UNEP

CBD

CONVENTION ON BIOLOGICAL DIVERSITY

Distr.
GENERAL

UNEP/CBD/WG8J/5/INF/18
31 July 2007

ORIGINAL: ENGLISH

AD HOC OPEN-ENDED INTER-SESSIONAL WORKING GROUP ON ARTICLE 8(j) AND RELATED PROVISIONS OF THE CONVENTION ON BIOLOGICAL DIVERSITY
Fifth meeting
Montreal, 15-19 October 2007

REPORT ON INDIGNEOUS AND LOCAL COMMUNITIES HIGHLY VULNERABLE TO CLIMATE CHANGE *INTER ALIA* OF THE ARCTIC, SMALL ISLAND STATES AND HIGH ALTITUDES, WITH A FOCUS ON CAUSES AND SOLUTIONS

Note by the Executive Secretary

The Executive Secretary is circulating herewith, for the consideration of participants in the Ad Hoc Open-ended Inter-Sessional Working Group on Article 8(j) and Related Provisions, the above-mentioned report, which may be a useful contribution to the discussion on the second phase of the composite report and programme of work for Article 8(j).

The report is being circulated in the form and language in which it was received by the Secretariat.

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HIGHLY VULNERABLE INDIGENOUS AND LOCAL COMMUNITIES, *INTER ALIA*, OF THE ARCTIC, SMALL ISLAND STATES AND HIGH ALTITUDES, CONCERNING THE IMPACTS OF CLIMATE CHANGE AND ACCELERATED THREATS, SUCH AS POLLUTION, DROUGHT AND DESERTIFICATION, TO TRADITIONAL KNOWLEDGE AND PRACTICES WITH A FOCUS OF CAUSES AND SOLUTION

Prepared for the Secretariat of the Convention on Biological Diversity

by

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Introduction

In its decision VIII/5 B, paragraph 6, the Conference of the Parties (COP) to the Convention on Biological Diversity (CBD) noted the specific vulnerabilities of indigenous and local communities to the impacts of climate change and the accelerated threats to traditional knowledge, innovations and practices. It has requested that further research be conducted into highly vulnerable indigenous and local communities, with focus on causes and solutions.

In response, the Executive Secretary of the CBD has commissioned a report on the specific vulnerabilities of indigenous and local communities (highly vulnerable indigenous and local communities), *inter alia*, of the Arctic, small island States and high altitudes, concerning the impacts of climate change and accelerated threats, such as pollution, drought and desertification, to traditional knowledge, innovations and practices, with a focus on causes and solutions.

The February 2007 report of the Working Group I of the International Panel on Climate Change, titled "The Physical Science Basis for Climate Change", identifies numerous long-term changes in climate. This includes changes in Arctic temperatures and ice, widespread changes in precipitation amounts, ocean salinity, wind patterns and aspects of extreme weather including droughts, heavy precipitation, heat waves and intensified tropical cyclones. The report concludes that it is very likely that global warming is largely driven by the concentration of carbon dioxide and other greenhouse gases caused by human activity, and that this will lead to dangerous levels of warming and in the rise of sea levels. The Working Group also concludes that this is a trend very likely to continue. It can be inferred that further climate changes are bound to occur and it seems inevitable that people affected by climate change will need to adapt to these new conditions.

Based on the emerging scientific consensus on the physical effects of climate change, including the human and natural drivers, there must be greater efforts to assess the social and cultural impacts of climate change. This should include avenues for adapting to the projected scenarios and means of mitigating the impacts of climate change. This is particularly relevant in the case of indigenous and local communities, who depend on the environment and its resources, and who have a very close relationship with their natural surroundings.

As requested by the Executive Secretary, the present report focuses on the human and social aspects of the impact of climate change to indigenous and local communities in the Arctic, small island States and high altitudes. National reports, case studies, reports commissioned by the CBD Secretariat, and other data and information submitted to the Executive Secretary in response to various COP decisions, as well as various other relevant reports published by the United Nations system and relevant non-governmental organizations and indigenous organizations, have been taken into account when preparing the report.

Traditional Knowledge, Innovations and Practices

No definition fully captures the concept of "traditional knowledge" held by indigenous and local communities, nor is there a clear definition of the concepts of "innovations" and "practices".

For the purpose of this report, the conceptual basis of the term "traditional knowledge" refers to the knowledge, innovations and practices of indigenous and local communities, developed and shared through experience gained over time and adapted to the local social structure, culture and environment. Such knowledge tends to be collective in nature. It is usually communicated through indigenous peoples' way of life, stories, songs, folklore, proverbs, cultural and religious values, beliefs, rituals, customary laws, practices and traditions, languages and other ways of transmission. This knowledge is normally of a

practical nature, and covers areas such as traditional livelihoods, health, medicine, plants, animals, weather conditions, environment and climate conditions, and environmental management (http://www.biodiv.org/programmes/socio-eco/traditional/default.shtml).

Traditional knowledge of indigenous and local communities is an integral part of their culture and life. Such knowledge is not merely a collection of facts and observations; it includes analysis and understanding of the subject matter from a practical perspective. Consequently, adverse external impacts on indigenous and local communities' way of life, social structures, culture and habitat will also affect their "knowledge, innovations and practices."

Article 8 (j) of the Convention acknowledges the knowledge, innovation and practices of indigenous and local communities, and promotes its wider application in the context of conservation and sustainable use of biological diversity. The Convention has established specific obligations for State parties to respect, preserve and maintain such knowledge, innovations and practices, as far as this is possible, and as appropriate within the framework of their respective national legislation and subject to the approval of the knowledge holders.[1]

Climate Change

Different descriptions of the phenomenon of climate change exist. Working Group I of the Intergovernmental Panel on Climate Change recently released its assessment of the physical science basis for climate change: "climate change as any change in climate over time, whether due to natural variability or as a result of human activity"(IPCC WGI 4th Assessment Report, February 2007). This usage of the term "climate change" differs from that in the United Nations Framework Convention on Climate Change, where climate change refers to a change of climate that is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and that is in addition to natural climate variability observed over comparable time periods (Article 1 (2) of the Framework Convention on Climate Change).

