



THE CLIMATE SHIFT:

# ICEBREAKERS

by Johan Hegardt

versus

# THE ART OF SLEDGE DRIVING

## abstract

President Trump wants to build 40 new icebreakers to conquer the ice around Greenland, according to the news, May 2025. Interestingly, Finland might play a part in the production of these ships.<sup>1</sup> There is a deep historical dimension here and in this essay I return to a time before the ice-

breaker, that is, before the 1850s, and look into how we related to ice and snow then. It turns out that in the centuries preceding the late 19<sup>th</sup> century, people in Sweden had an overwhelmingly positive attitude towards ice and snow. In fact, these elements were crucial for the whole Swedish society.

Today it is the opposite, as the icebreaker illustrates. I argue that between these two historical temporalities lies the climate shift, which has an ontological dimension to it. **KEYWORDS:** Climate change, ice and snow, combustion engine, icebreaker, sledge



"Vinterlandskap, motiv från Orsa", by Olof Arborelius, 1870.

PHOTO: HANSA ANDERSSON,  
DALARNAS MUSEUM

**W**hat are snow and ice?

When air in the upper layers cools to below freezing point, the water vapor condenses into ice crystals. The shape of the ice crystals varies depending on the temperature and at -12C to -16C the classic snow star with its typical six arms appears. Snow stars can have fewer arms and at very low temperatures be completely round. It is not true that there are no two identical snow stars, but the possibil-

ity of finding two identical stars is vanishingly small. When snow stars fall through air at close to zero Celsius degrees, a layer of moisture forms on them. Different stars stick to each other and give rise to snowflakes that can become quite large and the snow falls slowly to the ground.<sup>2</sup>

Ice is formed when the water temperature is below zero Celsius degrees. A mixture of ice and water is always zero degrees and the temperature can only drop or rise in water or ice alone.



Express (probably II).

PHOTO: HANGÖ MUSEUM

When water turns into ice, large amounts of heat are released. Water has a higher density in liquid form ( $1,000 \text{ kg/m}^3$ ) than in solid form ( $917 \text{ kg/m}^3$ ), which is an unusual physical property. Therefore ice always floats on top of water. It is because of the hydrogen bonds in water that ice melts. If there were no such hydrogen bonds, no life on Earth would exist because all water would be bound in ice.

Despite hydrogen bonds, a lot of heat is required to melt ice. For one kilogram of 0-degree ice to melt into one kilogram of 0-degree water, 334 kJ is required.<sup>3</sup> This explains why ice and snow have a stubborn tendency to remain even though the spring sun is shining bright.

There are also different kinds of snow and ice and people who live in snowy lands have many different terms for snow, because snow or ice is never the same. For example, the Sami language has 300 words for snow. The Swedish Academy's dictionary lists over 450 words under the main heading "Ice" and there are 1,400 Swedish words related to ice.<sup>4</sup>

This vocabulary is at risk with climate change and because with the modernization of society we no longer need this vocabulary to be able to exist in a world of ice and snow.

This is not specific to Sweden. The World Meteorological Organization, for example, has a list of over 200 terms for sea ice and the circumpolar area is filled with Indigenous groups and vernacular speakers with different dialects and local languages

with their own specific words for the diversity of snow and ice. The countries in the circumpolar area are called the Arctic Eight and include Canada, Finland, Denmark (including Greenland and the Faroe Islands), Iceland, Norway, Russia, Sweden, and the United States (Alaska). I will focus on Sweden in this essay but similar examples can be found in for example Finland.<sup>5</sup>

## The importance of ice roads

In the agricultural and fishing villages of the archipelagos along the entire eastern coast of Sweden, ice roads were important in the past for various forms of transport.<sup>6</sup>

It is important to keep in mind that ice roads are still in use in the northern parts of Sweden, for example on Storsjön in Jämtland.<sup>7</sup> Another example can be found in Luleå, where ice roads connect Sandön with Junkön and Lövskär with Storbrändön, Långön and Hindersön.<sup>8</sup>

Hence, ice roads are used in various places today, but only on ice formed on water. This is important because in the past, the ice road went over land with snow as a base. Therefore, we may talk about winter roads in the past and ice roads today, but I choose ice roads, a road only used in the winter, passing mainly over frozen water and partly over land with the purpose of transporting both people and goods. No parts of it or only a fraction were used during other seasons.

