Name of the case study	Khara Tumul, Yakutia - Connecting local communities with urban communities, sharing networks evolution- Russia [Resilience]		
What about this case makes it interesting? How does this case contribute to understanding of resilience and/or regime shifts in the Arctic?	The Republic of Sakha (Yakutia) is the coldest place on the planet and is mainly permafrost. The area is experiencing a drastic effect of climate change, being one of the most vulnerable areas. The melt of permafrost, the increase in precipitation, and the land-use change increase the risk of flood in the area. Natural events such as floods have affected several villages, destroyed the infrastructure, and affected the ecosystem and the traditional livelihood. Besides the environmental impacts of climate change, industrial expansion shifts land- use, affecting the reproduction of traditional knowledge. Sakha communities implement different strategies to cope with the effects. Sharing traditions is based on trust, generosity, and reciprocity are the foundations of their resilience. Technology, social media, and transportation strengthen the networks, extended beyond local. The younger generation who lives in the city can support their communities with resources and make their community issues visible.		
Templated completed by: *Main contributor	Carla Lanyon, Stockholm Resilience Centre Juan Rocha*, Stockholm Resilience Centre	**Key references: Cite in the text using (1), (2), (3) etc. and provide a reference list at the bottom of the template.** (1) Solovyeva V and Kuklina V. 2020 . Resilience in a changing world: Indigenous sharing networks in the Republic of Sakha (Yakutia). Polar Record 56(e39): 1–9. (2) Sakai T. et al. 2018. Monitoring Spring Floods on the Lena River Using Multiple Satellite Sensors. In: Hiyama T., Takakura H. (eds) Global Warming and Human - Nature Dimension in Northern Eurasia. Global Environmental Studies.. 53-69 pp. (3) Fujiwara, J. 2018. Flood risk and migration in the Sakha Republic (Yakutia). In T. Hiyama, H. Takakura (eds.), Global Warming and Human - Nature Dimension in Northern Eurasia, Global Environmental Studies. 125–144. **(*) Mainly all the information comes from (1). Otherwise is explicit cited**		
Reviewed by (name and affiliation)			
Category	**Resilience/ Adaptability**	**Loss of resilience**	**Transformation**

	X						
Case study details:	**Country**	**Place**	**Scale – space**	**Scale – time**	**Sector(s)**	**Other (e.g. disturbance)**	
	Republic of Sakha	Khara Tumul Yakutia		1989-2020	Harvesting		

Drivers (mark with X in appropriate boxes)	**Climate**	**Geopolitical**	**Mineral/ oil extraction & infrastructure**	**Tourism**	**Shipping**	**Biological invasion**	**Rapid demographic change**	**Other: Socio-economic**
	x	x					x	

	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 series of diagrams to capture different periods in the case and the drivers/ actors/ events that characterize the period.	a) What types of ecosystem(s) and other major biophysical features are present? The Republic of Sakha (Yakutia) is the coldest place on the planet and almost entirely covered by permafrost. Permafrost is affected by the change in temperature and precipitation (2). b) How are the case boundaries defined in terms of ecosystems or biophysical characteristics? The political limits of the village Khara Tamul set the case study boundaries.	c) Who are the key groups of people in this case? The Sakha community in Khara Tamul is integrated by 29 households, 94 people based on the agricultural settlement. Yakutia is the central Arctic city with a population of rural and indigenous migrants. The city houses different ethnics and cultural institutions. New populations keep their contact and networks with the small village.. d) What kinds of livelihoods are important in the system? In Khara Tamul local community subsist from cattle, horse breeding, hunting, fishing, and gathering. They have access to water through the river and heat their houses using fire. Another source of income is the kindergarten where most women work and the heating station. Men tend to have seasonal works and develop subsistence activities out of the house. The Yakutia population works mainly in wage labour.

		e) What institutions are key to this case? National government who provides help during emergencies Rural and indigenous community from Khara Tumul Communities from Yakutsk that support local communities and act as mediators. f)How are the case's boundaries socially defined, and how do these social boundaries relate to biophysical boundaries? The administrative limits of Khara Tumul define the boundaries of the system.
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2. **Timeline** Draw a timeline of *key* events/ developments to the case. Define the time period (decades – centuries) over which change is considered, Provide a brief description of event/ actors, and ecological impacts Is it possible to 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. Consider both biophysical and social dimensions. Mark particularly significant events with *.	Sovietic Union Collapse 1998 increase of floods due to climate change (3)