CBD - Climate Change

Climate change is bound to affect biological diversity and the knowledge, innovations and practices of indigenous and local communities. However, it is difficult to give a precise projection of the scale of these impacts.

Climate change and its impacts on the Earth's biological diversity were not at the centre of discussions when the CBD was drafted and adopted. The focus was on the development of international standards for the protection of biological diversity in a traditional development context.

Nevertheless, Parties to the Convention are obliged, as far as possible and as appropriate, to introduce necessary measures, administrative as well as legislative, to prevent and mitigate the impacts of climate change to the Earth's biological diversity. This also applies to Parties' obligations in relation to knowledge, innovations and practices of indigenous and local communities. It is required that such knowledge is respected, preserved and maintained, if it is relevant to conservation and sustainable use of biological diversity. Parties also have an obligation to make promote of such knowledge, innovations and

[1] Article 8 (j): "Each contracting Party shall, as far as possible and as appropriate: Subject to national legislation, respect, preserve and maintain knowledge, innovations and practices of indigenous and local communities embodying traditional lifestyles relevant for the conservation and sustainable use of biological diversity and promote their wider application with the approval and involvement of the holders of such knowledge, innovations and practices and encourage the equitable sharing of the benefits arising from the utilization of such knowledge, innovations and practices."

practices, with the approval of the knowledge holders, whenever it might contribute to the conservation and sustainability of biological diversity, including in the context of climate change.

When considering what the knowledge, innovations and practices of indigenous and local communities can contribute within the context of climate change mitigation, regardless of differences of opinion about strict legal obligations, it is recognized that such contributions may be of great value. In cases where indigenous peoples have been involved in climate change research, their observations and contributions have proved to be an extremely valuable part of the overall research, one such instance is the Arctic Climate Impact Assessment (Arctic Climate Impact Assessment, 2004).

Climate Change – Physical Basis

The Report of Working Group I of the Intergovernmental Panel on Climate Change (February 2007) has contributed to a shift in the climate change debate, due mainly to its unanimous conclusions. It is now widely acknowledged that it is necessary to also focus on the need to adapt to climate change, and that this should take place simultaneously with the attempts to slow the growth of greenhouse gas (GHG) emissions.

According to the working group, the past century has been unusually warm compared with the previous 1,300 years. The last time polar regions were significantly warmer for an extended period than at present was about 125,000 years ago (IPCC WG I, Climate Change 2007: The Physical Science basis, Summary for Policymakers).

The IPCC Working Group predicts a continuing rise in temperatures and sea levels for the next century. Temperatures are predicted to rise from 1.8 to 6.4 degrees Celsius (3.2 to 11.5 Fahrenheit) by 2100, and sea levels from 18 to 55 centimetres. It is expected that the seas will continue to rise and coastlines to retreat for at least a thousand years, while heat waves and droughts are expected to become more intense and last longer. Furthermore, the widespread trend of melting snow and ice, and an increase in hurricane and tropical storm strength is also expected to continue.

In the view of one of the authors of the Report, Kevin Trenberth, the director of climate analysis for the National Centre for Atmospheric Research in Boulder, Colorado: “This is just not something you can stop. We are just going to have to live with it. We are creating a different planet. If you were to come up back in 100 years time, we’ll have a different climate.” (Chicago Sun-Times, 2 February 2007).

In sum, the IPCC Working Group predicts the following phenomena and future direction of the climate change trend (IPCC WG I, Climate Change 2007: The Physical Science Basis, Summary for Policymakers):[2]

- Warmer and fewer cold days and nights over most land areas;
- Warmer and more frequent hot days and nights over most land areas;
- Warm spells/heat waves. Frequency increases over most land areas;
- Heavy precipitation events. Frequency or proportion of total rainfall from heavy falls increases over most areas;
- Area affected by drought increases;
- Intense tropical cyclone activity increases;
- Increased incidence of extreme high sea levels (excludes tsunamis).

[2] See page 9 of the Working Group’s summary report.

Although the assessment report of the Working Group does not elaborate on possible social impacts of climate change, it predicts that climate changes are likely to have a profound and adverse effect on humanity. For instance, coastal settlements could be swamped due to sea level rise. Climate associated phenomena, including sea level rise, floods, drought, desertification, rising temperatures, increased frequency and strength of storm, melting ice etc., will change the lives of millions, if not billions of people. Climate changes might also create a growing number of climate refugees.

Indigenous and local communities are amongst the communities that have contributed the least, per capita, to the emission of carbon dioxide and other greenhouse gases, yet they are among the first to face direct adverse consequences of climate change. The fact that communities that have little responsibility for emissions will be amongst the communities suffering the most severe consequences brings in an important moral, ethical and equitable dimension to this matter.

1. The Arctic

The Arctic region is an enormous and diverse region of over 30 million km2 covering approximately one sixth of the Earth's landmass. It includes Greenland and the Faeroe Islands (Denmark), parts of Canada, the United States (Alaska), Russia, Iceland, Norway, Sweden and Finland, as well as the Arctic Ocean.

The Arctic climate is characterized by cold winters and cool summers. Precipitation mainly comes in the form of snow. Due to its unique nature and climate and sensitivity to climate changes the Arctic is an important early warning system as far as climate change is concerned.

The Arctic indigenous peoples, their life, culture and traditional knowledge, are adapted to and largely dependent on the cold and extreme physical conditions of the region. As recently stated by Sheila Watt-Cloutier, the former chair of the Inuit Circumpolar Conference, the culture of the indigenous peoples of the Arctic depends on the cold. Their culture is inseparable from the conditions of their physical surroundings (News independent, 2007).

