Storing Data, Infrastructuring the Air: Thermocultures of the Cloud

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I am sitting in a bus with participants of the Cloud and Data Center Days Conference at Luleå Technical University (LTU), Sweden's northernmost highschool. We are on our way to the nearby city of Boden, for a guided tour at one of the Hydro 66 data center construction sites. 'Welcome to the server paradise', the Hydro66 website reads, referring to the free cooling offered at the company's data centers located in Northern Sweden. The bus takes us through large forest areas interspersed with clearings were electricity poles and thick cables can be seen. We are joined by a representative of Boden municipality who guides our group of IT and data center experts. He tells us that as an industrial town – a military stronghold, which houses one of the largest garrisons of the Swedish army – Boden has experienced a decline in its population and labor market as a result of the demilitarization that followed the Cold War. In his view, to bring the data center industry to Boden makes for a perfect opportunity to fill empty industrial buildings and military bases with data. Cool climate, cheap hydro energy, strong infrastructures, geopolitical security, and an abundance of free space for business expansion are among the advantages listed by the guide and offered by the municipality to this new industry. 'Boden is the most boring place in the world for people', he admits, 'but the best place in the world for servers' (Field notes, 2014).

Over the last decade, the growing need for data storage and server cooling has prompted the migration of global cloud infrastructure to cool climate regions, Sweden among them. This has triggered expectations of a new industrial era in these geographically remote and demographically weak regions. Regional representatives hope to turn peripheral places into commando posts of digital capitalism, promising new opportunities for work, economic wealth, and regional prosperity (Vonderau, 2017, 2018; Hogan, 2015). Politicians, state authorities, business developers and other local actors all are eager to grasp the opportunity of turning a 'hot' profit from the cold climate which is now an emerging natural resource. One of these actors is the Swedish Business Agency which offers a portfolio of services and potential data center sites for sale around the country, under the slogan 'Data Centers by Sweden. Hot Spots in a Cool Place' (Business Sweden).

Reports about the data center industry's impact, often commissioned by IT companies, tend to take a global perspective and to emphasize expected growth in technological efficiency, environmental sustainability, and smart innovations (Clipp et. al., 2014). Studies such as Greenpeace's 'Clicking Clean' report deliver a critical view on global IT infrastructures (Cook, 2017). However, qualitative, reflexive, and longitudinal studies of the data center industries' local social and environmental impact remain rare (Johnson in this issue). Obvious is, however, that looking from the cloud's infrastructural sites, the discovery of 'cold air' as a new natural resource not only opens novel possibilities for making profits. It also triggers a transformation of complex relationships between local communities, industries, and natural environments. Those transformations are not only expressed in economic statistics, but also in the daily work of infrastructuring and are perceived as an atmospheric and bodily experience by the involved actors.

In this essay I reflect on how the social sciences contribute to the production of locally embedded knowledge about data centers. What can anthropology us tell about these new industrial sites that emerge in the midst of the seemingly just empty nordic landscapes? How are these automated and anonymous spaces – mere dots in the world's digital infrastructures – related to their localities? In what sense are data centers 'local' while being owned by global IT companies? Can data centers be regarded as emerging from specific social contexts and natural landscapes even if they are built from imported materials? And in what ways are they open and accessible to (or closed off from) social research?[1]

I argue that in order to understand the sociocultural embeddedness of IT industries and infrastructures and their environmental consequences, situated attention to specific industrial sites is needed (Howe et. al., 2016: 552). In what follows, I focus on the case of the data center industry's implementation in the Northern Swedish region of Norrbotten in order to show how natural and social environments are entangled with the global cloud through processes of infrastructuring, that is: by manipulating, and regulating air and data flows. Such a perspective is attentive to socio-technological intimacies and frictions characteristic for the 'thermocultures' of the cloud – that is, attentive to the ways and modes through which materiality, movement, and temporalities of data are entangled with both specific localities and the border-crossing economic zones of digital capitalism (Starosielski, 2016). Introducing the notion of *thermocultures*,

