# Polar climate change may lead to ecological change

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(PhysOrg.com) -- Ice and frozen ground at the North and South Poles are affected by climate change induced warming, but the consequences of thawing at each pole differ due to the geography and geology, according to a Penn State hydrologist.

"The polar regions, particularly the Arctic, are warming faster than the rest of the world," Michael N. Gooseff, associate professor of civil and environmental engineering, told attendees today (Aug. 11) at the 96th annual meeting of the Ecological Society of America in Austin, Texas. "As a consequence, polar ecosystems respond directly to changes in the earth systems at the poles."

These changes, though different at each pole, could be significant in their effects on not only the local environment, but also globally. While the central part of the Arctic is composed of ice over water, northern Canada, Alaska, Siberia and Greenland all have landmasses within the Arctic Circle. The associated land and water ecosystems are affected by melting ice and thawing soils, but in Antarctica, where much of the ice overlays a continent, the warming alters streams, lakes and the tiny plants and animals that live there.

"Our focus on the north is in part because it is inhabited, but it is also because the ice there is more vulnerable," said Gooseff. "Temperatures and snow and rain across the tundra shifts annually and seasonally. We know that fall is beginning later than it once did."

In the Arctic, where there is more immediate feedback from the higher temperatures, the warming is degrading permafrost, the layer of the ground that usually remains frozen during annual thawing events. This causes creation of a boggy, uneven landscape with a disturbed surface. Subsequent rain or snowmelt can erode this surface carrying silt and sediment into bodies of water, changing the paths of rivers and streams. Debris flows are also a common occurrence in degraded permafrost areas.

"Algae, insects and fish all must deal with this increased level of sediments," said Gooseff.

Extended frost-free time causes soils that do thaw annually to have longer active periods when microbes can mineralize nutrients. While the soils remain frost free longer, plants continue their normal cycle dictated by the length and intensity of daylight, which has not changed. Microbes may continue to create nutrients, but the plants no longer use them, so that when rain or meltwater comes the nutrients leach into the rivers and streams.

"That is exactly what we are seeing," said Gooseff. "In September and October, we see a substantial increase in nutrients in the water. Concentrations increase many times for nutrients such as nitrate and ammonium."

Another problem with degrading permafrost is the release of the carbon that was permanently trapped in frozen organic materials in the frozen ground. Warming will eventually liberate carbon dioxide and methane into the atmosphere.

"It is estimated that the permafrost contains twice the amount of carbon that is currently in our atmosphere," said Gooseff.

We think of Antarctica as a vast empty place, but lakes and streams exist in several polar desert oases, including the McMurdo Dry Valleys. These bodies of water are filled with a variety of life including microbial mats, plankton and filamentous algae.

"While there are no bugs or fish in these waters, there are diverse microbial communities," said Gooseff. "Some algae in the dry valleys go dormant for nine months or more and then begin to grown when hit by meltwater."

Because there is so much permanent ice in Antarctica, the annual impact of increased temperatures on its environment is slower than in the Arctic. The huge expanse of white ice reflects some of the heat energy into the atmosphere.

"We expect in the next several decades that we will see the Antarctic start to warm up," said Gooseff.

The Antarctic permafrost is very dry with high nitrogen concentrations in some places. When water reaches some of these dry soils, it will mobilize the nutrients and increase potential habitat for freshwater aquatic communities in Antarctica. This climate change will alter the flow patterns, expand the stream networks, and change both the location of habitats and the timing of life cycles.

"Beside the information that we can obtain about climate change on Earth, understanding what happens in Antarctica is important to understand what happens on Mars," said Gooseff. "There is potential for microbial communities on Mars, and if they exist they will probably be similar to the McMurdo Dry Valley communities."

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