Name of the case study	Kiruna – Relocation for mining activities – Sweden [Resilience]		
What about this case makes it interesting? How does this case contribute to understanding of resilience and/or regime shifts in the Arctic?	Kiruna is a town of 20 000 people (see Appendix 2 in template) lying approximately 145 km north of the Arctic Circle in Swedish Lapland. The town was established in 1900 due to the iron mining activity in the area. Nowadays the mine is the largest underground mine in the world, and accounts for approximately for 90% of the European and 2% of the global iron ore production (4, 7). In 2013 alone, iron ore exports accounted for 1.7% (US$ 2.79B) of total national Swedish exports (US$ 164B) (15), bringing wealth to Kiruna (approximately 10% of the population is employed by the mine (4, 6)) and Sweden due to the high global demand of iron for steel (see Appendix 4 in template). The iron ore body extends in depth at an angle of 60° beneath built-up areas. This has contributed to geological destabilization, deformation zones and cracks on the surface (7). "Kiruna not only was built on mining but is actually built *on* the mine" (9). Kiruna Kommun (Kiruna Municipality), advised by the state-owned mining company Luossavaara-Kiirunavaara Aktiebolag (LKAB), decided to relocate the affected parts of the town approximately 3 km east (3). The process began in the early 2000's, and will be carried throughout the coming decades. Besides the economic and technical difficulties, of much importance are the social implications, which show aspects of the resilience of this system. Most of the information used in compiling this case study relates to the main initiators of the relocation process.		
Template completed by: *Main contributor	Daniele Crimella*, Stockholm Resilience Centre Juan-Carlos Rocha, Stockholm Resilience Centre Lize-Marié van der Watt, Stockholm Environment Institute Dag Avango, Kungliga Tekniska Högskolan	**Key references: Cite in the text using (1), (2), (3) etc. and provide a reference list at the bottom of the template.** (6) Nilsson, B. 2010. Ideology, environment and forced relocation: Kiruna-a town on the move. *European Urban and Regional Studies* 17(4):433-442	
Reviewed by (name and affiliation)			
Category (mark with X)	**Resilience/ Adaptability**	**Loss of resilience**	**Transformation**
	X		

Case study details:	**Country**	**Place**	**Scale – space**	**Scale – time**	**Sector(s)**	**Other (e.g. disturbance)**
	Sweden	Kiruna	Municipality of Kiruna, area of approx. 20 000 km^2 and northernmost municipality in Sweden (9)	Beginning of mining activity in 1890's - present	Mining, Urban planning, Local governance (democratic processes)	

Drivers (mark with X in appropriate boxes)	**Climate**	**Geopolitical**	**Mineral/ oil extraction & infrastructure**	**Tourism**	**Shipping**	**Biological invasion**	**Rapid demographic change**	**Other:** ***state here***
			X					Global economy (demand for iron)

	Biophysical	**Social**
1. Basic description of coupled social-ecological system in focus **(**What are the key components and stake holders) If possible draw a systems diagram or conceptual map of the case – this can be a	a) What types of ecosystem(s) and other major biophysical features are present? Kiruna is situated in the Swedish subarctic, 145 km north of the Arctic Circle, with yearly average temperature of -3°C (3). It lies in the transition between the birch forest ecosystem and the arctic tundra. The landscape of the municipality includes seven large rivers, over 6000 lakes, including the 70 km-long Lake Torneträsk. Several mountains are present, among which Mount Kebnekaise, the highest peak in Sweden at 2117m. The area includes two national parks, 19 Natura 2000 sites, and other locally-	c) Who are the key groups of people in this case? Refer to Diagram in Appendix 1 in template. LKAB (Luossavaara-Kiirunavaara Aktiebolag) is the state-owned company that owns the mine in Kiruna, and the main employer of the town. Kiruna was established after the creation of this company, and it is heavily dependent (if not completely) on LKAB for its existence (2, 5, 6, 7) Kiruna residents: approximately 18 200 people live in the town of Kiruna (of 22 944 people living in the

series of diagrams to capture different periods in the case and the drivers/ actors/ events that characterize the period.	protected areas for wildlife and for the use of Sami people. A third of the area is kept undeveloped for use as rocket launch range (9). b) How are the case boundaries defined in terms of ecosystems or biophysical characteristics? Relevant biophysical boundaries extend upwards (several hundred kilometers) and downwards (a few hundred meters) from the earth's surface, as Kiruna hosts a space station, Spaceport Sweden, and bases its existence on the iron ore mine at Kiirunavaara in the vicinity of the town's center (6). The mine is the world's largest underground mine – it contains about 400 km of roads – and the ore body is 4 km long, 80 m thick and reaches a depth of 2 km. As of 2009, approximately one-third of the ore had been extracted (6). The current extraction rate is mainly driven by technological advances and iron market prices. LKAB estimates (in 2015) that mining in the area will still be profitable in the coming decades, at least up to a century more (11).	municipality, 2010 census, see Appendix 2 in template). Some 10% are directly employed by LKAB (see box 1d), but the majority of the residents are indirectly dependent on it to sustain their lives (2, 5, 6, 7). As the deformation zone is expected to extend in the decades up to the town centre (8), some 3 000 inhabitants will be directly relocated (3, 4) and all of them will be affected by changing the town plan, to some extent (7, 8) Kiruna is characterized by a mostly male population, defined partly by the historically masculine structure of miner groups, and partly by the lack of opportunities for women, whom often move south at a young age (10) Vulnerable youth and elderly groups often have little possibility to find their own place in society and decision-making (6). Therefore, young people often leave to find alternative education and livelihood options (9). The socio-economic condition of the residents is also a crucial point to consider. Those who have worked with and sustained their lives through mining are more likely to support LKAB's decisions (9). These dynamics contribute to the power structures within the town. Planners: external actors to the system, composed the master plan for the city relocation. The planning process has been long and winding (see box 2, timeline). A first masterplan was approved in 2011 for a north-west relocation, but then was discarded (due to the possible