Nicole Starosielski redirects attention of media geological analysis from the histories of earth materials to the practices of temperature manipulation which form the conditions under which these geological materials are actualized as mediating forms (2016). In a similar vein, I highlight another (anthropological) aspect of the cloud's thermocultures, by directing my analytic attention from IT infrastructures to the historically and culturally embedded practices and strategies of infrastructuring Nordic air, that is: to the branding, packaging, measuring, and extracting of its 'hot' effects, as they are performed by diverse communities of actors. Such infrastructuring practices shape the conditions necessary for activating and normalizing data centers as both inherent parts of local industrial and natural landscapes and as hubs within the global data economy.

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Sweden's Norrbotten region reaches up to the polar circle and covers one quarter of the country's territory. Less than three percent of all Swedes, however, inhabit this county. When it comes to the region's industrial history, Norrbotten can be said to be filled with 'ruins of infrastructural promises' (Appel et. al., 2018). As a scarcely populated and resource-rich region, historically inhabited by native Sami people, the region was for a long time regarded as a 'no man's land', connected to Sweden's political centers and its territories via the infrastructures of industrial production chains (Sörlin, 2018). Norrbotten's natural resources such as iron ore, timber, minerals, wood and hydro power were of major importance for Sweden's modernization and industrialization in the 19th and 20th centuries. Due to the harsh climate, peripheral geographic position, and the lack of employment alternatives, a majority of Norrbotten's inhabitants depended on steel, mining, and other process industries. Industrialization not only led to modern lifestyles and jobs but also disappointed some aspirations for a better life and prosperity. Construction of dams for hydro power stations, for instance, destroyed native life worlds. Nature changed due to resource extraction (Öhman, 2015). During the oil crisis of the 1970s, and following other periods of industrial decline, many of Norrbotten's residents lost their jobs and were forced to leave the county. One of the most tragic and recent example for this complicated relation between Norrbotten's local communities and industries was the relocation of the town of Kiruna, which was gradually swallowed by a giant sinkhole related to the worlds' biggest iron ore mine located just underneath the city – forcing citizens to leave their homes.

Over the past years, data centers have been erected around the region by Facebook, Bitcoin, Fortlax, and other IT companies and infrastructure providers. National and regional authorities are aiming to attract more server farms, in response to what they see as the upcoming wind of industrial change and regional development. The Swedish Government offers data centers a tax rate reduced by 97 percent for electricity use, local authorities rush to integrate the new industry into regional development programs, and visions of these 'factories' bringing new jobs to the region, and increasing diversity, are spread across local and national media (Vonderau, 2017, 2018).

However, comparatively, the new industry's product – data – is not graspable in material terms, and is difficult to locate. So are its local impacts. Seen from a specific data center site, the cloud and its server farms appear 'visibly invisible' (Barry, 2006: 248). Luleå, Norrbotten's capital, hosts one of the world's biggest data centers, owned by Facebook. Gigantic server halls, connected to massive electricity grids, are surrounded by huge construction sites and security arrangements. It is not possible to peak inside any of the giant shoe box-like buildings; there is no sound, smoke or other sign of industrial activity. From a legal perspective, one even might question if Facebook is present at all in Luleå, despite its infrastructure dominating the city (Meyer in this issue). Facebook's European headquarters are located in Ireland, and the data center is registered under the name of a subsidiary, Pinnacle Sweden AB. While certainly visible as a global and powerful IT infrastructure from a bird's perspective, the cloud dissolves and disappears when seen from ground. So how can the cloud's local embeddedness be grasped? What are we expecting in terms of presence? And under what thermocultural conditions is the clouds local presence activated?