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? Floods have become more common in the area. Land-use change due to industrialization development	b) Have there been major social disturbances that are relevant for the case? Floods, directly and indirectly, impact local households by, for example, destroying existing village infrastructure such as roads and bridges. Soviet Union collapse generates a deep crisis in Khara Tumul, leading to residents' migration to other villages and Yakutsk where the administrative buildings, schools, and shops are. Digital resources and media communication bring opportunities for sharing, exchange information, and connect urban with local.
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? The increase in temperature is two times faster in this region than in the rest of the world. This rapidly change has led to a change in hydrological dynamics in the area. The increase of precipitation and earlier melting affect the permafrost, increasing the risk of floods.	b) What are the key social drivers of change? Industrial development generates land-use change decreasing the space for local communities to reproduce their traditional livelihoods. Growing urbanization captures the young population's attention. Young people often move to the city and adopt the "modern" culture. Migration also generates a gender imbalance; women stay in rural areas while men tend to migrate to cities. Limited support from authorities in local communities.
5. **Sources of adaptive capacity:** What factors allow(ed) the system to adapt to disturbances in the past and present?	a) Within the ecosystem? (+) Spring flood fed the lakes in the area that provides fresh water to the village. (-) Floods events change the riverbed and landscape, affecting	b) Within society (e.g. people, social capital, management, institutions, infrastructure): (+) Network's revitalization. Networks have different purposes such as sharing among the community, connecting elder with the young; to connect urban with local for support; to share food or

Give a brief assessment of recent or on-going changes (+/-/0 = increasing/ reducing/ not affecting adaptive capacity)	biodiversity.	Money and during emergencies. (+) Extended distant networks promote the transmission of traditional knowledge and act as a remote community to represent pressuring the government to help their village. (-) The introduction of technologies to access social media may affect social sharing. (+) The introduction of technology and transportation has extended the sharing network beyond the local scale.

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 change and resilience in the face of change?	a) Within nature: Change: Warmer climates have increased natural events, such as floods. These events have affected the hydrological cycle, river beds, and biodiversity. Furthermore, the land-use change has affected the biodiversity of the area (2). Resilience is found in: Natural floods are part of the system allowing the community to subsist in the area providing water to the lakes and helping the agriculture production.	b) Within society: Change: Communities are facing a migration of young people, given the lack of job opportunities, cities are capturing the interest of young people. This has led to the adoption of "modern" culture in young people and a gender imbalance, more women remain in the rural sector. Industrial development used larger areas that affected space for local communities to reproduce their traditional livelihoods. Currently, communities are more dependent on wage labour, losing local knowledge associated with traditional practices. Resilience: The evolution of sharing networks allows people to have support themselves by sharing food, money, jobs and, among others, enhancing the resilience of the community. These share networks are based on traditional values such as respect, reciprocity. Social media and technology allow networks to go beyond the local and connected with distant networks, supporting local identity, and sharing knowledge. Remote networks put local issues into the government's plan, pushing for solutions, especially in emergencies.

II.2. What are the system's key components?	a) Key Ecological components (e.g., lakes, coastal zones, caribou) Lakes, rivers, land to reproduce traditional livelihoods, fish, cattle, horses.	b) Actors in society (e.g. individuals, groups, public or private organizations)? How are people organised – by geography, livelihood, family, etc.? Among families in rural areas, women and men have their roles and responsibilities. Women mainly worked at the kindergarten with a low salary. However, women are the leader in the house. She makes the decisions regarding sharing networks. Women are h aware of who needs help from the community and is the one connected with the distant actors. Therefore, they are more related to social media. Men have a seasonal job, with more salary than women. They oversee food by hunting and fishing and exterior domestic labour such as collecting wood, preparing water, feeding the cattle, bringing water from closer lakes. In the urban sector, young people work in different services with a regular income, relying less on natural resources. However, they support their local communities. Young people have the social responsibilities to help the elder share food, help them with physical labour and transmit technology skills. On the other hand, elders also have a role in sharing income from their pension to the households and transfer traditional knowledge.
II.3. What are the critical linkages? E.g. ecosystem services, resource extraction. These linkages should exist. If there are not mutual links between	a) From nature to society (e.g. ecosystem services) - Primary production - knowledge and educational values - Traditional livelihoods.	b) From society to nature – modifying nature, extracting resources (e.g. hunting, mining, water pollution) Fishing, hunting, farming, and harvesting