The findings of the IPCC working group show that eleven of the last twelve years (1995-2006) rank among the 12 warmest years in the instrumental record of global surface temperatures since 1850. Average temperatures in the Arctic increased at almost twice the global average rate in the past 100 years. Consequently, the annual average Arctic sea ice extent has shrunk by 2.1 - 3.1% per decade. Temperatures at the top of the permafrost layer have generally increased up to 3˚C since the 1980s. It is projected that higher temperatures will contribute to continuing snow contraction and widespread increases in thaw depth over permafrost regions. The gradual melting of the Greenland ice sheet is projected to contribute to sea level rise, even beyond the year 2100. There are some scientific models projecting that the Arctic late-summer sea ice will have disappeared almost entirely by the latter part of the 21st century (IPCC WG I, Climate Change 2007: The Physical Science basis, Summary for Policymakers).

1.1 Causes of Vulnerability Associated with Climate Change

The consequences of climate change are becoming more visible in the Arctic, and are greatly influencing the environment, animals and the living conditions of humans, especially the indigenous peoples who depend on nature and its resources. The indigenous peoples of the Arctic have adapted to the challenges brought about by the Arctic geography and climate. Although the Arctic climate has always undergone change, the ongoing changes in the climate are taking place at such an alarming speed that indigenous communities have severe difficulties coping.

The Arctic Climate Impact Assessment (ACIA), commissioned by the Arctic Council,[3] provides important insight into the impacts of climate change in the Arctic region (Arctic Climate Impact Assessment, 2004). This assessment was prepared over a period of five years by an international team of over 300 scientists, other experts, and members of indigenous communities. The ACIA Report identifies a range of climate change impacts, including the following:[4]

- Rising temperatures in the Arctic, with worldwide implications;
- Arctic vegetation zones will shift, bringing wide-ranging impacts;
- Animal species' diversity, ranges, and distribution will change;
- Many coastal communities and facilities face increasing exposure to storms;
- Reduced sea ice will increase marine transport and access to resources;
- Thawing ground will disrupt transportation, buildings, and other infrastructure in the Arctic;
- Indigenous communities will face major economic and cultural impacts;
- Elevated ultraviolet radiation levels will affect people, plants, and animals;
- Multiple influences interact will cause impacts to people and ecosystems.

The ACIA Report devotes a separate chapter to address matters concerning the changing Arctic from an indigenous perspective. Indigenous peoples have provided case studies addressing the situation in Kotzebue, the Aleutian and Pribilof Islands Region, the Yukon Territory, Denendeh, Nunavut, Greenland, Sápmi and Kola. These case studies analyse how climate change is seen in specific terms for particular indigenous communities. An important common theme or observation in the case studies is that the weather in the Arctic region has become more variable and less predictable by traditional means (Arctic Climate Impact Assessment, Chapter 3, 2004).

A Case study on the situation in the indigenous community of Kotzebue in Northwest Alaska (the Qikiktagrugmiut): This case study identifies a large number of impacts associated with climate change. It was conducted by the tribal government of the community. It documents traditional indigenous knowledge, and environmental change in the region from the 1950s to the present. Researchers used a semi-directive interview form to engage Elders in conversations about environmental changes. This case study specifically focuses on impacts that the indigenous people concerned associate with late freeze-up, demonstrating both the scope of their environmental knowledge and the patterns of interconnection that they see in their physical surroundings. It demonstrates how the timing, quality of ice, speed of complete freezing, associated weather, and ecological effects all combine to produce the many impacts of a late freeze-up, positive as well as negative impacts (Arctic Climate Impact Assessment, Chapter 3, 2004).[5]

The case study identifies a number of impacts of late freeze-up which are regarded as positive by the indigenous community concerned, in particular better whitefish harvests, better clamming, better spotted seal hunting, better access to caribou, better arctic fox harvests, better access to driftwood. Many other impacts are regarded as negative, including shorter ice-fishing season, poor access to the main village for people living out in the country, rough ice conditions, more danger from thin ice, and more erosion and

[3] The Arctic Council is a high-level intergovernmental forum that provides a mechanism to address the common concerns and challenges faced by arctic people and governments. It is comprised by the eight Arctic states (Canada, Denmark/Greenland, Faeroe Islands, Finland, Iceland, Norway, Russia, Sweden, and USA), six indigenous peoples organizations (Permanent Participants: Aleut International Association, Arctic Athabaskan Council, Gwich'in Council International, Inuit Circumpolar Conference, Russian Association of Indigenous peoples of the North, and Sámi Council), and official observers (including France, Germany, the Netherlands, Poland, United Kingdom, non-governmental organizations, and scientific and other international bodies).

[4] Arctic Climate Impact Assessment, Policy Document, Issued by the 4th Arctic Council Ministerial Meeting, held in Reykjavik, Island, 24 November 2004.

[5] Arctic Climate Impact Assessment, Chapter 3, 2004, pages 73-76.

flood problems. This is not an exhaustive list of impacts. Moreover, it mainly focuses on short-term impacts. This case study does not give an insight into possible long-term impacts to these communities, including whether these changes will threaten their existence and culture in the longer-term perspective. However, the documentation of this knowledge is valuable to future members of this community for preservation purposes and comparative analysis (Arctic Climate Impact Assessment, Chapter 3, 2004).[6]

A Case study on the situation in the Aleutian and Pribilof Islands region in Alaska:
This was undertaken by the Aleut International Association and the Aleutian and Pribilof Island Association, and provides a number of observations and concerns related to climate change in this region. The changing weather patterns have a dramatic effect on the security of villages and the local infrastructure. The Nelson Lagoon community, situated on a narrow strip of sand between Nelson Lagoon and the Bearing Sea, have for many years already faced adverse affects of winter storms, and have been forced to build strong break-walls along the shore. The increasing violence of the storms and changing winter sea-ice patterns have exacerbated the problem. The break-wall was designed to brace the shore ice, which would in turn provide the real buffer from winter storm wave action. However, as the winters have been warmer over the last decade, the buffer provided by the shore ice has been lost, allowing the full force of the waves to surge against the wall and the village. Other vital infrastructure has been disrupted by the changing weather patterns. The pipeline that provides the village's drinking water has been threatened when storm waves eroded cover soil and caused a breach in the line.

