As noted by Christensen et al. (2018: 5), surprisingly little exchange between media studies and environmental humanities has taken place, given the fundamental role media play in human relations with the environment. Studies in environmental media and communication, including studies in ecomedia, have analysed how narratives are produced and conceived across a range of media, such as film, books, art and computer games, in which the environment features as the topic of a given cultural expressions (Christensen et al., 2018), as well as investigating how a largely inaccessible region like the Arctic comes into being through a series of mediations ranging from satellite imagery to news media and social media. Environmental conceptions and narratives are thus affected by the media through which they are communicated and constructed, media devices that are increasingly interconnected. The same smartphone that streams the news of drought in sub-Saharan Africa and connects social media networks of user interactions may also be used by the farmer whose harvest is threatened to supply data for so-called smart agriculture controlled by Big Tech corporations such as Microsoft and big farming companies like John Deere. Like the personal data harvested from platforms in what Shoshana Zuboff proposes we call surveillance capitalism (Zuboff, 2019), environmental data is emerging as new source for value through platform operations and algorithmic rationales (Jaton, 2021).

Over the past years, there have also emerged an increasing number of studies on elemental media (Horn, 2018; Jue, 2020; Parikka, 2015; Peters, 2016; Starosielski, 2021), a notion that has been presented as a way to politicize media's material substances and overcome the separation between humans and environment (Starosielski, 2019). In this context, the concept of environing media proposes a complementary route of understanding the ontological and epistemological construction of environments critically and historically by focusing on how the global environment itself, as an epistemic object, is fundamentally mediated (Edwards, 2010; Wickberg and Gärdebo, 2022). Chains of mediation could thus be traced from the data gathering in distributed sensor networks, through the processing of this data into epistemic objects and concepts to the policy, politics and public perception of a given phenomenon such as climate change. This conception of media is intentionally broad and includes the logistical role of media as agencies that arrange, catalogue, organize, network and index people, places and things (Peters and Wickberg, 2022). In this context, we may for instance talk about agricultural media and consider how certain historically changing practices of farming organize and give rise to conceptions of and interactions with the environment, thus negotiating the conflation of nature and culture.

The verb e*nvironing* signals a processual understanding of the environment as a constantly changing and shifting phenomenon, which is also relative to human activities rather than prefigured. Animals too intervene in and shape their environments, as in the classic example of beavers building dams. In ecological sciences, niche construction theory has been developed to explain this phenomenon from an evolutionary point of view, and this theory has also been used to explain similar processes in human culture (Laubichler and Renn, 2015; Renn, 2020). Niche construction refers to the modification of selective environments by organisms (Laland, 2016) and has become an important framework for evolutionary ecology. In essence, it tries to explain how the non-random and systematic modification of environments affects the organisms' own evolution. Applied to human history, the rise of agriculture can be understood as a form of niche construction in which the development of technology allowed humans to construct their niche, using tools, transforming matter and controlling the energy pathways that sustain them.

Over time, different practices such as farming, deforestation, or mining established historical relationships between land and people that were both social and environmental. The concept of environing was developed in environmental history over the past decade as a means of rethinking how environments come into being. The term was in use in the early modern era and would usually mean something such as encircling a piece of land for agricultural use. In recent decades, it was picked in environmental history and presented as a way of overcoming the legacy of understanding everything beyond the farmland and human culture as the environment, a notion that proved increasingly problematic the more anthropogenic pressure on the environment increased and became evident over the past century. In this context, Sörlin and Warde (2009) proposed a 'history of environing, the study of how all human activity demarcates and generates an environment, an outside that haunts the space in which people choose to act'. Thus, different environing processes that societies have undertaken can be studied historically in an expanded notion of the environmental aligned with our current situation. In subsequent publications, Sörlin proposed that 'environing is what people do when they transform nature into environment' (2013) and, coupled with the word 'technology', that 'to environ is a process of making' (Sörlin and Wormbs, 2018) and key to this making is technology. As I have discussed elsewhere (Wickberg, 2022), even the now dense but rapidly declining rainforest of Amazonia was environed by its human inhabitants in the pre-Columbian era, before the mass death caused by Spanish colonization eradicated these people and resulted in massive regrowth of then abandoned farmland.

