DATA CAPTURE TEMPLATE

We welcome additions, clarifications and response on the information in the case. If you wish to make your response directly in the template clearly mark your additions in a Word document using "track changes" or highlight your additions in the template. If you provide a references or other details please make clear how this compliments the template.

Please send to Juan Rocha juan.rocha@stockholmresilience.su.se and ARR@sei-international.org.

Name of the case	Reindeer herding in the Yamal Peninsula in Yamal-Nenets Autonomous Okrug (YNAO)	
study		
Main Contributors	Students from the 2014 Resilience Thinking course at the Stockholm Resilience Centre (Stockholm University): Svetlana Avelova, Anna Degteva, Jonas Gren, Vivi Mellegard, Hanna Ahlström, Linda Lindström, Ashley Perl, and Philipp Siegel	Key references: Cite in the text using (1), (2), (3) etc. and provide a reference list at the bottom of the template .
Other Contributors	Svein Mathiesen; Miriam Huitric	
What about this case makes it interesting? How does this case contribute to understanding of resilience and/or regime shifts in the Arctic?	Herding has been a traditional livelihood in different being to key ecological dynamics that could potentia Peninsula fared comparatively well to other herding of life. Currently the largest disturbance to herding is transportation, to which Nenet herders have adapted.	communities across the Arctic linking their cultural practices and well- lly change in the near future. Additionally, herding in the Yamal cases in Siberia in terms of being able to maintain their traditional way is the increase amount of infrastructure related to gas exploration and

	Biophysical	Social
1. Basic	a) What types of ecosystem(s) and other major biophysical	c) Who are the key groups of people in this case?
description of	features are present?	Nenets – The indigenous people living in the Yamal
coupled social-	Yamal Peninsula in western Siberia	region, the Yamal Nenets Autonomous Okrug, can be
ecological	Tundra – pastures, wetlands	either nomadic herding or non-nomadic.
system in focus	Taiga – pastures, wetlands	Nenet nomadic herders, around 5,000, have been
(What are the key	Water/ Ice crossings	reindeer herding for up to 2000 years in the southern
components and		part of the peninsula and at least 700 years in the
stake holders)	b) How are the case boundaries defined in terms of ecosystems	Bovanenkovo area; (4)
	or biophysical characteristics?	Reindeer herders and their organisations: The herding
If possible draw a	Tundra/ Taiga – climatic zone	activities are structured in different enterprises,
systems diagram or	Movement through the boundaries varies annually and depends on:	composed by several <i>brigades</i> which in turn consist of
conceptual map of	season, herd's welfare, weather conditions, grazing status, mosquito	herding families. (4).
the case – this can be	status,	
a series of diagrams		Local indigenous NGOs: play an important role in
to capture different	A system map of social and biophysical actors and components	promoting their organization's interest e.g. Nenets'
periods in the case	including the main global drivers of the YNAO's SES and how they	rights (3).
and the drivers/	are connected on a global/national, regional, and local scale (1)	
actors/ events that		Local and regional governmental agencies
characterize the		
period.		Extractive industries –
		Recently immigrated workers – especially late 2000's
		– development of modern communities along the
		coastline – for extraction and communities (7).
		d) What kinds of livelihoods are important in the
		system?
		Most important ES for herders are provisional services,
		such as reindeer or fish, during winter and summer
		migration (5). Cultural services are provided by
		specific sites that serve rest or spirituality purposes.
		Reindeer herding. Livelihood is connected to



	part of its agricultural sector (3). National authorities provide for instance subsidies to herding Nenets for slaughtered reindeer to regulate herd size (8).
	International human rights agreements and indigenous peoples legislation and agreements give the basis for the national legislation (9).
	 f) How are the case's boundaries socially defined, and how do these social boundaries relate to biophysical boundaries? The social boundaries are defined through the
	individual Nenets reindeer herding brigades. The social boundaries also extend to those groups who interact with the reindeer brigades (such as the hydrocarbon workers, government representatives, and NGO representatives).
	Nenet herders brigades travel from the south end of the peninsula in the winter in the taiga area, to the north end in tundra pastures in the summer months. Moving through grazing grounds and grounds for calving females and the males. 1,200 km. Notably, hydrocarbon development has impacted the brigade's migration routes.









