Chapter 5
The Global Warming and the Water Resources of the Earth

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Abstract This paper presents some of the climate changes that are occurring at Earth level. It highlights particularly the main temperature increases caused by the greenhouse effect. One of the consequences of the temperature increases is the melting of polar ice caps, polar glaciers and mountain glaciers that feed many streams and rivers. The result may be the rising of the sea and ocean level with catastrophic flooding and loss of an important land reservoir of drinking water, without which life is not possible.

Keywords Climate change • Temperature increases • Greenhouse effect • Melting ice caps • Floods

5.1 Introduction

The Paris Conference of December 2015 devoted to climate change stressed one undeniable thing, global warming and the danger this poses to the whole world. Recently, in early October 2016, the decisions taken in Paris have been ratified by all Member States of the EU.

According to the deal reached in Paris, the main objective is to limit global warming to a maximum of 2 °C by 2100 and this should be done by drastically reducing anthropogenic emissions of greenhouse gases, especially carbon dioxide and methane. If this is not achieved, temperatures may rise by 5 °C, as shown –

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since 2009 – by a team of researchers from the Massachusetts Institute of Technology, which will be a disaster for life on Earth (Brown 2011b). A group of scientists was therefore constituted and, by 2018, they must bring concrete proposals for all countries so that temperatures do not rise more than 1.5 °C.

5.2 Discussion

In order to combat global warming the appropriate measures must be analyzed. One the one hand, there is a need to assess the evolution of climate in the near and distant future and, on the other hand, there is a need for the analysis of the proposed measures (Houghton et al. 1997). In order to do these things, different climate models have been developed and they were accepted by the scientific community and considered relevant by the Intergovernmental Panel on Climate Change (IPCC), through which the evolution of temperatures throughout the twentieth century could be simulated. Using such models it was estimated that the global climate will grow hot by 1.1–6.4 °C over the twenty-first century (Houghton et al. 1997). Such a model is HadCM3 (Hadley Centre Coupled Model, version 3), used for the third Report of the IPCC assessment (Collins et al. 2001; Houghton et al. 2001) (Fig. 5.1).

One of the main consequences of global climate warming is the reduction of freshwater, given that world population is still increasing, the estimations indicating

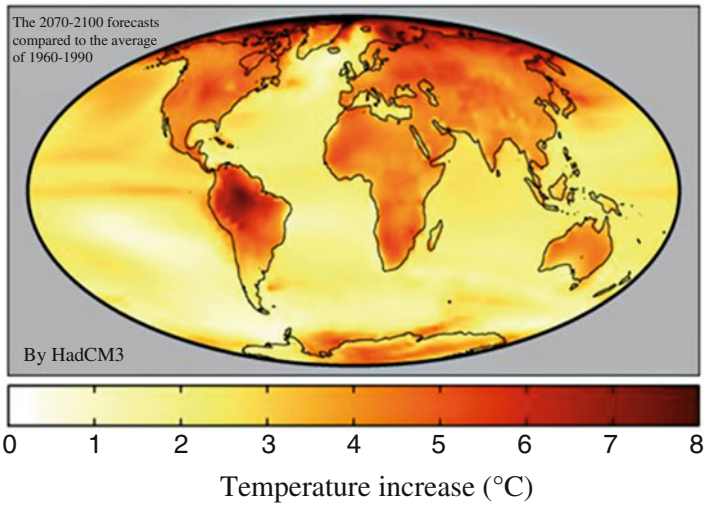

Fig. 5.1 Map indicating the geographical distribution of warming forecasts in the twenty-first century, based on the HadCM3 climate model involving current scenarios concerning the economic growth and greenhouse gas emissions. In this figure, the average global warming corresponds to approx. 3.0 °C (Web 1)

nine billion people by 2100 (if not earlier). All these people needs a growing amount of food and water as well.

For instance, in terms of water, given the population growth, the researchers from UNESCO and the UN believe that within only 20 years mankind's need for water will double. The individual water consumption has an impressive increase: from 15–20 l/day in the Middle Ages to over 600 l/day per person today (of course, there are considerable differences between countries and geographic areas).

The World Health Organization (WHO) is making a recommendation: to consume approximatively 150 l of water/day per person. In these circumstances, this recommendation remains a challenge for many countries.

