

# On the Death of a Glacier

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## I – Feeling Small

Another step, and another, and another. My breath is heavy, my heart is pounding, my muscles sore and I am wondering how many more times I will be entirely convinced that I can see the crest, only to be surprised by another set of rocks to climb after reaching the supposed finish line. But this time, my feet carry me onto the final ridge where I can finally catch my breath. Looking around, I can see the path I took to climb up here to my right, first marked with the red-white marks of the Club Alpino Italiano (CAI) long before I ever entered this world, and to my left the peak of the Adamello at 3554m above sea level, highest mountain and name giver of the region. And in front of me its glacier, hidden under a plain of white snow so bright that it hurts to look at it. *No one told me that it's going to be this big.* It reaches as far as I can see and then down into a valley that escapes my sight.



Picture 1: The Adamello Glacier extending beyond the borders of the photograph. *Photograph by author (17.07.2023)*

The Adamello Glacier, with a surface area of  $\sim 17 \text{ km}^2$  and an estimated ice volume of  $2 \text{ km}^3$  the largest in Italy, is located in the Italian Alps north of Lake Garda on the border between Lombardia and Trentino Alto-Adige. It is comprised of several ice bodies (Pian di Neve Plateau, Miller Superiore, Salarno, Adamé, Corno di Salarno, Mandrone) that together constitute  $\frac{1}{4}$  of Lombardia's glacierized surface and cover hundreds of meters of altitude (2530m – 3440m) with a thickness of more than 260m in certain parts. Snow melt at higher altitudes begins in April and turns into ice melt in June once the snow crust has succumbed to solar radiation, supplying the surrounding valleys with the water they need to survive (Ranzi et al. 2010; Bocchiola and Diolaiuti 2010; Maragno et al. 2009).

Looking at this massive sheet of ice and the mountains all around me makes me feel very small. My breath slows down and I try to understand what my eyes are showing me, then I stop trying and for a while I forget everything except my current experience. But shortly after I am pulled back to reality by the inevitable signs of the presence of humanity.

## II - Contamination

Right next to the glacier, so close to the edge of the ridge that one might be forgiven to ask the question why it hasn't fallen off it yet, I find the Bivacco where I will spend the night. Its bright yellow metal structure is plastered with stickers, hailing from all around the continent. Some of them seem to have spent many days there, judging from their receding colors. I pull the rusty door handle to the side and open the door to find the six wooden sleeping benches, blankets to keep you warm, and a lot of trash. *How is it possible to be so careless?* I would have imagined that at least the people that reach this most remote of places, with no access except by hiking for hours, to be sensible enough to not leave their trash around. But alas, convenience seems to have trumped responsibility once again. So, I start cleaning, finding everything from actual trash to unopened food cans, unsmoked cigarettes, and plastic bags, into which I put everything that I find (except for the scientific equipment with an attached note that specifically requests for it not to be touched). *I wonder how long all this waste has been here.*

