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Glacier blanketing: Two approaches in the European Alps

Carey Clouse Architecture University of Massachusetts

PROJECT NAME
Pontedilegno-Tonale (Adamello) ski resort

LOCATION
Presena glacier in northern Italy

CLIENT
Pontedilegno-Tonale (Adamello) ski resort

SURFACE AREA
c. 100,000 m²

DESIGNERS
Carosello Tonale

DESIGN PERIOD
2008 – present

BUDGET
c. 100,000 € annually

PROJECT NAME
The Ice Grotto

LOCATION
Rhône glacier in Switzerland

CLIENT
The Carlen Family

SURFACE AREA
c. 20,000 m²

DESIGNERS
The Carlen Family

DESIGN PERIOD
2008 – present

BUDGET
c. 10,000 € annually

Abstract
As a response to climate change, the use of glacier blanketing in the European Alps helps to slow the melting of snow and ice, and in turn, allays the impacts of global warming on recreational landscapes. The practice of laying geotextiles across glaciers and snow fields reveals important information about the capacity for human engagement and, ultimately, the role of design interventions in addressing the climate crisis. Blanketing efforts have been prominent in large-scale environmental art works and might be seen as acts of care for a broken planet. In this study, interviews with stakeholders and associated fieldwork underscored the significance of human values and agency in two adaptive management projects. The comparative study of an individual ski resort and an ice grotto demonstrate the ways in which glacier blanketing is used to slow the rate of ablation, the benefits and limitations of such interventions and the values that underpin this work. These decisions carry implications for design practice beyond the Alps, and make a case for foregrounding the role of human agency, values and decision making in global climate-adaptive design efforts.

Europe / geotextiles / design values / mountain landscapes / climate change adaptation