The specialists believe that the Earth would have sufficient resources, if they were properly used. Nowadays, the consumption is approximately 14% of the existing resources, and a reduction is desired in the future. Lester Russell Brown (2006) points out that water consumption has tripled in the last 50 years so a reduction of this is essential.

Four fifths of our planet – called "The Blue Planet" – is covered by water, the total amount of water being 1.4 billion km^3. Of this amount, sea water is 1.362 billion km^3 i.e. approx. 97.3%, while the remaining 0.038 billion km^3 (2.7%) is freshwater. The largest freshwater reserve is located in the polar caps and glaciers, estimated at approximatively 77.2% of all fresh water. According to other specialists, glaciers occupy only 11% of the earth's surface but contain 3/4 of the drinking water. And thus, we reach one of the main consequences of this phenomenon, of global warming, namely the melting of polar ice caps and glaciers, which are, as we said, the largest freshwater reserve.

Lester Russell Brown (2011b) mentions a study developed by the Arctic Climate Impact Assessment (ACIA) in 2005 and titled "Impacts of a Worming Arctic", in which it is demonstrated that the Arctic is getting warm twice as fast as the rest of the planet. Over the past decades in Alaska, western Canada and the north-western part of Russia, winter temperatures have increased by 3–4 °C, the conclusion being that this area is experiencing one of the most rapid and severe climate change, representing in fact "a picture of what is happening to our planet." Here, in the Arctic, life has and will increasingly suffer more. Arctic animals, especially polar bears, are in great distress, lack of food will make them cannibals, and very many of them – the estimates say about two-thirds – will disappear by 2050. Lester Russell Brown (2011b) reminds us, in one of his last books, that research made by the National Snow and Ice data Center (NSIDC) between 1974 and 2006 showed that the melting ice in the Arctic Ocean accelerated by 9.1% every decade, and a record melting occurred in 2007 which decreased the surface of the Arctic ice by 20% compared to 2005.

It is known that about 70% of the sunlight that reaches the Arctic ice is reflected back and only 30% is absorbed. If the ice disappears – more dark water color – the reflected light will be only 6% while 94% of it will be converted into heat, contributing to an accelerated melting of the ice.

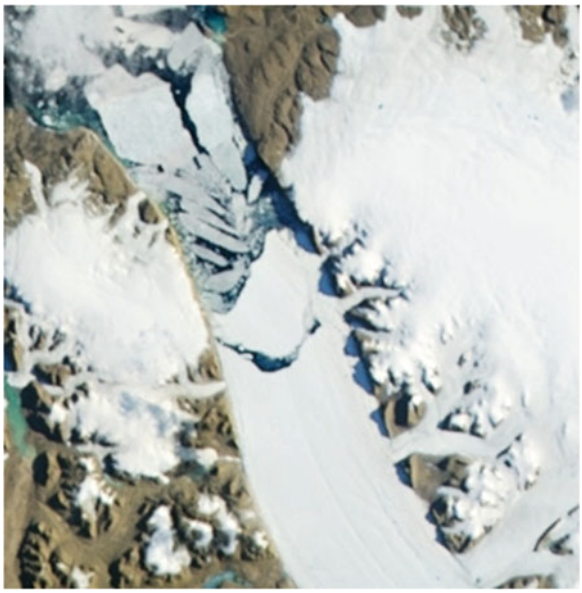

Fig. 5.2 The fatal events of the Petermann glacier (Greenland). Image taken from NASA's Aqua satellite. Author NASA, July 16, 2012 (Web 2)

Still sadder is the fact that the Arctic ice will no longer be restored over the next winters, its thinning continuing year after year and questioning thus the future of the Arctic ice cap.

Lester Russell Brown (2011b) again shows that the same researchers from the National Snow and Ice Data Center (NSIDC) believe that we are witnessing a shortening of the Arctic winter and, in the future, the Arctic Ocean could be free of ice in the summer, facilitating thus navigation.

