Name of the case study	Igloolik – Food security in Arctic Inuit community – Nunavut, Canada [Transformation]	
What about this case makes it interesting? How does this case contribute to understanding of resilience and/or regime shifts in the Arctic?	An area of concern in arctic regions is food security for indigenous inhabitants. Food security exists "when all people at all times, have physical, social, and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (5). This case study is based in the Canadian arctic hamlet of Igloolik, Nunavut, a community of 1600-2000 people (6, 7, 8), 95% Inuit (1). Igloolik is situated on an island, in an arctic tundra environment; sea ice is present for 9 months/year (1). As for many indigenous arctic communities, since the development of tighter connections to the western world and lifestyle from the 1950's, Igloolik's food system has expanded to become dual (Appendix 3): food security is both determined by harvested traditional foods (e.g. seals, walrus, caribou) and store-bought foods imported from mainland Canada (3, 9, 10). The three areas that define food security (food access, availability and utilization) are subject to multiple drivers, both biophysical and socio-economical, causing the community to face episodes of food insecurity (2, 3, 10). Food security is the basis for life, therefore analysing the dynamics of this food system contributes to the overall understanding of Arctic resilience and is relevant to other communities around the Arctic where food systems have been changing rapidly. This case illustrates the need for new food systems (e.g. store food) to be integrated with traditional food systems in order to enhance food security rather than reduce it and to support rather than erode the culture.	
Template completed by: *Main contributors	Students from the 2015 "Systems Theory and Resilience Thinking" course at the Stockholm Resilience Centre (Stockholm University): Hanna Linnéa Kylin*, Stockholm Resilience Centre Rawaf Al Rawaf*, Stockholm Resilience Centre Daniele Crimella*, Stockholm Resilience Centre Cornelia Ludwig, 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) Laidler, G. J., J. D. Ford, W. A. Gough, T. Ikummaq, A. S. Gagnon, S. Kowal, K. Qrunnut, and C. Irngaut. 2009. Travelling and hunting in a changing Arctic: Assessing Inuit vulnerability to sea ice change in Igloolik, Nunavut. *Climatic Change* 94(3-4):363-397. (3) Ford, J. D., and M. Beaumier. 2011. Feeding the family during times of stress: Experience and determinants of food insecurity in an Inuit community. *The Geographical Journal* 177(1):44-61. (9) Ford, J. D., and L. Berrang-Ford. 2009. Food security in Igloolik, Nunavut: an exploratory study. *Polar Record* 45(03):225-236.

Reviewed by (name and affiliation)								
Category (mark with X)	**Resilience/ Adaptability**			**Loss of resilience/ Collapse**			**Transformation**	
							X	
Case study details:	**Country**		**Place**	**Scale – space**	**Scale – time**		**Sector(s)**	**Other (e.g. disturbance)**
	Canada		Igloolik, Nunavut	Community (focal scale), Hunting grounds and surrounding communities (up to ~700 km far)	1950s' - present		Food security of the community	Several drivers affecting the food system of Igloolik
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	x	x	x			"Westernization" (knowledge and values shift)

	Biophysical	**Social**
1. Basic description of coupled social-ecological system in focus (What are the key components and stake holders) If possible draw a	a) What types of ecosystem(s) and other major biophysical features are present? Arctic coastal environment (see Appendix 1 at end of template), Igloolik is on an island. Ecosystem type is polar tundra with relatively flat topography, the sea is frozen for most of the year (late October-late July) (1), some freshwater bodies are present on land (8).	c) Who are the key groups of people in this case? Community members have differing availability, access and utilization of food based on their livelihood, age class, sex (9): • **Full- and part-time hunters** - Suppliers of traditional foods; sources and maintainers of Inuit knowledge. • **Wage earners** - Financially support the harvesting of traditional foods and procurement of store-bought food