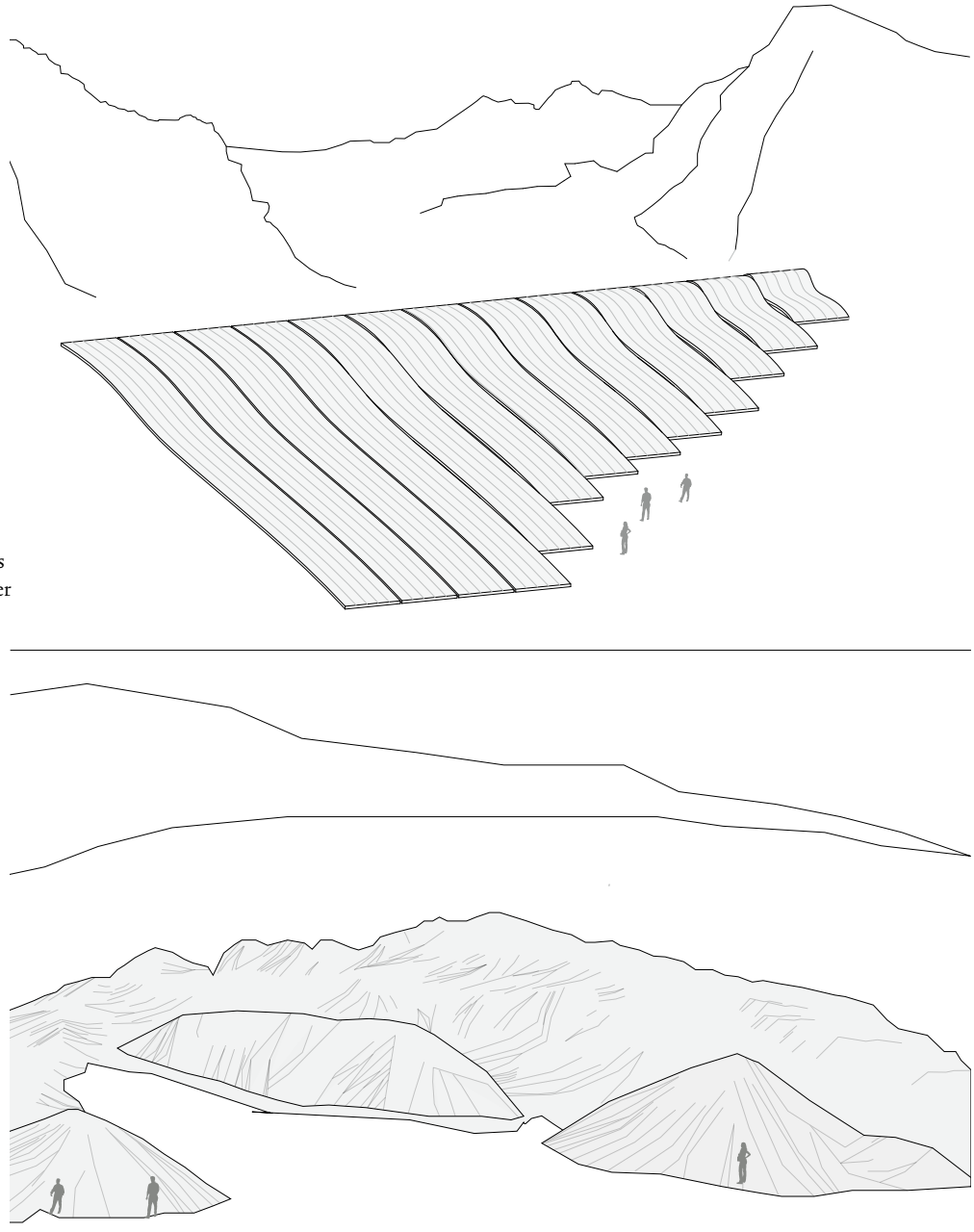

Figure 1 One technique for the preservation of glaciers is to roll out swaths of insulating geotextiles, or 'glacier blankets' across mountain landscapes. The two techniques shown are found at Presena glacier (*top right*) and the Ice Grotto (*bottom right*).

Introduction

For more than a decade now, the European Alps have been a stage for glacier-preservation efforts. One strategy for the retention of glaciers under a changing climate is to protect this terrain by applying large swaths of insulating geotextiles (Fig. 1). These 'glacier blankets' represent a Sisyphean effort to mitigate glacial erosion in mountain landscapes, because the scale of this work is so outsized as to effectively make it an impossibility.[1] However, the very act of applying blankets to mountains might be construed as an act of care, demonstrative of the ways in which values and meaning might be brought into focus by the business owners and individual decisionmakers who are actively responding to the problem of melting glaciers.

The dependent human-environment relationship is well established in the European Alps, where tourism acts as a central economic driver and is fuelled by human access to mountain landscapes for recreation and leisure.[2] For more than 150 years, the glaciers have served as popular tourist destinations, landscapes that have been cultivated for both sport and an experience of wonder.[3] Glacier blanketing might be viewed as an extension of care for these sites, where evidence of novel design thinking, technical problem solving and guardianship coalesce under the banner of water management. As an intervention that influences the reading of the land, blanketing might be viewed as a landscape architecture phenomenon: it is a design product that could effectively shapeshift as needed, that could

Figure 2 The striking mountain landscapes in the Alps attract tourists for recreation and leisure.

serve to enhance or diminish the experiences of human-altered tourist landscapes and that might begin to build out a portfolio of climate-centred design strategies (Fig. 2).

Scientists now forecast the widespread melting of glaciers in the Alps, caused by warmer weather and a decoupling of precipitation regimes across the seasons.[4] This changing climate causes significant shifts to critical tourist landscapes, making a case for employing blanketing as an interim solution. However, according to Matthias Huss et al., these types of 'technocratic solutions for saving glaciers at the large scale cannot be a priority in comparison to efforts to mitigate CO_2-emissions'.[5] Indeed, models demonstrate that artificial glacier melt-reduction efforts lack the ability to efficiently upscale across the Alps, serving as a reminder that the global problem of climate change must ultimately be addressed at the source, namely through minimizing greenhouse gas emissions.

Geotextiles in Europe

Geotextiles range in material composition, size and durability, differing across sites in Europe and in China. Typically, white materials are used for their albedo effect, insulating materials are preferred, and blankets are composed of polypropylene and polyester fibres. Rolls of these fabrics are unfurled across glaciers and snowfields in the late spring of each year, and either left in situ or bundled and stored for use again the following year.