The concept of environing is thus particularly apt for analysing and understanding anthropogenic change in answering the 'how and why questions' – that is how and why do humans change their environments? These may seem like simple and straightforward questions, but we still lack a critical understanding of how and why humans come to change the environment at various scales, and particularly how current and projected future changes can be historicized. During the same period, German media theorists had reverted to agricultural history for a new concept that could explain the making of ontology and epistemology from material practices, but with more of a cultural and philosophical focus. Thus, the old agricultural word *kulturtechnik* (cultural technique), was repurposed as a way to study how ontic operations precede and produce ontological concepts (Siegert, 2015; Winthrop-Young, 2013). Culture, originally meaning cultivating or growing, only took on the metaphorical meaning of cultivating in the spirit we associate with it today with 19th-century Romanticism. From this vantage point, 'media' was conceived of as a transdisciplinary endeavour to overcome a certain humanist technophobia and to emphasize the techno-epistemic effects in the production and processing of power and knowledge. Instead of the more common conceptualization of media as being synonymous with the content they transmit, as in 'news media', a more material understanding of media as cultural techniques was developed. Cornelia Vismann, who studied law and media technology, offers another striking example of agricultural practice to explain the ontological implications of the concept.

> To start with an elementary and archaic cultural technique, a plough drawing a line in the ground: the agricultural tool determines the political act; and the operation itself produces the subject, who will then claim mastery over both the tool and the action associated with it. Thus, the Imperium Romanum is the result of drawing a line – a gesture which, not accidentally, was held sacred in Roman law. Someone advances to the position of legal owner in a similar fashion, by drawing a line, marking one's territory – ownership does not exist prior to that act. (Vismann, 2013: 83)

With Vismann's example we come back to environing from a different angle, one informed by philosophical inquiry where the making of ontology and epistemology is pushed to the fore. From the earliest land ownership practices to current proposals for geo-engineering the Earth system, technical and material operations precede the ontological and epistemological concepts derived from them, and we gain a better understanding of these objects if we understand how this process unfolds.

The concept of environing media thus draws on this turn in German media theory towards cultural techniques, which attempts to subvert the dualism between media and culture by focusing on the 'operative sequences that historically and logically precede the media concepts generated by them' (Siegert, 2008: 15), but directs it towards the dualism of environment and society. In brief, the theoretical thrust of environing media is to reorient focus from ontological concepts as givens, to the ontic operations that exist before they are conceptualized and to better understand these processes of worldmaking. Writing, reading, painting, or counting are practices – or cultural techniques – that pre-date the concepts generated from them. Drawing on this philosophical insight to bear on the ontology and epistemology of the environment, environing media designate the manifold technical processes that are involved in the recursion between environmental epistemology and environmental change. The essential means for environing can in this way productively be understood in terms of media, which also connects to an emerging broader notion of media. Understanding of the concept should include elemental and planetary processes, as well as smaller scale change (Peters, 2016).

The relation between media and environment since the post-war era

The current idea of *the environment* is to a large extent the product of post-war developments and discourses. It emerged out of the ashes of the Second World War, as the bombed cities of Europe were still struggling to recover while their American counterparts found themselves in a boom of wealth and economic growth. In contrast to civilians in Europe, East Asia and North Africa, the war for most Americans meant not suffering and privation but prosperity and abundance (McMahon, 2021). At the same time, the war itself had shown the human capacity for destruction and led to severe impacts – such as the nuclear bomb – that would later become a marker for the new geological epoch of the Anthropocene. The protection of the global environment became a geopolitically feasible project that attached to shared concerns even while environmental pressure from human activities was on a steadily increasing upward curve that continues to this day. Natural resources became the building blocks of a new prosperity that was starting to be imagined. American wealth during and after the war became the ignition motor for a rapid increase in production and consumption, which would eventually spread to Western Europe and transform how populations were fed in a the so-called green revolution or third agricultural revolution to which I will return below.

The emerging new conception of the environment in this post-war context differed significantly from older ideas in which it had referred to surroundings of wherever one found oneself. In this new conception, the planet itself started to become visible as such, in a process that would only be reinforced over the coming decade. The starting point for the view of the vulnerable environment is often related to the publication of two books in 1948, William Vogt's *Road to Survival* and Fairfield Osborn's *Our Plundered Planet*. Both books took a global perspective on the environment to show that anthropogenic impact was already a severe threat to the natural world. In Vogt's book the concept of the environment shifted from meaning 'context' to take on the meaning of a global object of all the ecological interconnections that make up life on this planet. Osborn used the term in a similar way, and even talked about humanity as a geological force. The emergence of this new way of understanding the environment was of course not coincidental but rather the result of several interrelated epistemic changes that emerged in the post-war world.

