Cryo-technologies of fish storage in the Arctic zone of Western Siberia: “lessons” from indigenous peoples

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Abstract. The article presents traditional ecological knowledge of natural cryogenic resources (ice, snow, permafrost, etc.) for food preservation used by indigenous people, living in the Yamalo-Nenets Autonomous Okrug of Western Siberia. On the basis of ethnoecological approach and original fieldwork research, we analysed the construction of different types of storages for fish (“lednik”, ice cellar, “snezhnik”, and “merzlotnik”). As a result, we offered to adapt traditional ecological knowledge of indigenous people, living in the Arctic zone of Western Siberia, to developing new energy saving and eco-friendly technologies for preservation and transportation of fish, which could effectively use specifics of cryogenic conditions of the Arctic region.

Introduction

Due to prevalence of cold climate and location on the Arctic latitudes, the most part of the territory of Russia has unique variety of different natural phenomena connected with low temperatures. More than 65% of the Russian Federation is situated in permafrost area. Snowfalls, freezing of rivers and lakes in a winter period and off-season are typical for the most parts of Russia. Cryogenic conditions of Northern Asia had significant impact on traditional culture and economic activity of the people, living on this area. However, due to the stereotype of low temperatures and cryogenic effects to be adverse and dangerous for people, these phenomena have not been studied enough. For a long time, the main focus of scientific research was decreasing of the cryosphere impact on humans.

At the edge of XX-XXI centuries growing attention to global warming processes resulted in developing the idea of the Earth’s cryosphere as a key driver for maintaining balance in global climatic processes, landscapes and ecosystems. This changed an axiological paradigm perceiving cold as a source of cryogenic resources, which role has still not been completely comprehended [1]. This approach primarily was developed by ethnoecology, which was recognized as an independent science only in the in the middle of the XXth century. Pioneer works in the field belonged to American ethnologists and anthropologists G Konklin, Ch Freyk, etc. [2]. One of the key concepts of ethnoecology is “subsistence” as the reproduction of material culture elements and the practical skills, which allow to maintain life activity of a local community. Since 1980s ethnoecologists also used a concept “traditional ecological knowledge” [3] as “as a cumulative body of knowledge, practice, and belief, evolving by adaptive processes and handed down through generations by cultural transmission,
about the relationship of living beings (including humans) with one another and with their environment” [4]. Adaptation of ethnos to some physiographic areas, climatic conditions and landscapes, including implementation of natural resources to provide traditional subsistence systems, became one of the research fields of ethnoecology, called “resource ethnoecology”. Nowadays, it is mostly focused on the local features of agricultural and trade forms of economic activity with the emphasis on consumption of certain biological resources. However, the implementation of natural inorganic substances, as well as natural cryogenic resources, in traditional cultures is still less studied [5].

This article is aimed to review the implementation of natural cryogenic resources in traditional subsistence systems of the indigenous peoples, living in the Yamal district of Western Siberia, and show the prospect field for ethnoecological studies.

On the Yamal area fish was always one of the key products in the traditional food diet. Fishery was an important trade activity in this region. Therefore, since ancient times people, living in the Arctic zone of Western Siberia, developed skills of fish preservation using natural cryogenic resources. In the Soviet period, in the Yamalo-Nenets Autonomous Okrug traditional approaches to storage and transportation of fish, based on the use of natural cold, were explored for commercial purposes. However, this experience did not become an object of special scientific research. Though, we consider it to be an important resource for developing modern energy-saving and eco-friendly technologies for industrial preservation of products.

Up to 1940’s Russian and Zyrian population of the Arctic zone in Western Siberia used various constructions for the cooled storage (but not freezing) of fish, such as “lednik”, “ice cellar”, “snezhnik”, etc., which allowed to keep fish caught in winter up to a summer navigation period, but were not aimed for keeping fresh fish caught in summer.