		presence of iron in that area), in favour of the east relocation option. An international competition was set up by the municipality. The winning proposal, Kiruna 4-ever, describes the relocation process as a slow millipede moving 3 km east along the new urban belt to the new Kiruna. The aim (8) is achieving a carbon neutral, denser, “more intelligent” plan, equipped with meeting places and cultural amenities, which promote public life, broadening the male dominated demographic of Kiruna (10), and allowing for a more diverse community to settle and thrive. The idea is for the process to be democratic and participative (8). Several heritage buildings and landmarks have been selected to be moved piece by piece (e.g. the clock tower and the church). Reuse of building material from the “old” Kiruna will be possible through the “Kiruna Portal” (8). The masterplan has mainly been structured on modern concepts of urbanism. One source (11) argues that residents and local Sami communities had little influence on it: “[…] this is a forced displacement […] completely controlled by the mining company”. Kiruna municipality administrators: the decision-makers for local policies, including the relocation process. Elected by the citizens, municipality administrators are highly aware of the importance of mining in sustaining the town (2, 5, 6, 7)

		Indigenous Sami people (or *sameby* traditional reindeer husbandry units): seemingly left out in the literature. At least two Sami communities could be affected by the relocation (16). Reindeer migration routes also will be affected in the new town plan (9) d) What kinds of livelihoods are important in the system? • Mining is the main source of livelihood in Kiruna (1, 2, 3, 4, 6, 7, 8, 9), where some 1 800 people work for LKAB directly, despite personnel reductions of 400 positions were announced in early 2015, to maintain profitability in spite of falling iron ore prices (13). According to some sources (2, 3, 4, 7, 8, 9) no other livelihood would be profitable enough for the town to remain in place • Tourism is a secondary but important employer, seasonally several activities are available: snowmobiling, ice hotel visits, Sami living, dogsledding, skiing, hiking, ptarmigian hunting, fishing, aurora borealis watching, midnight sun watching, reindeer visits, mine tours, SpacePort space centre tours, etc. (9) • Reindeer husbandry is a small-scale traditional livelihood option, often practiced by Sámi communities (9) who lived and moved with their herds in the area for thousands years (12) Wide and diverse areas of pasture are needed for this activity to be sustained (12). In this case, as in many other cases, the Sami's voice remains unheard when conflicting with economic development (11, 12).

		• Businesses and services are vital to life in the town, but can only survive (or expand) with stable population numbers (8) e) What institutions are key to this case? If possible define what scale it addresses. • Kiruna Kommun (Kiruna Municipality) is the main formal governing institution. It is the ultimate body deciding the relocation plan (3, 8). It takes into account the opinion of different parties involved, while planning (LKAB, technical infrastructure agencies, national legislation, indigenous Sámi groups, etc.) (4). It addresses the whole municipal scale. • National Government of Sweden defines the laws regulating the mining activity and the town planning. Specifically, it prohibits mining under populated areas (4) It is nonetheless the sole owner of LKAB, and benefits from 60% of the profits (in taxes and dividends) (4). On the other hand, LKAB is managed and held accountable as a private company would be, causing some difficulties in understanding what actors are responsible (11). For instance, key politicians simultaneously serve on the governing board of LKAB as well as in Parliament, or within regulating agencies, and this creates obvious potential for conflicts of interest (11) f) How are the case's boundaries socially defined, and how do these social boundaries relate to biophysical

		boundaries? The socially-defined boundaries are the municipality of Kiruna, the largest (area of approximately 20 000 km^2) and the most northern municipality in Sweden (9). However, the area relevant to the relocation is the settlement of Kiruna, where 80% of the population is situated (3, 9). The boundaries of the social system are closely related to the biophysical boundaries of the iron ore body extending below Kiruna. In the small area of central Kiruna, living space above the ground coexists, vertically, with the iron underneath. The social-ecological interaction (iron ore extraction) happens in this spatial context (see Appendix 3 in template). Alternative livelihood options to mining extend in the whole territory of the municipality (9). A tight cross-scale interaction to the global commodities market (see Appendix 4 in template) (e.g. steel) and the dependence on external materials, knowledge and resources make Kiruna connected to the outside, blurring the boundaries of this system.

2. Timeline

Draw a timeline of *key* events/ developments to the case. Points to include:

Make clear the period of time over which the change is being considered.

Provide a brief description of event/ actors, and ecological impacts. Mark particularly significant events with *.

Consider both biophysical and social dimensions.

Additional points that can be considered:

Is it possible to

Year	Event
1888	Iron ore mining begins in the area
1900	Hjalmar Lundbohm (LKAB first managing director) establishes the town of Kiruna, with the ambition to make it a modern, well-planned ideal town
1902	The railway reaches the town
1912	Kiruna has a hospital, fire station, sewage, roads, church and the priest's home
1915-1918	Iron ore production drops to historical low during WWI
1920's-1930's	Production increases, but drops again during the Great Depression
1939-1945	Production flourishes during WWII due to the supply of iron to the war industry
1950's-1960's	Increasing wealth from the mine, renovation of the town center and expansion of the town Underground mining begins Airport opens to civilian traffic
1966	Esrange Space Center is established close to the city
1970	The area of the city closest to the mine (few hundreds of inhabitants) has to be vacated due to surface destabilizations
1970's-1980's	New roads to Nikkaluokta and Narvik opened
1977	Steel crisis causes LKAB to have losses for the first time, a declining trend in mining protracts for some 10 years, miner numbers are halved, Kiruna's population declines
1990's-2000's	Population numbers stabilize around 20 000 after the diversification of the economy, and the increase in global demand of iron for steel, especially from BRICS Increase in summer and winter tourism Increased development of space-related education, research and activity
2004	LKAB notifies Kiruna Municipality of the issues with mining under the city and the need to revise the city plan Swedish Transport Administration, began planning for a new railway
2006	Infrastructural adjustments to mitigate effects of fracturing and to support the development of the new town (bridges, new roads etc.)
2007	First in-depth development plan produced, the city center is to be moved north west
2008	Infrastructures for energy distribution are rerouted, adjusted and modernized