The case study also provides information about climate-related observations from the Aleutian Islands, which includes the presence of non-indigenous warm-water fish species. These new species are competing for resources with traditional species and marine mammals. On St. George Island, storms are creating severe shoreline erosion. The warmer weather has reduced subsistence hunting opportunities on the neighbouring St. Paul Island, because certain species have left the island. (Arctic Climate Impact Assessment, Chapter 3, 2004).[7]

As a result of climate change, several indigenous villages in Alaska are currently actively trying to find out where they could move entire communities, in particular due to erosion caused by the thawing of permafrost and large waves slamming against the west and northern shores of Alaska. Coastal indigenous communities are severely threatened by storm driven coastal erosion because of the melting of sea ice; previously sea ice effectively diminished the intensity of waves. The loss of permafrost also causes large scale erosion, in particular along river banks. More than 80% of Alaskan communities, comprised mostly of indigenous peoples, are identified as vulnerable to either coastal or river erosion. Moreover, melting mountain snow and ice creates rapid water level rise, which in turn wash away big amounts of riverbanks in villages. This takes large amount of soil into the rivers, causing riverbeds to rise as eroded soil accumulates on the bottom. Shallow waters are harmful to fish stocks and thus also to indigenous subsistence fishing. In addition to all the immediate problems these changes are causing, they also force indigenous communities to actively consider various relocation possibilities. It will be enormously difficult for many indigenous communities to finance the relocation of entire villages and build up new infrastructure in new settlements without external assistance, in particular economic assistance (Cochran, 2007).

Recent research provides information about the appearance of a rare bacterium in Alaskan waters, which is believed to be linked to climate change. The rare vibrio paraheamolyticu microbe that usually infects seafood in warm waters, such as in the Gulf of Mexico, has now been found off Alaska's Prince William Sound. When this microbe is ingested, it causes diarrhoea, cramping and vomiting. Scientists believe that warmer temperatures allowed the microbe to travel to an area that in the past has been much too cold for it to survive. This is seen as being part of the global disease proliferation caused by climate change

[6] Arctic Climate Impact Assessment, Chapter 3, 2004, pages 73-76.
[7] Ibid, pages 76-77.

(Science Daily, 26 February 2007). The introduction of the vibrio paraheamolyticu microbe to cold waters may seriously affect traditional food traditions and safety of some indigenous peoples, in particular those communities which still to some extent practice the tradition of eating raw sea food.

Case study concerning the impacts of climate change to the Yukon First Nations: This case study, which was conducted by the Council of Yukon First Nations, shows that the indigenous communities concerned are seriously concerned about their future due to the ongoing changes in climate. It provides information about unusual rain during the winter that encapsulates the ground below the snow in ice, preventing animals from reaching their source of food. In some areas, thawing permafrost has caused the ground to drop. The study refers to increased sightings of new types of insects and an increase in some animal species, such as cougar.[8] Lakes and streams are reportedly drying up, or are becoming choked with weeds, which is making the water undrinkable. Some animals are changing their distribution and behaviour. These changes have forced people to alter their habits and they are now more dependent on market foods and eat less traditional foods. (Arctic Climate Impact Assessment, Chapter 3, 2004).[9] This brings about additional financial challenges for people, as they are gradually buying more of what they eat. One of the biggest concerns of these communities is the possible shortage of drinking water, which has never been a problem in the past.

Research done in Nunavut (Canada) provides information about low water levels in rivers and lakes and subsequent impacts. This is a relatively recent phenomenon, as the increase in weather variability and unpredictability was not noticed before the early 1990s. The weather has reportedly become so unpredictable and extreme that Elders can no longer predict it using their traditional knowledge and skills. The survival of Inuit communities settled in the Baker Lake area is closely linked to the harvesting of lakes and rivers. The case study from Nunavut that is included in the ACIA Report shows that the water level in lakes and rivers around Baker Lake has dropped dramatically since the 1990s. Thus, travel routes on rivers are often blocked by shallow waters, preventing people from travelling by water, as many indigenous hunters are thus unable to get to important caribou hunting grounds. Many summer hunting grounds can no longer be reached. The shallow water has reportedly also affected fish in rivers and lakes. There are fewer fish in areas where they are traditionally found, and when found, they are often small and skinny. The case study draws attention to an important factor, which is that indigenous peoples adjust their day-to-day coping strategies, e.g. hunting, fishing and travel strategies. They change fishing and hunting areas, and adjust their travel routes; this allows communities to continue their day-to-day life. However, the case study emphasises that it is very unclear what will happen to the communities if the water conditions and other changes persist or worsen, and that these communities have not developed any long-term strategies yet (Arctic Climate Impact Assessment, Chapter 3, 2004).[10] If the situation persists or worsens, these communities may be faced with a threat to their food security, and in the worst case scenario, they may be forced to relocate or face environmental genocide.

Indigenous communities in the Inuvialuit Settlement Region of Canada's Northwest Territories identify a number of climate change impacts. Those communities are faced with many challenges caused by climate change, including not being able to store traditional winter food supplies properly due to warmer temperatures in summer. Warmer weather also makes it more difficult to prepare food in the summer by traditional means, such as drying and smoking, because the food gets pre-cooked in the heat. Warmer weather in winter makes animal fur shorter and thinner. This reduces the quality of the fur/skin used for making clothes, as well as the price of fur/skin. Changing animal behaviour is said to render hunting more difficult and expensive, and even prevent some people from taking part in hunting, especially the elderly.

[8] However, some communities have reported greater numbers of animals such as polar bears – when in fact this is evidence of animal populations under stress – coming into human settlements and areas looking for food, or feeding of garbage. Thus, increase sightings can in some cases mean a drop in number.
[9] Arctic Climate Impact Assessment, Chapter 3, 2004, pages 77-78.
[10] Ibid, pages 82 – 84.