The ice layer in Greenland is in the same situation. A study of the University of Colorado (USA) showed that within 2 years (2004–2006) Greenland lost its ice 2.5 times faster and this will continue in the future if the warming continues, while the draining of the glaciers will intensify (Brown 2011b). In our country, the mass-media reported in the summer of 2008 that a large piece of the Petermann Glacier in northern Greenland, measuring 11 nautical miles, detached and slid into the sea (Fig. 5.2). Such processes have continued every summer and will continue in the future, more intense if temperatures keep rising.

The satellite observations of the researchers from the European Space Agency (ESA) and the studies conducted by specialists from the National Snow and Ice Data Center (NSIDC) and those of the University of Colorado (USA) (Fowler et al. 2004; Maslanik et al. 2007, 2011) show that between 1988 and 2005, the average age of the Arctic ice decreased from 6 to 3 years due to the accelerated climate warming in this region, approx. 2.5 °C (instead of 0.7 °C, the planet average). Due to the temperature increase, the average glacier thickness decreased by 40% between 1993 and 1997 compared to the period 1958 to 1976. It was also found that in 2007 there was a decrease in the Arctic floating ice surface by 20% in a single year, as a result of the acceleration of melting glaciers, the process increasing alarmingly as well between 2000 and 2011 (Figs. 5.3a, b and 5.4a–c).

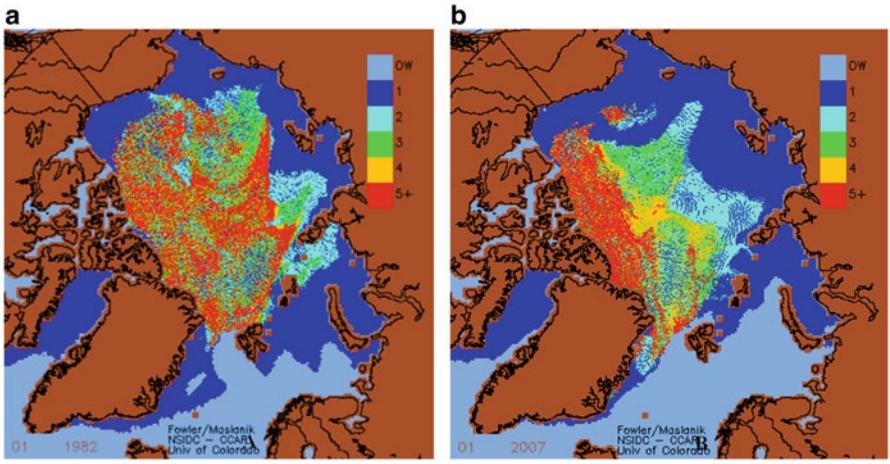

Fig. 5.3 The decreasing of Arctic ice thickness between 1982 (**a**) and 2007 (**b**) (Web 3)

In Antarctica – the opposite pole – similar things are happening. Here, like in the Arctic, studies have shown the same occurrence: temperatures increases in recent years by approximately 3 °C compared to the temperature of 30–40 years ago.

More research shows that the Antarctic ice sheet – 2.5 km thick – with an area 1.5 times larger than the US, began to melt too (Brown 2011a). Since 1995, reports have started of huge pieces of ice detaching and sliding into the sea due to temperature increases. We will mention only one example among many others, made known by the Romanian mass-media: in 2002 NASA witnessed the moment a piece of ice the size of Manhattan (New York) detached and broke.

But all these breaks and fallings of huge blocks of ice into the sea, in addition to the thinning of the Arctic and Antarctic ice, lead to a reduction of the world's drinking water and, inevitably, to an increase of the seas and oceans level, causing catastrophic floods (Fig. 5.5).

In his book *Plan B 4.0. General Mobilization to Save Civilization*, Lester Russell Brown (2011b) mentions a study made by a team from the Institute for Arctic and Alpine Researches, University of Colorado (USA), accomplished 8 years ago (2008). According to this study, glaciers melting will lead to the rising of the seas and oceans by 0.8 cm^{-2} m by 2100. Also, the reports of the International Panel on Climate Change (IPPC) indicate ocean levels increased by 0.1–0.2 m in the twentieth century (Fig. 5.6). These reports estimate a rise of the sea by 0.18–0.59 m by the end of the twenty-first century and 2 m by the end of the twenty-third century if the current rate of temperatures rising is maintained. Some observers believe that if the trend of temperatures rising continues, the sea ice will be completely melted by 2030 or even earlier. But there are other studies that estimate the water levels will rise much more. Researchers at Harvard and Princeton University have published the results of their studies and believe that these increases will vary between 4 and 6 m; which would be a real catastrophe.