social 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? The rivers flow from south to north, making a difference in temperature between and upstream. During spring, rivers start to melt in the south, where it is warmer. Downstream the river is still thick, the ice obstructs the flow of water, increasing river level. This generates moderate floods necessary for subsistence, help with agriculture, and fill lakes in the area. Due to climate change, spring floods are becoming aggressive destroying villages and currently perceived as a risk for these areas (2) (3). The temperature has increased by 2-4 °C over the last century. The warmer environment impacts the water balance, altering evapotranspiration and increasing precipitation rate, especially during winter. Winter precipitation affects permafrost, hydrology dynamics among rivers and lakes, the biodiversity of the area (2). b) What are the most important biophysical tele-connections to distant systems?	c) What collaborations, conflicts, or other key linkages exist between actors? Regarding sharing networks, young people share physical labour helping older people and sharing food t from their subsistence activities. Elder receives the food and supports the households with their pensions. Elder also has the role to transmitting the traditional knowledge to younger generations and younger people share technology skills. d) Between local actors and distant actors? Distant sharing networks between Khara Tumul and Yakutsk through social media, especially between families. People from the rural communities send local food to the cities and help to support students. Sharing networks during emergencies. Due to the inefficient solution of the government with rural communities in an emergency. Communities organize them to raise money, especially between remote communities. Central management authority local communities do not have agency in the decision-making process.
II.5. Culture	a) How is the relationship between society and nature viewed?	c) What are key cultural features of relevance for the case? Khara Tumuls community relies on farming, hunting, cattle and horse breeding, fishing, and gathering. These activities play an important cultural role contributing to the self-identity of the community and strengthen the social bonds

	b) What meanings are attributed to nature and to interactions with nature?	d) What are key cultural practices and beliefs related to nature? Sharing network among the community is a practice that is still alive. Elders have been transmitting this practice through generations. People share food and goods without expecting something in return.
II.6. Disturbance What are important types of stress & shock	a) Describe important biophysical or ecological shocks and stresses (e.g. floods, storms, etc). Aggressive floods change the riverbed, lakes, and the land available to practice traditional livelihoods (1).	b) Describe important social shock and stresses (e.g. austerity policies, changes in government policy, introduction of new technologies, etc) The collapse of the Soviet Union Increase of floods or natural events The introduction of transportation technology and social media has strengthened the community's social network and allowed distant networks, revitalizing the sharing traditions.
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? - Loss of permafrost due to the increase of temperature and precipitation.	b) What types of slow social processes (e.g. aging, population growth, loss of language) are driving important changes in social institutions and behaviours? - Industrial development generates land-use change decreasing the space for local communities to reproduce their traditional livelihoods. - Growing urbanization captures young population attention generating migration. They tend to move into the city and adopt the "modern" culture. - Migration and gender imbalance in rural areas due to migration of man to the cities.

II.8. Relationships with ecological regime shifts	a) Are ecological regime shifts driving further ecological change or pressure? No ecological regime shift recognized in the case. b) Are external or internal ecological dynamics potentially or actually producing ecological regime shift(s)? The melts of permafrost could produce an ecological regime shift	c) Can social stresses or major changes be attributed to ecological regime shifts? Yes, the land-use change in the rural area may affect the ecosystem causing a regime shift. However, more information is needed to recognize an ecological transition. 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)?	
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	a) Changes in ecological processes that produce ecosystem	b) Changes in demand for ecosystem services (market and

services substantially impacted by regime shift	services	non-market)
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 SE	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 and who can do the intervening? This can be listed here or marked with (*) in the table above	Ecological oriented interventions	Socially oriented interventions

REFERENCES/ SOURCES CITED:

(1)	Solovyeva V and Kuklina V. 2020. Resilience in a changing world: Indigenous sharing networks in the Republic of Sakha (Yakutia). Polar Record 56(e39): 1–9.
(2)	Sakai T. et al. 2018 Monitoring Spring Floods on the Lena River Using Multiple Satellite Sensors. In: Hiyama T., Takakura H. (eds) Global Warming and Human - Nature Dimension in Northern Eurasia. Global Environmental Studies. 53-69 pp.
(3)	van Fujiwara, J. 2018. Flood risk and migration in the Sakha Republic (Yakutia). In T. Hiyama, H. Takakura (eds.), Global Warming and Human - Nature Dimension in Northern Eurasia, Global Environmental Studies. 125– 144pp.
(4)	
(5)	

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.