Warde et al. (2018: 14–18) propose that the emergence of the idea of the environment be related to the four dimensions of *future*, *expertise*, *trust in numbers* and *scale*. The first dimension of *future* relates to the future of the planet and how it would be affected by human actions. This was indeed a new orientation and largely relating to a shared sense of a need for direction following the destruction of two world wars, a sense which was built on notions of science. *Expertise* simultaneously emerged as a new form of scientific aggregation, where multiple sources would be mobilized to increase knowledge and understanding, particularly of the environment. Further, *trust in numbers* became the foundation of this new scientific paradigm built on quantification. Infographics spoke a new language about the natural world and narrative was played down for the benefit of data. Numbers could then be used to prove change beyond human subjective perception. The final dimension of *scale* and scalability made the environment a powerful concept that could link the local with the global. In addition to these dimensions, I argue that the role of digital media technologies was crucial for how we came to understand and change the environment over time.

The concept of the environment as it developed in the post-war era is a mediated object. The scaling, modelling and data-oriented understanding of the natural world that has developed over the last 80 years would be unthinkable without the parallel development of digitalization. Drawing media and environment together is therefore less of a stretch than it might first appear, as the former supplies the condition of the possibility for the latter as epistemic object. With inspiration from the foundations of critical media theory (Kittler, 1999), we may say that the process, storage and transmission of data is constitutive of the epistemic object of the environment.

The emergence of computational infrastructures, which grew out of military needs for surveillance and control in the Cold War, were thus integral to this new way of understanding the environment. Early computers like ENIAC – the Electronic Numerical Integrator and Computer – were first developed to calculate complex wartime ballistics tables between 1943 and 1945 and were then received by civil society as a revolutionary means to increase efficiency in engineering, modelling and predicting weather, and would also be part of revolutionizing the understanding of the environment. In 1946 the *New York Times* reported on the ENIAC along the following lines, 'one of the War's top secrets, an amazing machine which applies electronic speeds for the first time to mathematical tasks hitherto too difficult and cumbersome for solution, was announced here tonight by the War Department. Leaders who saw the device in action for the first time heralded it as a tool with which to begin to rebuild scientific affairs on new foundations' (Kennedy, 1946).

The year 1948, when Vogt's and Osborn's books on the threatened environment were published, was also the year of a conference in New York where, among others, Claude Shannon, Norbert Wiener and John von Neumann laid out the very conceptual foundations for the coming digital age (Rosol, 2022). Cybernetic ideas about communication and control would lead both to a computable world for which data processing became the condition of possibility, and lend itself to new ecological thinking. The title of Norbert Wiener's seminal 1948 book is telling in this regard, *Cybernetics: Or Control and Communication in the Animal and the Machine*. It offered the public the first attempt to understand self-regulating mechanisms understood as cybernetics. Claude Shannon, a student of Wiener's, offered a mathematical theory of information which reduces information to bits, thereby making the signals of any communication medium universally calculable. This new concept of information as data would become the technological foundation of digitalization. Mathematician John von Neumann, who was part of the same panel, had been working on a new integrated computer architecture since 1945, which supplied the hardware for digital computing, a design that is still the basis for most computers today.

These new computing capacities were quickly used for both civic and military strategic needs. As the Cold War developed with ever more need for surveillance and control, the 1960s saw a turn to outer space, which, by means of satellite mediation, would also become a turn back to the Earth as a planet. The images of the Blue Marble showed a vulnerable Earth which was now, for the first time, seen in its entirety. In the early 1970s, concerns about increasing pressures on the environment, which could now be monitored from the outside, peaked with the report from the Club of Rome on *The Limits to Growth* and the first UN Earth summit in Stockholm 1972. At the same time, the idea of *Spaceship Earth* gained currency and traction. This discursive figure expressed the threat to the planet and its limits to supporting life in the future while it also 'framed the planet in technoscientific terms and recreated the planet as a new hybrid entity' (Höhler, 2015). The mediated view of a global environment under increased pressure from human impacts was made visible by the very same technologies that facilitated population growth and impact. At the same time, hope that increased efficiency would lead to less impact has continuously been dashed in a phenomenon sometimes referred to as Jevon's paradox, which occurs when increased efficiency in resource use leads to increased consumption thereby nullifying the potential decrease in environmental impact.