identify periods of change from one type of system to another, transformations ? Identify disturbances or events that challenged, built, or reduced resilience or adaptive capacity in the system.	2009	A new sewage line is built, as the old one would be in the deformation zone
	2011	New railroad work begins New evidence showing possible presence of profitable iron ore bodies in the northern area of the town lead the municipality to discard the north-west option for relocation. Instead it decides for the 3km east option, and launches an international planning competition for the relocation An LKAB relocation information office in Kiruna is opened
	2012	A few other affected housing and recreational facilities are replaced with new ones
	2013	White arkitekter (Stockholm-based) and Ghilardi + Hellsten Arkitekter (Oslo-based) win the competition with a 20-year masterplan of Kiruna's phased relocation titled "Kiruna 4-ever" (actually proposing a masterplan over 100 years), Danish firm Henning Larsen Architects wins new town hall competition with the project "Kristallen" New temporary train station opens
	2014	In March the construction of Phase 1 begins with LKAB pledging an investment of €415.5 million for the development of the new town center, estimated completion in 7 years (a new civic square, which will be home to Kiruna's historic clock tower as well as a new travel center, the new city hall, new library, swimming pool, and moving the Kiruna Church)
	2015	Demolition of the first part of the Ullspiran quarter in the housing area begins during the spring
		Relocated highway 870 to Nikkaluokta opens for traffic on September 1st
	Planned:	
	2018	*Planned completion of new City Hall*
	2021	*Planned completion of Phase 1 (civic square, travel center, library, swimming pool, church)*
	2030-2035	*Deformation zone projected to reach current city center* *City transformation has now affected buildings totaling more than 400 000 m^2, including just over 2 500 homes in the existing city center*
	2050-2100	*The vision planners have for the transformed Kiruna is achieved*

3. Disturbances What are the key disturbances in the system (present and past)	a) Have there been major biophysical disturbances that are relevant for the case? • The extraction activity itself erodes the biophysical system, removing substrate underground, degrading ecosystems on the surface and above (terrestrial, aquatic and atmospheric) (9, 11) • Mining leads to geological destabilization in the bedrock, which causes deformation zones in the strata above, and ultimately geomorphological subsidence and cracks damaging the built environment (roads, houses, parks… (3, 4))	b) Have there been major social disturbances that are relevant for the case? The town has been historically dominated by prevalence of working-age males, while young people, especially women, typically move south to look for more opportunities (3). Demographic fluctuations could then be an internal disturbance (refer to box 1c).
4. Drivers of change Clarify what impacts these drivers have on the SES and if these are direct or indirect	a) What are the key biophysical drivers of change? • Positioning of the iron ore bodies (see Appendix 3 in template) under the town is why Kiruna must relocate, if mining continues (4) • Fluctuations in presence, ease of extraction and quality of iron in the iron ore bodies, led in the past to reorganization in LKAB's extraction strategy (some mining areas were closed or used for research, e.g. Luossavaara, Svappavaara, Tuolluvaara) (4). The current most profitable mined body "Fabian" (1/3 extracted; (6, 9)) is expected to still be profitable in the future, but some uncertainty exists in its quality, extent of the body and ease of extraction.	b) What are the key social drivers of change? • Continued mining activity is clearly the single most important driver of change (see Appendix 1 in template; 2, 3, 4, 5, 6, 7, 8, 9). The global demand for iron, especially steel, has been high and continuous in the last decade (4), making it very profitable for LKAB to continue extraction at a very fast rate. This has helped make Kiirunavaara one of the biggest mines in Europe, contributing 2% of the global iron ore production (7) Kiruna was established because of the mine, and, remains heavily dependent on it (6, 10). The dependence can be illustrated through the impacts of the global steel crisis in the 1970's (see box 2 timeline and Appendix 2) that caused a plunge in population numbers, where miner numbers halved (8, 9). • Lack of alternative livelihoods to mining support the town's in the current state. While other economic sectors are developed/developing, they are currently just a minor component

		in the town structure (9) • A pro-relocation narrative, depicting the mine as Kiruna's identity with a lack of alternatives, suggests moving if the town wants to survive, and is strongly supported by LKAB and Kiruna municipality (3, 4) One source (6), analyses it as an ideological and rhetorical construction aimed at supporting the clear economic gains, supported by the historical masculine and small-town social structure (6, 10). According to some, Kiruna residents do not seem to mind those changes, knowing they *are* there because of the mine (2, 3,4). While others clearly state the technical (e.g. household economy, feasibility) and psychological difficulties (e.g. attachment, sense of place and identity) (2, 6, 7, 8) • While it might appear that there is plenty of room to build a "New Kiruna," space is in actual fact constrained by the position of infrastructure (e.g. airport, railway, the mine and its waste rock, dams), protected areas (e.g. reindeer migration routes), the surface deformations, and the probability that there are more ore deposits in and around today's Kiruna that may be of commercial interest in the future (8)
5. Sources of adaptive capacity: What factors allow(ed) the system to adapt to disturbances in the past and present?	a) Within the ecosystem? (+) The reserves of iron ore in the ground (intended as in 14, p. 94) seem to be the main source of resilience keeping Kiruna in the current state, a third of the ore body currently mined has been extracted (6, 9), and there is reason to believe that profitable bodies lie in the vicinity (4). Even though iron reserves could sustain mining for some time, the	b) Within society (e.g. people, social capital, management, institutions, infrastructure): (-) Kiruna's livelihoods supporting the overall existence of the town are dependent on mining (see boxes 1c and 1d). A saying goes "if LKAB sneezes, Kiruna catches a cold" (6). Only being reliant on one activity does not endow the town with capacity to deal with uncertainty and change. Residents reported their inability to plan their lives on a longer timescale, given the lengthy decision process for the relocation