The European Alps have hosted blanketing projects since at least 1993, when the German ski resort at Zugspitze began experimenting with geotextiles.[6] Today there are at least nine active sites in Switzerland and more than a dozen blanketing projects in Europe, at sites ranging from Les Arcs in France, Austria's Stubai and Pitztal glaciers, the aforementioned Zugspitze resort in Germany and various resorts in the Italian Dolomites.[7] This paper specifically addresses two divergent tourist sites in Italy and Switzerland, at the Presena and Rhône glaciers, respectively (Figs. 3 & 4).

Figure 3 The mountain landscapes in the Alps, where fieldwork was conducted to compare the Presena glacier (right) and Rhône glacier (left) blanketing projects.

Figure 4 Each blue dot indicates a site where glacier blanketing projects have been tested or are in use (ordered from left to right):

Les Arcs, France

Nine active sites in Switzerland, including:
Mt. Titlus, Rhône glacier, Diavolezza, Vorab, Feegletscher, Corvatsch, Gemsstock, Theodul glacier, and St. Annafirn.

Presena Glacier, Italy
Pitztal Glacier, Austria
Zugspitze, Germany
Stubai Glacier, Austria
Mt. Aragats, Armenia

The application of glacier blankets appears to work remarkably well; in an early study on the efficacy of these methods, researchers found that melt rates and ablation slowed by roughly 60 %.[8] Since then, an array of more extensive, technical solutions has been developed and tested,[9] and blanketing experiments have moved beyond the geographical boundaries of Europe into Armenia and as far away as China.[10]

The glacier-blanketing measures employed in the European Alps reveal the deep connections that people have to their livelihoods in mountain landscapes, and the great lengths that they will go to in order to sustain endangered experiences. As design ideas for climate-change adaptation are compiled and evaluated, the application of glacier blankets may have components worth exploring and emulating. This paper outlines relevant context and precedents, introduces two different glacier-blanket site studies, and follows with recommendations for integrating values and people-centred decision making in broader climate change-adaptation design interventions.

Formal blanketing precedents

In the arts, as well as in popular culture, blanketing has come to be seen as an act of care or guardianship. The effort to highlight particular landscape features, to call attention to the land or to address an environmental concern might be acted out through explicit 'cues to care', and these signals carry social and cultural meaning.[11] A design project taking the form of a carefully draped blanket signals warmth and tenderness, invoking a nearly universal understanding of protection. Several formal blanketing precedents stand out for their framing of landscape, environmental concerns and care, serving as reminders that large-scale blanketing efforts have become enmeshed in the arts-environment discourse, where they might signal an intention to highlight natural processes or concerns. Although scientists typically frame glacier blanketing as a stand-alone technical response to the problem of melting ice, the presence of a vibrant arts legacy of blanketing efforts makes a case for viewing such technocratic solutions against the backdrop of intentional acts of discourse and meaning.

The idea of draping material across the land to highlight landscape features first captured the art world in the 1960s. In 1968–1969, artists Christo and Jeanne-Claude wrapped a portion of the Sydney Coastline, some 56 km, with 93,000 m² of erosion control fabric.[12] This was a Herculean effort, requiring 17,000 person hours; the artists used this blanketing spectacle to call attention to landscape features (Fig. 5).

In 2010, Artist Ann Jordan laid *Cwtch Blanket* across a mountain on the Brecon Beacons National Park in the UK (*cwtch* means hug, or cuddle, in Welsh). The 6-m circular blanket was composed of almost 20 km of yarn gathered from sheep along the route, hand spun and handknitted (Fig. 6). The blanket highlighted a coffin route that is a part of Welsh farming history, but was also constructed to call attention to broader environmental concerns. In 2015 the blanket was sown with heather seeds and placed permanently on this landscape to promote peat conservation, where it continues to facilitate growth today.

