Name of the case study	Kyllakh Village – Flooding and relocation – Russia [Loss of resilience]					
What about this case makes it interesting? How does this case contribute to understanding of resilience and/or regime shifts in the Arctic?	During the last decade the number of catastrophic floods on Lena river, caused by climate change, has dramatically increased (3). Local population expresses concern about a lack of the government involvement and consistency in the prevention and/or mitigation action on the local, municipality and the region level (4). In 2002 after several catastrophic floods the Government of Sakha passed a resolution to relocate the most affected flooded villages (3,5). First relocation work began in 2005 when the village Kyllakh was relocated to a non-flooding terrace on the right bank of Lena river - settlement Dapparay (3, 5). The local government's attempts to relocate the settlement created a number of challenges within the pastoralist community (3). Due to a number of socio-economic challenges, only a small number of residents moved to the new settlement. The residents have experienced major social shocks caused by the relocation. The local government has not considered the residents' needs and priorities during the relocation. That resulted in difficulties to adapt to a new place and unwillingness to move (3).					
Template completed by:	Julia Olsen, Nordland Research Institute, University of Nordland Grete Hovelsrud, Nordland Research Institute, University of Nordland		**Key references: Cite in the text using (1), (2), (3) etc. and provide a reference list at the bottom of the template.** (3) Filippova, V. V. 2011. Social Challenges of Periodic Flooding in Yakutia. *Arctic and the North* 4:204-208. (5) Crate, S. A. 2013. *Climate change and human mobility in indigenous communities of the Russian Nort*h. Brookings-LSE Project on Internal Displacement, The Brookings Institution, Washington, DC, USA.			
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)**
	Russia	Villages Kyllakh and Dapparay in	Kyllakh is located on an	2000-present	Pastoralists	The area has been affected by extensive and

		Sakha Republic (upper River Lena)	island (2x3 km) in the River Lena					novel flooding that has called for the relocation of the village with limited success
Drivers (mark with X in appropriate boxes)	**Climate**	**Geopolitical**	**Mineral/ oil extraction & infrastructure**	**Tourism**	**Shipping**	**Biological invasion**	**Rapid demographic change**	**Other:** ***state here***
	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?** Average January temperature: from −30 to −35 °C and average July temperature: from +12 °C in the mountains to +18 °C in the valleys. **b) How are the case boundaries defined in terms of ecosystems or biophysical characteristics?** The settlement of Kyllakh, Olyokminsky District, is on an island area in the middle of the Lena River - 60°12'46", 119°55'59". The drainage basin of the Lena River	**c) Who are the key groups of people in this case?** Key stakeholders: - Residents of Kyllakh (Dapparay village). Number of inhabitants: Population - 1,181 in 2010. Households – 327. - Local authorities. Olyokminsky District is an administrative and municipal district, one of the thirty-four in the Sakha Republic, Russia. Kyllakh *nasleg* (settlement of Kyllakh and Dapparay) is one of the 23 municipalities in the region. - Government of Sakha **What kinds of livelihoods are important in the system?** The local economy is based mostly on agriculture and cattle and horse breeding (Pastoralism, fishing, hunting, and gathering). **f) What institutions are key to this case? If possible define what scale it addresses.** Olyokminsky District is an administrative and municipal district, one of the thirty-four in the Sakha Republic, Russia. Kyllakh *nasleg* (settlement of Kyllakh and Dapparay) is one of the 23

		municipalities in the region. Local arrangements and dialogues with municipal leaders vs. Regional policies and resolutions. Local population expresses concern about a lack of the government involvement and consistency in the prevention and/or mitigation action on the local, municipality and the region level **g) How are the case's boundaries socially defined, and how do these social boundaries relate to biophysical boundaries?** Before the relocation the social boundaries were limited to the physical area of the island. However due to relocation and partly movement of some of the residents to Dapparay village, the social boundaries were extended.

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 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.	

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?** Large-scale in time and space floods. The extent of these are new phenomena and are associated with climate change	**b) Have there been major social disturbances that are relevant for the case?** Relocation of settlements to mitigate impacts of flooding, have incurred socio-economic disruptions
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?** Warm springs (temperatures) and changes in seasonality became a reason for earlier river open and thus catastrophic floods in Yakutia.	**b) What are the key social drivers of change?** In 2002 after several catastrophic floods the Government of Sakha passed a resolution to relocate the most affected flooded villages (3,5). First relocation work began in 2005 than village Kyllakh was moved to a non-flooding terrace on the right bank of Lena river - settlement Dapparay (3,5). However due to a number of socio-economic challenges only 10% percent of residents moved to a new place. The residents have experienced major social shocks caused by the relocation of the settlement. The local government has not considered the residents' needs and priorities during the relocation. That resulted in difficulties to adapt to a new place and unwillingness to move (3). The main reasons keeping inhabitants at the old flooded place were: - Poor planning of living conditions: new houses did not have a central heating system (3,5); - Small size of allotted land makes it difficult for the majority of Kyllakh residents to breed cattle and horses (3). Therefore some of the residents probably will not move to a new place (5) - Difficulties with social adaptation. Families with school-age children had to move to a new settlement so children could go to school. However men had to stay on the old place and take care of livestock (3) - Lack of economic support. Not everybody could receive credit to buy a new house (5).
5. Sources of adaptive	**a) Within the ecosystem?**	**b) Within society (e.g. people, social capital, management,**

capacity: What factors allow(ed) the system to adapt to disturbances in the past and present? Give a brief assessment of recent or on-going changes (+/-/0 = increasing/ reducing/ not affecting adaptive capacity)	(+)The construction of dams, (+)The deepening of river beds (+)River bank protection (-) permafrost thawing	**institutions, infrastructure):** (+) leads to (0 or -) Re-settlement: To ensure the safety from flooding of people the government relocate the settlement to a non-flooding terrace. However a: (-)lack of the government monitoring and prevention programs, (-)a lack of local funding budget and a (-)lack of governance coordination became a barrier in adaptation process (7). (-)Lack of economic support (-) place attachment is high to the original settlement place, which together with the former 3 points reduced scope for a successful relocation. (+) social networks, sharing activities, gender roles, traditional knowledge