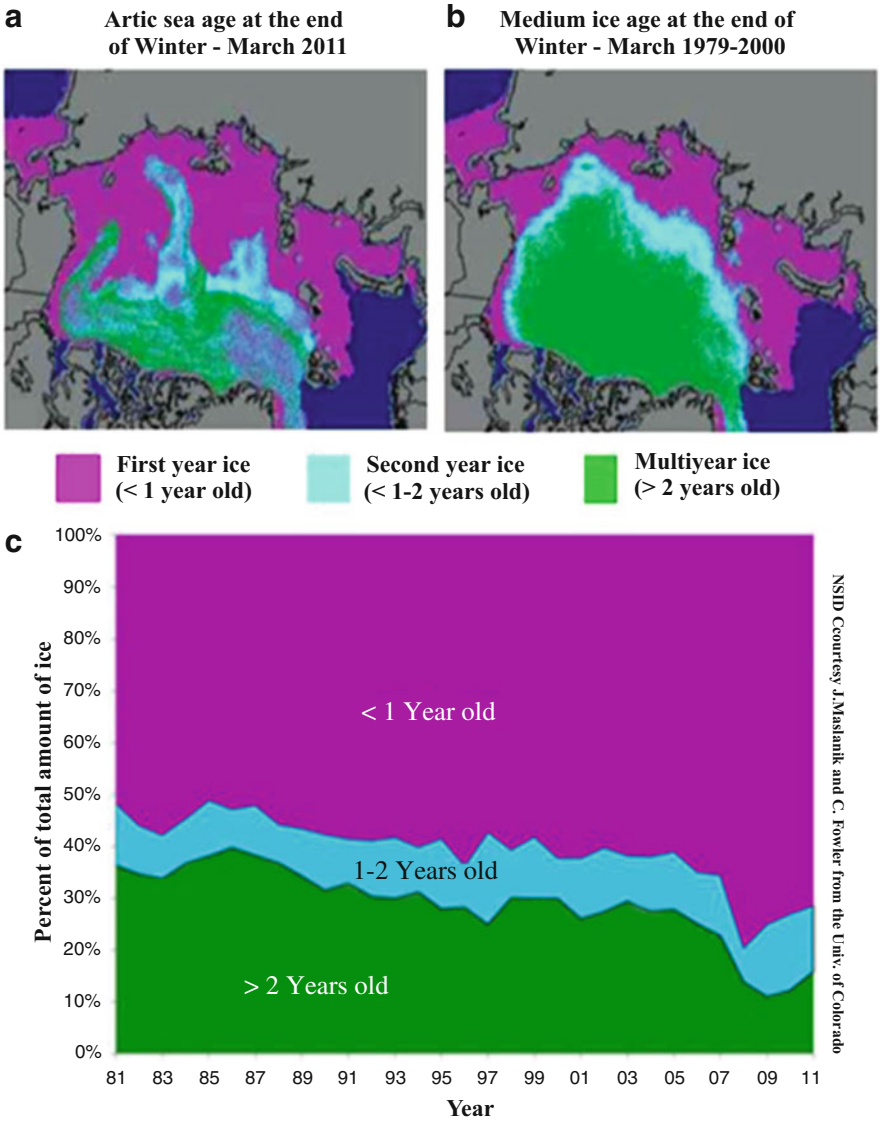

Fig. 5.4 Images showing the Arctic glaciers age in the third week of March 2011 compared to their average age during the reference period of the years 1979–2000 (**a**, **b**). Images taken by NSIDC (by J. Maslanik and C. Fowler University of Colorado). The glaciers age as a percentage of the total Arctic ice (**c**) (Web 4)

However, the estimates may not be accurate because they depend on the emissions of greenhouse gases.

