Our mountains and the climate change

Introduction

Scientists who assess the planet's health see indisputable evidence that Earth has been getting warmer, in some cases rapidly. Most believe that human activity, in particular the burning of fossil fuels and the resulting buildup of greenhouse gases in the atmosphere, have influenced this warming trend. In the last ten years scientists have documented record-high average annual surface temperatures and have been observing other signs of change all over the planet: in the distribution of ice, and in the salinity, levels, and temperatures of the oceans. Everywhere on Earth ice is changing. The famed snows of Kilimanjaro have melted more than 80 percent since 1912. Glaciers in the Garhwal Himalaya in India are retreating so fast that researchers believe that most central and eastern Himalayan glaciers could virtually disappear by 2035. From the Arctic to Perù, from Switzerland to the equatorial glaciers of Puncak Jaya in Indonesia, massive ice fields, monstrous glaciers, and sea ice are disappearing. When temperatures rise and ice melts, more water flows to the seas from glaciers and ice caps, and ocean water warms and expands in volume. There are no words, though, to describe how much, and how fast, the ice is changing. Researchers long ago predicted that the most visible impacts from a globally warmer world would occur first at high latitudes: rising air and sea temperatures, earlier snowmelt, later ice freeze-up, reductions in sea ice, thawing permafrost, more erosion, increases in storm intensity. Ice melting can’t be overlooked anymore: the world is changing and the more we wait, the more it will be harder to stop this phenomenon.

Causes

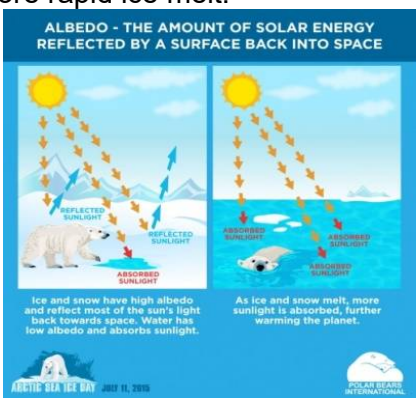
Most climate scientists agree the main cause of the current global warming trend is human expansion of the "greenhouse effect" — warming that results when the atmosphere traps heat radiating from Earth toward space. Gases that contribute to the greenhouse effect include: Water vapor, Carbon dioxide, Methane, Nitrous oxide, Chlorofluorocarbons.
Since 1990, humans have been the primary cause of melting glaciers worldwide; in the past two decades, about two-thirds of the world's glacier loss was due to rising temperatures from the burning of greenhouse gases, along with land-use changes. "In our data we find unambiguous evidence of anthropogenic (human-caused) contribution to glacier mass loss," said study lead author Ben Marzeion, a climate scientist at the University of Innsbruck in Austria.
The consequences of changing the natural atmospheric greenhouse are difficult to predict, but certain effects seem likely:

- On average, Earth will become warmer. Some regions may welcome warmer temperatures, but others may not.
- Warmer conditions will probably lead to more evaporation and precipitation overall, but individual regions will vary, some becoming wetter and others dryer.
- A stronger greenhouse effect will warm the oceans and partially melt glaciers and other ice, increasing sea level. Ocean water also will expand if it warms, contributing further to sea level rise.

The Albedo problem

Albedo is a non-dimensional, unitless quantity that indicates how well a surface reflects solar energy. Albedo (Î±) varies between 0 and 1. Albedo commonly refers to the "whiteness" of a surface, with 0 meaning black and 1 meaning white. A value of 0 means the surface is a "perfect absorber" that absorbs all incoming energy. Absorbed solar energy can be used to heat the surface or, when sea ice is present, melt the surface. A value of 1 means the surface is a "perfect reflector" that reflects all incoming energy. Sea ice has a much higher albedo compared to other earth surfaces, such as the surrounding ocean. A typical ocean albedo is approximately 0.06, while bare sea ice varies from approximately 0.5 to 0.7. This means that the ocean reflects only 6 percent of the incoming solar radiation and absorbs the rest, while sea ice reflects 50 to 70 percent of the incoming energy. The sea ice absorbs less solar energy and keeps the surface cooler.

