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RESEARCH ARTICLE

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Smart(en)ing the Arctic city? The cases of Kiruna and Malmberget in Sweden

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ABSTRACT

In this article, we problematize the implementation of smart urban experiments in the resource-rich, Arctic periphery. Our case study is the so-called Norrbotten Technological Megasystem in Sweden, with a specific focus on the mining towns of Malmberget/Gällivare and Kiruna. Kiruna in particular is a well know case study as its urban centre is being relocated due to subsidence caused by underground mining. The new town centre is being developed as a testbed for smart urbanism. We argue that if we look at the nexus between resource extraction and urbanization in Kiruna and Malmberget, we find smart city thinking more aligned to the bottom line of the resource extraction industry rather than being an innovative project to make economic development compatible with broader climate and societal challenges. Methodologically, we use historic analysis and assemblage thinking to look at the territorialization and de-territorialization of resource-extraction in Norrbotten over the last 100 years.

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1. Introduction

Smart and sustainable urban development is the latest mantra of city makers (i.e. planners, mayors, consultants, business, etc.) and academic thinkers (Inkinen, Yigitcanlar, and Wilson 2019). This applies not only to the growing global cities that are at the intersection of the international trade, but also to middle and small size towns located in the global periphery. Within this latter group of towns we can also find settlements that are intertwined to resource extraction activities and that, as a consequence, have a strategic and fundamental role in providing the global market and global cities with critical raw materials (e.g. copper, cobalt, iron, etc.) that are necessary for the green transition. The case of resource extraction regions is quite interesting because while at the global and national levels there is the demand to decarbonize the economy and deliver the sustainable development goals agreed with the 'international community' (see the Paris Agreement in 2016, the Sustainable Development Goals, etc.), in these towns there is a long tradition of carbon-intensive, resource-dependent development. We use this

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background as the point of departure to argue that the so-called extractive periphery is a good case study to show the inconsistencies of the smart and sustainable urban rhetoric that is so popular in the global capitals and economic centres of the world.

Inspired by post-colonial urban scholarship in the global south, some of us have studied the enmeshing of extraction drivers with urban ones in context as different as Malaysia, Qatar and India (Rizzo 2020; 2021a). This has led us to theorize a resource-predatory form of urbanism that isn't peculiar to global south polities alone but it characterizes resource urbanism worldwide. Arboleda's (2020) studies in Chile and those of Correa (2016) in Brazil show how mining towns are an integral part of extraction operations that are affected by cycle of technological obsolescence (abandonment and shrinking) similar to other mining fixed capital (e.g. machinery, dams, etc.). Although there is ample literature that criticizes smart cities from several angles – corporate story-telling (Svensson and Wetterberg 2014; Cugurullo 2018); one size fits all (Kitchin 2014; Watson 2019); political legitimization (Söderström, Paasche, and Klauser 2014); post- and neo-colonialism (Vanolo 2014; Bedford et al. 2021) – our point of departure in this article is the nexus between resources and urbanization. Our study aims to illuminate the symbiotic, socio-technical interrelationships between resource-extraction and urban infrastructures over time (Rizzo 2019 and 2021b). In this paper, we are interested in the contradictions that this nexus produces when compared to the sustainability and smart rhetoric deployed by decision-makers.

There are several examples in which such a strategy of inquiry has brought interesting results. In Kaika's (2005) investigation of the relationship between water infrastructure policy and urbanization in Greece and England, water is operationalized as a manufactured resource, rather than a natural element, that cannot be separated by human intervention. This standpoint is particularly useful because it allows a better focus on the role that the infrastructures supporting the commodification of natural resources have played in the making of our resource towns. In the town of Kiruna, one of our two examples, the newly built town centre is rendered as a smart urban infrastructure for a town that aspires to have the same qualities as those of Stockholm but, at the same time, concealing the (literally) underlying extraction process. Similar is the case of the nearby town of Gällivare, another example covered in this article, that brands itself as a world-class arctic small town. Kaika (2005, 33) argues that this fetishization of urban infrastructures aims at ' … being carriers of the modernist promise of participating in the phantasmagoric new world of technological advancement and progress; a world in which human freedom and emancipation resides in connecting to technology'.

Our research question is: is the idea of smart cities more compatible with business-as-usual, resource extraction or to sustainable local development? We deploy historic analysis and assemblage theory (see section 2) to study the territorialization and de-territorialization of resource extraction. In section 3 we chronologically analyse the territorialization and de-territorialization of resource extraction in the Norrbotten's Technological Megasystem mainly by focusing on Kiruna and the neighbourhood of Malmberget in Gällivare municipality. This latter section will be discussed also in light of the role that urban models have had for the development of towns in Norrbotten, societal trends, and the commodity boom of the early 2000s. In section 4, we zoom into the Kiruna Sustainability Center to problematize the straightforward application of smart city planning into a context so charged with institutional disagreements

about the responsibilities and future of the town. In the conclusions, section 5, we discuss and summarize the findings, highlighting the deficiencies of the smart city discourse to address the socio-environmental issues caused by resource-extraction.