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.	"Walrus (*Odobenus rosmarus*, aiviq in Inuktitut) and ringed seals (*Phoca hispida*, natsiq in Inuktitut) are the marine staples of wildlife harvest; harbour seal (*Phoca vitulina*, qasigiaq), bearded seal (*Erignathus barbatus*, ujjuk), narwhal (*Monodon monoceros*, allanguak), beluga whale (*Delphinapterus leucas*, qilalugaq), and bowhead whale (*Baleana mysticetus*, arviq) are also occasionally harvested" (1). b) How are the case boundaries defined in terms of ecosystems or biophysical characteristics? The concept of foodshed: "The local processes and actors involved in the production, processing, distribution and exchange of food within [the] specific geographic area," (12) is useful to frame the boundaries of this system. For traditional foods, the limits are the hunting grounds and the surrounding communities involved in the food sharing practices (see Appendix 1 in template). As traditional livelihood is increasingly less prominent (1, 9) this foodshed is shrinking. Store-bought foods are instead mainly indirectly linked to this biophysical system, as they mainly derive from the Canadian (and global) food market (3, 4), defining their boundaries is much more complex, possibly this aspect of the foodshed is expanding.	• **Youth, middle-aged, and elders** - Knowledge and preferences dictate the future direction/makeup of food system • **Males, females** - Differing gender roles with respect to livelihoods and Inuit knowledge, where males are traditionally harvesters, and females take care of preparing and distributing the food (matrilineal knowledge transmission) (11) External actors to the community also play a fundamental role in defining food security, most importantly: • **Policy makers** - Coordination of funding and development projects aimed at enhancing food security; as well as general economic development; Public administration as a main employer (3) • **Healthcare professionals** - Health monitoring of community; providers of nutritional knowledge (4) d) What kinds of livelihoods are important in the system? • Harvesting (hunting/fishing/gathering): Traditionally the only way of food procurement, and the most socially and culturally relevant activity for the community (3, 9) • Wage employment in new economic activities: recent developments of the seasonal mining industry, the developing tourism sector - mostly linked to sport hunting of arctic game, and the opening of new sea shipping routes offer possibilities to earn a wage (3) • Support services: due to harvesting and the other economic activities, forms of support work emerge, in the fields of business (e.g. stores, technical services...), education, public administration, healthcare,

		transportation management (by air and sea), communications etc. (3) e) What institutions are key to this case? If possible, define what scale it addresses. • Hunters and Trappers Organization (HTO): local organization representing the interests of harvesters in defining hunting and fishing regulations • Inullariit society: local organization in Igloolik, working to preserve and promote Inuit knowledge • Nunavut Tunngavik Incorporated (NTI): legal representative of the Inuit of Nunavut for the purposes of native treaty rights and treaty negotiation • Government of Nunavut (GN): - Nunavut wildlife management board: main agency responsible for wildlife management - Department of culture, language, elders and youth: responsible for developing and implementing policies to strengthen Inuit culture, language and heritage - Department of fisheries and oceans: define fishing quotas - Department of environment: provide financial support and insurance to harvesters f) How are the case's boundaries socially defined, and how do these social boundaries relate to biophysical boundaries? Physical boundaries are defined by the distance of hunting grounds and of other communities, the area covered for procuring traditional foods is very large and dynamically

		changing. Biophysical boundaries of the system are way bigger than the boundaries of the community itself. When accounting for store-bought food, boundaries become blurred, as the community is indirectly connected to the global food system. This cross-scale interactions has an uncertain role for food security, allowing Inuit to procure food in times of little harvest, but also exposing them to global economic market fluctuations (3, 10)

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.