The ice roads had to be maintained, and kept open, safe and marked, which is a technical problem. In 1940 the road engineer Major A. Wolff published an article in the Swedish Road Association's magazine entitled "Winter roads on ice". Wolff gives some historical facts, but the main purpose was to describe how ice roads should be constructed to achieve maximum safety. The winter 1939 to 1940 was very cold and Wolff underlines that the ice in the Stockholm Archipelago remained until May 1, compared to April 1.<sup>9</sup> Today the ice, if any, is gone already in March.

In 1929, the Swedish Archipelago Association developed ice roads from the mainland to the inhabited islands of the Stockholm Archipelago.<sup>10</sup>

Although Eric Elgqvist mainly deals with the city of Växjö, he has a long exposition on the importance of the ice roads:

**The use of the winter roads brought significant advantages. The road ran, to the greatest extent possible, over a horizontal plane, which meant that the sledges were able to carry significant loads. This was a great advantage, especially when transporting heavy goods such as wood and timber, ore, and bulky goods such as hay, leaf bundles, and charcoal. Furthermore, the distance was considerably shortened.<sup>11</sup>**

Hence, winter gave people great benefits and Elgqvist mentions that these roads were so important that Swedish royal law in 1734 stipulated that:

**A general winter road, over islands and bogs, should be marked out by each village where the ice is strongest and least difficult to pass [...]<sup>12</sup>**



Finland's first state-owned icebreaker Murtaja from 1890 was in service until 1958.

PHOTO: STIG LÖTHNER

Every village, throughout the country, even in the far south when possible, I assume, was supposed to arrange so that the ice road was safe and mark out its route.

When Elgqvist wrote this in 1934, the history of the Swedish ice roads had not yet been written, and today they are almost forgotten. But attempts have been made in the past.

In 1978, for example, the Nordic Museum in Stockholm opened an exhibition on traveling in Sweden, which also resulted in a book. Here Bo G. Nilsson explains that ice roads are limited to two climate zones in the northern parts of Sweden, the four-month boundary for snow and the 6 months zero-degree limit. However, there are areas outside these climate zones, such as Stockholm County and the inner parts of Småland, that Elgqvist describes in his article.

An example of the importance of ice roads is that the route Stockholm–Strängnäs that ran over 65 kilometers of ice and five kilometers of land during the late Middle Ages. Another example is the 260-kilometer-long coastal road in Norrbotten that became 30 kilometers shorter during the winter.<sup>13</sup>

Nilsson quotes the economist Eli F. Heckscher (1879–1952):

[...]Sweden possessed more than most European countries the only kind of land roads that nature itself provides, namely the winter roads, by which I include all possibilities for transport over snow and ice independent of paved roads. Their importance for Swedish material and spiritual culture right up to the latter half of the 19<sup>th</sup> century can hardly be overestimated; without them, Sweden's culture would have had a completely different appearance.<sup>14</sup>

Heckscher in turn quotes Aubry de La Motraye (1674–1747), a French/British writer and traveler:

**“The sledge is [...] one of Sweden's greatest pleasures, and there is no more pleasant and faster means of transport in the whole world and no country better suited to it than this, when the snow covers the great country roads, mountains and cliffs and when lakes and rivers**

**become as solid as flat fields. The length of the nights, which seems to constitute an obstacle, is not such since the reflection from the snow, the clarity of the sky and the brilliance of the stars make it very easy to see how to travel, and one usually gets into the sledge after evening meal.”<sup>15</sup>**

The average speed of transport on land and water was rarely more than 2 kph, or 4 knots. Thus de La Motraye mentions that it took the Mayor of Uppsala three days to travel between Uppsala and Stockholm by conventional road. This was around 1719. Motraye made the same journey in a sledge in six hours. He also made the journey between Stockholm and Örebro on a frozen Lake Mälaren in 18 hours.<sup>16</sup>

The land route between Uppsala and Stockholm today is about 70 kilometers and the water route between Stockholm and Örebro about 180 kilometers. In a sledge, Motraye could maintain an average speed of about 10 kph, about five times as fast as during ice- and snow-free periods.