1939-45 – WW2
1950 – Ob'Bay did not freeze – spent winter on autumn pastures Decree of central committee of farmers' amalgamation
1960s Sovkhozy – strict borders for the brigades From 1960s onwards – increased immigration onto peninsula. Until then mainly inhabited by Nenets
1971 – Boanenkovo – gas field exploration 1973 – Law on 2dry education - 1974 – Port Kharasavey
 1980s – Fur trade collapses Kruzenshternskoe gas field explorationIn the 1980s hydrocarbon exploration began in the YNAO, which contains the largest known gas deposits in the world (7). The development of infrastructure and industry has changed the land use and degraded pastures in some parts of the Yamal Peninsula (7). Change of migration routes in northern Yamal Dismiss (?) hunting brigades of Yarsalinsky – increase private herders?? 1985 - Conflict with gas company – brigadier commits suicide 1985 - Start railway by Transstroy 1987 - Perestroyka 1987 - reduced control of number of reindeer slaughtered *1989 – Gazprom company started Bovanenkovo gas field active 1989 – NGO Yamal to decendents
 1990s *1991 – USSR collapses 1990-98 economic crisis At the same time, climate change – began to be felt in the 1990s, is affecting tundra vegetation and producing unexpected climatic conditions that pose challenges to the Nenets' migrations and a resulting loss of reindeer (7).

	1994 – first private gas company	
	1998 – regional laws on reindeer husbandry	
	1999, 2000, $2001 - Laws$ on indigenous peoples	
	1999 – ice event kills part of herds	
	2000 – gas and oil prices increase – increased number of plant	s built and railways
	2000 = FU slaughter house	s built, and failways
	2006 - influx of labour begins	
	2006 - ice cover of pastures which blocks access	
	2007 – Northern Sea Route opened for first time	
	2010 – decrease herb size	
	2011 – early melt of Ob'Bay	
	2013 – suspected Brucellosis cases	
3. Disturbances	a) Have there been major biophysical disturbances that	b) Have there been major social disturbances that are
What are the key	are relevant for the case?	relevant for the case?
disturbances in the		
system (present and	Snow/ ice cover events – unexpected and extreme events:	Restrictions to traditional family units – boarding school
past)	permatrost thawing, rain-on-ice events	Loss of TEK as a hand structures mismation nottoms losues
	Insect sworms must find loss infected grounds reduce	Loss of TEK – e.g. nerd structures, migration patterns. Issues
	survival of young	seen as the largest threat to the survival of their traditional
	survivar or young.	knowledge and lifestyle due to the foreign influence
		increased modernization of the society (3: 6)
	Infrastructure-related events – loss of grounds/ routes – must	
	change and increase routes to go around infrastructure and	After 1990s crisis – loss of income due to loss of subsidies:
	plants	results in subsistence husbandry.
	Reindeer – hoof disease caused by litter and waste hidden in	Forced relocation of Nenets by Soviet Union from 1935-
	shrubs from hydrocarbon industry. Reindeer step on litter,	1985
	causing wounds and contributing to infections	
	Reindeer – warble fly outbreaks – can be treated	Development of the hydrocarbon industry starting in the
	Industrial waste – damages reindeer hooves	1980's

		Herders forced to relocate from certain parts of the peninsula
		due to land fragmentation
		Russian-EU pipeline built in 2012
4. Drivers of change	a) What are the key biophysical drivers of change?	b) What are the key social drivers of change?
Clarify what impacts		The main social shock – and subsequent drivers – that the
these drivers have on	Reindeer herd – maintain the herd through calve production,	Nenets experienced was the establishment of the USSR (14),
the SES and if these	in turn affected by disease, survival, attacks from worker's	which limited freedom or their traditional lifestyle.
are direct or indirect	dogs	
		TEK not valued/ captured by science and non-indigenous
	Landcover changes:	managers – loss of activities and knowledge.
	The vegetation available determines the land's carrying	Loss of TEK – e.g. herd structures, migration patterns. Issues
	capacity for reindeer (2013). Gone from: shrub to grass/	related to globalization and sedentarization of Nenets are
	lichen/ moss cover – this is regulated by grazing rates of	seen as the largest threat to the survival of their traditional
	reindeer and clearing of land for infrastructure by gas	knowledge and lifestyle due to the foreign influence,
	companies (10; 5; 7).	increased modernization of the society (3; 6).
	Shrub encroachment in the north (12).	
		1990s – fall of the USSR increased ability to live by
	Fragmentation of landscape:	traditional lifetstyle, while economic crisis meant fewer
	Changes in vegetation cover – shrub encroachment, reduces	subsidies
	grazing – due to increased temperatures and over grazing.	
	Lichen cover – takes 15-20 yeas to re-establish, long time to	Demands on stable production of reindeer
	recover from shrub cover.	Subsidies were introduced to regulate herd size but appear to
	Loss of grazing lands – lost to infrastructure and plants for	cause have the opposite effect because they are an incentive
	resource extraction.	to keep a big herd and sell more reindeer (8). Ended in
	Loss of access to grazing lands – cut off by infrastructure and	1990s.
	plants	
		Developers to Yamal-Nenets SES influence soil formation,
	Climate change:	landscape tragmentation, and other environmental factors
	Temperature changes: Arctic temperatures have increased an	through creating infrastructure (/). Development contributes
	average of 2 °C with forecasts suggesting a 7 °C increase	to a warming of the permatrost, which again encourages
	over 30 years.	shrubs to establish (10).