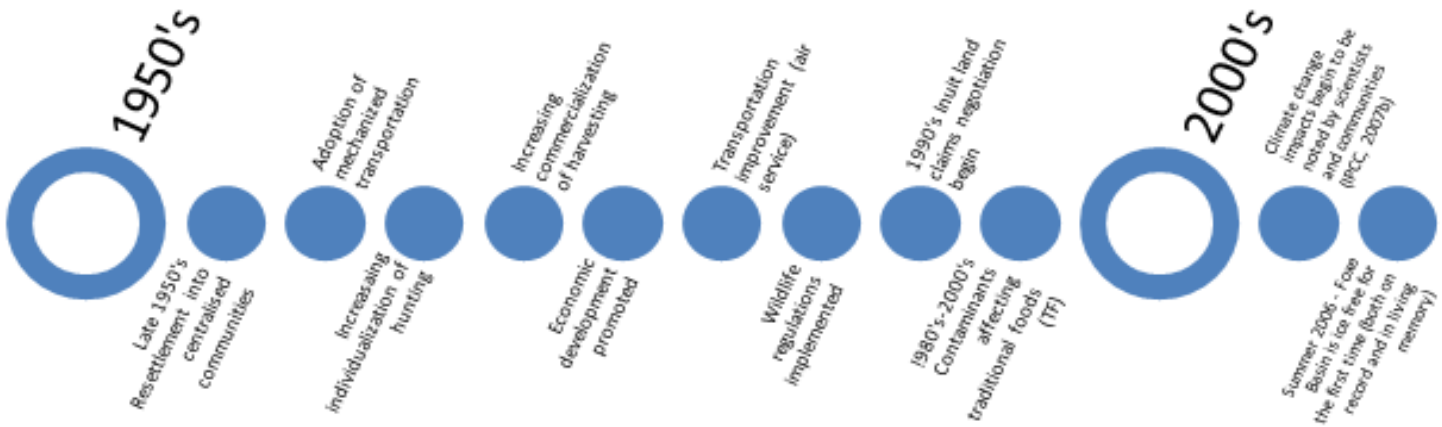
Additional points that can be considered:

Is it possible to identify periods of change from one type of system to another, transformations?

From (4)

Table 2
A summary of changes affecting Canada's Inuit population since the 1950s. Note that specific dates at which these changes occurred differs by region and community, and the date attached can be considered an approximate generalization (based on Myers et al., 2005).

	Change	Impact
1950s	Resettlement of Inuit into centralized communities	Reduced harvesting, increased participation in wage economy, changing socio-cultural norms, reduced mobility
	Adoption of mechanized transportation replacing dog	Travel further and faster to hunt and fish, dependence on imported technology, need cash income for subsistence activities
	Increasing individualization in hunting	Reduction in group hunting activities
	Increasing commercialization of harvesting	Increasing commercialization of aspects of hunting to support subsistence, participation in international markets, animal rights campaigns target hunting activities, increasing importance of money
	Economic development promoted	Big resource development affect wildlife health and population, increasing integration into global economic markets
	Transportation improvement	Development of regular scheduled flights improves access and importation of food, improved opportunity for economic development
	Wildlife regulations implemented	Affects the flexibility of harvesting by controlling what can harvested, when, and where for certain species, conflict among hunters regarding division of quotas, conflict with regulatory agencies.
	Inuit land claims negotiations begin	Increased political power and decision making capability for Inuit, increasing community involvement in decision making
	Contaminants affecting traditional foods	Anxiety over traditional food consumption
2000s	Climate change impacts begin to be noted by scientists and communities	Alteration to access and availability of traditional foods, increasing danger, international political actors begin to demand decreased hunting activity



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? • Hunted species' health due to contaminants accumulated in the Arctic environment (2, 9) can determine significant and abrupt loss of traditional food sources	b) Have there been major social disturbances that are relevant for the case? • Irregular food deliveries, while imported food can provide alternatives to food access, irregular deliveries severely aggravate a traditional foods scarcity condition (2) • Loss of major capital investments due to accidents (e.g. hunting equipment/snowmobiles lost in the sea due to unfavourable ice conditions) (1), lead to major disturbances in a family's finances up to loss of livelihood
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? **Refer to CLD in Appendix 2**. Climate change dynamics, mainly linked to an increase in average temperatures in all seasons (1, 2, 3, 4, 9, 10, 11): • Snow cover (direct): snowing later and thawing earlier, increased variability in snow quantity and conditions (e.g. compactness) → affecting traveling on snow (possibility of using snowmobiles, increased gasoline use), and therefore hunting and traveling to surrounding communities (food sharing) • Sea ice dynamics (direct): later and slower ice freeze-up, earlier ice break-up; thinning ice; more snow on ice	b) What are the key social drivers of change? **Refer to CLD in Appendix 2**. **Economic** (direct and indirect) dynamics increasingly influence access to food, with a necessity to have financial resources to access expensive store food (1, 11). Traditional food is being increasingly sold as opposed to the traditional way of harvesting for subsistence and sharing within the community and with other communities (3). Developing economic activities, such as mining, tourism and shipping, while allowing for diversification of livelihood, creates disparity within groups and erodes Inuit