Roland Svensson, a Swedish artist and writer with a great interest in archipelagos and islands, describes how it worked in the Stockholm Archipelago:

**As soon as the ice had set, an ice road had to be marked out with fir-tree branches (“buskas”). When the work was done, the Crown sheriff arrived [...] Large and mighty in his wolfskin coat, with ice in his eyebrows and beard, he was like a symbol of the Crown's power and ruthlessness when he exacted the contributions.”<sup>17</sup>**

## **Ice roads and war**

Perhaps one of the most famous “ice roads” is the Swedish King Charles X Gustav's (1622–1660) military campaign across the ice over the Little Belt and the Great Belt in Denmark in the



The Swedes crossing the ice over to Zealand in 1658, by Johann Philip Lemke. (The image is cropped at the top.)

PHOTO: WIKIMEDIA COMMONS

winter of 1658, which resulted in a crushing Danish defeat.<sup>18</sup>

Sweden has also been affected by ice roads. During the war against Russia between 1808 and 1809, Russia attacked Åland with 17,000 men who crossed the ice from Finland. On Åland, Georg Carl von Döbeln (1758–1820) was stationed with 6,000 men. At the same time the Russians cut across the ice of Norra Kvarken to take the city of Umeå.<sup>19</sup> This war is called “Riksklyvningen” because Sweden lost Finland to Russia after 600 years. One third of Sweden’s territory was lost.

Using winter for warfare was not unusual. A majority of the wars during the Middle Ages and into the 17<sup>th</sup> century were fought in winter and many medieval castles blocked ice roads. Some battles were even fought on the ice.<sup>20</sup>

## Sledges and the customs regime

During the winters of the 17<sup>th</sup> and 18<sup>th</sup> centuries there was a special customs station on the ice outside Stockholm. That is because twice as many people passed through Stockholm’s customs system during winter compared to summer.

Since agricultural work was reduced in the winter and transport was easier, common people could make long journeys to cities or to friends, relatives and others who could not otherwise be visited. Officials of various classes preferred to travel in the winter, which also applied to royalty.<sup>21</sup>

The most common sledges were bark sledges and long sledges. The bark sledge was fast-moving. In the long sledge the traveler lay down in pelts. In Norrland, the long sledge was called a “rissla” or a long-distance sledge. The upper class used covered sledges, much like their wagons.<sup>22</sup>

Svensson describes a sledge from the Stockholm Archipelago:

[...] ‘notbönderna’ (fishing farmers) took turns providing horse, sledge and driver to bring the herring to Stockholm. Sometimes several ‘strömmingslurkor’ (herring sledges) could be required. They loaded about a hundred ‘valar’ (two and a half kilos, or 80 herring) if it was not ‘menföre’ (bad ice and snow conditions). A sledge or ‘lurka’ consisted of two parts, the undercarriage and the runners where ‘fimmelstängerna’ (the shackles) were attached with iron hooks, and the sledge hull, the so-called box. The hull was divided by boards, and the rear space was called the back pocket, where the driver used to store oats, ‘slafatet’ (a food box, with a domed lid and base) and a jug of brandy.<sup>23</sup>

## Iron ore transports, the weight of the sledges and the durability of the ice

Our relationship with sledges is non-existent today. At most, they are used in the tourism industry. Here the sledge is romanti-

cized. Sheepskin and torches in the winter night. The museums that I have contacted testify that they have sledges of various kinds, but that the sledges are not entered into databases like other objects and are stored in external warehouses. On farms they are stored in dusty log cabins or in old carriage sheds. This is the fate of the sledge. The bells have fallen silent.