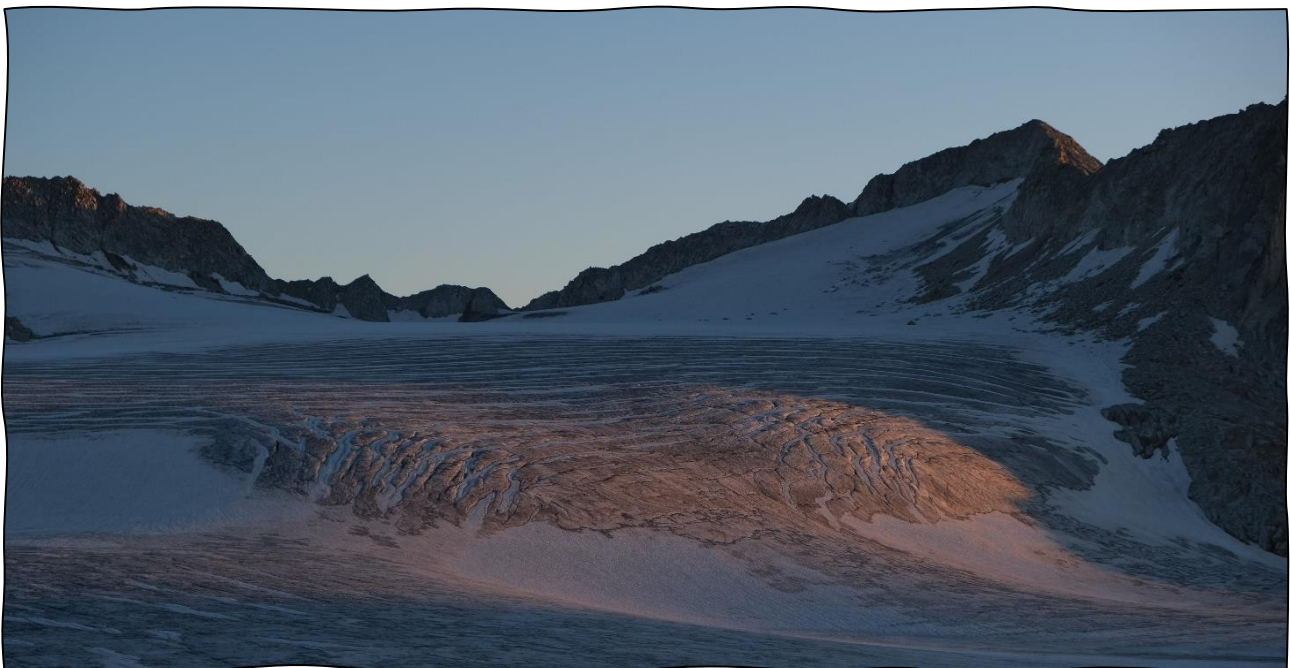
Sadly, physical trash is not the only anthropogenic product that contaminates this glacier and others. Pesticides, herbicides, and other volatile chemicals used for agriculture south of the Alps can travel hundreds of kilometers through the air, rising with it, and depositing through rain- and snowfall onto glaciers. The European Alps, with their densely populated regions near the mountains and the high amounts of precipitation, are particularly vulnerable to this mechanism of accumulation, since most currently used pesticides are water soluble (C. Rizzi et al. 2019; Cristiana Rizzi et al. 2022). Once deposited, pesticides can remain in the glacier until the snow and ice melt, releasing them into the meltwater and therefore into the aquatic ecosystems comprised by them. This can contaminate the water if certain thresholds are surpassed, negatively impacting the organisms of the ecosystem as well as the local human inhabitants that depend on the water originating from the glacier. Furthermore, the release is not a gradual but a periodic one, since the most intense melting occurs in spring, making high concentrations of contaminants coincide with highly vulnerable phases of life for many organisms (C. Rizzi et al. 2019; Cristiana Rizzi et al. 2022). The most prevalent pesticide Chlorpyrifos (CPY), which is widely used in the regions of Veneto, Emilia Romagna and Lombardia, has been found in meltwaters of multiple glaciers hundreds of kilometers away (C. Rizzi et al. 2019). According to Rizzi et al., 2022 all the meltwaters of the Adamello Brenta Natural Park they investigated suffered exactly this fate, with the exact impacts of the contamination still unclear. Here we are met with an invisible pollution that is so dislocated across space and time in cause and effect that it is very hard to grasp the connections. Yet it is an inevitable result of the wasting relationships we have with the things around us through which we create and outsource our waste in order to preserve our privileges (Armiero 2021). Reflecting on mechanisms like these we discover that not even the most remote regions of the world can escape the transformations we have brought on to this planet, and that we truly have entered an age where humans have become an all-encompassing geological force.