Yarn Bombing also stands out as a clear precedent for the act of covering landscape features, with projects such as the attempt to create the largest patchwork Afghan blanket in the world, which was draped across the steps of the Helsinki Cathedral in Finland in 2011. Large-scale landscape blanketing projects also address climate change activism: in 2018, more than 125,000 postcards were stitched together across the Aletsch Glacier to call attention to climate action.[13]

Glacier-blanketing practices: A comparative study

This study compares two glacier-blanketing projects in different contexts: one at the Pontedilegno-Tonale (Adamello) ski resort on the Presena glacier in northern Italy, and some 300 km away, the ice grotto tourist attraction inside the Rhône glacier in Switzerland. Both sites have been practicing glacier blanketing for more than a decade, and these efforts appear to work well enough to justify the investment of labour, maintenance and material. The two sites were chosen because they apply the same design response, glacier blanketing, in radically different ways. Each example supports a particular type of tourist activity, employs distinctive resources and achieves unique aesthetic outcomes. In both cases the social values, decision making and stewardship goals may be aligned, but in terms of design products the two sites show surprising heterogeneity.

Rhône glacier

The Rhône glacier has been blanketed annually since at least 2008, by the family-run business operating an ice grotto at Furka Pass (Fig. 7). The small business has a large presence in the region, perched on the edge of a well-travelled road in Switzerland, a major stopping point for tour buses and car-bound travellers. While the site of the parking area, gift shop and turnstile entrances are fixed architectural assemblages, the mouth of the ice grotto annually recedes with the glacier (Fig. 8). This stationary edge, and the visible movement of the glacier relative to this infrastructure, have made a compelling case for the short-term solution of blanketing. According to the owners, the glacier blankets have demonstrated their value by significantly reducing glacier movement and have become part of the maintenance regime for the ice grotto itself. For the family operating the ice grotto, stewardship values encompass both the glacier and their business, as the health and future of both are inextricably linked.

Blankets above the ice grotto are composed of 1 to 2-mm canvas tarps, as well as layers of 4-mm fleece, and most of these materials are reused from year to year (Fig. 9). Compared with the more costly operations in place at regional ski resorts, this blanketing approach reveals a lean, cost-effective process, driven primarily by stakeholders who benefit directly from the associated tourism. According to journalist Helena Bachmann: 'The hauling and spreading of the tarpaulins takes several hours and costs thousands of dollars, mostly paid by local residents.'[14] The aesthetics of this project communicate an improvisational approach; blankets have been deployed for their insulative and reflective utility over visual presentation, and yet they intrinsically change the way that the landscape in and around the ice grotto is read and understood.

PHOTO: SHUNK-KENDER. © ESTATE OF CHRISTO V. JAVACHEFF AND J. PAUL GETTY TRUST

Figure 5 Christo and Jeanne-Claude, *Wrapped Coast, One Million Square Feet, Little Bay, Sydney, Australia, 1968–69.*

SOURCE: ANN JORDAN

Figure 6 Artist Ann Jordan's *Cwtch Blanket.*

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Figure 7 The Rhône glacier, with blankets applied to the portion closest to the edge where the ice grotto is located, right side.

CAREY CLOUSE

Figure 8 The entrance to the ice grotto in the Rhône glacier, buffered by blankets in the early summer.

CAREY CLOUSE

Figure 9 This blanket detail, photographed from inside the ice grotto in the Rhône glacier, shows layers of reused blankets that impact the human experience of the site.

Presena glacier

At the Presena glacier, nearly 100,000 m² of blankets cover critical ski runs, helping to retain a base of snow and ice that in turn enables a longer and more profitable ski season. The glacier has lost more than a third of its volume since 1993, and geotextiles were applied in an effort to stem this rapid erosion. As in the case of the ice grotto, the tourism value of this mountain landscape is tethered to critical, fixed infrastructure that cannot move along with the glacier. Polypropylene blankets insulate the ice and snow, and in 2020 officials noted that 'the project had saved more than 2.5 meters (8.2 feet) of glacier mantle from melting away'.[15]

Unlike the blanketing at the Rhône glacier, at Presena new material is rolled out in strips each year (Figs. 10 & 11). Here, the white geotextiles are brought up to the top of the lifts in heavy rolls, then pinned with rebar and unfurled down the mountain in a streamlined and cost-efficient way (Fig. 12). The result of this work is an orderly, organized series of lines that create a neat, rectilinear blanket. The annual cost of blanketing surpasses 96,000 euros, including materials, machinery and labour. At least two companies, one Austrian (Tencate) and the other Swiss (Landolt) provide the 4-mm felt blanketing material to ski resorts in the region, in 5 x 70-m rolls.