If the sledge ride today is a commercial tourist product, it was crucial in the past for Swedish industrial, material and spiritual development, as we have seen. Olof Söderbäck writes:

**Ore was transported in special ore sledges on the ice while the coal was transported in coal sledges, called ‘kolryssar’.**<sup>24</sup>

The scale of ore transportations was huge as how Bengt-Erik Johansson describes it:

**The ore mining itself took place all year round. The ore ordered by the steel mill was mined, piled up and stored until winter when it could be transported to the mill. For the winter special sledges (foror) were hired**

**from local farmers, but also longer-distance drivers were hired... Around three hundred carriages could participate in one ore rally alone... Those who participated have told of hundreds of horses that were stabled or lined up along the mill street with oat sacks (havretornistrar) in front of their mules. And just as many sledge drivers (forkuskar) that moved around [...]**<sup>25</sup>

An ore sledge could weigh up to 850 kilograms.<sup>26</sup> They never traveled alone, but

in caravans in “endless rows”, as Greta Möller described it.<sup>27</sup> It takes quite a lot of ice to carry such loads.

Ice is never the same. A rule of thumb states that core ice grows by 2.5 mm per 24 hours for every minus Celsius degree. There are a number of problems with this rule, including that it does not take into account the ice’s own insulating ability, humidity and cloudiness. More accurately calculating the growth of ice involves complex formulas. Another important issue is whether the ice is on saltwater, brackish water or freshwater. Transport was carried out on all types of ice.

How thick must the ice be to carry a caravan of ore sledges each weighing 850 kilograms? Today the Swedish Road Administration does not allow speeds above 30 kph on their ice roads, even though the ice is more than 20 centimeters thick. Double carriageways are used to prevent the ice from being worn out by traffic.

To calculate the thickness of the ice we can use this formula:  $P = c \times h^2$  where P is the load in kilograms, c is the stress index and h is the thickness of the ice in centimeters. The stress index should be 5 to be on the safe side.<sup>28</sup> This means that the ice must be at least 13 centimeters thick to carry an ore transport of 850 ki-

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Approaching the timber from the forest by horse and sleigh in Ångermanland, Sweden, about 1900.

PHOTO: UNKNOWN / FLICKR

los. This applies to fresh water and core ice and is hypothetical. The Swedish Road Administration's standard of 20 centimeters would have been the same for 19<sup>th</sup> century ore sledges weighing almost a ton.

Given the growth rate of ice, it didn't take many days for such ice to settle if the night temperature was -10C. In many places around the Swedish coasts and on inland lakes the ice could become over a meter thick in the past and could easily carry the loads of the sledges.

Almost everywhere in Sweden people longed for winter. Svensson writes:

**Some mornings after cold nights the bay lay like gently undulating silk. The blue ice had set and the general question was: 'Shall the bay set?'. But when the wind woke up, the ice split and disappeared with a clanking sound.<sup>29</sup>**

Elsewhere he writes:

**The ice rarely became navigable until twenty days after Christmas. The older people who had experience believed that 'Karl-dagen' gave an indication of what the ice winter would be like.<sup>30</sup>**

"Karl-dagen" is for some reason connected with the French king Charlemagne's death on January 28, 814 AD.

## The ice road — a success story

As we have seen, ice roads were core infrastructure during a period that extends from the Middle Ages and partly into the present day, but above all until the 1850s. That the ice roads were essential for industrial development is not so strange, but that they also had great importance for culture is less of a given. Snow and ice became an ontological part of the spiritual and metaphysical world of the people, which also characterizes identity. Winter was a positive part of people's lives for more than 600 years, which is not insignificant. In other words, the ice roads were a success story.

Even today, older archipelago residents can talk about journeys over the ice that they themselves experienced and even more about what it was like in the past, stories that they have heard as children.

The transports were so important that the Governor of Kopparberg County, Hans Järta (1774–1847), wondered what would happen if snow and ice did not freeze or fall as usual. Järta was a Swedish politician and a writer. He was a member of the Royal Swedish Academy and National Archivist from 1837 to 1846. Järta writes: "When in this town on a winter day one looks at all roads, one sees smaller or larger groups of the sledge driving population that the mining industry sets in motion, one can easily imagine what a loss lack of snow or the abundance of it might cause this County. Bare winters, such as the last one, and the one now threatening to become, acts like stunted growth. I am



In the winter of 1996, the ice conditions caused difficulties for ferry traffic across the Kvarken. Here, the Swedish icebreaker Oden breaks open a channel for the ferry Fennia.