The initiation of a community program for the elderly, through which younger hunters provide meat to the elderly who are unable to travel to hunt for themselves, is identified as a possible way of responding to changing animal migration routes (Arctic Climate Impact Assessment, Chapter 3, 2004).[11] In many indigenous communities in the Arctic, the provision of game meat to the elderly and the disabled is a common practice based on customary obligations relating to sharing and family ties should be supported and continued.

The severe and dramatic changes taking place in Greenland today are widely reported. Rising temperatures have contributed to melting ice and changing coastlines. Nunataks, or "lonely mountains" in Inuit, that were located in the margins of Greenland's ice sheet now appear as islands due to the fact that glaciers which joined it to the mainland have melted. This trend is expected to continue along the coastline of Greenland. (Rudolf, 17 January 2007, *Melting ice keeps Arctic mapmakers busy*, International Herald Tribune).

Uusqqak Qujaukitsoq, an indigenous hunter from Qaanaaq, North Greenland describes the climate changes in Greenland as very dramatic. Torrential rain during December, which traditionally is the coldest month of the year, causes problems for animals to find anything to feed on, because of the layer of ice forms that covers everything. Uusqqak Qujaukitsoq, reports that hunting grounds that they used to travel to in October in the late 1990s, are not covered by sea ice anymore, not even as late in the winter as January, due to shifting wind conditions and sea current. He observes that ice is now generally thinner and is slower to form off the smaller forelands. Glaciers are very notably receding and place names are no longer consistent with the topography. For instance, Sermiarsussuaq – "the smaller large glacier" in Inuit, which previously stretched out to the sea does not exist any longer. (Arctic Climate Impact Assessment, Chapter 3, 2004)[12]. These severe changes in the environment mean that traditional knowledge is no longer as applicable as it used to be, in particular as far as ice and ice conditions are concerned and thus indirectly undermines traditional knowledge and its value. These new climate conditions have a direct impact on traditional hunting and fishing activities, and will adversely impact many communities. The melting of sea ice also makes previously ice-covered areas accessible for other forms for resource utilization. The consequences of such activities are still unknown, but many fear that industrial activities that might replace traditional resource utilization will have severe consequences for the environment and add to the factors that accelerate climate change.

Case study conducted in Sámi areas in Finland: This case study shows that the weather is changing, and there is rain in the winter and other extreme weather events. Weather fluctuations, in particular rain and mild weather during the winter season often prevents reindeer from accessing lichen, which is vital for their survival. In some years, this has caused massive loss of reindeers. The Report provides information about unusual rain during the winter that encapsulates the ground below the snow in ice, preventing animals from reaching sources of food. This has forced many Sámi communities to feed the reindeers with hay and fodder whenever the lichen becomes trapped in ice due to winter rain. This has serious consequences for reindeer herding Sámi communities, as reindeer is vital to their culture, subsistence and economy. There are reports about extreme fluctuations in the amounts of snow, as well as thinner ice on rivers and lakes. In some instances, this seriously affects the possibility to travel in the snow and ice, and thinner ice makes it more dangerous to cross rivers and lakes. There are reports about the disappearance of certain birds, especially ground birds. Many reindeer Sámi used to hunt birds while herding reindeer, which is not an option any longer in many areas. Some Sámi Elders state that traditional weather reading

[11] Ibid, page 93. The information included in the Arctic Climate Impact Assessment, is adapted from Nickles, S., Furgal C., Castleden, P, Moss-Davis, P., Buell, M, Armstrong b., Dillion, D and Fonger, R., (2002). Putting a human face on climate change through community workshop: Inuit knowledge, partnerships, and research. In: Krupnik, I., Jolly, D. (eds). The Earth is Faster Now: Indigenous Observations of Arctic Environmental Change.
[12] Ibid, page 84.

skills cannot be trusted anymore due to the climate change (Nieminen,2004).[13] The Sámi normally combine various natural resource-based economic activities, including reindeer herding, fishing, hunting, trapping and berry picking. Relatively sudden accumulated climate changes have serious adverse impacts on most of the resources that their subsistence and economy largely depend on (Helander, 2004).[14]

The winter of 2007 has been an extremely difficult winter for the Sámi reindeer herding communities in Sweden, due to heavy and wet snowfall. In many areas, the reindeers are not able to reach down to the lichen due to a hard ice cover. In order to save their herds, many reindeer herders have been forced to feed their herds with fodder. The Government of Sweden has allocated approximately 5 million US$ in emergency aid to affected communities, in order to enable them to feed their herds with fodder. Reindeer herding is vital to Sámi reindeer herding communities, as it is their livelihood, material basis for their culture and traditional knowledge (BBC TV World News, 26 February 2007). The situation in Norway is very similar to that in Sweden, According to the Norwegian Reindeer Herding Authority the rapid changes in the climate may lead to a reduction in the number of reindeer, and in the number of reindeer herders. Researchers predict several winters with heavier snowfall than normal in the years ahead. Much snow and ice on the Finnmark Highlands will make it difficult for the reindeer to find food. To buy supplement fodder is expensive, and not economically viable in the long run (Solholm, 2007)

A case study drawn from research carried out in the Sámi community of Lovozero in the Russian Federation also documents that climate change has had a definite impact on the traditional indigenous lifestyle. Sámi and other indigenous communities in Russia are reportedly facing problems similar to the Sámi communities in the Nordic countries. Comparatively, the burden associated with climate change may be higher for the indigenous peoples in Russia due to the fact that they are already in a relatively vulnerable situation. The case study states that “documentation of change cannot be separated from broader questions of development of Russian territories and their indigenous peoples”. The people interviewed stated that there are many other concerns in addition to climate change, such as the state of Russian society, economic hardship, and lack of resources. But climate change has had a definite impact on the traditional lifestyle. (Terva, Muustonen and Zavalko, 2004).[15]

The Arctic Climate Impact Assessment recognizes that further research is required into the environmental changes occurring in the Arctic, as well as the ways in which people view these changes. It states that in both cases, there is a growing but still insufficient body of research to draw on, in particular in those Arctic areas where there are few or no current records of indigenous observations available. The assessment concludes that further research needs to detect and interpret climate change, and to determine appropriate response strategies.[16]

1.2 Summary

[13] This case study come from a project carried out as part of the Snow Change program organized by the Environmental Engineering Department at Tampere Polytechnical in Finland. Mika Nieminen spent a month in the region, living and practicing reindeer herding with Sámi reindeer herders, and interviewing active reindeer herders and elders. Elina Helander, a Sámi researcher at the Arctic Centre of the University of Lapland in Finland, also took part in the preparation and community activities for the documentation work that produced this Sapmi case study. [13] Arctic Climate Impact Assessment, Chapter 3, pages 84-86.