Comparing two approaches

Each of these two sites use geotextiles to preserve a contained, high-value, discrete tourist feature. The Pontedilegno-Tonale (Adamello) ski resort offers year-round recreation opportunities directly on top of the Presena glacier, while the ice grotto is literally carved into the Rhône glacier, with more permanent fixtures such as the gift shop and parking area just below the glacier's edge. Both sites typically lose the majority of snow covering the ice masses in the summer months; in some respects these glacier blankets have become a stand in for the insulating blanket of snow that may have protected these sites in the past. In both cases, snow and glacier blankets offer a relatively affordable design solution to stop the immediate melting of critical ski runs or tourist attractions, but cannot stem the broader, inevitable erosion of host glaciers.[16]

In comparison with many highly engineered, state-of-the-art climate-adaptation and mitigation efforts, glacier blanketing reveals an imperfect, human aesthetic. Blankets can be scrappy and handmade; over time they become weathered, wrinkled and torn. On the Rhône glacier, canvas tarps are reused from year to year, darkened by sediment accumulation over time. At Presena glacier, new white fleeces are unrolled in parallel lengths, but even these layers show signs of wear, betraying the scant material qualities of this bootstrap solution. These two different approaches have distinctive design languages, revealing differences in business investment and capacity.

Figure 10 Crews assemble in preparation for summer blanketing at the Presena glacier in Italy, in the upper section of this ski run.

Figure 11 New rolls of Polyfelt have been dropped at the top of a ski lift, ready to be pinned and then rolled down the ski runs.

CAREY CLOUSE

Figure 12 Rebar pins, sandbags and Polyfelt comprise the mountain attachment system at the top of ski runs.

While the two approaches differ considerably in terms of management, investment and aesthetics, they share the same human impulses and motivation. In both cases the erosion of glaciers threatens the viability of the businesses that have literally grown up on and around natural glaciers. When the rapid, visible deterioration of the glaciers began, the stakeholders at these two sites took matters into their own hands to initiate blanketing projects. In both instances the decision-makers decided to try a relatively untested, unproven technique by applying geotextiles. Both systems have been improved over the years on the sites, and have been tested by third-party scientists, but the impulse to start this work came from individual businesspeople, rather than government institutions. Finally, both of these glacier-blanketing projects underscore the human dimensions of blanketing work, reinforcing a sense of human care or stewardship for environmental features that are wildly outside of the control of any one stakeholder. The desire to act, to be agents in a process of holding back the inevitable melting of a glacier, characterizes the relationship that both sets of stakeholders have to their mountain sites and the values that they hold in adopting this technology.

Taking into account the human-environment relationship

The human-environment relationships illustrated by the adoption of glacier blankets also point to potentially useful lessons for the disciplines of planning, landscape architecture and land management. These lessons include activist opportunities: exposing invisible systems and processes for education, stewardship and reflection. By engaging sociocultural values in addition to engineering concerns, designers can help to situate climate-adaptive projects within broader public consciousness.

Mountain landscapes draw visitors for a variety of reasons, not the least of which is the experiential qualities of the environment and the accompanying recreational amenities.[17] Similarly, these landscapes retain long-term residents through an economy that is reliant on mountain-recreation stewardship and management. The European Alps alone draw more than 100 million visitors each year and tourism activities support an entangled web of associated services and jobs.[18] Meanwhile, the working landscapes of the Alps are shifting, with competing needs for resource extraction, farming and tourism, each of which prioritize different land uses in a natural mountain setting.[19] In tourism as well as local farms and

Figure 13 Meltwater forming at Presena glacier in the summer months.

businesses, these mountains have become tethered to human connection and experience, creating associated implications for aesthetic and values-driven management and planning, particularly under climate change (Fig. 13).[20]