Snow has an even higher albedo than sea ice, and so thick sea ice covered with snow reflects as much as 90 percent of the incoming solar radiation. This serves to insulate the sea ice, maintaining cold temperatures and delaying ice melt in the summer. After the snow begins to melt, and because shallow melt ponds have an albedo of approximately 0.2 to 0.4, the surface albedo drops to about 0.75. As melt ponds grow and deepen, the surface albedo can drop to 0.15. As a result, melt ponds are associated with higher energy absorption and a more rapid ice melt.



Effects

Global sea level has risen by about 8 inches since reliable record keeping began in 1880. It is projected to rise another 1 to 4 feet by 2100. This is the result of added water from melting land ice and the expansion of seawater as it warms.

In the next several decades, storm surges and high tides could combine with sea level rise and land subsidence to further increase flooding in many of these regions. Sea level rise will not stop in 2100 because the oceans take a very long time to respond to warmer conditions at the Earth's surface. Ocean waters will therefore continue to warm and sea level will continue to rise for many centuries at rates equal to or higher than that of the current century.

Melting glaciers would shortly have strong repercussions on human societies, enormous. Just think, simply, that 60% of the population is concentrated along the coastal areas of the world, within 100 km from the coast. To be submerged along the coast, there are many cities that are at risk because of melting glaciers: Miami and New York, for example, but also Shanghai, Bangkok, Mumbai, London, Amsterdam, Alexandria.

If not submerged, however, 70% of the world's coasts will suffer strong alterations and there are Pacific islands that we can start to say goodbye: thus continuing with the melting of glaciers will disappear forever. The Maldives in the Indian Ocean, within 30 years could, depends on us. Significant effects that would follow the melting of glaciers, such as the global greenhouse effect which is further increased. And then on the food chain of many animals including whales and polar bears. With no ice in 2050 two-thirds of polar bears could disappear, the Adelie penguin fall by 75% in Antarctica, and so on with walruses in Alaska, ptarmigans in the Alpine peaks, flamingos in Chile. A serious biodiversity loss.

Glacier melting in Italy

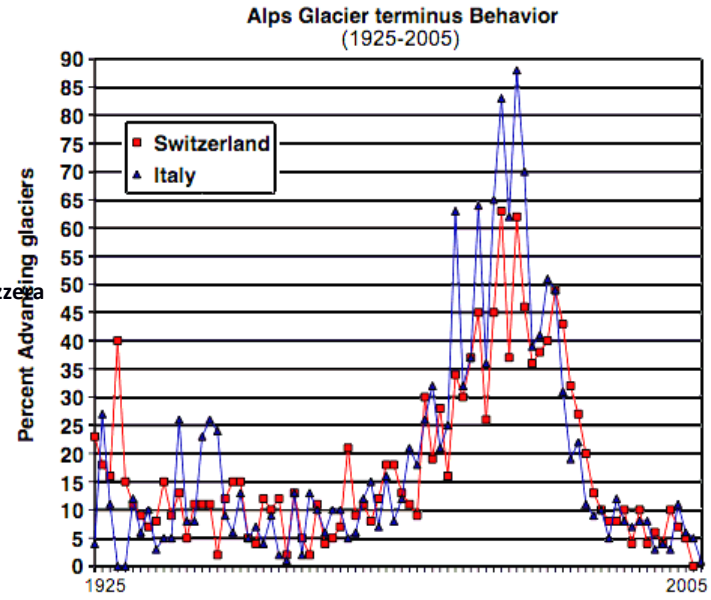
According to the new Land Registry data Glaciers Italian, in 26 years have been lost 2000 billion liters of water reserves on the Central Alps. The latest data of the Inventory of Italian glaciers confirm a tendency to regress. In fact, from the sixties of the 20th century to the first decade of the

21st, there has been a reduction of 30%, from 527 square kilometers to 370 square kilometers. From 2007 to 2012 another 5% contraction was added. To give an idea of the lost glacier surface is equal to that of Lake Como.

"Future scenarios of the Italian glaciation, also based on the evolution of the climate caused by climate models point to a reversal of the current trend is unlikely and that in a few decades could create further approaching a Alpine landscape almost totally devoid of glaciers, which seems the inevitable fate of the mountains of the future "says Claudio Smiraglia, Professor at the University of Milan - Department of Earth Sciences.