[14] Arctic Climate Impact Assessment, Chapter 3, pages 86-87.

[15] The interviews with elders, reindeer herders, cultural activists and other local people were recorded and edited by Jyrki Terva, Tero Mustonen, Sergey Zavalko, and several indigenous and non-indigenous students. Arctic Climate Impact Assessment, Chapter 3, pages 87 – 90.

[16] Ibid, page 93.

Table 1: The most commonly reported climate change observations, vulnerabilities, and short-term adaptation/mitigation strategies for indigenous and local communities in the Arctic region.

Observed Changes	**Vulnerability**	**Adaptation/Mitigation**
Late freeze-up due to rising temperatures.	Impacts that are viewed as positive by the concerned communities: better whitefish harvests, clamming, spotted seal hunting, access to caribou, arctic fox harvests, and access to driftwood. Impacts that are viewed as negative by the concerned communities: shorter ice-fishing season, poor travelling conditions, rough ice conditions, dangerously thin ice, and increased erosion and flood problems.	People adapt their day-to-day life to new conditions by taking advantage of new possibilities. People also adjust their behaviour to respond to adverse impacts, for instance by taking different and longer travel routes due to poor travel conditions.
Combination of higher temperatures, melting sea ice, and stronger and prolonged winter storms.	Flooding and winds causing physical threat and damage to villages, infrastructure, fresh-water supplies.	Building of walls along the shore to break waves, to reduce wave intensity and erosion.
Thawing ground.	Disrupt transportation, buildings, and other infrastructure.	Relocation of individual homes and villages. Certain transportation routes will have to be changed.
Coastal and riverbank erosion due to waves and thawing of permafrost.	Threatening and damaging villages and infrastructure along the coastline and riverbanks. In addition to accumulated subsistence, economic, social and human impacts, these conditions entail severe financial challenges for communities.	Relocation of individual houses. In other cases, the relocation of entire villages and communities may be the only option.
Increasingly unpredictable weather and increased extreme weather.	Weather cannot be predicted using traditional knowledge and skills. Traditional knowledge can be lost, as it is no longer as applicable as in the past. Such	Reduced application of traditional knowledge in day-to-day life and survival. Recording and documentation of such knowledge could prevent it from being lost.

	knowledge is valuable to future community members for preservation purposes and comparative analysis.	
Melting mountain snow and ice creates rapid water level rise, which in turn washes away large amounts of riverbanks into the rivers, causing riverbeds to rise as eroded soil accumulates on the bottom.	Shallow waters threaten fish populations. This has severe impact on indigenous subsistence fishing, and economy in general.	If possible, adjust fishing strategies by using other fishing areas.
Reduced population of some animal species, due to warmer climate.	Reduced subsistence hunting opportunities and increase in hunting accidents.	Change hunting strategies, including by shifting to other species.
New marine species, due to warmer sea water, including warm-water fish.	This can have both negative and positive impacts. New species will be competing for food with indigenous species, which can be harmful for the traditional biological diversity and balance. However, new species can in some instances provide new subsistence opportunities.	If possible, adjust fishing strategies to take advantage of new species and while trying to manage the population of new species.
Increase in new types of insects and increase in some animal species, such as the cougar.	An increased number of insects causes severe problems for humans and animals, including animals on which indigenous peoples largely depend, such as caribou and reindeer. An increase in some animal species, in particular predators, can cause severe problems for communities, including reindeer herding communities.	People will adapt to the increase of insects, whereas there are no obvious adaptation possibilities for animals except moving to higher and cooler grounds. Abnormal increase in predator populations can potentially be managed through human intervention.
Unusual rain during the winter season, which encapsulates the ground below the snow in ice, preventing animals from accessing food.	For wild animals, including caribou, prolonged icy conditions will have catastrophic consequences, as it can cause a massive reduction in the animal population. This has an immediate impact on subsistence and economy.	For non-domesticated animals, there are no obvious solutions, besides that they might move on their own to other areas with more favourable conditions.

	Semi-domesticated reindeer herds will have to be fed with hay and fodder, if possible.	Feeding of animals with hay and fodder, if and when possible. Alternatively, relocate to areas with more favourable snow conditions, if possible.
Increased snow depth.	Increased snow depth makes it difficult for animals to reach food. Increased snow depth creates travel problems for community members, as it becomes more difficult to travel on snow.	
Lakes and streams are drying up.	Adverse impact on the water security of communities, as less good natural sources of drinking water becomes available. Travel routes on rivers are often blocked by shallow waters, preventing people from travelling by water. Hunters have difficulties getting to vital hunting grounds, and some summer hunting grounds can no longer be reached. There are fewer fish, and they are often small and skinny. This reduces food security.	In some areas bottled water is now taken on trips, something which was unthinkable in the past. Indigenous hunters are forced to adjust their travel routes in order to enable the community to continue its day-to-day life. Change fishing strategies, by shifting to other areas to fish.
Some lakes and streams are becoming choked with weeds.	In some cases the water becomes undrinkable. Such water conditions also have an adverse impact on fish populations in rivers and lakes.	Bottled water is now taken on trips. Change fishing strategies, by shifting to other areas to fish.
Appearance of new bacterium in cold waters.	This will have adverse effects on food safety and food preparation traditions in some indigenous communities.	Due to food safety reasons, some traditional food preparation methods and cultural eating habits may