Glacier blankets impact the physical and visual experience of snow-covered mountain landscapes, many of which appear to be outside the purview of human care or management, to both tourists and locals. While tourist landscapes often are manipulated for desired preferences and attributes, the physical landscape presented in these settings tend to appear to have naturalistic features.[21] Even a groomed ski slope, for instance, can be cast as a natural mountain feature. In contrast, glacier blankets read as a physical barrier draped across the mountain, an artificial band-aid. These interventions reveal the human hand and associated management practices that underpin naturalistic recreational landscapes. Glacier blanketing creates significant visual implications for tourist landscapes. At both the Rhône and the Presena glaciers, the surface application of geotextiles reads as a striking artificial intervention on landscapes that were originally capitalized upon because of, and meant to be viewed for, their natural splendour. While this visual impact appears to be limited to visitors of the two sites in the summer months, it cannot be hidden from view. In this case, the tourism narrative becomes unequivocally changed, as the focus moves from an appreciation of natural wonder to a newfound awareness of human mediation—and perhaps even culpability.

Several artists have intentionally worked with blanketed landscapes to produce discourse about care and responsibility. For the past decade Stefan Schlumpf has photographed the Rhône glacier for an exhibit called *Hidden Landscapes*, in which the glaciers are likened to a swaddled baby.[22] Photographer Simon Norfolk's international exhibit in 2019 also highlights geotextiles at the ice grotto: viewers are asked to see the blankets as a sort of shroud, to consider the inadequacy of our current efforts in the face of climate change. In this sense, 'Norfolk's photographs humanize the glacier, provoking us to consider the role of community actions in the face of environmental catastrophe'.[23] Indeed, visitors to both the Presena ski slopes (which remain open during the summer months) and the Rhône glacier ice grotto at Furka Pass encounter summer blanketing, and in so doing may contemplate climate change anew. Thus, the visual effect of blanketing may change one's perception of the environment and, as in *Wrapped Coast* and *Cwtch Blanket*, cause visitors to reflect on broader environmental concerns.

CAREY CLOUSE

Figure 14 The future of mountain landscapes in the Alps will involve adaptation, if not more aggressive mitigation efforts.

Mountain landscape aesthetics have shifted across previous decades in Europe, particularly as cultural and social values change to accommodate different patterns of land use.[24] Uta Schirpke et al. state that: 'Environmental value orientations and the degree of attachment to nature may be decisive for society's relationships with landscape, as values, attitudes and behaviour change over time with new generations.'[25] In the Alps, narratives of adaptation will likely become the new normal, and many different outcomes must be considered, including the possibility of moving beyond the paradigm of winter sports for recreation (Fig. 14).[26]

Surprisingly, researchers found that tourists in the French Alps appeared to be unlikely to perceive impacts of climate change even while visiting diminishing glacial landscapes.[27] However, as environmental pressures continue to shift cultural consciousness, visitors are more likely to embrace landscape features that demonstrate active environmental amelioration, particularly if unnatural interventions are accompanied by signage and education meant to create greater awareness. The acceptance of landscape design interventions that have some productive or ameliorative capacity is a key precondition for the widespread use and acceptance of climate-adaptive design work. It is therefore useful to propel narratives beyond the technical properties impacting the efficacy of blanketing to incorporate additional dimensions of this work, such as values, education and human agency.[28]

Recommendations for more holistic adaptive design thinking

The science supporting glacier-blanketing interventions is now well established, and when combined with a better understanding of associated human factors, these projects support new directions to consider in climate-change design interventions. In the case of blanketing efforts at the Rhône and Presena glaciers, the interplay between design thinking and human decision making highlights important objectives for broader climate-change design interventions as well as for the future of the profession. These findings offer some guidance to landscape architecture practitioners as they engage in various types of adaptive projects:

Local gains matter

Interviews with stakeholders revealed that actors absolutely recognized that the scale of the problem (climate change) is out of proportion to the solution (seasonal glacier blanketing). Yet, these decisionmakers still found compelling reasons to use geotextile barriers, primarily because this imperfect design response was just effective enough to make a difference. In the case of the Rhône glacier, blankets reduce melting enough to slow the erosion of the ice on the particular site that the family owns. This glacier will almost certainly continue to retreat, but if the erosion occurs at a slightly diminished pace, the site will remain visitable, and thus economically viable to the family business, for a little longer. Similarly, at the Presena glacier, the resort operators have a compel-

ling reason to retain as much glacial mass on their site for as long as possible. Reducing the rate of melting extends the ski season, and the life of the business, in measurable ways. Moreover, while short-term gains might not lead directly to a medium- or long-term solution, they buy stakeholders the time and space to try out new ideas, behaviours and perhaps even business plans.