PHOTO: PÅR-HENRIK SJÖSTRÖM

not overstating it when I estimate every working day during a smooth and good winter, after the sledge drivers have completed their work, that the monetary profits, especially at the mines, to an amount of 8,000 to 10,000 Rd. Banco”.<sup>31</sup> From this we understand that stable and cold winters were crucial for both the local and the national economy.

Much has been written about the Swedish iron mills. Fine details have been described, such as the sound of the horses’ bells tinkling. Greta Möller says: “When we trudged to school on frosty winter mornings, we were met by endless rows of sledges loaded with pig-iron and coal. In winter, the horses’ tinkling bells also played a part in the rhythm and melody of the mill.”<sup>32</sup>

John Broman describes winter driving at the turn of the century 1900:

[...] up at 4 o’clock from the straw mattress, on with the coffee [...] When we have had our needs met, the horse shall have its turn. A splash of water and then a portion of oats... It is sparkling cold, at least minus 20 degrees and there is a creaking under the sledges. Far away the sound of a few dozen bells can already be heard...

And Broman continues:

The music or ringing of bells that was heard for a long distance can hardly be described in words. Filled with excessive poetry was such a journey. Where the sky was cloudless, the sun shimmered and conjured up millions of ice crystals over the snow that weighed down the trees and bushes.<sup>33</sup>

A romanticized image of sledge drivers, perhaps, but it is obvious that the sledge with its horse, the snow and the ice, meant

a lot to people in the past, even well into the 19<sup>th</sup> century, but changes were coming that would radically uproot the lives of sledge drivers and sledge traffic in general. Ice, like snow, would become a problem rather than an asset.

## The icebreaker versus the sledge

From the middle of the 19<sup>th</sup> century large-scale changes would occur and this at the expense of the sledge. Winter became a cost instead of an asset. It is even possible to paraphrase Järta and instead of calculating the costs of a snow-free winter, calculate the costs of a snowy winter, which is something we do today.

The World Meteorological Organization’s list of sea ice, mentioned above, is not about the durability of the ice but about breaking it up. The icebreaker was developed after the 1850s primarily for breaking ice around ports. During the 1850s, railways expanded, not least to the ports. Throughout the second half of the 19<sup>th</sup> century, the internal combustion engine was developed in various forms. The steam engine is a gas-pressure engine. It uses external combustion. The diesel and Otto engines instead use internal combustion. But in both cases the engines use fossil fuels: Coal for gas-pressure engines and oil for internal combustion engines.<sup>34</sup>

Such machines make it possible to break ice and move large amounts of snow, which takes us into a new (ontological) era where these engines were perceived as a veritable success. With their power, they outshone everything else that man had achieved.<sup>35</sup> The horse with its sledge was consigned to history and quickly forgotten. The bells fell silent while the superpowers of the machines were praised for their ability to break ice and move snow, thus creating a snow- and ice-free infrastructure for industry and society.

Above all, the icebreaker becomes the superpower that represents the emerging industrial society. But the icebreaker is not

only a machine that works against winter but also an indicator of the winter quality. Icebreakers lying idle in port are a clear sign of the absence of winter. In other words, the icebreaker is the ultimate example of the time we live in, a time that began to take shape in the second half of the 19<sup>th</sup> century.