2. Methodology and case study

In this article, our case study is the so-called Norrbotten Technological Megasystem (NTM) (Hansson, 1998), a transnational infrastructure corridor stretching from the North Sea to the Baltic coast for 400 km (Figure 1). The corridor has been developed since the late nineteenth century to exploit the rich mineral resources of the region (initially iron-ore). The Megasystem schematically comprises the iron ore mines and the mining towns of Kiruna (Kiruna Municipality) and Malmberget (Gällivare Municipality), the railway connecting the mines with the shipping harbours of Luleå (Luleå Municipality), Sweden and Narvik, Norway as well as the hydro powerplant in Porjus (Jokkmokk Municipality), which was built to electrify the railway, and the fortress system in Boden (Boden Municipality) – this latter built to protect this industrial complex from foreign threats (mainly Russia). Malmberget and in particular Kiruna are well known in literature as their urban centres are going to be relocated due to subsidence caused by underground mining (Sjöholm 2016; Rizzo and Sordi 2020; Morata et al. 2020).

Methodologically, we analyse the evolution of the NTM by using an historic analysis of the milestones of this territorial corridor. In this analysis, we are interested in highlighting the evolutionary trajectory of the NTM. In particular, we want to differentiate between those positive feedbacks that strengthen the coherence of the NTM from the

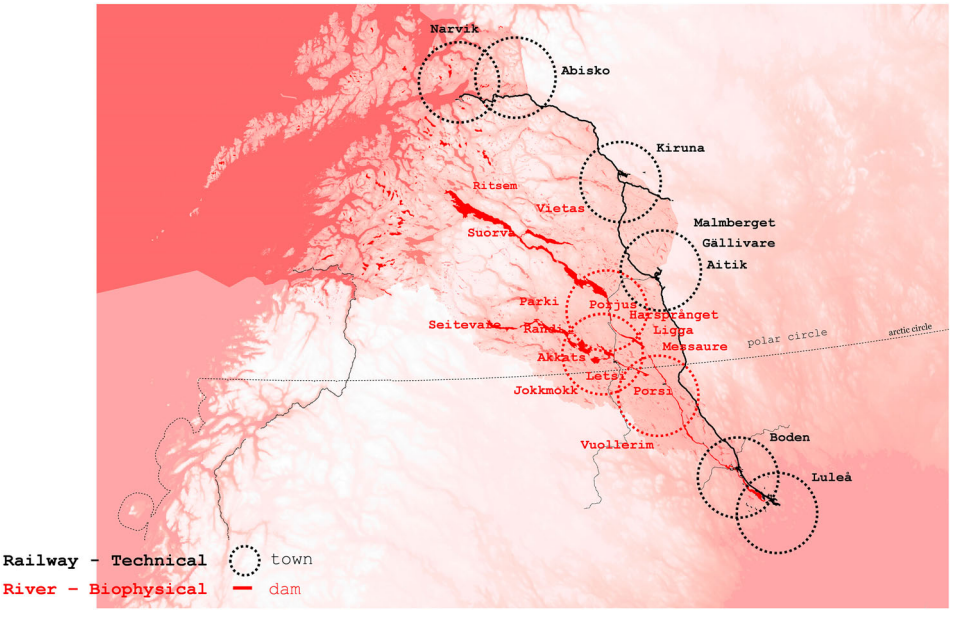

Figure 1. The Norrbotten Technological Megasystem (NTM). Water-energy system along the Lule river and railway Luleå to Narvik (Illustration: B. Morata).

negative feedbacks whereby parts of the NTM are questioned or enter into crisis. To do so, we supplement our historic method with assemblage theory as developed by Manuel DeLanda (2019) who built upon the original writings by Deluze and Guattari. Assemblage theory focuses on the processes of emergence and becoming of complex systems such as cities and regions (McFarlane 2011; Kamalipour and Peimani 2015; Nail 2017). In its interpretation of assemblage thinking, Manuel (2019), suggests understanding complex systems as made of a 'relationship of exteriorities', meaning that an assemblage is made of well-defined parts that are somewhat independent from the entire system and functioning regardless. For example, in our case study, mining sites, towns and logistics function as interacting, independent systems. When the single parts of such an assemblage lose their contours, for example when the existence of a city neighbourhood is questioned in the name of extraction, or when a railway section is de-commissioned or re-organized for efficiency considerations, then the assemblage is de-territorialized. Territorialization works instead to sharpen the contours of the semi-autonomous parts of the assemblage and to make them stronger. An example of territorialization could be public or private investments that confirm the underlying economic model of resource extraction towns.

Moreover, and by paraphrasing McFarlane (2011) words, 'assemblage thinking is attentive to both the [agency of the] individual elements and [that of the] whole', where both can evolve in relation to one another over time. Assemblage analysis is descriptive (it asks the how question Nail 2017) and it focuses on processes of becoming (it asks questions about futures and for whom). We think that this perspective is compatible with our historic method, and we will reflect on this in the discussion.

However, the assemblage conceived in such a way is not, at least in our view, an a-political construction that is disconnected from the rest. Assemblages are affected by external events – what De Landa calls 'converters' – that can put in jeopardy the entire purpose of their action. For example, in their analysis of the Norwegian 'carbonscape', Haarstad and Wanvik (2017) identified the discourse on climate change and the environmental movement in Norway as a threat to the oil-assembled landscape. In our paper, we refuse to have a dogmatic understanding of assemblage as a sort of 'telescope' to study urbanization and resources from afar. We are well aware that a strict application of such an ontology, the assemblage ontology, may squeeze away the more political objectives of critical urban studies, i.e. to reveal the political structures and actors that exploit people and the environment for the purpose of capital accumulation. This is why we agree with Brenner et al. (2011) in that assemblage should be used as a method, rather than as an ontological theory, to study the 'emergent' possibilities of a complex, socio-technical organization such as a city.