Loss of fish due to poaching (and possibly), which is an important part of Nenets summer diet (1).Loss of access to /between grazing grounds. The Nenets are concerned about the progressive loss of pastures, campsites and sacred sites; and gas workers' poaching of reindeer and fish (5, 7). Competition for higher terrain from Nenets and industry. F the former it offers good chum sites and shelter from heat and mosquitoes that stress their reindeer. For industry high terrain offers better drainage (4). The outcomes for Nenets this competition could be: poor grazing and possible herd loss; stressed herds caused by loss of higher ground to esc mosquitoes; and change migration route leads to delay in getting to next grazing area (at higher scale this affects oth brigades).Nenets – suffering lung diseaseNew resource exploiters – increased since 1980s and even	This has already resulted in longer growing seasons (12), and would impact the migration route and vegetation available to reindeer (3; 8). Warmer summers – Permafrost thawing; insect harassment increases, earlier break-up of ice in spring and later setting of the ice – reducing time to complete migrations. More frequent abrupt weather events; extremely high temperatures, sea level rise, new disease and pests (5; 7).	Global market for gas (7) The global market price for gas is the main indirect driver to historic and further exploitation on the Yamal peninsula (15). The higher the price gets due to increased consumer demand, the more profitable gas extraction becomes. Russia has a special interest Yamal's hydrocarbon resources as means to secure energy for the whole nation until 2030 (16).
New resource exploiters – increased since 1980s and even	Loss of fish due to poaching (and possibly), which is an important part of Nenets summer diet (1).	Loss of access to /between grazing grounds. The Nenets are concerned about the progressive loss of pastures, campsites and sacred sites; and gas workers' poaching of reindeer and fish (5, 7). Competition for higher terrain from Nenets and industry. For the former it offers good chum sites and shelter from heat and mosquitoes that stress their reindeer. For industry high terrain offers better drainage (4). The outcomes for Nenets of this competition could be: poor grazing and possible herd loss; stressed herds caused by loss of higher ground to escape mosquitoes; and change migration route leads to delay in getting to next grazing area (at higher scale this affects other brigades).
faster in 2000s – Increased immigrant population, industrial development, (2 6).		New resource exploiters – increased since 1980s and even faster in 2000s – Increased immigrant population, industrial development, (3, 6).

		indigenous workers and Nenets is an issue in the region as field workers frequently disrespect and/ or do not understand the Nenets traditions (5; 7).
5. Sources of adaptive 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)	 a) Within the ecosystem? (+) Nenets know that smaller herds increase overall herd heterogeneity. Reduced herd sizes are more resilient because every herd has specific individual characteristics (6). Phenotypic variance amongst reindeer within herds increases resilience because diverse types of reindeers can cope differently with various environmental situations (9). (-) With respect to Nenets usage of YANO, land conversation has degraded the ecosystem that the Nenets rely on. (-) Climate change has reduced the ecosystem's adaptive capacity through creating extreme and unexpected weather events, and changing the season length (1, 2) 	 b) Within society (e.g. people, social capital, management, institutions, infrastructure): (+) The Nenets' understanding of natural processes and their environment is that everything underlies constant change. Every year is different and there are weather variations as well as human influence. Their mind-frame is highly resilient through their acceptance of change. The Nenets have established a wide array of methods to cope with disturbances which has allowed them to keep their lifestyle in the face of change (8; 6). They are adaptive and flexible when it comes to land changes. (+) At the landscape level, Nenets' knowledge at the micro scale about growth cycles of lichen enable them to travel to the best pastures at the right time of year to ensure the reindeer get the right minerals and nutrients for optimal health (4). This intimate knowledge of the landscape enables them to be flexible when there are obstacles such as physical barriers through land use change and industrialisation and when climate events. In spring 2005 Se-Yakha River thawed two weeks early and the Nenets speeded up the migration to get to cool pastures providing insect relief and nutritious meadows for growth of calves (6). (+) Nenet culture and way of life has survived despite enormous social, political and economic events, including collectivisation between 1928-1933, the collapse of the LISSR and the subsequent economic crisis in the 1990s (4, 5)