These and similar questions become relevant for my research which ethnographically traces the implementation of the data center industry in the Norrbotten region. While my initial intention was to follow the process and to observe what happens when 'the cloud hits the ground' as my interlocutors put it, during the course of my study I began to ask myself if this was an adequate way of conceptualizing this research project. Since getting a permission for research within Facebook's or any other industrial size data center proved to be impossible, long-term observation of decision-making and construction processes inside the data center were not feasible. Instead, I came to follow the steps taken by institutions and experts, including ecologists, city planners, engineers, and

politicians, as they discussed and arranged local infrastructural and political conditions, and tried to harmonize the cloud's infrastructural needs with local climate and other biological systems such as groundwater flows and bird population. As Andrew Barry and others have noted, we tend to think of infrastructures as technologies located on a stable ground – the earth. But the earth is neither static nor stable; it forms an integral part of infrastructures and is itself in need of infrastructuring (Barry, 2016; Maguire & Winthereik, 2017: 168). Accordingly, my methodological approach may be described as a study of the infrastructuring of air and climate, or thermoculture (Ruiz, 2018).

In reference to Brian Larkin's definition of infrastructure, the cloud – and data centers as its infrastructural core – may be defined as '*matter* that enables the movement of other *matter*' (Larkin, 2013: 329, emphasis by author). The cloud represents a socio-technical assemblage consisting of industrial sites, technologies, as well as variously located state institutions, private companies, and human actors, which taken together enable the flow of data. However, the functionality of the cloud also essentially depends on flows of air which are needed for server cooling. Air, comparable to data, is an ephemeral matter, entangled with human bodies, technological and biological systems, and transcending territorial borders; it is a major reason for cloud infrastructure to migrate northwards. The air connects virtual data flows to technological materialities by which such flows are enabled, and also links locales at the peripheries of the world to the global zones of IT economy.

During my research I observed how various expert groups attempted to arrange, stabilize, and govern Norrbotten's air in relation to the new industry's needs, by means of scientific experiments, documentation, measurement, or branding. As my interlocutors kept telling me, a broad variety of new measurement devices had to be developed for that purpose. The Head of the Swedish Data Center Initiative lamented: 'You can't imagine what calculations we are required to deliver. Wind statistics! Who needs wind statistics?' (Interview, 2016).

Among the communities of practice involved in such infrastructuring process were data scientists at Luleå Technical University who were building so-called 'intelligent agents' – small air conditioning fans – with Lego bricks, programming these fans to optimize air flow manipulation inside data centers. The county's ecologists, meanwhile, were busy measuring temperatures and observing local air and water flows, in an attempt to estimate how the waste heat emanating from server

farms might affect the surroundings. Regional and national business developers, in turn, did their best branding Norrbotten's air as 'nordic climate': a local product that could be monetized and sold to data infrastructure providers, and which also could be used for political purposes such as the promotion of Sweden as a hub of IT competence and sustainable cooling technologies. 'In Sweden, we have a climate for innovation', the official slogan used by the Swedish Business Agency stated, conveying 'the hotness' of cool (Volvo Cars: Journey to the NodePole).

[EMBED VIDEO Volvo Cars: Journey to the Node Pole https://www.youtube.com/watch?v=YwqtBJMZJIU]

Such infrastructurings of air and its entanglements with data flows and technologies of the cloud proved to be innovative insofar as they were ontologically transformative and 'pressing into the flesh' (Appel et.al., 2018), that is, generating new subjectivities, technosocial intimacies, and constellations of the world. As the local ecologists admitted, data centers' waste heat warms up the near surroundings, raising the average outside temperature two to four degrees celsius, which will most likely change the surrounding flora and fauna. The large and inaccessible data center sites reorganize urban landscapes and the movements of locals. In the case of Luleå, Facebook's site came to span an area comparable to twelve soccer fields, separating the city's residents from its recreational area, a natural bird reserve. To the disappointment of municipal planners, the IT giant did not keep its promise to leave the territory fenceless so that residents would have been able to walk across the area and inbetween the server farm buildings to enter the reserve. The planners feared, that such separation of the city from its recreational area would negatively change the quality of life and urban atmosphere. However, in the same time many of my interlocutors related the 'new climate' to expectations regarding new lifestyles and corporalities. They envisioned that the international experts, regularly working at or visiting the data centers industrial sites, would bring cultural and social diversity and change what was described to me as a traditionally proletarian, male-dominated local mentality. Especially my male interlocutors repeatedly admitted expecting the new industry to bring new work opportunities for men, who are not interested in working at mines, steel mills or other traditional industries, and motivate young people to stay in the region.