A frozen well “lednik”

“Lednik” was a well located in the wood with snow or permafrost, mostly close to the river. It was dug out up to the permafrost layer, and its depth did not exceed 3 meters. Permafrost gradually melt, and year by year the well was getting deeper. The walls of the well were strengthened by larch poles. A vertical timbering was an important detail of a “lednik”, used for preventing collapse of the bottom of the well, while thawing of permafrost layer. For drainage purposes bundled up larch branches were used. In spring “ledink” was covered with pieces of ice or snow to keep low temperature regime.

Usually the well was filled with ice, while ice drifting, to spend less effort to saw it. To keep low temperature in the well up to autumn, winter ice was mostly used, because it did not melt for longer time. Pieces of ice were interlayed with the packs of sphagnum which has low heat conductivity. The well was covered by poles, branches, old reindeer skins or tarpaulin. Sometimes the separate hole for storage of ice and snow was made. In summer before putting fish into the well, heat-insulating layer was removed. A part of ice was replaced to cover fish. The well was fumigated with a juniper or larch shaves. Ice was usually covered with bundled up thin birch branches. Fish was put in layers on them.

All the “gaps” between fish were filled in with ice crumbs. The last layer of fish, shaped as a pyramid, was covered with tarpaulin. It provided draining condensate and water from tarpaulin along walls but not through the fish layers that considerably increased terms of its storage. Tarpaulin was covered with ice blocks, and then with packs of sphagnum, planks, branches, and sometimes with old reindeer skins.

As a rule, a “chum” (a traditional indigenous house, shaped as a cone, made of sticks covered with reindeer skins), a wooden house or a tent, were built over the well. These constructions allowed to find a well quickly, to protect it from flooding by a surface waters and attack of bears, and to slow down warming up in summer.

On the areas, crowded with bears, a well was covered by “ezh” (the stakes connected into a bunch with a blunt end). The construction shaped like a “funnel” was fixed in the middle with "zamok" (load placed into the center of the bundled up stakes), and sometimes it looked like a thistle flower (figure 1). It was not easy for a bear to get over such obstacle. However, a man could easily remove this load, collect stakes into a bundle and remove them from a well.
Singed skins could also be used to cover a well. Their smell frightened off bears and polar foxes. For scaring away of mice and voles fir-tree branches were the most effective.

In autumn, after fish being taken out of the well, old ice was to be removed. Bundles of branches were thrown away and burnt on fire for disinfection purposes. Placed vertically and shaped like pyramids, they were left outdoors for a winter period to dry out. Water and mud, accumulated after permafrost melting, was removed, and timbering was fixed. The well was left opened for the whole winter to freeze the walls enough. It provided a long-term exploitation period of such wells: i.e., in the lower reaches of the Nadym river, near an old settlement Ivlevskie peski the wells, constructed at the beginning of the XX\textsuperscript{th} century, are still being used.

Ice cellar
Ice cellar was a sort of a hole dug out mostly on the steep banks of the rivers or the slopes of ravines (as usual, on the northern slopes). It provided easy access to food supplies and served mostly as a storage for salty fish kept in barrels. Its vaults were strengthened by wooden timbering, and sometimes boarded up. A floor was covered by larch poles or logs. It had a drainage groove, filled up with birch and larch bark, to prevent clogging up and unpleasant smell. There was a hole for accumulating and removing water at the end of this groove. Along the walls of a cellar two fences, made of boards or poles, were usually built to provide their fast demounting and mounting the construction for rolling-out of barrels filled up with fish, chipped ice and spring snow. Before the entrance of a cellar the felling or the board platform was usually built. It was used for freezing fish in winter and keeping reserved ice in spring. Mostly there were no air-channels in the cellars. For ventilation purposes there was typically a window above the door.