	 (-) At higher scales the Yamal SES is constrained by governance and legislation about land rights. For example in 1961 the Sovkhozy was established with defined borders for each brigade's migration. The implications across scales is that external drivers such as land use change and pasture degradation due to industrialisation can force Nenets to use migration routes outside their specified territories. This might increase competition between brigades for good pastures. Sudden acceleration and expansion of BIC alongside industrial development at the regional scale would reduce the choices of migration routes available. (-) One of the key factors during the Soviet-era administration to remain resilient was that the government did not restrict private ownership of animals. The intrusion of the Soviet system made the other indigenous groups lose their adaptive capacity through confiscation of private property, and forcefully sedentarizing nomads (6). (+?)The Nenets were the only indigenous group in Siberia that was able to cope with this political change and not lose its autonomy. When the Soviet Union collapsed, Nenets were still self-sufficient because they had maintained private herd ownership (3).
	Adapting to new development:
	(+) Nenets have domesticated their reindeer to such an extent that they are able to cross gas installations, which would be considered impossible among the wilder Norwegian reindeer (3).

		(+/0) There is some cooperation between Nenets and hydrocarbon workers. For instance, Nenets accept mobile phone communication to co-ordinate migration through (BIC), but refuse car transportation through BIC (4); However, it's hard to say if this is helping to degrading Nenets adaptive capacity when it comes to nomadisim.
		(+?) National legislation today allows the Nenets to remain resilient.
The next two sections information pertinent	break down the information in Section I. While it is not nece to specific rows below feel free to enter the material.	ssary to fill these sections, if you have additional
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 Genetic diversity in herds – within and between.	 b) Within society Reindeer herder NGOs Flexibility – open to and understand change (2) Mobility – resilient herders must migrate constantly (2) Independence – rely on herds for sustenance (food and clothes), and also self-autonomous (making decisions at the herd level) (2)
II.2. What are the system's key components?	 a) Key Ecological components (e.g. lakes, coastal zones, caribou) Grazing lands – taiga tundra 	 b) Actors in society (e.g. individuals, groups, public or private organizations)? How are people organised – by geography, livelihood, family, etc.?

	Reindeer	Sedentary Nenets
	Waterways	Nomadic Nenet reindeer herders – organised in Brigades.
	•	Groups of families migrating together. Do communicate
		between brigades for migration.
		6 6
		Gas extraction-related communities
		Organised in sector:
		gas production/extraction;
		transport: rail, pipeline or ship
		communities: eg shops, schools (?)
II.3. What are the	a) From nature to society (e.g. ecosystem services)	b) From society to nature – modifying nature, extracting
kev linkages?	Dry, high grounds – desired for grazing and animal relief and	resources (e.g. hunting, mining, water pollution)
v B	for infrastructure.	
E.g. ecosystem		Overexploitation of fish in waterways – poaching by
services, resource	Grazing grounds for reindeer – move by season and for	hydrocarbon workers (1, 2)
extraction.	female and male grounds – need areas for grazing and shrubs	
	for fuel wood.	Pollution from development – damages reindeer hooves
These linkages should		1 0
exist. If there are not	Provisioning ES – reindeer, salmon, fuel wood.	Fragmenting the landscape
mutual links between	Cultural ES – spiritual grounds, interaction between nature	
social and ecological	and society.	Overgrazing and shrubification
components the case is		
not a social-ecological	Nenets culture is deeply rooted in the landscape (cultural	
svstem.	ecosystem service) (1, 2).	
5		
	Hydrocarbon extraction from the landscape for societal use	
	in Russia and Europe (1, 2)	
II.4. What are key	a) What are the key ecological interactions within the	c) What collaborations, conflicts, or other key linkages
interactions?	case?	exist between actors?
	Grass/ shrubland	Conflict
	Open/covered water ways	Lack of feedback to the groups of actors associated with gas
		mining creates conflict between these and the Nenets.