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** Local population expresses their concern about local climate change. At the same time they do not consider the negative impacts of climate change as a major threat to their communities due to the number of socio-economic problems (7) Socio-economic challenges kept Kyllakh residents at the old flooded place: - Poor planning of living conditions: new houses did not have a central heating system (3,5); - Small size of allotted land makes it difficult for the majority of Kyllakh residents to breed cattle and horses (3). Therefore some of the residents probably will not move to a new place (5) - Difficulties with social adaptation. Families with school-age children had to move to a new settlement so children could go to school. However men had to stay on the old place and take care of livestock (3), - Lack of economic support. Not everybody could receive credit to buy a new house (5).
II.2. What are the system's key components?	**a) Key Ecological components (e.g. lakes, coastal zones, caribou)** Freshwater: river Lena and lakes Permafrost (Yakutia is located on permafrost with the average thickness 1500 m.) taiga	**b) Actors in society (e.g. individuals, groups, public or private organizations)? How are people organised – by geography, livelihood, family, etc.?** - Households (Residents of Kyllakh and Dapparay village). Number of inhabitants: Population - 1,181 in 2010. Households – 327. - Local government. Kyllakh *nasleg* (settlement of Kyllakh and Dapparay) is one of the 23 municipalities in the region - Olyokminsky municipal district, one of the thirty-four in the Sakha Republic, Russia.

		- the Government of Sakha
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 and ecological components the case is not a social-ecological system.	**a) From nature to society (e.g. ecosystem services)** Agriculture, pastoralism, hunting, fishing, gathering Water regulation Habitat – for targeted species for extraction Habitat for grazing	**b) From society to nature – modifying nature, extracting resources (e.g. hunting, mining, water pollution)** Agriculture Hunting, Fishing, Gathering Pastoralism Damming river, dredging rivers
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?** Concern about an increasing number of catastrophic floods, and lack of the government involvement and consistency in the prevention, and/or mitigation action at the community, municipality and region level (2, 4). Local authorities underestimate scale and effects of floods. **d) Between local actors and distant actors?**
II.5. Culture	**a) How is the relationship between society and nature viewed?** According to traditions, the local population perceive and treat nature as “mother”.	**c) What are key cultural features of relevance for the case?** Yakutians are the most northern pastoralists. Residents perceive changes to be a direct threat to the traditional cattle breeding.

	b) What meanings are attributed to nature and to interactions with nature?	**d) What are key cultural practices and beliefs related to nature?** An important behaviour norm is gathering, fishing and hunting, which does not exceed the population needs.
II.6. Disturbance What are important types of stress & shock	**a) Describe important biophysical or ecological shocks and stresses (e.g. floods, storms, etc.)** Floods Floods damage infrastructure (6), narrow farmland and residents territories, change transportation routes, and have a negative impact on to the traditional cattle breeding (1, 2).	**b) Describe important social shock and stresses (e.g. austerity policies, changes in government policy, introduction of new technologies, etc)** Poor planning of living conditions: new houses did not have a central heating system. Small size of allotted land makes it difficult for the majority of Kyllakh residents to breed cattle and horses. Lack of economic support. Not everybody could receive credit to buy a new house.
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?** Permafrost thawing, seasons come late, changes in wind (1), fewer birds and animals, and the arrival of new species including a variety of insects, sudden changes in the temperature, more snow, standing water and more flooding.	**b) What types of slow social processes (e.g. aging, population growth, loss of language) are driving important changes in social institutions and behaviours?** Difficulties with social adaptation. Families with school-age children had to move to a new settlement so children could go to school. However, men had to stay on the old place and take care of livestock. Despite the challenges caused by relocation, the population of Kyllakh has increased from 1055 in 2001, to 1181 in 2010 (5). However, in other rural settlements with a similar

		socio-ecological system the population is decreasing, mostly due to flooding.
II.8. Relationships with ecological regime shifts	**a) Are ecological regime shifts driving further ecological change or pressure?** **b) Are external or internal ecological dynamics potentially or actually producing ecological regime shift(s)?**	**c) Can social stresses or major changes be attributed to ecological regime shifts?** The local population expresses their concern about local climate change and reported that they cannot read the weather anymore (1). However, they do not consider the negative impacts of climate change as a major threat to their communities due to the number of other socio-economic problems (7). **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)?** Permafrost loss, increasing number of catastrophic floods, new species. **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)** Changes in traditional ways of life, relocation.	
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).** Warm spring temperatures increase the amount of floods on Lena river. 205 villages were inundated. **b) How do these changes alter biophysical feedback processes?**	**c) Drivers of social regime shifts (either social or ecological).** Relocation to a new place due to catastrophic floods, caused by climate change, limited the ability to breed cattle. **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** (-) Pastoralism activities were mostly affected. Small size of allotted land makes it difficult for the majority of Kyllakh residents to breed cattle and horses (3).
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 and who can do the intervening?	**Ecological oriented interventions**	**Socially oriented interventions** Improve the decision-making process by local authorities Relocation process requires the involvement of local population's ideas and concerns.

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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.