Environmental mediation is thus nothing new, but rather follows a long historical trajectory of how we come to understand and act upon what we understand as the environment. In Rachel Carson's (1962: 22) words, there had been a shift from a world where man was 'moulded by the environment' to being able to 'alter the nature of his world'. In the 1960s, NASA recruited British scientist James Lovelock to the Jet Propulsion Laboratories in California to help build instruments that investigated the probability of life on Mars, whereupon he proposed that one need only look at the composition of the planet's atmosphere, which could be seen from Earth. In order to stay alive, any organism must consume materials, transform them chemically, and release waste products into their surroundings, a phenomenon known as entropy. If the atmosphere of Mars contained only carbon dioxide, it was a clear sign that the planet lacked life. The atmosphere of Earth, by contrast, contained a mix of highly reactive gases such as ozone, methane, carbon monoxide, nitrogen and sulphur actively maintained and regulated by life on the surface (the biosphere) and held in a state of constant chemical disequilibrium through biogeochemical cycling and feedback loops – creating a habitable planet for humans and other life forms – which subsequently also formed the basis for Lovelock's Gaia hypothesis (Lovelock, 1967). By looking at the atmosphere of another planet, scientists began to think differently about Earth's atmosphere in turn. From this combination of ideas (the atmosphere as an extension of the biosphere) and media technologies (infrared telescopes and satellites) came atmospheric analysis and biogeochemistry, which are now crucial for environmental epistemology about how the Earth system is changing.

From the vantage point of the 21st century, it is clear that the post-war period saw a rapid increase in pressures on the Earth system linked to the technological development that made possible a hitherto unimaginable level of wealth, which has been very unequally distributed. Originally published around 2004 and then updated in 2015, the graphs of what has been termed the *Great Acceleration* from 1950 to 2010 shows the rapid increase in 12 essential human activities and the impact on 12 aspects of the Earth system.[1] Population, real GDP, primary energy use, water use, fertilizer consumption, transportation and telecommunications have all been on a very steep upward curve in these now iconic graphs. In the Earth system part, mirroring steep curves can be observed in CO_2, surface temperature, ocean acidification, marine fish capture, domesticated land, tropical forest loss and terrestrial biosphere degradation.

The field of Earth system science emerged in earnest in the 1980s, in a Cold War context, with the rise of environmental and complex system sciences like cybernetics, building on the recognition that life exerts a strong influence on the Earth's chemical and physical environment. Through military patronage as funding for Earth sciences, geophysics experienced unprecedented growth. While monitoring and surveying the global environment had become a geopolitically strategic imperative, it also provided a lot of the information that would go into Earth system sciences. The older paradigm of direct observation gave way to 'field instrumentation, continuous and quantitative monitoring of multiple variables and numerical models' (Steffen et al., 2020: 54), that is, environmental mediation by means of digital computers. James Lovelock's Gaia hypothesis – the idea that life on Earth as a whole has a self-regulating mechanism that strives to maintain homeostatic and thus optimal conditions for life itself – was one of the more important epistemic precursors to this field. The key insight of Lovelock was the cybernetic notion of feedback and control between integrated systems which came from information theory and computing, which in turn would form the conditions of possibility for the emergence of the global environment as an epistemic object.

The environment as a mediated object

Environmental knowledge has thus long evolved in tandem with new media technologies. This has been true since early modern knowledge of the environment, which relied on the emergence of various print media, cartographic and pictorial techniques as well as new instruments for data gathering and processing, particularly in the marine environment. Since the post-war era however, and in parallel with the onset of the Great Acceleration and the proposed starting date of the Anthropocene, environmental knowledge has rapidly evolved through new approaches and techniques of modelling, computation and global networks of data collection (Stalder, 2022; Wickberg, 2022). This process of large-scale quantified knowledge production also entails that we have moved successively further from *in situ* observations of particular environmental phenomena to ever more mediated forms of knowledge that are also increasingly automated to such an extent that we may speak of a mediated planet, understood as an interconnected, increasingly detailed and continuously updated data-driven view of Earth and the life it supports. Gabrys (2015) calls this process the 'becoming environmental of computation' and points to how the multifaceted process of sensing environments is produced through exchanges of energy, materialities, relations and milieus. Computation here includes the distributed sensor networks as well as the media formations of hardware and software built on silicon, glass, minerals and plastic, server farms that make them run and landfills where the e-waste ends up, as well as the novel digital experiences this media infrastructure makes possible. This is not just the process of Earth as an environmental object of observation of study, which emerged already in the first globalizaton after 1500, but rather of novel ways of perceiving, understanding and experiencing environments contingent on data and largscale computation since the post-war era, which have intensified over the past decades.