	(1) → affecting mobility as sea ice allows to travel to hunting grounds (e.g. for caribou, or fishing lakes) and other communities; provision of habitat for hunted species (e.g. walrus, ringed seal) (1) • Weather variability (direct and indirect): unpredictable wind changing of predominant direction, more frequent storms → define critical safety conditions for hunting and traveling, such as visibility, ice thickness, snow conditions. • Geomorphological processes (direct and indirect): thawing permafrost, accelerated coastal erosion, more active slope processes → impacts infrastructures that may be damaged; reduces suitable habitat for hunted species; riskier conditions for traveling; emission of greenhouse gases reinforcing global warming	culture (1). The emission of toxic pollutants from those activities further aggravates the risk of contaminants in traditional foods (9). Global economic market fluctuations in price of food and other commodities (e.g. gasoline, extracted minerals) influence both directly and indirectly Inuit families' ability to access food (1, 9). **Social** change (direct) occurring as "westernization", or a shift in the knowledge and values systems towards: - more individualistic practices - preference for store-bought food - disinterest in traditional culture and activities - language barriers - inter-generational segregation - educational system requirements - increased importance of financial means This implies a direct erosion of Inuit knowledge, impacting: - the skillset necessary to harvest - the process of sharing food, equipment and commodities - the know-how for preparing, storing, cooking traditional food **Political** processes (direct and indirect) also affect food security, especially when a mismatch exists between the governance system at higher levels (e.g. government and international institutions) and local level dynamics (e.g. hunting bans on protected species). Influence on prices of store-bought foods and other essential commodities or infrastructures through taxation

		and subsidies also impact food access.
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? • (+) Diversity of traditional food sources (1): marine and terrestrial, animal and plant-based respond differently to environmental change and thus allow to always have something to harvest	• Within society (e.g. people, social capital, management, institutions, infrastructure): • (+) Maintenance of traditional knowledge (1): →allows to manage the risks of harvesting in changing/unfavourable ice, snow and weather conditions by identifying signs in the environment →maintenance of a strong social network, where food, commodities (e.g. harvesting equipment) knowledge are shared, attenuating/ spreading/ sharing disturbances that may affect parts of the network →flexibility in hunting; harvesting what, where and when available; applying a conservationist ethic (not over-harvesting, just taking what is necessary) • (-/0) 'Westernization' (1): →erosion of traditional knowledge, especially in younger generations and non-fulltime harvesters, resulting in loss of harvesting skills and of capacity to cope with uncertainty, this is exacerbated by the increasing introduction of new hunting technologies (e.g. GPS) →change of sharing networks, with a trend towards individualization, in contrast to the community-oriented sense of collective responsibility →Financial constraints, as there is an increasing importance of money (for food, mobility, equipment…), which creates social tension, especially between generations Access to store-bought foods: • (+) can provide alternative food source in times of scarcity

		• (+/0/-) depending on selection of food in stores can affect diet • (-) can erode traditional food-related activities, e.g. hunting, food sharing and the social capital associated with these activities
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 and ecological components the case	a) From nature to society (e.g. ecosystem services)	b) From society to nature – modifying nature, extracting resources (e.g. hunting, mining, water pollution)

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 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? 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	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?	

A case study can contain more than one type of regime shift	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	Ecological oriented interventions	Socially oriented interventions

dynamics and who can do the intervening?		