Our data and observations were collected in a number of research projects developed by us and members of our research group over the past 10 years or so. In the Kiruna Sustainability Center project, we conducted a number of interviews with planners at the Kiruna City Council (Öberg and Ebrahimabadi 2020). In a commissioned project for the Swedish Transport Agency, the group mapped the discourse between national, municipal and company (LKAB) for the relocation of train station in Kiruna (this latter affected by mining operations too; Ebrahimabadi et al. 2018; Öberg and Ebrahimabadi 2013). In other projects, the team collected a number of interviews and observations also with citizens along the NTM (mainly in Gällivare, Kiruna) to understand what

makes attractive (and by converse what it does not) living in resource rich municipalities (Hidman 2018). In other smaller studies located in Kiruna, we studied the evolution of the built environment with a specific focus on built heritage (Sjöholm 2016; Luciani and Sjöholm 2019; Littke 2019).

3. Analysing the territorialization and de-Territorialization of iron-ore extraction in Kiruna and Malmberget

The Arctic and sub-Arctic regions have been shaped through several waves of transformations that contributed to the current variegated geographic and demographic patterns of co-existing multiplicities (Rizzo and Sordi 2020). An important climatic characteristic of the European Arctic is created by the effect of the Gulf Stream; as the result of it the North Sea, unlike the rest of the Arctic Ocean, is free from ice all around the year. This condition challenges the North (cold) – South (warm) stereotype in favour of an East–West direction, with harsher colder conditions towards Eastern Russia and Canada. Development is linked to climate and also to resource extraction activities; fishery, minerals, oil, gas, forestry and others. For that, the role of the states has been crucial, offering incentives and rewards to settle, investing in fixed infrastructures (towns) and even using coercion.

The colonization of the Scandinavian arctic region dates to the late Middle Ages and Early Modern period. The states have played a major role in it by, first, introducing tax incentives and free land for colonizers; secondly, in the nineteenth and twentieth centuries, with the successful implementation of extractive industrial complexes (of forestry, mining, maritime industries, etc.) – large companies were formed to contribute to national treasuries at the expense of its indigenous communities (Sjöholm and Nilsson 2019). The low population densities in the Scandinavian Arctic meant that nation states would focus more on surveying natural resources rather than its people: extensively mapping and inventorying of resources has been driving extraction activities.

Moving into our case study, according to Hansson (1998) the NTM emerged between the end of the 19th and the early twentieth century by the following core sites (Figure 1). The sites are connected by the Malmbanan railway (iron-ore line) but the Lule river plays a role as important as the railway. It is a source of energy thanks to a number of hydropower installations that have been built since the Porjus dam during the twentieth century. The river and the railway form a sort of 'double infrastructural corridor' that characterize the NTM (see section 3).

The territorialization and urbanization of the Swedish North (Table 1) should be interpreted within the larger and longer process of appropriation and exploitation of local natural resources that has characterized this area for centuries (Sjöholm and Nilsson 2019; Rizzo and Sordi 2020; Morata et al. 2020). Large-scale mining began towards the end of the nineteenth century in this, at the time, remote and sparsely populated area. Three prerequisites would make mining profitable (Hansson, 1998). Firstly, new technology such as the development of the Bessemer- and the Gilchrist-Thomas processes made it possible to efficiently refine the iron ore. Secondly, the railway connecting the iron ore mines with the ore shipping harbours were essential to transport the heavy cargo. Thirdly, the establishment of towns to house the workers of the largescale industries, operating year-round.

Table 1. Assemblage analysis of the NTM.

Time	Territorialization/Re-Territorialization	De-Territorialization	Society/Economy forces
1888–1940	• Railway infrastructure connecting mining towns with shipping harbours. • Establishment of the mining towns of Malmberget and Kiruna. • Company town model and hierarchization of the built environment.	• Shanty towns were demolished	• Positive view of industrialization as a factor to organize society (Creation of new jobs and opportunities). • Investment of national and international capitals • New industrial processes & technologies help starting up large-scale iron ore industry.
1940s–1970s	• Construction of public buildings and facilities in Malmberget in the former site of the railway infrastructures and mine entrances. • New public facilities and expansion of Kiruna. • Transition from open pit mining to underground mining.	• Subsidence caused by mining operations causes the demolition or moving of some buildings and neighbourhoods in both towns.	• Post-war economic growth and push for the modernization of society • LKAB becomes a 100% State-owned company • Social-Democracy and welfare-state economy • Increased job opportunities in the public sector
1980s–1990s	• Continuous investment in infrastructure and innovation of operations. • Attempt to diversify the local economy.	• Depopulation and shrinking (Youth and women move to larger towns for lifestyle/education opportunities) • Environmental concerns/ Negative view of Industrialization.	• Crisis in the local mining sector • Lower demand for minerals results in lower production and reduced workforce
2000s–2010s	• The crucial role of mining in the local and national economy is reinforced. • Urban design competition for 'New Kiruna', and a new company area is established. • Gällivare established new development areas to relocate functions from Malmberget • Establishment of Kiruna Sustainability Center. • New hydrogen-fuelled demo plant (Hybrit) located in Gällivare.	• Several buildings in Kiruna and Gällivare are demolished or moved. • Social concerns regarding urban relocations. • Lack of housing and increased construction costs. • Increased use of seasonal workers.	• Boom and Bust demand for minerals and commodities worldwide. • Growing interest for resources in the Arctic and subarctic regions. • Climate change and sustainability discourse. • Continuing technological advancement (robotization, etc.)