People must feel empowered to act

These two glacier-blanketing projects function just well enough to limit climate change-induced summer melt on specific sites. They have been shown to work to a certain degree from a technological stance, as well as in terms of labour, management and access. However, it is also possible that the engagement of decisionmakers in these design projects is central to their ongoing success. Stakeholders need to feel that they have some agency, some opportunity to intercede, in order to be moved to participate in adaptive measures. In the case of the businesses on the Rhône and Presena glaciers, the immediate threat of losing glacier-reliant tourism spurred individuals to act. This highlights a powerful lesson: the human dimensions of climate-change adaptation, which includes an awareness of the interplay between people and environment, may be just as important as technocratic approaches to the climate crisis. Moreover, if this engagement is to be sustained, landscape architects and planners have a role to play in facilitating stewardship and empowerment for longer-term projects. Designers can help to bolster informal ground-up efforts by providing additional services such as access to technical knowledge or management planning.

Visual expression of climate change may offer broader educational benefits

If visitors to a glacier-blanketing site notice the geotextiles, they may process and reflect on climate-change challenges in new ways. The effect of these barriers on mountain landscapes may negatively impact the experience of these naturalistic environments. However, educational opportunities may also be knit into climate-change adaptation projects as a means of shifting collective consciousness. In this way, design interventions such as blanketing might be used to help to increase awareness of environmental crises.

Emotional ties can be leveraged

While economic decisions may be driving blanketing efforts in the Alps, these adaptation measures also serve as a reminder that people are deeply connected to threatened landscapes, and will go to great lengths to preserve their livelihoods and preferred experiences at these sites. These personal, emotional ties may help in the decision making that invokes individual action, either in terms of mitigation or adaptation. For instance, besides promoting the science of glacial modelling and the technology of various adaptive systems, designers and planners might integrate additional layers of social and environmental design thinking, such as opportunities for education, the arts, political action or rituals of caregiving. Landscape architect Carolina Aragón asserts that emotions are a critical piece of this puzzle, particularly in terms of empowering underrepresented populations to act in the climate crisis, and that designers have a key role to play in supporting public engagement through educational initiatives.[29]

These two projects in the Alps illustrate divergent design responses to a changing climate, even while using the same basic intervention. One could argue that they both invoke practices of environmental stewardship in the sole pursuit of short-sighted capitalist ends. This work could be critiqued, for instance, for its relative ineffectiveness, outsized carbon footprint and cost, and unplanned side effects coming from the spread of microplastics or other pollutants.[30] However, these actions, and by extension, glacier-blanketing projects, could also be viewed as protective acts towards the mountains and the natural processes they enfold. Such interventions have the capacity to offer educational value, or to become a means of engaging others in the climate crisis. This premise was explored by Alexandra van Zyl and Rudi van Etteger in their work with applied aesthetic creation theory, highlighting 'the psychological experience of glacier retreat in order to trigger much-needed engagement and stewardship'.[31] Design could become the shaping force in such an endeavour, where designers connect the tools and technologies used in geotextiles to a more substantial engagement with human experience.

Similarly, professionals may find value in learning from the actions and decisions of non-designers, who choose to engage in the climate crisis with the tools and technologies that are available to them. A more expansive practice for landscape architecture might adopt unconventional, non-expert precedents for study and in so doing, find inroads to adopting new ways of working. In this regard, the values, decisions and perspectives that outsiders bring to their own DIY projects begin to serve as new directions for the practice of landscape architecture.

On the surface, the design solution of glacier blanketing appears to be wildly out of scale with the enormity of the problem—of climate change broadly and at a smaller scale, and even of massive melting glaciers or snowfields on a specific site. However, one could argue that blanketing diminishing snow and ice is also a noble and deeply humanizing gesture. It is a signal that individuals care about climate change and that they are grappling with the reality of environmental pressures in physical, human terms, with available materials and energy, and by using something as simple and timeless as a blanket.

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