I step back outside onto the wooden platform situated in front of the Bivacco and start unpacking my bag to change into warmer and more comfortable clothes. After setting up my sleeping spot inside I eat the rice I brought with me while watching the magical colors of the sunset. By the time I finish eating I am no longer alone, a couple and another lone hiker have joined me for the night. We continue to sit outside until the darkness

and its freezing temperatures take over. *This is definitely the coldest summer night I have ever experienced.* We observe a thunderstorm travelling past in the far distance, its lightnings flickering through the night barely above where we are sitting now. The others go to sleep while I stay outside a little longer to watch the stars. A few shooting stars cross the night sky and looking at the millions of celestials I am reminded that I want to learn more about these constellations and what they might have meant to those that came before me. And I am also aware of the anthropogenic light that pollutes even this remote place, the highest spot that I have ever been in my life, from every side and that keeps me from seeing all those stars that now stay hidden behind the anthropogenic photons from below.

### III – The Fate of The Ice Giants

My phone alarm rings at 4:45, shortly before sunrise. When I step out of the Bivacco onto the wooden platform, I am met with an even more wonderful sight than the one I found the day before. While the cold morning air bites at every exposed piece of skin, the morning light is slowly conquering the shadows that ruled the night, turning the snow from grey into a golden white. Towards the Adamello's peak I can barely make out the silhouettes of those that woke up even earlier than me to climb it, almost too small to make out on the vastness of the ice. I sit down as the sunlight hits my face, cover myself in blankets and wait, for nothing in particular. Yet while appreciating the moment I can't but feel a little bit of sadness, for I know that this natural wonder that has outlasted so many generations before me might very well disappear within my own lifetime.



Picture 2: The first morning light reflecting on the glacier. *Photograph by author (18.07.2023)*

All around the world, global warming is causing the rapid loss of glacier and snow cover in mountain regions (Cristiana Rizzi et al. 2022; Maragno et al. 2009; Festi et al. 2021; Ranzi et al. 2010), resulting in alterations of biogeochemical cycles, cryophilous biodiversity and meltwater abundance and quality (Cristiana Rizzi et al.

2022). The rise of atmospheric temperatures is particularly severe in the Alps, with significant summer warming since 1970 (Maragno et al. 2009). Once the melting of a glacier has started, it succumbs to positive feedback loops, since smaller glaciers with less ice mass are more vulnerable to area loss due to their faster reaction time (Bocchiola and Diolaiuti 2010; Maragno et al. 2009). Additionally, the exposure of debris once contained within the glacier increases its surface albedo with its dark colors, strengthening solar radiation absorption and thereby the melting process (Maragno et al. 2009). The resulting increase in meltwater volume saturates the ground to such a degree that it cannot take up more water, leading to higher above surface runoff. This, coupled with the higher debris transport of said surface waters leads to increases in frequency and severity of extreme events such as floods, landslides, and mud flows, negatively affecting the ecosystems and their inhabitants downstream. What's worse is that mountain communities are often economically, politically and culturally marginalized in addition to their physical marginalization, lacking the necessary resources to adapt or prevent to these radical changes (Ingold, Balsiger, and Hirschi 2010). Another more far reaching and long-lasting consequence of glacier melting, and all other land-based ice masses for that matter, is its impact on sea level rise. With glaciers and ice sheets covering approximately 10% of the planet's land surface they could contribute to many meters of sea level rise, with predictions indicating more than two meters by 2300, with major and increasing contributions from glaciers and ice sheets (Zhang and Moore 2015). As becomes apparent, glaciers are very much one of the earth-human systems that has become highly unstable under contemporary circumstances. One of those systems whose collapse could lead to unforeseen and devastating consequences.