The co-evolution of computation and environmental knowledge rests on the same military-industrial complex acting as a technological and scientific driving force of the Great Acceleration since the post-war era. The cybernetic revolution that was initiated around 1900 and took off in earnest due to military needs of observation and control in the Cold War, at the same time fed into advances in meteorology, climate science and subsequently Earth system science (Edwards, 2010). This development of a mediated planet is thus not only synchronous to but also co-evolved with the Great Acceleration and the entering of the planet into the new geological epoch of the Anthropocene (Steffen et al., 2015). It is even possible to argue that knowing the environment by computational means since the post-war era has been the primary driver of a twofold process that stands in deep tension. On the one hand the accumulating knowledge created from environmental data contributed to the emergence of a conception of the environment as something out there in need of our protection as we could see the harmful effects of human-made products. On the other hand, the same technology enabled the Great Acceleration of natural resource depletion and human impacts on the Earth system. The paradox of the Technosphere – a concept coined by geologist Haff (2014) to describe the sum of large-scale technological systems driving the impact – means that the same technologies and concepts that allow us to assess the planetary state through computed knowledge production in Earth system science have also been part of driving the global environmental change we are observing.

Agri-cultural techniques of environing

Agriculture has played a key role in the rise of humans to a dominant position among life on the planet since the Neolithic revolution. As the ice receded after the last glaciation and warmer and milder climate developed, while the megaherbivores started to die out and leave an open niche to humans, the conditions were right for domestication of plants and animals which were transformed to provide food and fibre. In this first phase of environing, farmers learnt to capture the sun's energy for their purposes, thus increasing food availability and allowing populations to grow. Several key phases can be distinguished, among which the most relevant here is the one taking place in the early modern era with new regulations of agriculture directed towards increasing productivity and ultimately profit by changing the use of land (Warde, 2009: 74). These changes did lead to a steady rise in food production that fed a growing world population, a key step in the creation of a human-dominated planet (Lewis and Maslin, 2018: 171).

The emergence of farming happened first in three places in Asia and South America, and then in other parts of Asia and America as well as in Africa, and finally in Europe, in at least 14 independent places (Larson et al., 2014). While this turn from hunter-gathering to farming in fact meant more and tedious work with worse nutritional conditions and more diseases (Diamond, 1997), it created a continuous feedback cycle of population growth by supplying more food. Among other things, the rise of agriculture delayed the next ice age by releasing carbon dioxide into the atmosphere from forested lands and savannas – which store carbon dioxide – to farmland, which releases it, while methane was added from domestication of animals. Comparing paleoclimatological data from the last eight interglacial periods, Ruddiman (2005) showed that the current interglacial is different in that, instead of steadily declining atmospheric carbon dioxide, the Holocene sees a reversal of this process to increase, which occurred around 7500 years ago, coinciding with the advent of agriculture. This essentially means that environing impacted the Earth system already, thousands of years ago, but the current trend is based on an exponential growth of subsistence and population which is now set to radically transform the state of the Earth system (Steffen et al., 2018).

In fact, agriculture itself contributed to create the long climate stability of the Holocene, which in turn has favoured the growth and dominance of the human population. From the dawn of agriculture until 1500, the human population grew from 5 million to 500 million. The relation between population growth and agriculture thus created a positive feedback loop that for long worked in favour of humans. In this sense, the emergence of cultural techniques such as writing, counting and painting were connected to the stability in the Earth system created by agriculture that allowed cultures to grow and empires to form and rule over distances, with control over land being the core concern.

Around 1500 human dwelling on Earth and its relation to the Earth system started to change with the emergence of global colonialism, inaugurated by the Spanish and Portuguese empires (Peters and Wickberg, 2022). This led to what Crosby (2003) called the Columbian exchange, a biological event of immense proportions as previously separate biota were mixed as farming and human diets were transformed. From then on, farmers had a much greater variety of crops and animals to choose from and they were often selected to adapt to environmental conditions. This led to the single largest improvement in farming since the agricultural revolution, which increased productivity and yield worldwide, thus creating a single global farming culture (Crosby, 2003). One of the many consequences of the colonial world system for agriculture and food was that new products – so-called drug foods – like sugar, tobacco, coffee, and tea were being produced in colonies and sold on European markets. The demand for these addictive products became an essential part in a new development in Europe. Where previously in the feudal system farmers and landowners had essentially practised subsistence agriculture with mutual, if uneven, obligations, the new products drove a trend towards increased work time for pay, that is, money, which could be used for purchase.