	 b) What are the most important biophysical tele- connections to distant systems? Reindeers moving through Yamal peninsula to just off the peninsula 	Both Nenets and industry want higher terrain because it is beneficial for reindeer or hydrocarbon extraction, respectively.
	Climate change – increased hydrocarbon development will not only indirectly contribute to climate warming, but will also reduce Albedo (removing vegetation for development creates a warming effect on the Yamal peninsula) (1)	Industry and infrastructure is fragmenting the landscape – reducing access to grounds needed and increasing migration routes. Not yet a conflict but could become.
	ereates a warning erroet on the Tanhar permissing) (T)	Immigrants do not understand or respect indigenous way of life.
		Immigrants over-fishing water ways
		Collaboration Plants stop transport and activity to allow herders and herds through. National government supports indigenous rights and way of life.
		 d) Between local actors and distant actors? Governance and legislation about land rights. For example in 1961 the Sovkhozy was established with defined borders for each brigade's migration. Sudden acceleration and expansion of BIC alongside industrial development at the regional scale would reduce the choices of migration routes available Global gas market influences gas companies on Yamal
II.5. Culture	a) How is the relationship between society and nature	c) What are key cultural features of relevance for the
	viewed?	case? Nanots livelihood, way of life and cultural identity is
	Seen as a nonstic system	inextricably linked to both their reindeer and the land on
	b) What meanings are attributed to nature and to	which they live and depend.

interactions with nature?	 d) What are key cultural practices and beliefs related to nature? Get meat from reindeer, create clothes from hides. Nomadic way of life relies on migration between summer and winter pastures.
 a) Describe important biophysical or ecological shocks and stresses (e.g. floods, storms, etc). Non-crossable ice Water on ice events Insect infestations 	 b) Describe important social shock and stresses (e.g. austerity policies, changes in government policy, introduction of new technologies, etc) USSR – limited way of life, size of hers, ownership rights 1990s – subsidies removed 1980s to date – increased competition from extraction and transport of gas. Globalization Development of hydrocarbon industry Potential for governmental changes to influence the Yamal peninsula, and therefore the Nenets population
 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? Reinforcing feedback – large shrubs cannot be grazed by reindeers → more shrubs → warmer soil ↑ nutrients → plant growth (5; 17) Large numbers of reindeers graze shrubs and grass and trample and add nutrients to the soil, so as to enforce the productive grass-dominated state (5,18). A key variable that could show nonlinear behaviour is the 	 b) What types of slow social processes (e.g. aging, population growth, loss of language) are driving important changes in social institutions and behaviours? Large herd size reinforces a nomadic way of life There are two stable regimes for the Nenets, one nomadic and one sedentary (5;7). There is a strong consensus among Nenets, scientists and Russian society that keeping the Nenets' nomadic lifestyle is the desirable state, since it is part of a long Arctic tradition, is an important source of knowledge about tundra life and forms a rich culture (3). It is not clear whether the shrub or the grass state is desirable
	 interactions with nature? a) Describe important biophysical or ecological shocks and stresses (e.g. floods, storms, etc). Non-crossable ice Water on ice events Insect infestations 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? Reinforcing feedback – large shrubs cannot be grazed by reindeers → more shrubs → warmer soil ↑ nutrients → plant growth (5; 17) Large numbers of reindeers graze shrubs and grass and trample and add nutrients to the soil, so as to enforce the productive grass-dominated state (5,18). A key variable that could show nonlinear behaviour is the

	 vegetation. It is not clear to what extent nor at what speed the observed shrub encroachment is taking place. In a scenario where the number of grazing reindeers decrease, it is possible that large areas of Yamal could shift to the stable shrub vegetation state. Fragmentation of the pastures could have nonlinear effects on RH in Yamal. High connectivity between the parts is important for the resilience of RH, since mobility between seasonal pastures underpins the function of the system through provision of grazing land, insect relief areas and resting places (4). Increased temperatures – warmer summers Faster thawing of permafrost and ice cover 	Reindeer depend on a diversity of shrubs, moss, lichen, grass pastures (13). In a future case where most of the shrub land turned to grass, or vice versa, the resilience of nomadic herders would likely decrease.
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? Development is contributing to land and vegetation change (1, 2) Development is also contributing directly to local warming and indirectly to climate change (1, 2) d) Are there specific social practices that might be contributing to ecological regime shifts? Development is changing the vegetation – land fragmentation has caused areas to become densely covered in shrubs
II.8 Regime	If a regime shift exists and is important to this case describ	e it below.