		have to be abandoned.
Changing and shifting vegetation zones, e.g. tree-lines moving to higher altitudes.	Wide-ranging impacts for humans, animals and biological diversity.	
Combination of various impacts f climate change on indigenous communities' traditional food supplies.	Reduced traditional food security.	A shift from traditional foods to more consumption of purchased foods.
Change in the geography of coastlines and of the environment due to melting of ice and glaciers.	Traditional geographical names are no longer always consistent with the appearance of the land. In some cases, traditional knowledge is no longer as applicable as it used to be. Reduced sea ice is very likely to increase marine transport and industrial access to resources, which potentially can have negative impact on the environment and biological diversity.	
Warmer temperatures in summer.	People are not able to store traditional food properly, which adversely impacts on their winter food security. Less able to prepare food in the summer by traditional means, such as drying and smoking, because the food gets cooked in the heat.	Food is brought back to communities more often in the summer to store in freezers. Such preparations activities may have to be shifted to cooler seasons.
Warmer weather in winter, making animal fur shorter and thinner.	This is reducing the quality of the fur/skin used for making clothes; reduced quality of traditional winter clothing. Reduced fur/skin quality also has a negative economic impact, as it adversely affects the price of fur/skin.	
Changing animal travel/migration routes.	Makes hunting more difficult and expensive. Many Elders are no longer	Shift to other hunting grounds. Community initiatives which provide meat to people who

	able to participate in hunting.	are no longer able to hunt due to the longer distances.
Loss of or threat to biological diversity, caused by warmer temperatures.	Traditional biological diversity, which is often vital for indigenous communities, is being disturbed.	

2. Small Island States

Small island states are found in many oceans and regions of the world: Africa, Caribbean, Indian Ocean, Mediterranean, Pacific and South China Sea. Small island states are by no means a homogenous group of territories, as they span across many different ocean regions. However, they share many common features, including possible impacts of changed in climate. The very nature of these small island states, as relatively isolated territories, low-lying and surrounded by an ocean or a sea, makes them extremely vulnerable to climate change, in particular as far as the projected sea level rise and increase in hurricane and storm frequency and strength is concerned.

Many small island states, such as those in the Pacific, have indigenous and local communities and many of these communities are relatively poor and do not have the resources required to mitigate against climate change or for relocation.

The sea level rise is chiefly caused by rising temperature of waters, the melting of glaciers, ice caps and snow. The IPCC Working Group I concludes that the global average sea level rose at an average rate of 3.1 [2.4 to 3.8] mm per year over 1993 to 2003, which is a relatively remarkable increase compared with the average rate over year 1962 to 2003, which was 1.8 [1.3 to 2.3] mm per year. The Working Group regards it as very likely that hot extremes, heat waves, and heavy precipitation events will continue to become more frequent. Moreover, it is likely that future tropical cyclones (typhoons and hurricanes) will become more intense, with larger peak wind speeds and increased heavy precipitation (IPCC WGI 4th Assessment Report, Summary for Policymakers).

The projected modest rise in sea levels by 2100 is from 18 to 55 centimetres; it is expected that seas will continue to rise and coastlines to retreat for a very long period of time (Rosenthal and Revkin, 2007).

Many small island States are already facing severe problems caused by a changing climate, creating tremendous challenges for many communities and of course indigenous and local communities are at particular risk. The very nature of small island states and indigenous and local communities increases their vulnerability to projected impacts of climate change, including their subsistence economies, their small physical size and relatively isolated location, surrounded by large spans of the ocean or the sea. Those islands fortunate enough to have mountains are in danger of loosing local climate diversity as animals and plants existing at high altitudes retreat further and further up the slopes until there is no where to go and will then disappear entirely. Small island states also have limited natural resources, are prone to natural disasters and function upon open economies that are extremely sensitive to external shocks. Many small island states also have poorly developed infrastructure and limited financial and human resources. The cumulated affects of all these factors establish clear limitations to the capacity of small island states to mitigate and adapt to future changes in climate, in particular to sea level rise and extreme weather conditions.

2.1 Causes of Vulnerability Associated with Climate Change

The immediate problems faced by small island state communities are linked to enhanced climatic variability and extreme weather events (McCarthy et al., 2001). The increased small island States' coastal vulnerability to climate change is caused by sea-level rise, accelerated beach erosion, increased risk of storm flooding and elevated sea surface temperatures (Nurse, 2002). In many small island States, the majority of indigenous and local communities, and infrastructure, are located in low-lying coastal areas. Projected sea-level rise will exacerbate coastal erosion, loss of land and property, and dislocation of the inhabitants of such territories (Elisara-La'ulu, 2006).

The most severe impacts of climate change on small island States are projected to be beach erosion, loss of coastal habitat and infrastructure. Beach erosion caused by increased wave energy is already a severe problem for many coastal indigenous and local communities, and has resulted in the relocation of many communities. Various forms of infrastructure are at great risk, as infrastructure in small island states mainly is located along the coast. Tourism, which is a major revenue earner for many indigenous and local communities, is also expected to be disrupted due to erosion of beaches and vital infrastructure. Moreover, climate change impacts the availability of fresh water supplies, such as water tables changing, rising sea water levels, and storm surges tainting fresh water with salt water.

It is projected that flood risks and inundation from storm surge will increase due to sea level rise and impacts associated with climate change. For instance, studies in Cuba have identified 98 coastal settlements with a total population exceeding 50 000 individuals, which could be completely flooded by a one meter rise in sea level (Nurse, 2002).

Rising sea levels have already forced the relocation of many indigenous and local communities in small island States. In the Lateu settlement in Vanuatu, more than 100 residents were forced to abandon their settlement for higher ground after major flooding made their village uninhabitable and forced them to move half a kilometre inland. Their original settlement was being flooded up to five times a year due to tropical cyclones. Many experts project that this will be the future trend in the South Pacific (Caldwell, 2005). Tropical cyclones have for instance also caused damage to coastal areas and forced relocation of villages in Samoa. The Falealupo and Papa settlements in northwest Savai'i have been forced to relocate to the inland because their settlement areas became inhabitable (Government of Samoa, 1999, First National Communication to the United Nations Framework Convention on Climate Change). Relocation of communities can potentially have many adverse implications for the communities concerned. In addition to possible adverse impacts on the social, spiritual, cultural and economic life of the affected communities, relocation also establishes an additional financial burden upon communities.