The founding of the mining towns Malmberget and Kiruna, established in order to support the mining industry, are clear examples of territorializing processes. Historically, company towns were built by companies, often in remote areas to promote the extraction of natural resources. Sometimes, these were designed as model company towns, where the company not only provided housing – of good design and with high standards – but also built schools, libraries, parks etc. and provided social welfare (Garner 1992). The motives for building model company towns were purely economic, to ensure the company's production, which differentiate them from ideal cities or utopias based on religious or political incentives (Ahnlund and Brunnström 1987).

Mining had taken place periodically in Malmberget since the eighteenth century, but the history of the town begins symbolically in 1888, when the first train loaded with iron ore left to the Luleå iron ore shipping harbour. Malmberget is located nearby Gällivare, a market and church town that was founded in 1742. However, Gällivare was too far from the workplaces in the mine, so Malmberget developed as a shanty town, built in close proximity to the mine. The ownership of the mine shifted several times during this early period, and the mining companies lacked resources or ability to provide housing

and other facilities for the workers. A town plan for a service and supply town was adopted 1899, adjacent to which a railway area and eventually a company area with housing provided by the mining company was developed (Forsström 1973).

Kiruna was formally established in 1900, when the town plan was adopted. The town was built on the southern slope of the Haukivaara mountain, between the iron ore mountains. The lands had previously been used seasonally by the indigenous Sami population for hunting, fishing and reindeer herding. It was a cultural landscape, although commonly referred to as the wilderness by the people from southern Sweden, when urbanization and industrialization replaced the previous livelihood (Sjöholm 2016).

However, mining activities started already in 1890, when the mining company Luossavaara-Kiirunavaara AB (LKAB) was founded, with the objective to mine the rich iron ore deposits in the mountains Luossavaara and Kiirunavaara. Initially, the development was similar to the one in Malmberget, and during the 1890s temporary dwellings and shanties were built by the workers. These were rapidly replaced with permanent structures when Kiruna's town plan was adopted. LKAB was forced by the state to provide housing in order to open the mine; the poor social conditions in the shanty town of Malmberget were not tolerated (Brunnström 1980). Kiruna (Figure 2) was planned and organized in three separate areas: the company town built by LKAB, an adjacent service and supply town, and an area built by the Royal Railway Board along the railway (Brunnström 1980). The company town was designed as a model company town, with high-quality housing, schools, library and public transportation (Brunnström 1980, 2008). The adjacent service and supply town was, in comparison, not as well organized and lacked the funding to build and maintain streets, water and sewage systems (Nilsson

Figure 2. The oldest parts of Kiruna: the company area, the adjacent service and supply town, and the railway area. The three areas merged in 1948 as Kiruna was granted town rights. In the decades after the second world war, the town gradually expanded. (Illustration: Saeed Ebrahimabadi).

et al. 1976). Some of Sweden's most renowned architects and planners, such as Gustaf Wickman, Per-Olof Hallman and Folke Zetterwall, were hired to design the new developments. The three areas merged in 1948, when Kiruna was granted town rights. Kiruna, conceptualized as a model town, must be seen in the context of its location in the sparsely populated region. In territorializing the area, the urban is in clear contrast to the surrounding landscape. Modernity, housing of high standards, social welfare, high-income employments and culture characterized the so-called model town.

After the Second World War, the prices of iron ore increased. LKAB, which then also owned the mine in Malmberget, expanded its operations and started mining underground, while Malmberget and Kiruna flourished from the increasing mine revenues. New neighbourhoods were developed, and imposing architecture such as the Town Hall by Artur von Schmalensee and brutalist residential quarter designed by Ralph Erskine was developed in Kiruna (Brunnström 1993). In Malmberget the highrise Focushuset was built, challenging Gällivare nearby in being the more important town (Martins Holmberg 2008). This was partly possible because LKAB paid taxes locally, to the Gällivare and Kiruna Councils, which meant that there was funding available for developments. This changed when new legislation on limited companies shifted tax centres from the local to national levels. On top of this, a new Planning and Building Act adopted in 1986, placed great responsibility on the local councils, being in charge for the town planning. On the other hand, state politics wasn't able to carve an effective regional policy to create a diversified economy capable to attract and retain inhabitants. Slogans such as 'the whole of Sweden must live' were empty words in the hears of the many in Norrbotten who lost their jobs and were forced to relocate to the industrial complexes of the south. We see here a shift in the state's approach, from territorializing (extraction in) the region – not least to support the resource extraction through the Megasystem – to de-territorializing especially during the implementation of new economic ideologies such as neo liberalism and new public management.