shifts	Please indicate whether the regime dynamics are well-establish	ned, contested, or speculative.
 II.8.a. Detailed description of alternate regime shifts A case study can contain more than one 	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)? Potential regime shifts is from steppe to tundra and tundra to shrub-dominated. Steppes are grass-dominated systems usually in drier environments which have higher primary production and nutrient cycling. Tundra are dominated by moss and have lower primary production and nutrient cycling.	
type of regime shift	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) From the ecological perspective, a shift towards bushy vegetation will further reduce the grazing area for reindeers. Warmer climates could also promote permafrost thawing with implication for global carbon storage. From the social perspective that	
II.8.b. Feedback mechanisms within the system that maintain each regime	 could represent a major impact on traditional livelihoods and t Ecological feedback mechanisms Grazing Nutrient cycling feedback Competition between vegetation types Soil moisture Shrub microbial activity Albedo Soil drainage Shrub permafrost mechanism 	 herefore their culture. Social feedback mechanisms Castration regulations (national) Controlled prices (national) Landscape reading according to current and previous years for pasture condition and accessibility; and snow/ ice cover Migration feedback: determining when to move. Market feedbacks: demand of meat is unclear In the past subsidies were offered for production issues

II.8.c. What key	a) Drivers of ecological regime shifts (either social or	c) Drivers of social regime shifts (either social or
changes drive regime	ecological).	ecological).
shifts?	Warming (slow variable) – affects: freezing and thawing	Energy and infrastructure development, competing land uses.
	events (fast variables) – changes land cover, access to	
Describe how these	grounds,	
changes alter the state		d) How do these changes alter the social feedback
of the system or	Herbivory, herding, and grazing intensity; hunting;	processes?
feedback processes.	temperature increase; climate change; green house gas	The development sectors encroaches the area available for
_	emissions.	herding, in coastal Finnmark up to 35% or reduction has
		been reported.
	b) How do these changes alter biophysical feedback	
	processes?	
	Herbivory mediates the competition between grasslands and	
	shrublands, while climate change increases temperature,	
	extreme events, and precipitation regionally. Warmer	
	temperatures promote shrub encroachment further north.	
II.8.d. Ecosystem	a) Changes in ecological processes that produce	b) Changes in demand for ecosystem services (market
services substantially	ecosystem services	and non-market)
impacted by regime		
shift	Primary productivity, biomass available for grazing, and	Preferences about meat consumption is unclear at present.
	nutrients cycling is affected with the regime shift. In	
	addition, the ecological structures that have allowed the	Increasing demand of energy, development of infrastructure.
	Nenets culture to prosper and adapt to its environment could	
	disappear.	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 (+/-)	a) Impacts from regime shift on ecological components	b) Impacts from regime shift on social actors
impacted by changes		
in ecosystem services	(-) Shifts in land cover have potential impacts on the albedo	(-) the shift will decrease the adaptive capacity of herders by
directly or indirectly	feedback, climate regulation and carbon sequestration which	further encroachment of their activities threatening their

	reinforces itself and potentially other regime shifts in the Arctic.	livelihoods
II.8.f. Potential cascading effects	Describe, if any, the likelihood of potential ecological cascading effects to other SES Speculative: Although it is uncertain the strength of the	Describe, if any, the likelihood of potential social cascading effects to other SES
	coupling, this regime shift can increase fresh water runoff to the sea, affecting sea-ice formation and when aggregated at the global level, to some extend the thermohaline circulation.	
II.8.g. Where do actors intervene to alter	Ecological oriented interventions	Socially oriented interventions
regime shift dynamics	At the local to regional scale, actors can intervene by	Government intervention that historically have affected the
and who can do the	changing grazing pressure and migration patterns. At the	system includes the introduction of mandatory schooling.
intervening?	global level, actors need to reduce carbon emissions.	Ensuring that Nenets are able to pass down their TEK to younger generations would be one way to intervene with the
This can be listed here		social regime shift.
or marked with <mark>(*)</mark> in		
the table above		
REFERENCES/ SOUR	CES CITED:	
(1)	Ahlström H, Lindström L, Perl A, and Siegel P. 2014. Resilie	ence Assessment: Nomadic Nenets of the Yamal Peninsula.
	Class assignment for the course: Resilience Thinking at Stockholm Resilience Centre, Stockholm University, Stockholm, Sweden.	
(2)	Avelova S, Degteva A, Gren J, Mellegard V. 2014. Resilience	e Assessment Case Study
	Reindeer husbandry (RH) in Yamal Peninsula (Yamal) SES.	Class assignment for the course: Resilience Thinking at
	Stockholm Resilience Centre, Stockholm University, Stockhol	olm, Sweden.
(3)	Mathiesen, pers. Comm, 2014 – in references (1) and (2)	
(4)	Degeteva, A. & Nellemann, C. 2013. Nenets migration in the	landscape: impacts of indutrial development in Yamal
	peninsula, Russia. Pasoralism: research, Policy and Practice 3	3:15.
(5)	Forbes B.C., Stammler, F., Kumpula, T., Meschtyb, N., Pajur	nen, A., Kaarlejärvi, E., and Turner, B.L. 2009. High