If these forecasts come true, huge areas will be flooded, as well as numerous islands in the Oceanian, Maldives etc. Many cities on the seashore will be in serious

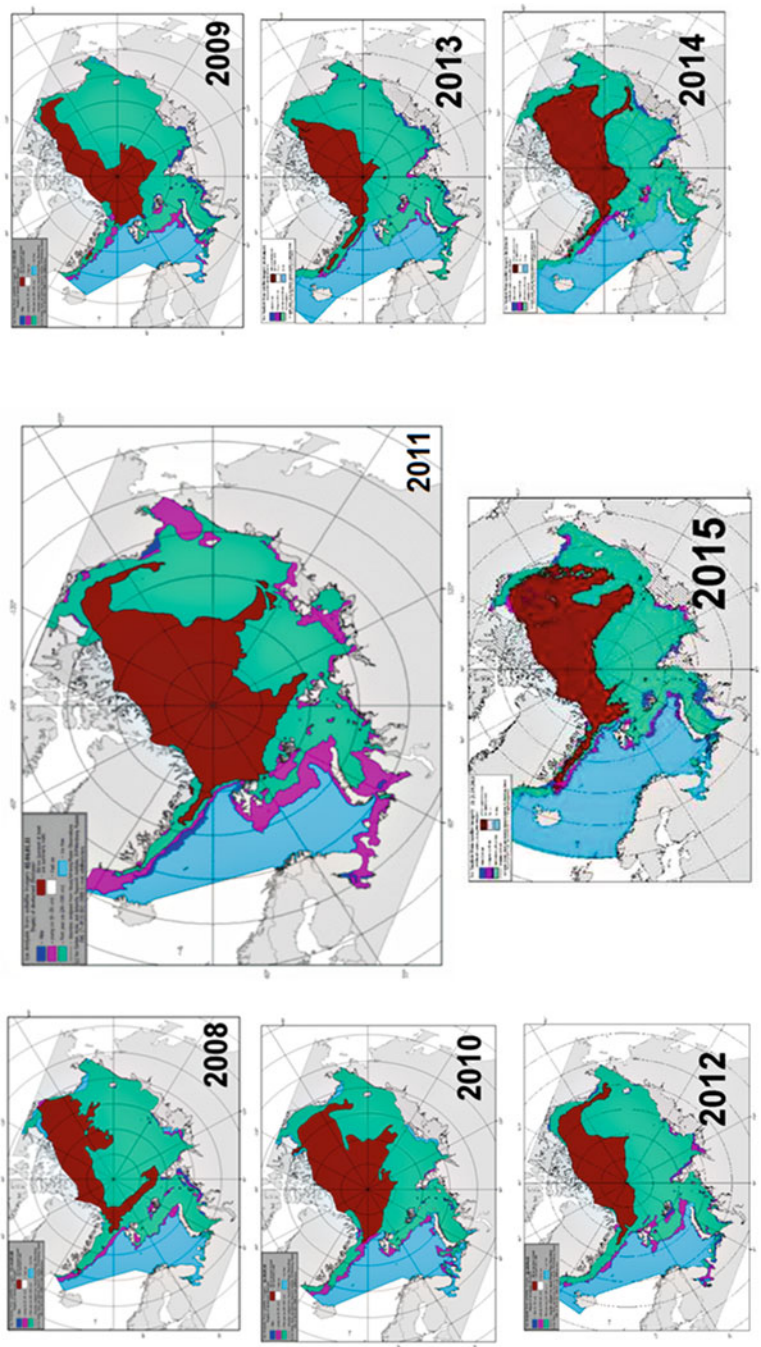

Fig. 5.5 Map representing the analysis of the glaciers realized by The Arctic and Antarctic Research Institute (AARI) from Sankt Petersburg (Russia), in 2011–2015 compared to 2008–2010. Legend of figure: *light blue* shows where the open sea is, *dark blue* is for water covered with very thin ice, *pink* is for young ice between 0–30 cm *thick*, *green* is for first-year ice with a thickness of 30–200 cm and *white* for the rapid melting of ice. The *brown color* is for old ice that survived at least one melting season, and it is this that interests us most, while white is the fast ice melting (Web 5, 6)