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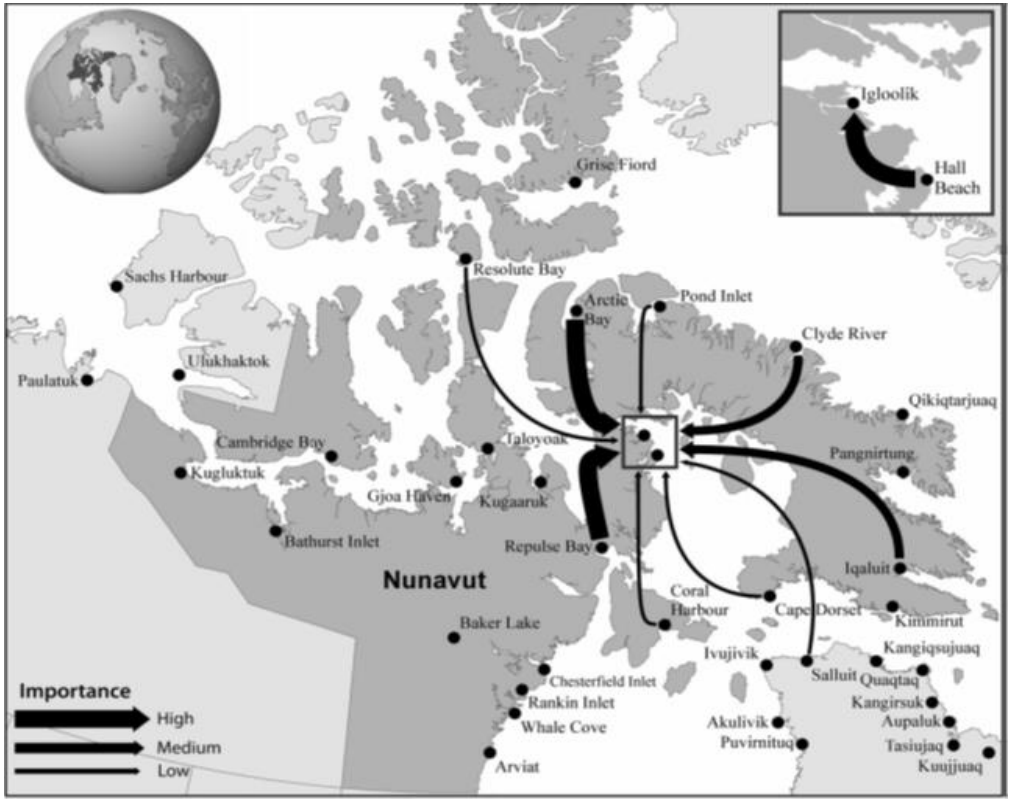
GLOSSARY OF TERMS IN THE TEMPLATE

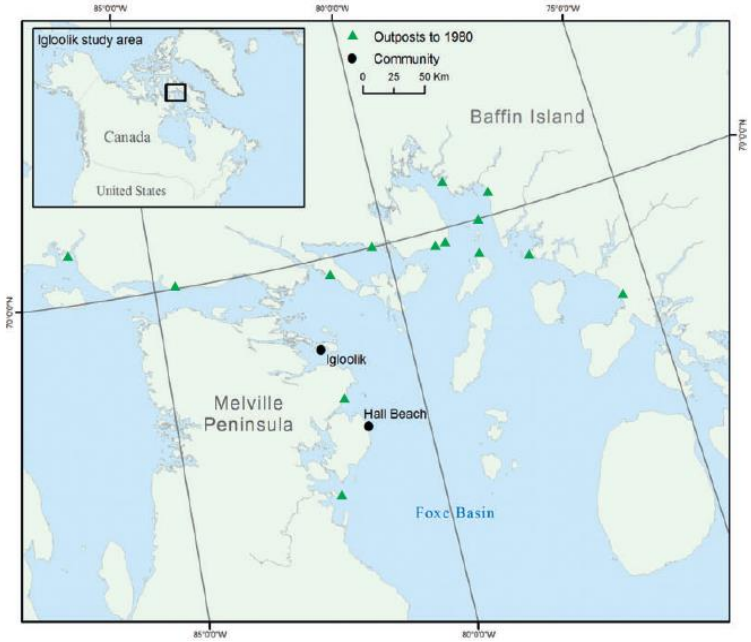
Actor	We use this term generally to look for individuals, groups, organisations, and so on that structure actions and/ or are stakeholders.
Adaptive capacity	Is the capacity of actors in the system to manage resilience in order to stay within a desired state during periods of change. This is related 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