Give a brief assessment of recent or on-going changes (+/-/0 = increasing/ reducing/ not affecting adaptive capacity)	whole activity is very much linked to global fluctuations in demand for iron ore (8, 9).	(see box 2), and having to cope with economic uncertainties (11). (+) Economic and livelihood diversification (6). In recent decades, the development of other activities in the town allows for more opportunities (especially for more vulnerable social groups, indigenous Sami, youth and women). This trend slightly affects the tight mining-Kiruna feedback loop (see Appendix 1 in template). The Spaceport Sweden and the related higher education, tourism development, and businesses and services have played an important role (8, 9). (+) The urban transformation process, much acclaimed by the planners and the municipality (3, 8), highlights the relocation as an occasion for the city to transform towards environmental and social sustainability. The "new Kiruna" masterplan is the structure for how this transformation could happen (8). Complementing local with external knowledge (i.e. that of the planners) could contribute to innovation that would boost adaptive capacity (14). (-) Potentially, this relocation could scale into a transformation. A true participatory and bottom-up process would be necessary for this to be successful. Residents and local Sami groups were reported to be "voiceless" (11). Seemingly this is linked to feelings of indifference, worry (especially on financial, pragmatic aspects) or disempowerment on how this would go from theory to practice (6, 7, 8, 9, 11). Reactions towards the town's development and future could be hindered by those feelings, and expressed as concerns in how the relocation will take place (8), and not even considering whether it should at all take place, or if alternatives could exist (e.g. other mining system (6)). The power of a few actors (most importantly LKAB, see box 1e) may be sharply influencing residents' views (6).

The next two sections break down the information in Section I. While it is not necessary to fill these sections, if you have additional information pertinent to specific rows below feel free to enter the material.		
II.1-8 SES, resilience and adaptive capacity		
	Biophysical	**Social**
II.1. Where do we find changes and resilience in the face of change?	a) Within nature	b) Within society
II.2. What are the system's key components?	a) Key Ecological components (e.g. lakes, coastal zones, caribou)	b) Actors in society (e.g. individuals, groups, public or private organizations)? How are people organised – by geography, livelihood, family, etc.?
II.3. What are the key linkages? E.g. ecosystem services, resource extraction. These linkages should exist. If there are not mutual links between social	a) From nature to society (e.g. ecosystem services)	b) From society to nature – modifying nature, extracting resources (e.g. hunting, mining, water pollution)

and ecological components the case is not a social-ecological system.		
II.4. What are key interactions?	a) What are the key ecological interactions within the case? b) What are the most important biophysical tele-connections to distant systems?	c) What collaborations, conflicts, or other key linkages exist between actors? d) Between local actors and distant actors?
II.5. Culture	a) How is the relationship between society and nature viewed? b) What meanings are attributed to nature and to interactions with nature?	c) What are key cultural features of relevance for the case? d) What are key cultural practices and beliefs related to nature?
II.6. Disturbance What are important types of stress & shock	a) Describe important biophysical or ecological shocks and stresses (e.g. floods, storms, etc).	b) Describe important social shock and stresses (e.g. austerity policies, changes in government policy, introduction of new technologies, etc)
II.7. What are key slow variables Changes that occur over decadal or longer time scales	a) What types of ecological processes (e.g. loss of permafrost, shifts in species composition) are driving important long-term changes in ecological structures and processes?	b) What types of slow social processes (e.g. aging, population growth, loss of language) are driving important changes in social institutions and behaviours?
II.8. Relationships	a) Are ecological regime shifts driving further ecological change or pressure?	c) Can social stresses or major changes be attributed to ecological regime shifts?

with ecological regime shifts	b) Are external or internal ecological dynamics potentially or actually producing ecological regime shift(s)?	d) Are there specific social practices that might be contributing to ecological regime shifts
II.8 Regime shifts	**If a regime shift exists and is important to this case describe it below.** Please indicate whether the regime dynamics are well-established, contested, or speculative.	
II.8.a. Detailed description of alternate regime shifts A case study can contain more than one type of regime shift	Briefly describe the structure of each regime. What does each regime look like? What are differences in ecosystem structure and function? (e.g. permafrost loss, vegetation change)? How do the properties and behaviours of regimes differ? e.g. collapse of subsistence food sources, fundamental change in types of livelihoods, change in governance institutions, new actors with significant political power who transform decision making)	
II.8.b. Feedback mechanisms within the system that maintain each regime	Ecological feedback mechanisms	Social feedback mechanisms

II.8.c. What key changes drive regime shifts? Describe how these changes alter the state of the system or feedback processes.	a) Drivers of ecological regime shifts (either social or ecological). b) How do these changes alter biophysical feedback processes?	c) Drivers of social regime shifts (either social or ecological). d) How do these changes alter the social feedback processes?
II.8.d. Ecosystem services substantially impacted by regime shift	a) Changes in ecological processes that produce ecosystem services	b) Changes in demand for ecosystem services (market and non-market) c) Changes in the institutional context of ecosystem services e.g. changes in access and changes in how ecosystem services are valued as expressed by rules and regulations.
II.8.e. What is (+/-) impacted by changes in ecosystem services directly or indirectly	a) Impacts from regime shift on ecological components	b) Impacts from regime shift on social actors
II.8.f. Potential cascading effects	Describe, if any, the likelihood of potential ecological cascading effects to other SES	Describe, if any, the likelihood of potential social cascading effects to other SES
II.8.g. Where do actors intervene to alter regime shift dynamics	Ecological oriented interventions	Socially oriented interventions

and who can do the intervening?		