But let us return to von Döbeln. He was obviously in need of an icebreaker, both at Åland and at Kvarken, and it would only take a little over half a century before the icebreaker was a fact, but by then the baron was dead. He is still included in the history of the icebreaker, but at a distance. He is a hero in Johan Ludvig Runeberg's (1804–1877) epic poem *Fänrik Ståls Sägner* [Ensign Stål's Legends], which describes the war between Sweden and Russia 1808 to 1809.<sup>36</sup> What have von Döbeln and Runeberg to do with icebreakers? The answer is that it was Johan Ludvig's son Robert Ivanovitj Runeberg (1846–1919) who contributed to the development of the icebreaker.<sup>37</sup>

Finland was trying to remedy its winter isolation and a railway was built to Hangö. From there the ship *Express* operated from 1877. *Express* was designed by Runeberg and was a steam-powered ice-breaking ship with 400 horsepower that carried 20 passengers and made 11 knots in open water. The journey to Stockholm took 17 hours. The ship easily broke through 12 centimeters of ice, i.e. ice that can carry over half a ton. The ship was perceived by the Finnish industrialist Henrik Ramsay (1866–1951) as something completely new in the whole world.<sup>38</sup>

In the 1890s, Runeberg became a member of the Russian icebreaking committee, which resulted in the giant icebreaker *Jermak*. With its 12,000 horsepower, it was the first polar icebreaker.<sup>39</sup> Runeberg published his theoretical findings in the award-winning essay "On steamers for winter navigation and ice-breaking".<sup>40</sup>

Thus the ice was doomed. Icebreaking had fatal consequences for the Stockholm Archipelago population. Sailing channels through the archipelago ice made it difficult or even impossible for sledge transports and ice fishing for herring, which had a negative impact on archipelago culture.<sup>41</sup>

The icebreaker is a very concrete example of a new era's need to remove ice, but it also breaks up old ice roads, affects fishing in the Stockholm Archipelago and elsewhere, and prevents people from being able to get across the ice as before. To make this possible, ice bridges and ice ferries were laid out to take sledges, livestock, and people across the channels, but these bridges and ferries have disappeared today together with the ice that is vanishing due to climate change.

## 1850 – the climate shift, an ontological issue

During the second half of the 19<sup>th</sup> century, another threat to the ice roads arose, namely the railway. The railway companies

described the sledge system as a fundament for a reprehensible and unreliable lifestyle. A horse in front of a sledge was seen in the railway companies' propaganda as a disgraceful occupation.<sup>42</sup> Activities of earlier times were painted in a negative light and the life of common people – in this case, the sledge – was described in derogatory terms.

The railway had its advantages. Exports were facilitated and manufacturing could be concentrated in fewer and larger units. Since the 1850s, the Swedish government decided that it would be responsible for the nationwide main lines. Other railways

were to be paid for with private funds. There was even a state fund for this, which resulted in the railway network tripling during the 1870s.<sup>43</sup>

The period 1850 to 1890 can be considered the breakthrough for Swedish large-scale industrialization. This also applies to Germany.<sup>44</sup> Thus, the period can also be considered a decisive epoch in incipient global climate change – a shift with ontological dimensions.

In a context of ice and snow, we must therefore understand this industrialization as a new form different

from that which took shape during the 17<sup>th</sup>, 18<sup>th</sup> and early 19<sup>th</sup> centuries.<sup>45</sup> This new industrialization process has major problems with ice and snow, which the previous industrialization obviously did not have. In other words, snow and ice became not only a problem for infrastructure and industrialization during the second half of the 19<sup>th</sup> century and thereafter, but also a problem for the entire society. Hence, the problems with snow and ice had to be addressed. In other words, the mid-19<sup>th</sup> century can be seen as the starting point for a shift in our relationship to snow and ice and thus to a shift in how we perceive ourselves. With neo-industrialization, a process began away from a time when snow and ice were perceived as something positive, to being instead viewed as a general obstacle and problem.

From being a wild creature and an asset, we have tamed both ice and snow or, rather, we have broken the ice and shoveled the snow away. Since the mid-19<sup>th</sup> century, winter has thus been disciplined in various ways. Climate change has further contributed to the retreat of snow and ice. This has of course affected us in many different ways and thus affected how we understand ourselves in Sweden and elsewhere among the Arctic Eight, and can therefore be understood as an ontological shift. ❌

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**“ACTIVITIES OF EARLIER TIMES WERE PAINTED IN A NEGATIVE LIGHT AND THE LIFE OF COMMON PEOPLE – IN THIS CASE, THE SLEDGE – WAS DESCRIBED IN DEROGATORY TERMS.”**

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