	Resileince in the Yamal-Nenets social-ecological system, West Siberian Arctic, Russia. Proceedings of the National
	Academy of Sciences 106:22041-22048.
(6)	Forbes, B. C. 2013. Cultural resilience of social-ecological systems in the Nenets and Yamal-Nenets Autonomous Okrugs,
	Russia: a focus on reindeer nomads of the tundra. Ecology and Society 18(4): 36
(7)	Kumpula T, Forbes BC, Stammler F, Meschtyb N. 2012. Dynamics of a coupled system: Multi-resolution remote sensing in
	assessin social-ecological response during 25 years of gas field development in Arctic Russia. Remote Sensing 4:1046-1068
(8)	Eira, R. B. M. 2012. Using Traditional Knowledge in Unpredictable Critical Events in Reindeer Husbandry. The case of
	Sámi reindeer husbandry in Western Finnmark, Norway and Nenets reindeer husbandry on Yamal peninsula, Yamal-Nenets
	AO, Russia. University of Tromsø. Master of Philosophy in Indigenous Studies, 48
(9)	Magga, O.H., Mathiesen Svein. D., Corell R.W., Oskal A.(eds). 2013. EALÁT Reindeer Herders' Voice: Reindeer
	Herding, Traditional Knowledge and Adaptation to Climate Change and loss of Grazing Land. Arctic Council SDWG
	EALÁT- Association of World Reindeer Herders. Kautokeino: International Centre for Reindeer Husbandry Report
(10)	Forbes, B.L. 1999. Land use and climate change on the Yamal Peninsula of northwest Siberia: Some ecological and socio-
	ecological and socio-economic implications. Polar Research 18:367-373
(11)	Kumpula, J., Parikka, P., and Nieminen, M. 2000. Occurrence of certain microfungi on reindeer pastures in northern Finland
	during winter 1996–97. Rangifer 20:3–8.
(12)	Macias-Fauria M, Forbes BC, Zetterberg P, Kumpula T. 2012. Eurasian Arctic greening reveals teleconnections and the
	potential for structurally novel ecosystems. Nature Climate Change 2:613–618
(13)	van der Wal, R., 2006. Do herbivores cause habitat degradation or vegetation state transition? Evidence from the tundra.
	Oikos, 114:1, 177–186
(14)	Krupnik, I. 2000. Reindeer pastoralism in modem Siberia: research and survival during the time of crash. Polar Research
	19:49-56
(15)	Arctic Council. 2013. Arctic Reslience Interim Report 2013. Stockholm Environment Institute and Stockholm Resilience
	Centre, Stockholm
(16)	Oskal et al.2009, EALAT Reindeer Herders' Voice: Reindeer Herding, Traditional Knowledge and Adaptation to Climate
	Change and Changed Use of the Arctic. Arctic Council SDWG EALAT-Information Ministerial book, International Centre
	for Reindeer Husbandry and Association of World Reindeer Herders. Kautokeino: International Centre for Reindeer
	Husbandry Report.
(17)	Myers-Smith, I. (2007). Shrub Line Advance in Alpine Tundra of the Kluane Region: Mechanisms of Expansion and
	Ecosystem Impacts. Arctic, 60(4), 447-451
(18)	Olofsson, J., Oksanen, L., Callaghan, T., Hulme, P. E., Oksanen, T., & Suominen, O. (2009). Herbivores inhibit climate-
	driven shrub expansion on the tundra. Global Change Biology, 15(11), 2681–2693

Arctic Resilience Assessment Group