Likewise, in Malmberget in the decades after the Second World War large urban transformations took place to deal with the impacts of continued mining extraction (Svensson and Wetterberg 2009). At the origins of the town, the mining took place opencast and for this reason the town developed around the main open pit, called 'the Captain's Pit'. The company area was northwest of the Captain's Pit, while the railway area, used for loading the extracted materials on trains, was located to its west. The rest of the town, including the town centre with the church and other public buildings, was developed south of the Pit (Forsström 1973). With the expansion of the mining activities the situation became problematic, as LKAB needed to mine different iron ore deposits lying below urbanized areas. The risk of subsidence and landslides caused many buildings to be evacuated and torn down in the town centre already in the 1950s and in the residential areas of Elevhemsområdet and Kilen in the following years. In the 1960s, when LKAB opted for underground mining and the entrance of the mine was relocated, the railway area was turned into the new town centre with many public buildings erected here by the Council to replace the lost ones, such as the Folkets hus, the grammar school and sport and education facilities (Lidelöw et al. 1963). Nevertheless, some relocation of buildings continued: the town church was moved from the old town centre to a new location in 1974 (Johansson 2007).

During the 1980s, the narrative of Kiruna as a model town was reinforced by the conservation planning and the town's recognition as cultural heritage, with many historic

buildings and environments (Sassen 2015). Ahnlund's and Brunnström's (1987, 1993) research influenced the aspiring interest in conservation and the knowledge was used in assessments of the built environments' significance as built heritage. However, the conservation documents show a geographical shift in how the model town was defined (Sassen 2015). Initially, when Kiruna was established, it was LKAB's company area that was considered a model company town. In the 1980s, the whole of Kiruna was regarded as a model town. Throughout, there have been high ambitions in the urban design and in remarkable architecture. Meantime, Malmberget's built heritage was also acknowledged by the conservation planning (Sjöholm 2011), although this had at the time less impact on the protection of buildings, compared to Kiruna.

From the end of the 1970s and during the 1980s there was a decline in the mining sector. The situation stabilized, and in the early 2000s a major economic mining boom occurred due to increasing ore prices on the world market. It became evident that continued mining would cause subsidence in both Malmberget and Kiruna. It was however never an option to close the extraction operations. The economic value of the natural resources was ranked higher than other interests such as health, environment, built heritage, etc. The consequent decision was instead to relocate most of Malmberget and a large part of Kiruna. Since then, the main challenge has been the negotiations of responsibilities between all parties involved in the urban transformations. A few key stakeholders have dominated the processes – mainly the local councils and the Swedish state through different agencies. The state plays an important role by being the owner of the mining company LKAB, but also through authorities such as the County Administrative Board of Norrbotten, the Swedish Transport Administration (responsible for public roads and the railway) and the National Property Board (owning the land needed for the relocations). Consultations are done when required in the planning processes, but other stakeholders have limited impact.

In Malmberget, most of the town will be affected by mining impacts and some buildings have been relocated. Already in 2007, some houses of the company area from the 1960s were moved on trucks and trailers to a safer zone as an experiment, but the operation resulted to be too complex and expensive (Söderström, Paasche, and Klauser 2014). Instead, planning proposal aimed for part of the population of Malmberget to be relocated in newly developed areas in Gällivare, such as Repisvaara and Vassaraälven's waterfront. Here new buildings were built in different forms (high-rise apartment blocks, villas, row houses) to compensate for the houses to be demolished. In addition, after an agreement between LKAB, the County Administrative Board of Norrbotten and the Gällivare Council, around 30 historic buildings from the company area have been moved and became a new neighbourhood in another near-by historic mining town within Gällivare municipality, Koskullskulle (Sjöholm and Elmén Berg 2022). The relocation started in 2016 and it is currently completed. The aim of this operation is not only to preserve part of Malmberget's built heritage, but it has also a social purpose. The decision of keeping these old houses and of limiting the interventions of renovation on them was also meant to keep the rentals low and to give a possibility to those citizens that could not afford to move into new houses with higher standards.

The ongoing physical and social shrinking of Malmberget and Kiruna can be interpreted as the most evident outcome of de-territorialization of the NTM (Figure 3). Thanks to technological evolution, the magnitude and productivity of mining operations

Figure 3. a and b. De-territorialization in Malmberget (sources: eniro.se 1960s, Google Earth 2019).

are continuously growing. At the same time, the NTM, once labour intensive, requires fewer and fewer workers. Consequently, the strong link local communities once had with the mining industry is nowadays fading (Luciani and Sjöholm 2019). It looks like settlements and communities are gradually becoming redundant for industrial production and resource extraction. Already in 1963, Malmberget was defined as 'an expendable community' in the journal of LKAB (Adolf Henriksson, 'Det moderna

Malmberget,' LKAB-tidningen 1 (1963), quoted in Söderström, Paasche, and Klauser 2014, p.29). The present condition of Malmberget confirms this prediction. The land reclamation for resource extraction, ongoing relocations and demolitions have almost completely emptied the town. The final outcome of the process will be the termination of this 130-years-old town, which according to LKAB should be completed around 2030.

In addition to this, the automation of extractive activities and the increasing use of flying-in flying-out workforce has for quite some time diminished the opportunities for employment of the local population (Müller 2015). In Sweden, this trend, compounded with an aging workforce and continuous stream of women outmigration from the north to towns located in the south, has contributed to stagnating population growth in Norrbotten. Population, in this mining rich region, peaked in 1960s (261,802 inhab. in 1960) and it has ever since decreased (248,609 inhab. in 2010) with a small rebound in 2015 (249,733 inhab.).