“Snezhnik”
The simplest construction for storage was “snezhnik” mostly used for keeping fish caught in spring at least for a month. It looked like an ice cave usually made in the narrow ravine of the northern slope of the hill or on the high river bank. The floor was covered with bundled up tundra birch branches. Fish was put over them interlayed with snow. A “snezhnik” was usually covered with branches, moss, turf, and, finally, with old skins to reduce impact of rain on the process of snow melting. This construction for fish storage was especially popular on the territory along the southern coast of Gulf of Ob, where snow in deep ravines is kept up to the middle of July, and on Gyda Peninsula, where snow can be found even in the beginning of August.
“Merzlotnik”

“Merzlotnik” was used as a storage for frozen fish even in a summer period (figure 2). It had a ventilation system provided keeping low temperature both in winter and summer (from −9°C to −12°C). Due to increased fishing volumes, it was especially important in summer when fish frozen in a “merzlotnik” could be transported by scows along the Ob river to Tobolsk, Tyumen, and Omsk. Ice for scows was also stored in the “merzlotnik”.

A “merzlotnik” had a complex construction aimed to accumulate cold in winter and keep fish frozen during the summer period. It was extremely important to find an appropriate place for a “merzlotnik” which was built mostly on the places where permafrost consisted of integral ice lens. It was always placed on the steep river bank. If it was possible, due to feature of the landscape, the entrance was faced the north or the east to “catch” the coldest winds in winter. Freezing walls in a tunnel was provided by passive ventilation (figure 3). The steep coast sent air streams directly to the gate of a “merzlotnik”, providing high-speed air exchange in its tunnels. Due to wind ventilation there was effective expulsion of water also reducing temperature.

The exploitation process of a “merzlotnik” was also rather complicated. Because of ice melting, the height of tunnels quickly went down, and needed regularly deepening tunnel arches. It required covering its walls with wet snow; replacing old layers of snow which might contain microorganisms effecting on long-term storage of fish; deepening tunnel arches, etc. A “merzlotnik”, cut down in an ice lens, accumulated cold worse than those constructed in permafrost with sufficient concentration of sedimentary rocks, since ice has smaller heat conductivity than mineral spots. Besides that, building a “merzlotnik” in permafrost containing many mineral particles was a very labor-intensive process. Therefore, it was important to find a balance between simplicity and long-term use of a construction, though mostly it was built in homogeneous massifs of permafrost. The site for construction was carefully examined if there were any ice cracks, salty layers, quicksands, lack of streams and ravines.

For a long time a “merzlotnik” was the cheapest way to save stocks of food. It can still be used for long-term keeping products after fast (“shock”) freezing in a refrigerator to avoid energy-intensive, but long storage in the environment with optimal level of humidity.

Conclusion

Traditional methods of long-term keeping and preserving fish were similar in both indigenous and non-indigenous populations, mostly due to specific features of the ecosystems and biological resources in the Arctic. The study of this old ecological knowledge can become important contribution to developing eco-friendly and eco-saving technologies.

Because of the key role of the Earth’s cryosphere in many global environmental processes, this experience developed over many centuries is extremely important for both survival of individual local communities, leading traditional types of management, and solving a number of innovative problems related to rational use of natural and energy resources. Increasing critical trends in electricity consumption, use of natural cryogenic resources for refrigerated storage of products can become again economically efficient. It needs collaborative work of the scientists and experts who invent and develop modern freezing equipment, study historically caused diversity techniques, use of natural cold for household purposes and its technological adaptation to development of new energy-saving and eco-friendly technologies for storage and transportation of fish, which could effectively take advantage of cryogenic conditions in the Arctic.
Figure 2. Merzlotniks in the settlement Gyda, Tazovsky district (a) and Nyda, Nadymsky district (b) of Yamalo-Nenets Autonomous Okrug.

Cold air (-45°C)

Warm air (-5°C)

The conveyor for loading of production

Freezing the walls of camera

Vent pipe

WINTER «Cold storage»

Tambour
Figure 3. The construction of a “merzlotnik”

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