Around 1600 Europeans began to work more to be able to consume more in a gratifying cycle that is recognizable today (Lewis and Maslin, 2018). This also changed production in Europe towards markets instead of local needs on the land. The phenomenon has been called the 'industrious revolution', which essentially shifted a large part of populations away from subsistence agriculture towards market conditions which would apply in the later Industrial Revolution (De Vries, 2008). Thus, in combination with globalized trade based on slave labour and overseas agricultural production, a market-oriented economy changed the way life was oriented and agriculture practised worldwide. In addition, new landowning practices originated in England that shifted away from commoners to landlords, allowing tenants to farm their land for rent, which could be increased by competition between farmers, who in turn started to employ wage labourers to increase productivity. This, it can be argued, was the birth of the capitalist mode of living, among the privatized fields connected to a globalized trade build on colonialism and slave labour (Linklater, 2014). Mercantile capitalism and agricultural capitalism were thus intimately connected and would continue to reinforce each other over the early modern era. Wealth extraction did away with local and indigenous systems of land relations in favour of a market-driven productivity competition, which led to repeated famines.

In the early 20th century, Fritz Haber and Carl Bosch developed a way to fixate atmospheric nitrogen artificially and convert it to ammonia. Thereby, the Haber-Bosch process, as it is called, allowed for an incredibly effective fertilizer for agriculture which led to a rapid growth in productivity. This invention was originally meant for explosives, for which it was used during the Second World War, but would subsequently have a much larger impact in supplying food for the growing world population after the war. Today, the atmospheric nitrogen fixed for use as fertilizer amounts to 115 million tons yearly in the form of anhydrous ammonia, ammonium nitrate and urea. These fertilizers have quadrupled the productivity of agricultural land which has effectively supplied food to the growing human population, some estimates holding that four times as much land would have been necessary to produce the same amount of produce globally without nitrogen. Since most land suitable for agriculture is already in use, it is difficult to see how 7.5 billion people would otherwise have been fed. However, the use of this fertilizer is also in itself a major contributor global greenhouse gases and, by entering aquatic ecosystems, they cause eutrophication, that is, dead zones.

Artificial Intelligence and environmental data

Today, Artificial Intelligence (AI) is being developed as a means to compete commercially and geopolitically. While leading Big Tech companies rely on AI for their business models within a globalized digital economy, state-actors like China, the US, Russia and the European Union (EU) are addressing and investing in automation, algorithms, and machine learning as part of holding international power over data. So far, a large portion of AI debates has focused on the consequences of extracting and exploiting human behavioural data (Zuboff, 2019). A recent development in this context is the use of AI to gather and analyse environmental data. A key feature of AI is the ability to perceive and learn from their surroundings, that is, digital and physical environments. As such, it holds enormous potential for environmental applications at every scale and in every sector from science to business.

There is no generally accepted definition of AI, instead it tends to vary depending on context. Machines with traditionally biological capabilities like perception and cognition often feature in the various attempts to define AI. In simple terms, we may understand AI as machines that can perceive of their surroundings – that is, environments – and from this perception learn how to solve problems and reach goals. The European Commission high-level expert group on AI recently defined it along these lines:

> AI refers to systems designed by humans that, given a complex goal, act in the physical or digital world by perceiving their environment, interpreting the collected structured or unstructured data, reasoning on the knowledge derived from this data and deciding the best action(s) to take (according to predefined parameters) to achieve the given goal. (Samoili et al., 2018: 8).

A recent research review article on AI and sustainable development defined it as 'software technology with at least one of the following capabilities: perception, decision making, prediction, automatic knowledge extraction and pattern recognition from data, interactive communication and logical reasoning' (Vinuesa et al., 2020: 1). Like humans and non-human biological organisms, AI can be understood through their ability to learn and change behaviour to solve problems or improve desired outcomes, much like we think of evolution.

Many definitions have focused on technical capabilities, which has tended to obscure the way AI operates as a sociotechnical system, dependent on planetary and human resources at large scale for its existence. Kate Crawford, who focuses on equity and justice in AI, has recently proposed that AI is neither artificial nor intelligent (2021: 7). By this she means that the abstraction of a disembodied AI hides the huge human and environmental costs that go into running any such technological system. The hype of AI has even led to instances of *fauxtomation*, where the services of alleged AI systems in reality is carried out by below minimum-wage click workers of a global proletariat to create the appearance to customers of an efficient AI system which is not yet developed. In another project called 'Anatomy of an AI System', she demonstrated how the disembodied appearance of an AI system like the Amazon Echo, is an intentional part of the commercial attraction. which indeed does not reflect the costs in terms of human labour, unclean energy and rare mineral mining. The cultural co-evolution of humans, biological non-humans and machines since the post-war era is a highly interconnected process of environing media where AI – while originally developed in the 1960s – is now starting to be applied at scale throughout environmental sectors.