The implementation of cloud infrastructure at a local site thus is not only a calculatory, but also atmospheric and bodily process.

It is not merely based on human intentions or technological procedures, but unfolds through the flows of air as infrastructural matter among human and non-human actors that respond to each other. Such emergent relations between the cloud as well as local ecologies and communities of actors demonstrate the 'response-ability' of technological and biological systems to each others needs (Maguire & Winthereik, 2017: 163).

While seemingly smooth and unproblematic, the implementation of data centers in Norrbotten nevertheless appears as a complicated and friction-loaded process, if one takes its temporal and historical dimensions into account. IT companies, regional politicians, and business developers claim the new industry to be different – 'clean' and environmentally friendly – as compared to the 'old' factories that remain from the 'dirty' times of steel, mining, and other traditional industries. However, server farms do not originate in empty space; they build on already existing industrial and thermocultural relations and are dependent on established infrastructures, most importantly Norrbotten's extremely stable and redundant electricity grid which was originally designed for those 'old' industries. Norrbotten's human and non-human actors have historically been linked to these infrastructures and industries through air. Luleå's most popular living area, called Svartö (black island), for instance, sits next to Sweden's biggest steel mill, making it inevitable for citizens to inhale its smoke. The steel mill is keeping their bodies warm throughout the arctic winter, since its waste heat is used for local district heating. Residents are aware of this industrial-infrastructural intimacy and dependency, and have experienced it as an inherent part of their lifeworlds for generations.

Accordingly, for many of the engineers and environmental experts I spoke with, it was obvious that historically and culturally embedded local thermoculture ties various technological and biological systems together with infrastructural layers and temporal frames that cannot be easily separated. Experts admitted, for instance, that locating Facebook's enormous data center in the city of Luleå required to cut huge numbers of trees, and that the sound pollution through regularly tested diesel generators would impact the nearby birds populations' and even students dormitories lives. Still, these same experts were reluctant towards my inquiries if the data center would negatively impact local 'nature'. As Luleå's municipal ecologist explained to me: 'Many visitors from continental Europe travel to the North imagining that they would find clean air and pure nature. But in reality, much of

that 'pure nature' actually is an industrial landscape, such as the endless forests which have been planted for the paper industry' (Interview, 2015). Building a data center for him thus merely meant adding a new infrastructural layer to an already existing infrastructural landscape and mixing new flows of industrial air in the already existing ones.

IT companies such as Facebook or Hydro 66, however, are not particularly eager to recognize their dependency on 'old' infrastructures, as they aim to highlight the image of a new and different industry which shapes a new climate of innovation. They refuse to locate their server farms in proximity to steel plants or paper factories, fearing harmful particles in the air. Instead, they choose the cleanest places as infrastructural sites, including the EU-protected nature reserve described above were Facebook has located its server halls. Facebook's infrastructural entanglement with exceptionally clean air thus is not only important for the servers, but also for the cloud's and the company's image. Hydro 66, for instance, claims to clean its customer's cloud by means of free cooling, reducing the carbon footprint for data storage to zero and freeing its customers from the environmentalist's gaze. As Ruiz notes, in a world apparently filled with pollutants, environmental degradation and other forms of crisis, the percepted purity of the arctic air and water is a sought-after commodity (2018: 184). In a similar vein, the fact that environmental authorities allowed Facebook to locate its industry next to a protected nature area in Luleå contributed to the image of the company's cloud as being as 'pure as nature', or as actually *being* nature (Levenda & Mahmoudi; Johnson in this issue).