REFERENCES/ SOURCES CITED:

(1)	Frearson, A. 2014. White Arkitetker unveils masterplan for Swedish city relocation. *Dezeen Magazine*ı [online] 4 June. URL: http://www.dezeen.com/2014/06/04/white-arkitetker-the-new-kiruna-city-relocation-sweden/ [Accessed 5 November 2015].
(2)	Kinder, T. 2014. Kiruna: How to move a town two miles east. *British Broadcasting Company* [online] 6 March. URL: http://www.bbc.com/news/magazine-26447507 [Accessed 5 November 2015].
(3)	Kiruna Kommun. 2015. *The City Transformation - English*. [online] URL: http://www.kiruna.se/English/ [Accessed 5 November 2015].
(4)	LKAB. 2015. *Urban Transformations - English*. [online] URL: http://www.lkab.com/en/Future/Urban-Transformations [Accessed 5 November 2015].
(5)	Macguire, E. 2015. A Swedish town's dilemma: Move brick by brick or be swallowed by a mine. *CNN* [online] 27 January. URL: http://edition.cnn.com/2015/01/22/world/sweden-kiruna-mining-millipede-town/. [Accessed 5 November 2015].
(6)	Nilsson, B. 2010. Ideology, environment and forced relocation: Kiruna-a town on the move. *European Urban and Regional Studies* 17(4):433-442.
(7)	Wainwright, O. 2014. Kiruna: the town being moved 3km east so it doesn't fall into a mine. *The Guardian* [online] 22 October. URL: http://www.theguardian.com/artanddesign/architecture-design-blog/2014/oct/22/kiruna-sweden-town-moved-east-iron-ore-mine [Accessed 5 November 2015].
(8)	White Arkitekter. 2012. *Kiruna 4-ever project description*. [online] URL: http://www.white.se/en/projekt/268 [Accessed 5 November 2015].
(9)	Zeff, F. 2007. *Visions for a Sustainable Future Before Relocation of an Arctic Town*. MSc Thesis. Stockholm University, Stockholm, Sweden.
(10)	Abrahamsson, L., E. Segerstedt, M. Nygren, J. Johansson, B. Johansson, I. Edman, and A. Åkerlund. 2014. *Gender, Diversity and Work Conditions in Mining*. Luleå University of Technology, Luleå, Sweden. [online] URL: http://www.ltu.se/cms_fs/1.124549!/file/rapport%20Gender-diversity_low.pdf.
(11)	Khazaleh, L. 2015. *Forced displacement in Sweden: When a mine company demolishes and rebuilds an entire city*. Department of Social Anthropology, University of Oslo, Oslo, Norway. [online] 12 September. URL: http://www.sv.uio.no/sai/english/research/projects/overheating/news/lopez.html [Accessed 25 November 2015].
(12)	The Local. 2013. Mining threatens Sami reindeer grazing. *The Local – Swedish news in English.* [online] 24 December. URL: <http://www.thelocal.se/20131224/mining-threatens-sami-reindeer-grazing-traditions> [Accessed 25 November 2015].
(13)	LKAB. 2015. *LKAB begins to make personnel reductions*. [online] Available at: <https://www.lkab.com/en/media/news1/?ni=7937&c=&m=4:2015> [Accessed 27 November 2015].
(14)	Walker, B. and D. Salt. 2012. *Resilience practice: building capacity to absorb disturbance and maintain function*. Island Press,