4. Smarting the NTM: learning from Kiruna (?)

As it was shown in the previous section, the urban transformations of both Kiruna and Malmberget-Gällivare, has resulted in extensive construction of new neighbourhoods and new public buildings in the two mining towns. In Kiruna, a new town centre is under construction (Figure 4). The development is based on the results of an urban design competition of 'new Kiruna' finalized in 2013. The competition brief of the urban design competition directly referred to Kiruna as a model town (Kiruna Council 2012), and expectations are that also the 'new Kiruna' will be a model town. This is largely interpreted as building an attractive and sustainable town centre with new, modern buildings. 'New Kiruna' means re-territorializing, as the new town centre is developed in an underutilized area northeast of the existing settlement. The

Figure 4. Rendering of the new Kiruna city centre (source: White Architects, 2013).

new town centre is layed out in a grid system, with a main town square surrounded by public buildings. Between 30 and 40 historic buildings will be relocated in the new town centre, while 5–10 historic buildings have been moved to a new company area northwest of the existing settlement.

However, keeping with their long history of urban innovation, the Kiruna Council has used the opportunity to rebuild its town centre to establish a testbed named Kiruna Sustainability Centre (KSC). Kiruna was together with five other Swedish towns an innovation platform for sustainable and smart cities and a testbed to test smart urban innovations that included the following sub-projects: sustainable buildings; waste management; urban farming; energy systems; IT and IoT; flexible traffic; and system integrated planning. The project was led by the Kiruna Council in cooperation with nearby university and research centres.

In system-integrated planning, the idea is to develop a socio-technical system that link all the phases of the construction of the new town centre (Figure 4); from planning to construction and management (Öberg and Ebrahimabadi 2020). One of the objectives is to collect and integrate urban data and find innovative ways to link these phases for more effective and efficient processes. A challenge in this integration is working with data sourced from different stakeholders. Infrastructure such as streets, district heating, water and sewage pipes are planned and managed by the municipal company Tekniska verken AB (TVAB). The construction of buildings is instead led by different private actors as well as the municipal company Kirunabostäder AB. Currently, there is no standard protocol for data sharing and the use of private data. Also, public planners and private developers operate in different epistemic communities that speak different technical languages and have different priorities.

However, smart technologies per se cannot deliver the promise of a smooth transition, but they need to be deployed to transform the way the Council and the constellation of different stakeholders interact with it. While smart technologies can be helpful to steer development in 'new Kiruna', according to our analysis, the challenges are more related to the assemblage of resource (extraction) and urbanization logics and their developments in the public and political discourse. The decision to start the KSC can also be illustrated as a political will to brand Kiruna as a destination for foreign investments and tourism. 'New Kiruna' and the KSC are often discussed in global media outlets and by regional actors such as the Luleå University of Technology, the Norrbotten Region, LKAB and the Kiruna Council takes every opportunity to visualize it abroad. In addition, the choice of the content of the KSC is based on the daily needs of knowledge.

The mining company LKAB and the town council have had converging and diverging aims that have affected the construction of 'new Kiruna' (Figure 5). When they converge it usually works to territorialize resource extraction. Less of it, or rather the opposite, when these interests diverge. For example, in the early phase there have been arguments about where to locate the town centre. Initially, LKAB wanted to keep it close to their land areas (in the northwest in the area called Luossavara). However, this decision was contested by the town council leading to an urban design competition for 'New Kiruna' to be in the current location in the northeast (nearby Tuolluvaara). Another determining factor has been to secure land for new developments; all land outside the existing town is owned and managed by the National Property Board. Other deterritorialization struggles between LKAB and the Kiruna council concerns the decision of where