For Sweden's state authorities, this was further proof of the fact that the new 'climate of innovation' is really clean and marks the beginning of a new non-extractive industrial era. Following the infrastructuring of air thus makes historical thermocultural dependencies and intimacies visible, and points to the temporal frames local communities relate to for understanding themselves. Such a perspective also allows to investigate cloud infrastructures as more than human-technology assemblages, as it shows how they are sunk into nature and are normalized as a second nature and an inherent part of peoples lifeworlds. Yet the local normalization of cloud infrastructure should not be understood as evidence for corporate marketing and its claims regarding a new and clean post-extractive industry. As Luleå's ecologist admitted, 'it is pure luck that the city's server farms have not negatively affected the nearby natural reserve, and that their construction was approved by the authorities'. The air and ground water flows in the data center and the natural reserve

territories happened to not cross each other, otherwise the data centers environmental impact would have been much more problematic. In other words, biological systems here responded in favor of a technological system, 'but it was nature's and not the new industry's merit', as the municipal ecologist admitted, and thus by no means proof that cloud infrastructures and data center industries are in principle environmentally friendly and harmless, as business people and politicians claim.

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Paying situated attention to the data center industry's implementation in Norrbotten and the subsequent manipulation of air as a vibrant infrastructural matter, I have demonstrated how the global cloud is shaped by local thermocultures – that is culturally embedded practices of infrastructuring the air – and how it effects social and natural environments, integrating them into border-crossing IT-economic zones. The infrastructuring of global data and local air flows in relation to each other here appears not merely as a technological but as a bodily, atmospheric, site-specific, and historically entangled process which shapes the conditions under which the cloud is activated. By way of concluding I would like to reflect on power-loaded tensions as an inherent dimension of the cloud's thermocultures.

At first glance, bringing the data center industry to Norrbotten seems to be a smooth and conflict-free process. Based on renewable hydro energy and air cooling, Norrbotten's cloud infrastructure represents the state of the art in environmentally friendly IT technologies. The tech industry is excited about the prospects of growth implied by the infinity of cold air. Local authorities expect this climate of innovation to solve regional demographic problems. Norrbotten's citizens, in turn, are used to technological intimacy and do not care too much which industry's air they inhale. So does this mean that Norrbotten's data centers are just technological and neutral? And is the new 'climate of innovation' good and harmless? Or could it also be problematic, or even violent?

Infrastructure studies tend to focus on 'infrastructural inversions', as Geoffrey Bowker calls those rare moments when infrastructures become visible for a broader public of non-experts and an object of critical debate (1994). These studies understand inversions in terms of breakdowns and open conflict. Thinking of Norrbotten, however, I would rather agree with Hannah Knox that moments of infrastructural rupture and violence 'do not have to simply be restricted to those times

when infrastructures fail but might equally be a response to when they succeed particularly well' (Nox, 2017: 377). The focus on breakdowns comes at the expense of overlooking infrastructural normality, the state when IT or other infrastructures become unremarkable and ubiquitous, just like air or nature. Such as in Luleå, where the presence of cold air and energy hungry mega server farms seems to be self-evident and even necessary, despite the fact that only a few years ago, it would have been deemed absurd to host technologies for the storage of 'holiday photographs' that consume more energy than Sweden's biggest steel plant. To phrase it like a data center industry manual for energy efficiency best practice, one shouldn't forget that even in case of perfectly functioning cloud infrastructures: 'The sole purpose of the cooling system is to provide a suitable environment for the equipment, and is not intended for human comfort' (DatacenterDynamics, 2015).

Thus, it seems not only important to ask how and by which means the cloud's infrastructural normalcy and 'invisible visibility' is produced and maintained, but also to analyze that maintenance as a governmental act. It should be the social science's concern to be attentive to the forms of 'slow (or light) violence' that data centers might exercise. Whose sustainability and whose economic effectivity does the new climate of innovation stand for?

Coming back to data centers in Norrbotten, one should admit that so far, the 'nordic climate' mainly serves the profit-orientation of IT companies and their customers in different parts of the world. Only a few of its effects are actually local, such as some minimal employment possibilities, waste heat, and huge water consumption. It therefore would be important to ask if the infrastructural normality and sustainability of the cloud indeed amounts to a 'sustainability of peripheries'. Understanding the thermocultures of the cloud thus includes an analysis of power relations that come into being when local interests and aspirations meet technological logics and economic rationalities.

Note

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