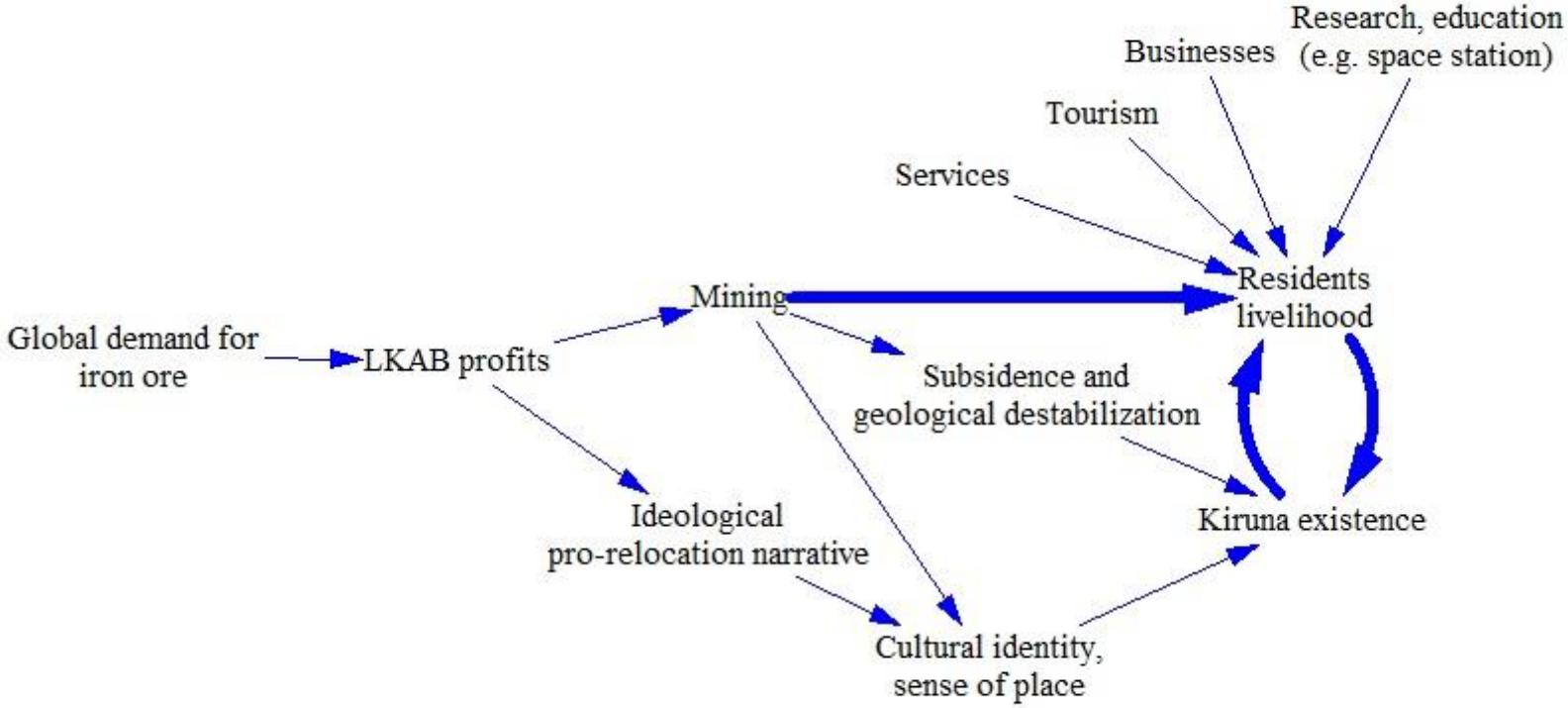
	Washington, D.C., USA.
(15)	Observatory of Economic Complexity. 2015. *What does Sweden export? (2013).* Harvard University, Cambridge, Massachusetts, USA. [online] URL: http://atlas.media.mit.edu/en/visualize/tree_map/hs92/export/swe/all/show/2013/ [Accessed 30 November 2015].
(16)	Avango, D. 2015. *Discussion about Kiruna relocation*. [interview] (Personal communication).

GLOSSARY OF TERMS IN THE TEMPLATE

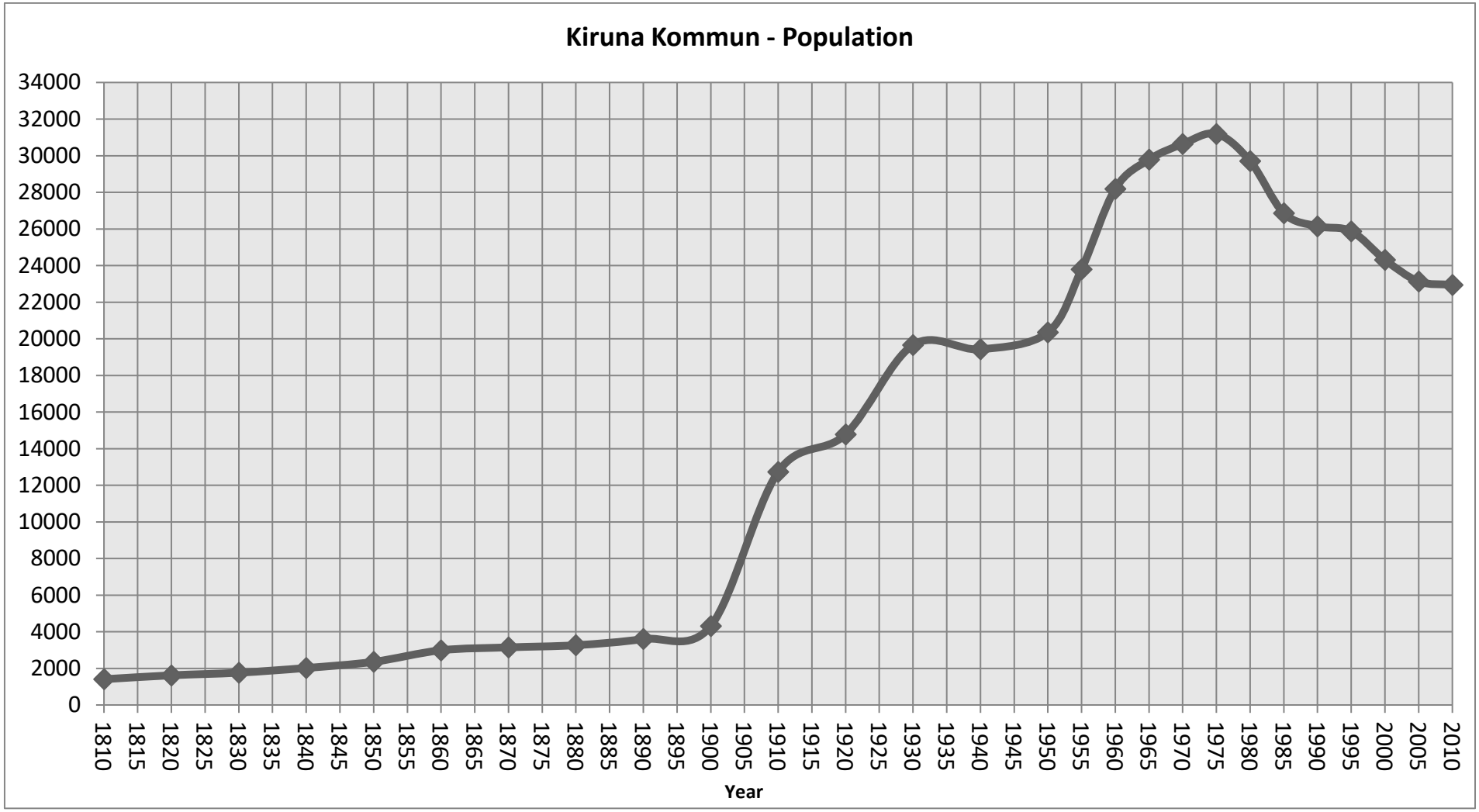
Actor	We use this term generally to look for individuals, groups, organisations, and so on that structure actions and/ or are stakeholders.
Adaptive capacity	Is the capacity of actors in the system to manage resilience in order to stay within a desired state during periods of change. This is related to the diversity in the system behind the provision of a function.
Disturbance	This refers to any disturbance to the system, regardless of scale, duration, intensity and frequency. See shock and stress.
Driver	Actor or process that directly or indirectly affects change in a social-ecological system. External means that the system in question (the scale being looked at) is unable to affect the driver in question – there is no feedback from the system to the driver.
Ecosystem services	The goods and services humans derive from ecosystems. These include: provisioning, regulating, cultural ecosystem services respectively.
Feedbacks	A change within a system that occurs in response to a driver, and that loops back to control the system. A feedback can help to maintain stability in a system (negative or balancing feedback), or it can speed up processes and change within the system (positive or enhancing feedback). Feedback processes play a very important role in determining system thresholds and in maintaining system resilience.