Precision agriculture – also known as smart farming – is shorthand for a reorganization of conventional farming's epistemological and professional foundations around datafication and algorithmic principles. It has been defined as the 'employment of computational and information technologies to improve the profitability and sustainability of agriculture' (Van Es et al., 2016: v).

Precision agriculture has been developed in various ways over the past 40 years, consisting in collecting data to increase productivity. Agricultural biology has been digitized and allowed for genetic engineering and manipulation of crops, while an array of digital technologies have been implemented in the practice of farming. Satellites and drones are connected to AI systems of machine-learning algorithms, which has led to most aspects of conventional agriculture now being computed. The declassification of the Global Positioning System (GPS) in the 1990s and the development of farm-specific Geographical Information Systems (GIS) were early phases of this development (Lowenberg-Deboer, 2015) that is now coming to a new stage. But as the promise of AI and big data has swept over sectors, so too has farming now become subject to a new wave of environing media – changing the way we grow and feed by computational means. Precision agriculture is now a dominant feature in farming worldwide and its discourses ties in with the development outlined above of agricultural efficiency and human population growth. Proponents of precision agriculture often describe it as revolutionary and disruptive, promising a third agricultural revolution following the first Neolithic and second fertilizer and technology in the 1960s. As the global population will grow to 10 billion people by 2050 food production must grow with 60% compare to current levels while reducing environmental impact, such as from nitrogen fertilizer use on the same amount of land. Precision agriculture, like many other sectors today, thus attaches disruptive and positive hope to sustainable futures by means of AI and digital technology (Miles, 2019). It is thus often maintained that farming is undergoing a digital revolution that will help set the world on path to sustainability. These imaginaries in themselves aptly capture the gist of environing media – mediated knowledge tells us of an environmental problem to which we respond by implementing technological changes while we monitor the effect to such an extent that we can no longer meaningfully maintain that the digital is separate from the organic. In this process, the oft quoted statement that 'data is the new oil' takes on a more material dimension, as we are no longer primarily talking about individual human data, but environmental data.

As precision agriculture is implemented and presented as a solution to environmental and social problems, there is also a risk that, like the preceding green revolution, it may leave the unequal global power relations that have grown since the 1500s intact, offering those in power new and more efficient ways to extract wealth while unforeseen ecological impacts may later be seen. Miles (2019: 8) maintains that 'precision agriculture is an intensification of conventional agriculture presented as a radical break. The realities of its use in many instances contradict this efficiency-generating, environment-sparing public image.' The way that precision agriculture is implemented lends even more depth to the notion of data colonialism, that has been proposed by Couldry and Mejia

(2019) to account for the colonial logic inherent to how platform capitalists operate. Data is being understood like a resource and likened to oil in the way that it fuels a vast machine of extractivism, and while the focus so far has been more on personal data, the shift towards environmental data could certainly reinforce and integrate a colonial logic that is already in place both in global food production and in data capitalism.

It should come as no surprise then, that Big Tech is now moving into the food sector by taking control over farming with precision agriculture. Amazon and Microsoft are joining big agribusiness companies like John Deere to offer farmers high-tech solutions based on big data collection and analytics (GRAIN, 2021). Microsoft has, for instance, built a digital farming platform called Azure FarmBeats based on their massive cloud computing infrastructure Azure. It offers farmers real-time data and analysis on the condition of soils, water, crop growth, pests and diseases as well as weather and climate change impacts. As the farmer is harvesting crops, Microsoft harvests big data about the process, data that is more valuable than the physical process from which it is collected as it feeds into AI systems of machine-learning algorithms. Microsoft then partners with companies that can act on the information that the data analytics produces, thereby creating a neo-feudal set up where food production and distribution become centralized as Big Tech is integrated with corporations supplying agricultural products like pesticides, tractors and drones. The aim of this business model, like in all platform or surveillance capitalism, is to get users, in this case farmers, to supply valuable data for free which can be used for profit in various ways, like selling products that may not necessarily be those the user actually needs. So far, high-quality data has mostly been available in the West – the US and Europe – where agriculture in Africa, for instance, has been harder to connect because of the lack of data. Bill Gates, Microsoft's founder, has long been investing in the promotion of agricultural technologies in Africa under the name of AGRA (Alliance for a Green Revolution in Africa), which has now formalized a partnership with Microsoft's Azure FarmBeats to expand and implement the platform across the African continent. There have been a rising number of protests against this development, with a call from African farmer organizations (Alliance for Food Sovereignty in Africa – AFSA) to end and defund AGRA by asking donor agencies like USAID to shift away from their CO_2 and chemical-intensive industrial agriculture model in Africa and instead fund self-sufficient agroecological farming that revitalizes soil and protects ecosystems. According to research from the Institute for Agriculture and Trade Policy (IATP), hunger increased by 30% in AGRA's focus areas since its foundation in 2006. With looming food security issues on the horizon, attempts to regulate the Big Tech agrobusiness model are sparse. An exception is the EU's Digital Market Act, which is expected to come in to force in spring 2023, but will affect only European farmers and not those in the Global South who may need it most. Together, the EU data regulation and increased demand from farmer associations such as AFSA could inspire new legal frameworks for the use of agricultural data in the Global South.