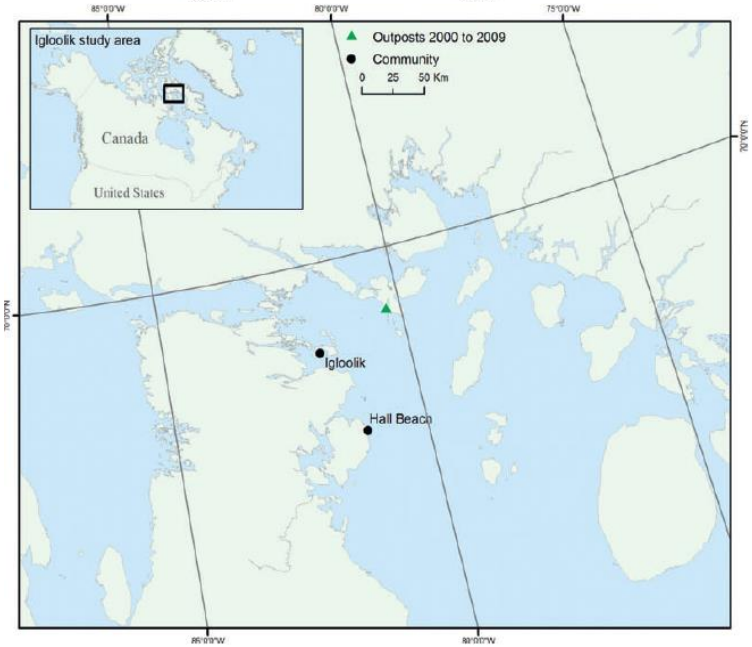
	components and the ecosystems/ biophysical components.
Stakeholder	See “actor”
Systems Diagram	This is using a diagram to illustrate the configuration of a system. This is done by defining its structure, function, and feedbacks. For a case there may be more than one diagram if the system changes in character (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.

Appendix 1

Left: Inter-communities sharing networks, Traditional Food flows to Igloolik (3). Right: Decline in number of hunting outpost camps in Igloolik region, from 1980 (top) to 2009 (bottom) (3).