Institution	Here we refer to the humanly devised constraints that shape human interactions, such as rules, norms and laws. These can be formal or informal. Note that we are not referring here to institutions as organisations.
Regime shift	For complex systems, a substantial and enduring reorganization of the system, where the internal dynamics and the extent of feedbacks undergo change.
Resilience	This is a property, in this context of social-ecological systems. It relates to the capacity of a system to cope with disturbances and recover in such a way that they maintain their core function and identity. It also relates to the capacity to learn from and adapt to changing conditions, and when necessary, transform.
Shock	A sudden, unexpected disturbance. This kind of disturbance is often punctual, and has important impacts on large parts of the system.
Slow variable	When analysing complex system is often useful separating “fast” and “slow” variables. Fast variables often represent the primary concern of ecosystem users, for instance game or crop production. Slow variables shape the behaviour of fast ones but change slowly with respect to the overall dynamics of the system. Examples of slow variables might include permafrost thawing for a social-ecological system of Arctic hunters where the fast variable is game, or soil organic matter for an agricultural system where the fast variable is crop production.
Stress	This is a disturbance that has long persistence and often low intensity in impact.
Social-ecological system	This is an interwoven system of human societies and ecosystems. This concept emphasises that humans are part of nature and that these components function in interdependent ways. In the template identifying these interactions between the components aims to identify the processes and actors/ components that interact and particularly the feedbacks between the human-related