Enquiries, made in the last 10 years by a group of scientists with the Grace satellite support, discovered that only in Lombardy from 1959 to the present glaciers decreased by 23%. The glaciers of the Alps in the Lombardy region have suffered a drastic drop which rose from 115 square kilometers, in the years 1959-1962 to 89 sq km in 2012.

The Land Registry is a collaboration among researchers at the University of Milan and by EvK2Cnr studies to monitor the trend of melting glaciers in our country.



This map on the research of the Commissione sui Ghiacciai in Italia e Svizzera shows the feed rate of the glaciers in the Alps. The half of the twentieth century saw a strong melting trend, but not as extreme as currently

Stelvio

The Italian glaciers are in danger. Between 1954 and 2007, in the Stelvio National Park have disappeared about 20 square kilometers of ice, with a rhythm that has been increasing rapidly over the past 10 years. Between 1954-1981 disappeared 0.24 kilometers of

ice per year; from 2003 to 2007, the loss was 3 times higher: 0.7 square kilometers per year. This was found by the project Share Stelvio , which involved three institutes of the CNR (Isac, Ise and Irsa), the ' University of Milan , the Catholic , the' University of Insubria and the Politecnico di Milano. According to the researchers, the data collected reflect the situation of all Italian Alpine glaciers.

Share Stelvio is a pilot project that was part of the project Share (high-altitude international environmental monitoring program) promoted by the Ev k2Cnr with the objective of analyze and quantify the impacts of climate change on ice and water of the Stelvio National Park. As we have said, however, the results throw an alarm that covers the entire Alpine region of our country.

"The Alps can be considered "water towers" that play a crucial role in the accumulation and release of this valuable resource," says Guglielmina Diolaiuti , researcher at the University of Milan and scientific coordinator of the project. "Through the ice and snow are a key reserve this primary good. The glacial reduction data obtained under Share Stelvio clearly indicate that "water towers"

(not only those of the Stelvio National Park) are changing ever more rapidly. " According to the researchers, the impact of these alpine ecosystem changes could be devastating. For now, they have already disappeared 36 alpine lakes located mostly below 2.500 meters, and appeared 22 new lakes above 2.900 meters.

Other data of extraordinary scientific interest have emerged from research carried out on the permafrost and the pro glacial areas . At the Stelvio pass a record drilling of 235 m deep was performed and measured a temperature below zero from the surface to the bottom. Prior to this research it was believed that the maximum thickness of the permafrost in the Alps could be of not more than 100 m. The " cold heart " of the Alps is therefore located in the Lombardy region, and is fortunately deeper than assumed previously.

The researchers then revealed an important element: the melting of glacier’s surface leads up dark rock material that increase the receptivity of the sun's rays, thereby increasing the melting of ice. And so we run for cover by placing geotextile sheets. Surpassed by years the experimental phase, for some Alpine areas, their use is now a technique essential to preserve strategic parts of the glaciers.

The geotextile, or non-woven fabric, is an inert synthetic cloth so named because similar to a fabric while not being produced with frames that intertwine the fibers. It is light and very resistant to tearing. It is a system that makes sense where there are ski slopes and then the ice takes on a significant economic value. It is unthinkable to want to cover the glaciers that descend from Mont Blanc, Monte Rosa, or from other mountain ranges.

Forni

Name	Forni Glacier
Location	Sondrio, Valtellina : 46°23′53.52″N10°35′17.16″E
Square	11,3 km ^{2}
Typology	Valley
Mountain range	Alps

Ghiacciaio Forni nel 1941

Ghiacciaio Forni nel 2012

The Forni glacier is the largest Italian glacier valley, that is a glacier whose tongue is flowing in the main valley. The Forni glacier is located in Alta Valtellina in the Lombardy area of the Stelvio National Park. The glacier currently covers just over 11 km². The ice surface has shrunk intensely (about 36%) and the tongue is set back about 2 km in the last 150 years. The glacier thickness decreased in the tongue of over 70 m during the period 1929-1998. The quantification of the ice reduction is possible due to the fact that the Forni glacier is one of the Italian glaciers monitored by longer time (late '800) by the volunteers of the Italian Glaciology Committee. The Forni glacier is now also studied as part of the SHARE STELVIO project, environmental monitoring program run by EvK2Cnr and FLA (Lombardy Foundation for the Environment) and aimed to detect and quantify the impacts of climate change in a large protected area Italian.