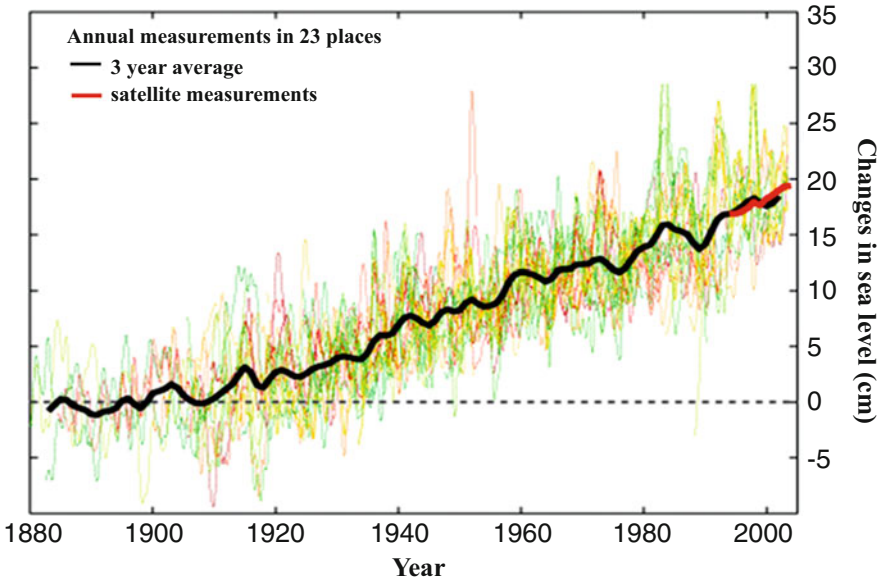

Fig. 5.6 Increasing of the sea levels in the twentieth century (Web 1)

trouble: New York, Shanghai, New Orleans, the Netherlands with cities like Rotterdam and Amsterdam. Bangladesh will lose 18% of its territory, a country which is an important agricultural area. The same will occur in the case of the Ganges and the Mekong delta, as well as other agricultural areas important for the cultivation of rice (Bavaru and Bercu 2014; Brown 2011a; Mâşu 2014).

Numerous glaciers on mountain ranges will suffer the same process – will melt – under the action of high temperatures, with the same serious consequences. The Glacier Monitoring Service of the Zurich University shows that in the last 18 years the alpine glaciers have reduced their volume continuously. They are melting twice as much now than a decade ago. In many regions of the world the phenomenon of mountain glaciers melting is extremely dangerous because it affects people's food security.

There are numerous such extremely eloquent examples in the specialized literature. Thus, in India, the giant Himalayan Gangotri glacier restricts its volume alarmingly every year and it may disappear by 2035. Its annual melting ensures 70% of the Ganges River flow, a river that is the main source of irrigation and drinking water for approximatively 400 million people in this river basin (Brown 2011a).

For China things are even worse. One of the most famous Chinese glaciologist, Yao Tandong, believes that if temperatures continue to rise, the Tibetan glaciers which feed the two great rivers of China, the Yellow River and the Yangtze, two thirds of these glaciers will disappear by 2050. And do not forget that these two great rivers are feeding hundreds of millions of people. Approximately 369 million

people live in the Yangtze River basin and 147 million in the yellow River basin. About half of China's rice production is cultivated in the two river basins (Bavaru and Bercu 2014).

In the USA things are also not much better and will continue to decay. In the West of Montana State there is a small reserve called "Glacier National Park". In this park there are approximately 100 glaciers protected by law. At the last evaluation done in 2009, there were 27 glaciers left and after 1 year, in 2010, two others disappeared. It is estimated that in a few years (by 2020) all of them will disappear (Brown 2011a).

South America is also in the same situation, as approximately 80% of its glaciers could disappear by the end of the next decade, seriously affecting the farming of some countries such as Peru or Ecuador (Brown 2011b). Let us mention that Lima, the capital of Peru, a town which currently has over eight million people get their drinking water from rivers that come from the highlands of the Andes mountains, fed by melting glaciers. If they disappear what will happen to this city whose population is continuously growing?

5.3 Conclusion

As the planet warms up, the Earth icecaps and glaciers will melt and we will witness a catastrophic rise of the sea and ocean water levels.

In addition, the melting of the mass of ice and its mixing with marine waters will slowly deplete our drinking water supply that the polar caps and mountain glaciers have always offered us and that we will increasingly need. Let's remember one known thing: life is not possible without water. Life was born in water and will disappear without it.

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