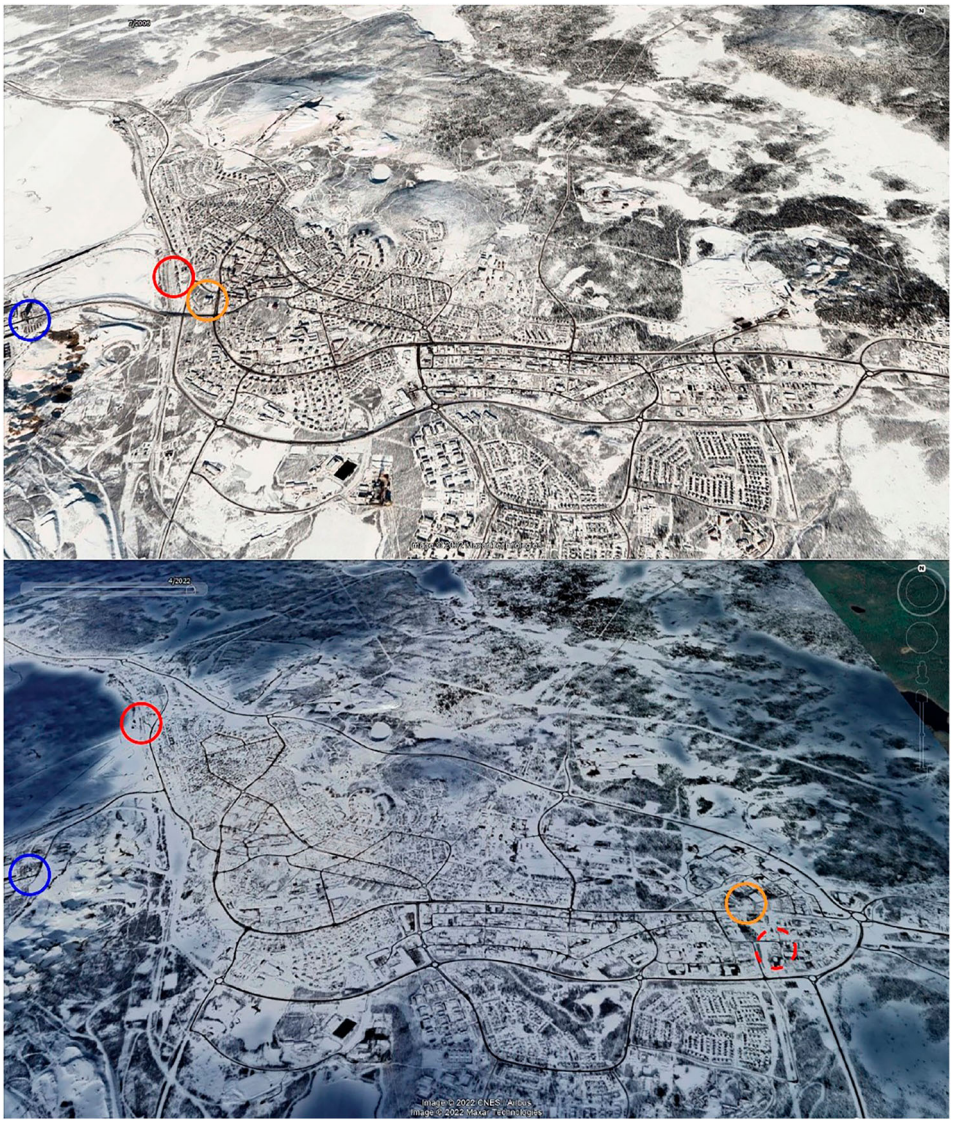

Figure 5: Re-territorializing Kiruna (Google Earth 2006 above and 2022 below). In orange the Old (now demolished) town hall and the New Town Hall, in the new town centre; In red the old railway station, the current, temporary, railway station and (dashed) the proposed location for the new train station; in blue the entrance of the mine.

to locate the new railway station. The Kiruna council argued for it to be located close to the new town centre in order to replace the function of the original, a proposal supported also by the Swedish Transport Administration. However, LKAB, as the sole responsible for all liabilities due to extraction, wanted to minimize the cost by keeping it in the current temporary location, once again, close to their premises. Interestingly, the local Sami also opposed the council on the grounds that the area close to the new centre would have too severe consequences for reindeer herding.

At the same time, LKAB and the Kiruna Council's interests converge, and therefore territorialize LKAB extraction interests, in the relocation of existing buildings and construction of new ones. The most significant episode exemplifying this convergence is during the process that led to the decision of demolishing the old town hall of Kiruna and the building of a new one in the new town centre. The two institutions jointly appealed in court against the request by the County Administrative Board to save the listed building until it was judged in their favour. Nilsson (2010) has discussed how the whole urban transformation process was biased by a strong 'ideological phantasy' created by LKAB and Kiruna Council to claim public support for the relocation of the town. In this perspective the new development plan of Kiruna and the KSC initiative, despite using and representing the green, smart and sustainable discourse, become rather functional and embedded to ensure the continuation of mining operations and extractive activities and their territorialization.

Another territorialization effect of LKAB's interests can be found in the countless modifications of the town plan for 'new Kiruna' as a way to contain costs and align the whole development to the needs of the mining industry. The so-called Kiruna Portal, a core facility to promote an innovative circular approach and to transmit the city material identity to the future was scratched from the process quite early. Also, most of the buildings that are being constructed in the new town centre of Kiruna, will not meet the NZEB (Nearly Zero Energy Building) standards and will not be climate neutral. The same goes for the town centre; there is no consideration for carbon neutral or positive energy goals despite Sweden is planning to be carbon neutral by 2045.

5. Discussion and conclusions

In this article, we problematized the ability of the smart urban rhetoric to deliver sustainability beyond the big city-capitals to question whether, in the extractive-periphery, smart city thinking is inconsistent with the entrenched development pattern. We have analysed the case of the iron-ore rich NTM in Sweden to exemplify these tensions. To unravel these inconsistencies, we have used assemblage theory to analyse in an historical perspective the 'resource-urbanization' nexus (Rizzo 2019 and 2021a), which is the relationship between the resource extraction and urbanization discourses (e.g. policy, investments, lobbying, etc.).

The added value of thinking of territorial systems, such as the NTM, as an assemblage of resource extraction and urban discourses lies in the ability of this assemblage to uncover the co-dependencies between their parts. In this sense, we have interpreted the category of territorialization as all those policies, narratives and investments/interventions that support resource extraction in the case study. On the flip side, de-territorialization emerged as all those counter-narratives (e.g. environmentalism), resistance movements (e.g. identity), involuntary impacts (e.g. urban relocation) that weaken resource-extraction as a positive story for community development. Using assemblage within our overarching historic analysis of the NTM underscores the fact that urbanization dynamics are not a historically linear result of top-down policies but, rather they are formed in a bundle, or a constellation, of 'human and nonhuman components that form [it]' (McFarlane 2011, 208).