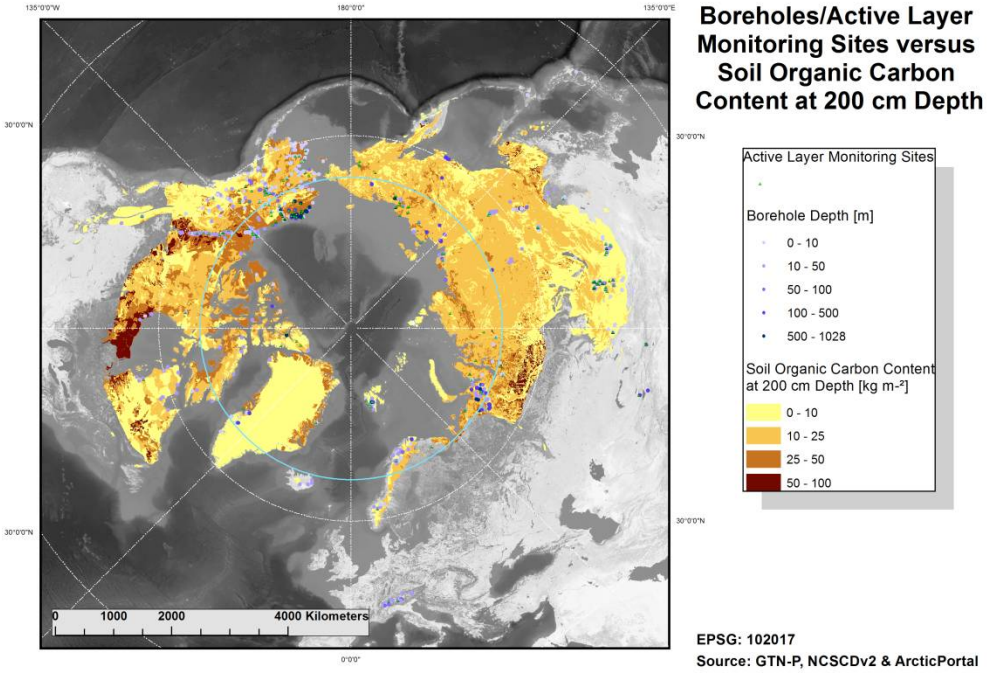
The Forni glacier in Stelvio Park was split into three during summer 2015. Of this impressive structure are now three smaller glaciers, two mountain and one valley. Furthermore, the lower part is in continuous collapse. The news is based on the New Italian Glacier Inventory. According to forecasts, the Forni glacier could resize strongly in the next 86 years. The study, published in the magazine of the Associazione interregionale neve e valanghe, has considered several potential scenarios for precipitation and temperature until the end of the century and it has emerged that the potential evolution of the Forni glacier pinpoints in 2100 with a reduction of more than 80% of the glacial volume valued in 2007. Today the Forni glacier has a 11,36 square kilometers.

Researchers from the University of Milan-Bicocca have identified forms of nested life on the ice surface that, perhaps, may have been complicit of the increase of the ice melting process. Scholars believe that the glaciers are home to complex communities of bacteria, whose presence and growth can have a major impact on the blackening of the ice sheet, which, in turn, affects the rate at which glaciers melt. The study, carried out by a group of scholars of DISAT (Dipartimento di

Scienze dell'Ambiente e del Territorio e di Scienze della Terra of the University of Milano-Bicocca) has chosen as a field of inquiry, the Forni glacier, at 2,700 meters above sea level and the Baltoro glacier in Kashmir, at an altitude of 5,000 meters. They're microorganisms that survive thanks to two alternative mechanisms metabolization different to those known, respiration and photosynthesis: they are a different form of photosynthesis, which does not have as final product the oxygen, through which certain types of microorganisms use the substance organic to grow by taking energy from the sun; and then the oxidation of carbon monoxide, used by bacteria to grow, which in those environments is produced through the degradation of organic substance by the intense sunlight. Millions of information that can point to other targets, already the target of researchers: one of the most important is the study of the relationship between bacteria and pollutants. The discovery has important implications and therefore opens up new scenarios of study: "If the presence of these alternative metabolisms had occurred in all or in most of the frozen areas of the world - which together make up 10 percent of the land - it would be necessary to recalculate the overall contribution of the ice in phenomens of crucial importance as the greenhouse effect and global warming" the researchers conclude.