The Adamello glacier is no exception to this fate of disappearance, experiencing rapid loss of ice cover, as much as 12% in twenty years (1983 – 2003). This is coupled with an increase of rainfall, replacing snowfall, which results in lower snow accumulation. Snow cover depth has been decreasing since at least the 1980s and snowfall days are reducing with an average of 0.6 days per year in the Alps. Rising atmospheric temperatures have shifted the onset of snowmelt from mid-May to mid-April for the Adamello glacier, resulting in a higher rate of ice decrease at the end of the melting season due to aforementioned feedback loops such as debris exposure (Bocchiola and Diolaiuti 2010; Maragno et al. 2009; Ranzi et al. 2010). The accumulation zone is retreating to higher altitudes, being replaced by a growing ablation zone, pulling the mass balance into the negative, particularly since 1998. For the last twenty years, no ice accumulation has been observed at the Adamello Glacier (Festi et al. 2021) and while reading through the literature I observe that the newer the text, the smaller the numbers it uses to describe the extent of the glacier. The retreat of the Adamello's ice sheet since the Little Ice Age is now estimated to be 2.1 kilometers in length and 900 meters in height (Ranzi et al. 2010).

What then will we have lost once all of these ice giants have died? At what point will they become parts of myths and legends instead of reality, and at what point will they be completely forgotten? Of course, they will be replaced with less harsh and more alive ecosystems, but what about all the stories they have yet to tell us, all the insights into the history of our planet that their air bubble filled bodies contain? With every millimeter of ice we lose a glimpse into the past, and since no layers are being added under the influence of the contemporary climate, they won't be able to tell future generations anything about our current times. Thoughts like these are haunting my mind while I am eating the rest of the food I brought. After finishing I climb out of

my mountain of blankets and return them to their rightful place, collect my things, change into my hiking gear, and start walking. Before climbing down, I take one last look at the glacier and wonder: *how much of you will be left when I come back?*

#### IV – Voices

How do you save a glacier? Can you, even? Certainly, there is no way to give back the ice we stole, at least not without technocratic tools whose appliance would likely cause more damage to the ecosystem than they would help it. Then what is there to do, except to leave it alone and at least save it from physical human trash? In the weeks before and after visiting the glacier I was volunteering on a farm a day's hike away, which is where I first heard of the possibility to visit and stay overnight at the glacier. I hurtfully remember the owners of the farm sending me a video of a huge landslide next to their house, blocking the street and keeping them from reaching the next village, some months later. And it makes me think. Maybe the change does not necessarily have to be something physically related to the glacier. Maybe it can be something that changes the humans that interact with it and that helps those that are affected by the glacier's changes.

There is power in the narratives of human imagination, both over the way we think as well as how these thoughts physically manifest themselves in the world. They reveal things about ourselves and how we relate to the past, present, and future. And they can incite change if taken to heart. So, if we want to change the fate of the glaciers, we would first need to change these narratives and with them change ourselves: our awareness of glaciers, our relationship to them and our sensibility to our impacts on them. As with any other-than-human actor in the current socio-economic framework, glaciers too need a voice in order to be heard and cared about. But where does that voice come from? The glacial voice I am imagining should not be a purely political one, though legal and political agency of other-than-human actors is long overdue. Neither should it be a voice spoken only by the intellectual elite or the communities directly affected by glaciers and their changes. Instead, it needs to be a voice spoken by everyone. This voice can, but does not have to, take auditory forms. It could just as well be expressed in the form of visual arts, architecture, and literature, as it could be in music, podcasts and the actual voice of environmental activists. Through its diversity it would allow for the necessary inclusion of everyone. The point is to create a counter narrative that lasts, that confronts and engages us, that makes us feel something in a way that we cannot but act on it. This type of movement needs to be one that lives in the collective consciousness every single day and most importantly, one that is based in pacifism and an undying hope that a better world is possible, so we can embrace the planetary geological agency we have, but direct it in a more positive direction than the paths we are currently on. And if that is still not enough, if the fate of the glaciers is truly to disappear from the face of the earth, then at least we will have done everything to immortalize them in our minds, in our works and in our hearts.

## Literature

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