The case of Kiruna for instance taught us that the iron ore industry has been driving the industrialization and urbanization in this northern part of the inland region, but also that it has had a huge impact on the town over time. Raising global prices of iron ore and developments in extraction technology meant the swallowing of entire parts of the city centre and conflicts with its inhabitants. At the same time, the dismantlement of an urbanized area to allow mining corresponded to the creation of new areas in other parts of the town that are safer to be built.

Our analysis of the historical evolution of the NTM with the context of the Arctic showed the crucial aspects of climate, iron ore deposits and river system as the main environmental elements with which resource extraction had to deal. The cities grew around the mineral deposits and parallelly the appropriation of the river system and transformation into a 'second nature' made of damns, temporary villages, roads and electrical lines constitutes that backbone with which Kiruna and Malmberget have been enmeshed in a very complex and dynamic socio-technical assemblage.

In this development over time we observed the dynamics between the elements that are relatively stable and, by contrast, those that are instead more subjected to changes and fluctuations as consequences of deterritorialization and re-territorialization processes.

Natural elements and resources appear like the invariants of the systems, especially in their geographical dimensions, but are nevertheless evolving over time in relation to the other components of the system.

The iron ore deposits, for instance, are progressively extracted and, as a consequence, the 'active' section of the mine moves both vertically and horizontally. Similarly, the bed of the Lule river can be interpreted as spatially immovable in the analysed range of time, but its hydropower exploitation has obviously deeply modified the territory around it in terms of flooded and dried parts, impacting the disposition and organization of the settlements around it. In section 3 we showed how the technological infrastructures (roads, railways, mines, powerlines), once they have been built, can also be interpreted as stable, invariants, only to be mobilized when socio-economic or technical needs have requested it. These changes have usually corresponded to important shifts in the system with remarkable consequences on the deterritorialization and re-territorialization of the analysed cases. For instance, the shift from open pit to underground mining, implemented by the mining company to increase the efficiency of the process, resulted in a complex re-organization of the urban morphology both in Malmberget and Kiruna. At the same time, even crucial infrastructures had to adapt to the needs of resource extraction, as in the case of the recent moving of the main railway tracks and station of Kiruna which lay in the subsidence area. The most movable components of the system, the population but also buildings, have been those more affected by the process of deterritorialization and re-territorialization, with very limited possibility over history to resist such socio-techological changes.

Assemblage theory has allowed us to show and explain why particular actors allied and agreed on particular ideas, to capitalise on particular resources, at particular times. In paragraph 4 we showed how the mining company and the town council aligned their policies and interests in the beginning of the urban transformation process to ensure the continuation of mining operation. At the same time, they instrumentally used the smart/sustainable/ideal city discourse to promote and get support to their initiatives and to contrast other dissenting voices or actors.

Similarly, the KSC was an initiative aimed at innovation by merging the municipality's needs with the expertise and interests of academic and R&D institutions. While the KSC testbed was supposed to modernize the town, it did not question the ongoing model of development. To return to our initial research question, without a historical understanding of the evolution of the NTM assemblage, smart city thinking can do very little to deliver sustainable urban development. The stakeholders involved in such a project perhaps hoped that in the future the town itself will find a way out from resource extraction. To be sure, Kiruna, unlike other mining towns in Sweden, has seriously attempted to diversify its economy towards tourism and the aerospace industry. However, this drive is recent and dependent more on local political conjunctions, a visionary council, rather than a clear roadmap steered together with the state and region.

All in all, it seems to us that the ideals of a smart and sustainable urbanism are more instrumental to the bottom line of the resource extraction industry rather than being an innovative project to make economic development compatible with broader climate and social challenges. The Arctic is the region of the world where climate change is more evident (melting of glaciers and permafrost, release of methane, etc.). It is also one of the most 'hunted' regions of the planet by resource-hungry industries (not only for oil and ores but also for renewable energy installations such as wind turbines). As anticipated in section 1, some of us have arrived to a similar conclusion when studying green megaprojects in the global south (Rizzo 2019 and 2020). In general, a number of authors have already questioned smart city policies and their appropriateness to achieve sustainable development (for example, Cugurullo 2018).

As we write, resource extraction companies are racing to invest in the Arctic periphery to green wash and extract more resources than ever. For example, LKAB announced in November 2020 annual investments of SEK 10 to 20 billion over 20 years for converting its extraction activities and production into fossil-free processes. Other announcements have followed to build wind farms, 'mineral cities' and speculate on modular nuclear reactors to further 'greenify' the industry. This development coupled with other parallel huge industrial investments for the green transition in Northern Sweden (gigafactories, wind and solar parks, hydrogen-powered steel mills, etc.), are advertised by policy makers as the new Klondike era for Norrbotten (with all social conflicts and environmental impacts that this term encapsulate). As many as 100,000 inhabitants (i.e. 10% of the population of Northern Sweden macroregion called Norrland or 20% of the current population of the northern most Swedish regions of Norrbotten and Västerbotten) are expected to move to Norrbotten and Västerbotten as results of the ongoing investments in the green transition. On the flip side, the Kiruna City Council and LKAB are again arguing with one another about the amount of funding that the mining company should correspond to the council to complete the resettlement of its infrastructures and inhabitants. Future research is needed to explore the ongoing dynamics of the urbanization of resource extraction in Sweden and worldwide. We hope to be able to report on this in future papers.

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