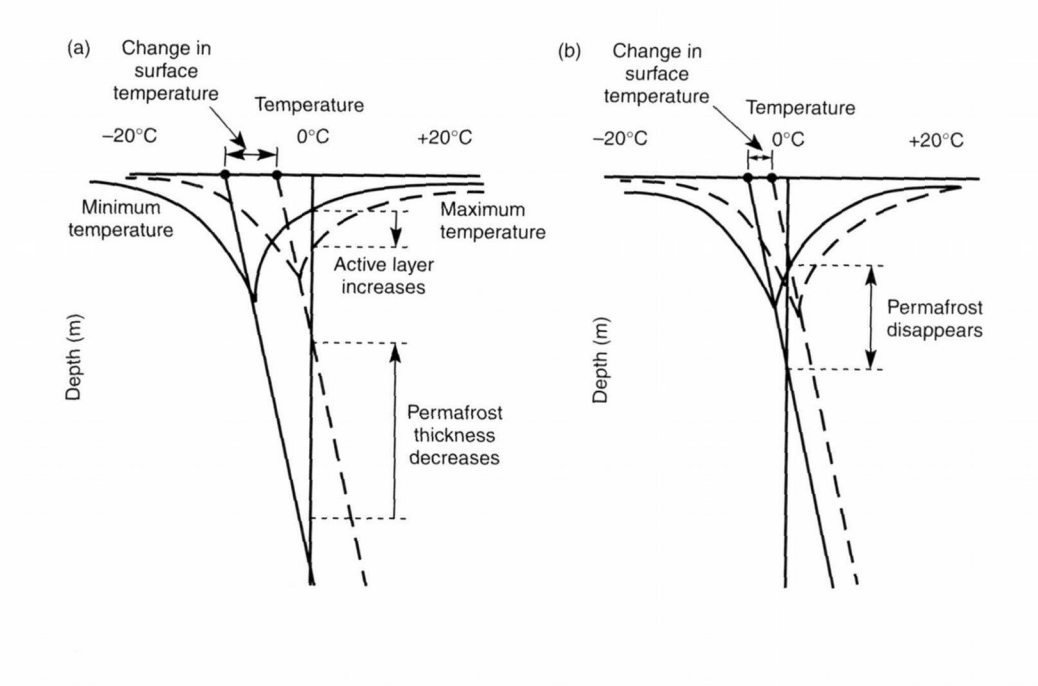
Permafrost Thawing

According to current researches, reported on the Global Terrestrial Network for Permafrost (GTN-P) , the permafrost thawing will be in a near future a serious problem to face, influencing hydrogeological systems, ecosystems and the release of CO2 and CH4 into the atmosphere due to high concentration of frozen organic materials buried below for thousands of years. I decided to focus on CO2 release problem, because this phenomenon could bring an enormous acceleration of the global warming.



This map shows the boreholes/active layer monitoring sites contained in the GTN-P Database versus the soil organic carbon content at a depth of 200 cm.

Permafrost is defined as ground (soil or rock and included ice or organic material) that remains at or below 0°C for at least two consecutive years. Instead the active layer is the surface layer of ground that freezes in the winter (seasonally frozen ground) and thaws in summer. Permafrost state depends from the ground surface temperature (GST) which in turn depends mainly on 4 factors :air temperature, solar radiation, snow cover and vegetation cover



Permafrost holding together the highest peaks in the Alps and other European mountain ranges is melting and threatening alpine villages and ski resorts with devastating rockfalls and landslides.

Alpine mountains are affected by significant geomorphological processes whose evolution is partly conditioned by permafrost warming: rockfalls of various volumes, destabilisation of rock glaciers, and cryokarst. These phenomena, because of their intensity, may generate risks for territories and all their hydrogeologie.

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