	components and the ecosystems/ biophysical components.
Stakeholder	See “actor”
Systems Diagram	This is using a diagram to illustrate the configuration of a system. This is done by defining its structure, function, and feedbacks. For a case there may be more than one diagram if the system changes in character (actors, processes, drivers, disturbances, feedbacks etc.) over time.
Timeline	The goal with the timeline is to capture important events – both punctual and over longer periods of time, identifying the causes of these events and the actors/ processes involved. This should be done chronologically and distinguishing events.

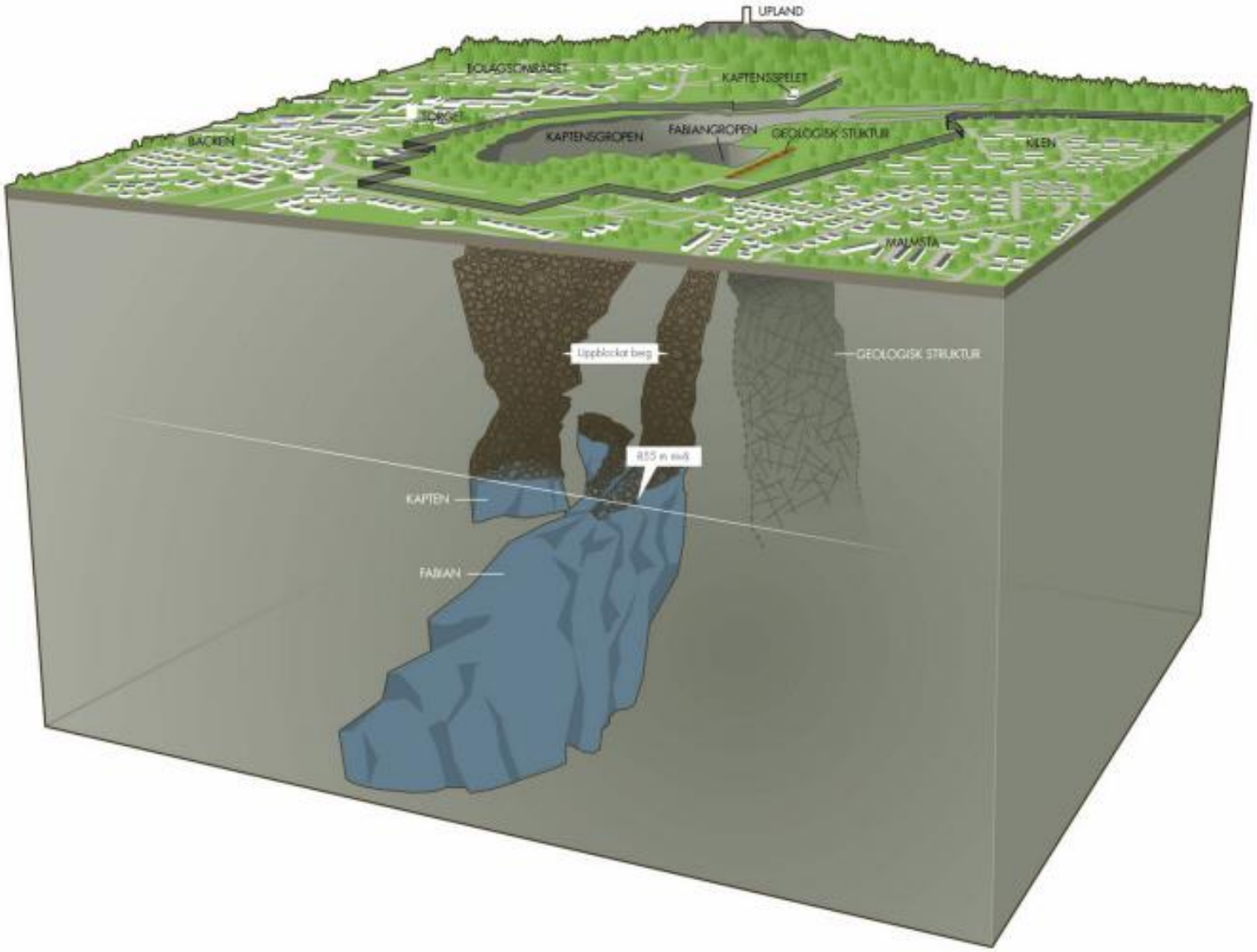
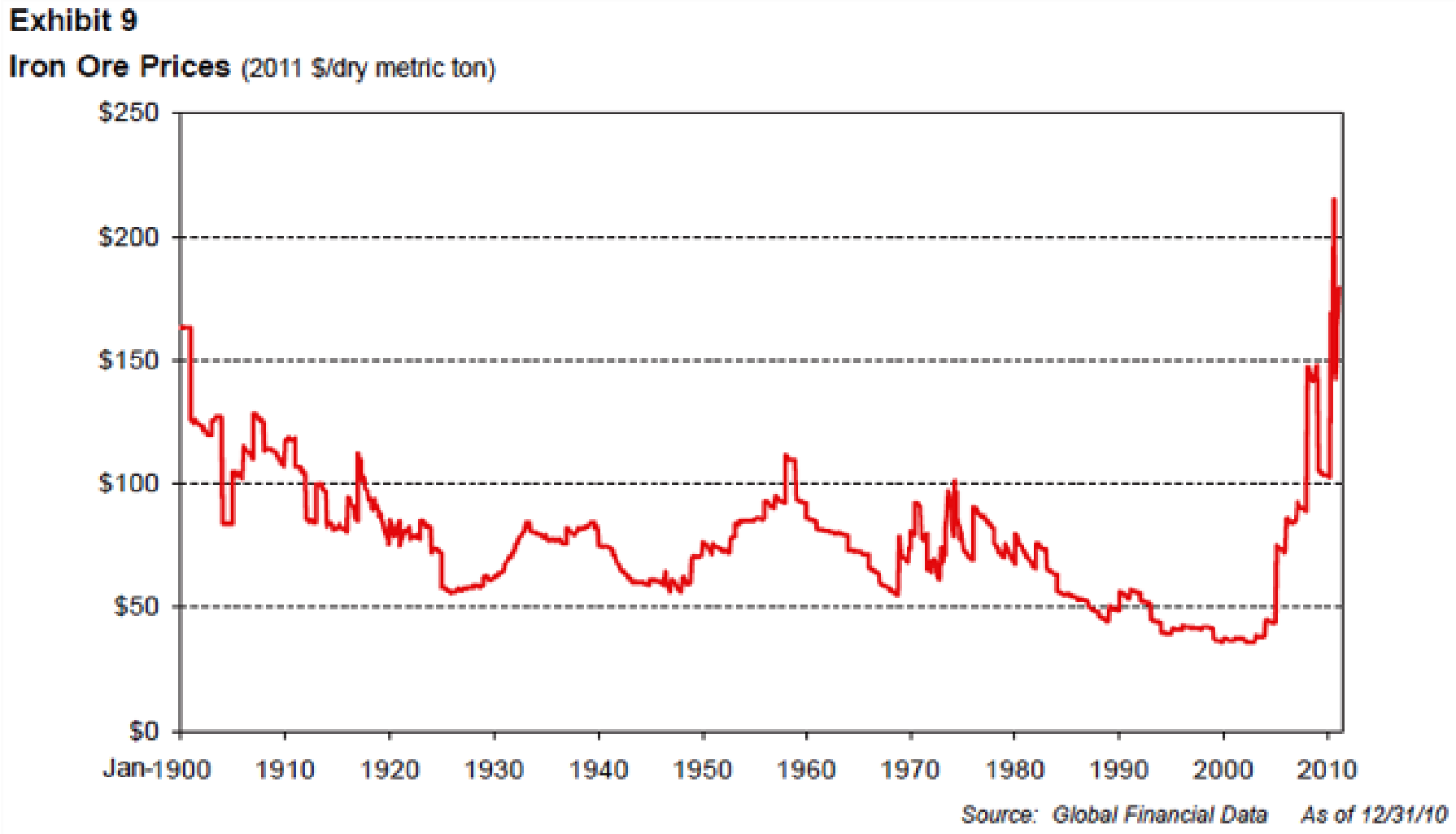
Appendix 1 A conceptual diagram of drivers of the relocation of Kiruna.



Appendix 2 Development of Kiruna population numbers, officially Kiruna was established in 1900 (from Demografiska databasen vid Umeå universitet and Statistiska centralbyrån - Folkmängd efter region och tid)



Appendix 3 Illustration of the positioning of the main iron ore body underneath Kiruna (from http://www.lkab.com/sv/Framtid/Samhallsomvandling/Varfor/Malmkroppen-Fabian/)



Appendix 4 Historical chart of global iron ore prices (from http://oilprice.com/Energy/Energy-General/Why-Falling-Resources-And-Rising-Prices-Demand-A-More-Thoughtful-Energy-Policy.html)