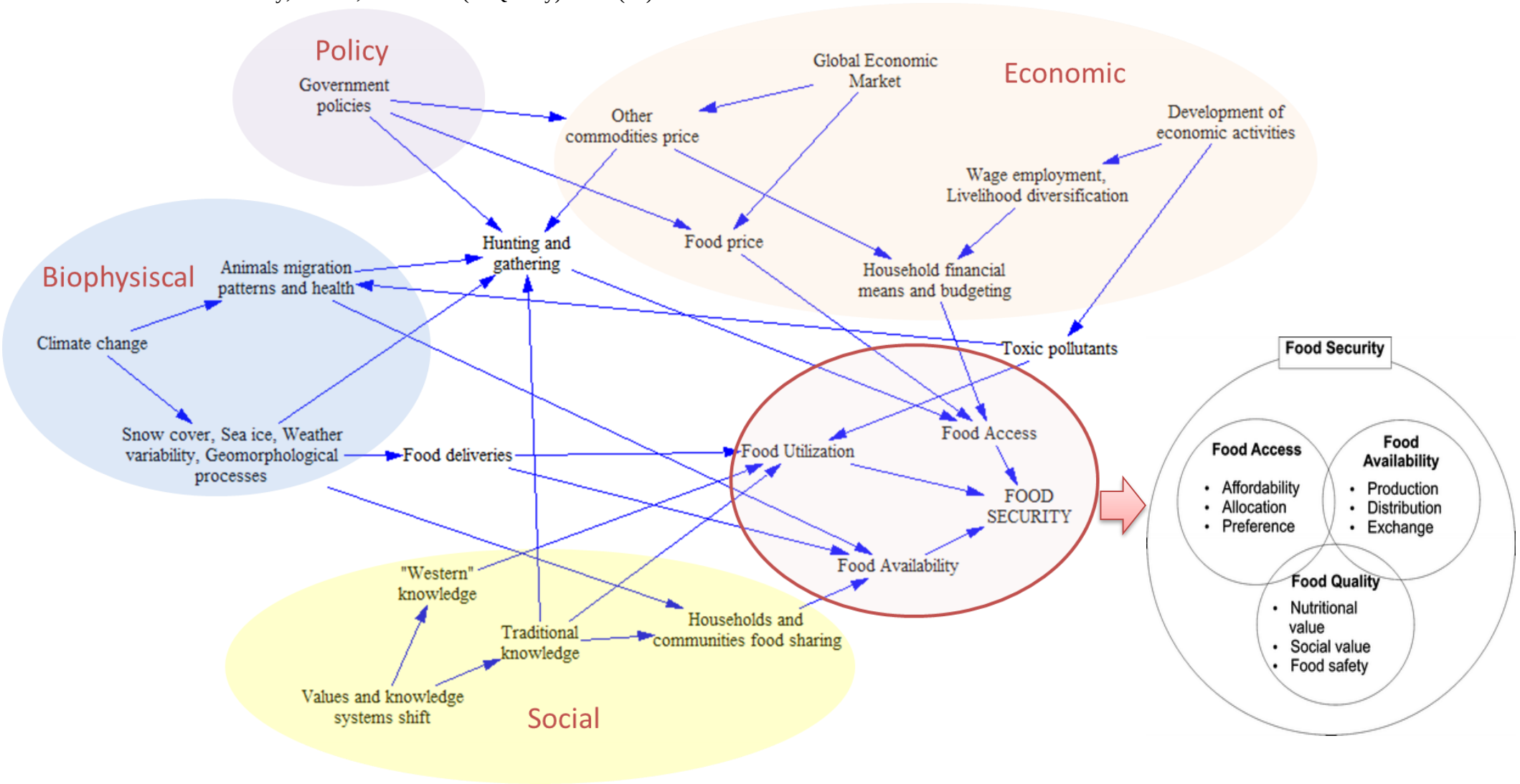


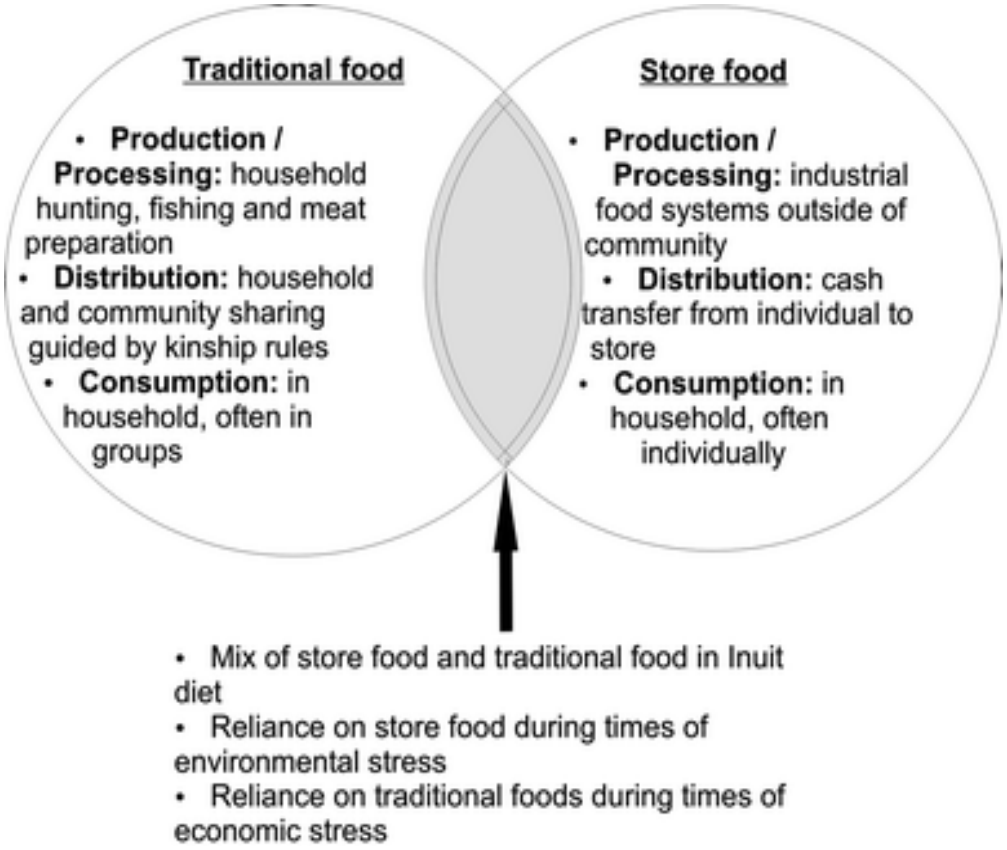




Appendix 2

Left: CLD highlighting the main drivers and dynamics of food security in Igloolik. Right: visual description of the operating definition of food security with its three domains - Availability, Access, Utilization (or Quality) From (10).



Appendix 3

Conceptual diagram of Igloolik's dual food system, from (10)