Conclusion

As we learn to see the environment as an object in continuous change that is now facing unprecedented pressure from human impacts, we need to develop new analytical tools and concepts to account for the ways humans transform the planet in the Anthropocene. Environing media is developed as concept to respond to this need. It underscores the processual and mediated nature of the environment, which is particularly salient as datafication and digitization penetrate ever more deeply the fabric of life. As environmental data grow larger, new avenues for implementation of AI systems are opening up that hold a double bind. On the one hand these new ways of impacting the environment through digital mediation promise efficiency to help build an environmentally and socially more sustainable future, as food security is promised by smart farming. But on the other hand, big data and AI systems are increasingly controlled by large corporations broadly labelled as Big Tech, and risk reinforcing current power relations and deepening the extractivist logic. The case of smart farming represents just one of the many sectors in which these conflicts around environing media and sustainable futures are currently playing out. Colonial and capitalist legacies underwrite the way AI systems are being implemented, while hopes of sustainability are looking bleak unless the dominant power relations are disrupted. In conclusion, I suggest that we need more theoretically informed empirical studies of how the planet entered into the Anthropocene and what the drivers of the Great Acceleration were. A starting point for such a research agenda is to focus on the role of environmental data from the post-war to the present and into the future. With a better understanding of the interplay between how we conceive of and change the environment through the deployment of various forms of cultural techniques and environing media, we may start to work towards such a research agenda, which would offer a historical understanding of the present state of the environment as a fundamentally mediated object, while also providing resources for a more nuanced and complex understanding of environmental futures in which digitalization and sustainability become increasingly intertwined from agriculture to oceans and climate control.

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ORCID iD

Adam Wickberg https://orcid.org/0000-0003-2616-5826

Note

1. The term *Great Acceleration* has become a standard reference in environmental studies to refer to this steep rise in energy use and human impact on the Earth system since the post-war era. It can be understood as sibling concept to the Anthropocene, which shows the pathways humans have embarked on that led to this era. While the Anthropocene is a geological epoch soon to be established as such, it has come to stand for the nexus between climate crisis, biodiversity crisis and environmental crisis, all of which are intimately connected to the Great Acceleration.

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Author biography

Adam Wickberg is a researcher in the History of media and environment and a visiting scholar at the Max Planck Institute for History of Science in Berlin where he belongs to the research group Anthropocene Formations (2020–2023). His research focuses on media and environment from the 16th to the 21st century. He currently works with the project *The Mediated Planet: Claiming Data for Environmental SDGs*, which explores the global environment as emerging through environmental data and asks how data gathering practices, data access and data ownership shape environmental perception and politics. In 2022 he co-edited the volume *Environing Media* (Routledge), which interrogates the role of media technologies in the formation of environments, understood both as physical spaces and as epistemological constructs about them. Using the concept of 'environing media', the book advances a deeper understanding of how media processes – defined here as the storage, process, and transmission of data – influence human-Earth relations. He has also published widely in journals like *Critical Inquiry, Media Theory, Necsus: European Journal of Journal of Media Studies, Global Environmental Politics, Humanities, and Resilience: A Journal of the Environmental Humanities*. In 2018 he published a monograph book with Open Humanities Press called *Pellucid Paper: Poetry and Bureaucratic Media in Early Modern Spain*. His research focuses on environmental data, digitalization and sustainability, and the history of the Anthropocene.