**What is an Alpine Glacier?**

Alpine glaciers are a slowly moving mass of ice originating from an accumulation of snow. It can either spread out from a central mass (continental glacier) or descend from a high valley (alpine glacier) (1).

**What’s the Big Deal?**

Alpine glaciers are important to the human way of life. They are globally present and among the world’s most scenic mountain views (Figure 1, above), and are one of the earliest indicators of global climate change. Annual water production from alpine glacier melt plays critical roles in the regulation of fresh water supply by providing meltwater during dry seasons for year-round flow. It is estimated that the global population gets 40% of our water from rivers originating in the mountains. For this reason, glaciers are vital to natural ecosystems, agriculture, hydropower, and human consumption, and they are threatened (3, 4).

**Glaciers Are Disappearing**

Global climate change is a primary driver for **glacial retreat**, or the loss of glacier height, worldwide. A 1°C rise in air temperature around a glacier can cause 1 meter of loss in glacial retreat in a year. Especially in locations more susceptible to warming, noticeable glacial loss is occurring with some ominous results.

Glaciers are basically a build-up of the snow that doesn’t melt during the dry period. For glaciers to be loosing mass, it means that there is either less precipitation during the wet period, or more melt in the dry period. While there may be some of both, it is clear that climate change is playing a large role.

The vulnerability of these glaciers threaten water use patterns, economies, and ecologies, as well as threaten catastrophic disaster of **glacial outburst flooding** (4, 5).

**South Cascade Glacier, Washington**

Figure 2: US Forest Service photo from 1928 (6)

Figure 3: US Forest Service photo from 2000 (6)

**Estimates of glacier volume in water equivalent (6):**

<table>
<thead>
<tr>
<th>Year</th>
<th>km³</th>
</tr>
</thead>
<tbody>
<tr>
<td>1928</td>
<td>.32</td>
</tr>
<tr>
<td>1970</td>
<td>.24</td>
</tr>
<tr>
<td>1985</td>
<td>.19</td>
</tr>
<tr>
<td>2001</td>
<td>.16</td>
</tr>
</tbody>
</table>

**How are People Affected?**

Glacial retreat will negatively impact regional water supply, agriculture, power generation, culture, and tourism. Other important risks include glacial outburst flooding, ecological damage and the release of methane, a greenhouse gas.

Without proper land use planning, changes in alpine glacier flows will have a dramatic negative impact on peoples’ way of life (3, 4, 5).

**Glacial Outburst Floods**

As a result of glacial retreat, high altitude glacial lakes are forming or growing. Figure 5 (below, left) shows an aerial view of the Himalayas with glacial lakes (7). As a result of raising water levels in lakes and/or topography changes, these high altitude lakes can escape natural dams and cause catastrophic damages. Figure 6 (below, right) shows an evacuation from the threat of glacial outburst flooding (8).

Risk management plans should include: public awareness efforts, government official preparedness, water monitoring measures, land use and planning plans, evacuation plans, and timely dissemination of warnings (12).

**Figure 5: Aerial view of the Himalayas from 2003.** The blue lines are growing glacial lakes at high altitudes relative to the populations (7).

**Figure 6: Community evacuation in Khyber Pakhtunkhwa, Pakistan (a region more susceptible to warming than average), due to threat of glacial outburst flooding (8).**

**We Have More to Learn**

There is still much we don’t know about specific regions that would help to plan for glacial retreat. Climate change models are limited, especially in mountains like the Andes, which are long and narrow. The result of not knowing undermines planning and educational efforts (3, 4).

**The Andes**

Alpine glaciers cover a large area of the Andes between Bolivia and Venezuela (Figure 8, right), but are quickly decreasing. Unfortunately, models are currently inadequate at simulating climate change in this type of region due to steep topography, though it is likely that warming will be similar to the arctic, thus of an immediate and severe concern due to high likelihood to change rapidly (4).

**The Páramos**

The páramos (Figure 7, left) are upper Andean grasslands with unique and delicate soils and vegetation. Because the water from the páramos is of good quality, and due to the rapid decrease of glaciers, it is withdrawn for human use and consumption. The rate of this consumption is both unsustainable, and growing.

Changes to the water cycle and soils due to current demand and increased development further the gap between our understanding and make it harder to plan. More must be learned about this (and other) interesting regions to be able to ascertain what is happening overall. Additionally, land use management and public education would significantly reduce human risk factors as well as risks of permanent damage to the regional environment (3, 4).

**Figure 6: Approximate extension (in black) of the páramos in the northern Andes of Venezuela, Colombia, Ecuador and Peru, with a small, isolated patch in Costa Rica (3).**

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