Increases in ocean temperatures caused by change in climate dramatically increases coral bleaching. (Buddemeier, Kleypas, Aronson 2004). This will adversely affect many indigenous and local communities, as coral reefs generate important tourism-related income for many communities. Above all, loss of coral reefs has adverse consequences for many communities' fisheries, shoreline protection and medical plants that depend on coral reefs.

There are numerous reports about accelerated loss of mangroves due to rising sea levels, which traditionally have provided settlements with protection from waves and storms; wave energy may be reduced by 75 per cent during a wave's passage through 200 metres of mangrove forest. In accordance to the United Nations Environment Programme, 16 Pacific island states and territories could see over half of their mangroves lost by the end of the century. It is projected that the worst-affected areas include American Samoa, Fiji and Tuvalu. Mangroves are also important nurseries for fish, sources of timber and construction materials for island communities, and provide filter for coastal pollution. Dyes from mangroves are also traditionally harvested in some communities to treat textiles, nets and fish traps. The

health of mangroves directly affects the health of local ecosystem. (World Watch Institute, 2006) The loss of mangroves has severe impacts on coastal indigenous and local communities due to the important functions mangroves hold. The loss of mangroves will adversely affect many important elements, such as the local biological diversity and ecosystem, fisheries, settlement and habitat safety, pollution, traditional livelihoods, and the availability of construction material.

The construction of protective installations, including seawalls and breakwaters, can provide protection to coastal communities against sea-level rise, storm surge and flood risks (Climate Change 2001: IPCC Working Group II: Impacts, Adaptation and Vulnerability). The undertaking of construction projects aimed at providing protection against sea-level rise, storm surge and flood risks is beyond the financial and technological capacity of indigenous and local communities. If natural protection systems are to be replaced by man-made installations, it will require external financial and technical assistance. The dykes in the Netherlands are an example of how artificial measures may not be effective in the long run.

The World Health Organization (WHO) projects an increase in diseases associated with increasing temperatures in tropical regions of the world. The WHO predicts that an increased number of people in tropical regions are expected to suffer from diseases like malaria and cholera. There will also be an increased threat of hunger in many tropical regions due to global warming (Bhalla, 2007). The WHO estimates from 2000, reports that close to 154,000 deaths worldwide could be attributed to diseases brought into proliferation by global climate change (Science Daily, 26 February 2007). Vector-borne diseases, including dengue fever, are becoming a problem in many tropical small island states, in particular in high population-density areas with inadequate sewage and draining systems. The increase in water-borne diseases, including gastroenteritis and diarrhoea, caused by poor water quality and flooding during rainy seasons and severe tropical storms, is yet another area of vulnerability that has increased due to climate change.

Although some small island States under normal circumstances have adequate access to surface and underground freshwater, these resources are in some cases dependent mainly on rainfall. Prolonged drought spells caused by global warming are projected to highlight this vulnerability in the future. Drought and contamination of freshwater supplies constitutes a serious threat to many communities in small island States.

Islands with low terrain are at risk for infiltration of sea water into their freshwater systems. This can occur through sea water flooding the island and entering into the freshwater system. It can also infiltrate freshwater supplies through rain falling from storms over the ocean seeping into the ground and the freshwater supplies. [17] Water reserves in atoll territories are normally restricted to narrow subterranean freshwater lens which can easily be contaminated by saltwater. These water resources are likely to be increasingly stressed in the future through a shift to more intense rainfall and possibly more intense droughts.

Many indigenous and local communities in small island States are heavily dependent on fisheries, commercially as well as for their own subsistence. It is anticipated that temperature rise can have a negative effect on fish productivity, in particular in shallow lagoons. If the rate of sea level rise proves to be rapid, the natural succession of coastal ecosystems on which many species depend can be seriously harmed (IPCC, Climate Change: 2001, The Regional Impacts of Climate Change). These ecosystems are important nurseries and forage sites for many species of importance for indigenous and local communities in small island States, and a disruption of these will have serious multiple consequences for such communities.

[17] The theory about rain from ocean storms infiltrating fresh-water supplies is discussed by C. Johnson in an article entitled “South Florida Water Supply Danger”, http://mb-soft.com/public/waterfl.html

Agriculture in small island states is highly vulnerable due to increased heat stress on plants, changes in precipitation and soil moisture, salt water incursion from rising sea levels, and increased damage from extreme weather events (Barnet and Adger, 2001). Food security is of great concern for many small island States, as their food production systems are frequently challenged by extreme weather conditions and disease outbreaks, which in many cases are associated with climate change. High population density, combined with weak food production systems, also make food security in many small island states particularly vulnerable.[18]

The Food and Agriculture Organization of the United Nations (FAO) is of the view that small island developing States are all vulnerable to their environmental situations because of their narrow natural resource bases. The FAO suggests that food security could be improved in many small island states by reinvigorating some traditional indigenous food systems, which have proved to be effective in mitigating disasters caused by more risky farming methods, such as commercial mono-cropping of the late 20th century. The FAO is of the view that "small-scale traditional systems, including artesian fisheries and non-grain starchy staples continue to hold the promise of better diets and less environmental damage. The erosion of traditional cropping systems and secure land rights, have contributed to increase poverty, malnutrition and unsustainable urbanization." The FAO also suggests that local skills and traditional knowledge should be enhanced with modern scientific guidance, as this would offer cost-effective solutions for renewing traditional food systems (FAO News, 2005). This is an acknowledgement of the fact that indigenous and local communities have valuable knowledge and skills to contribute to food security, including in the context of climate change. Furthermore, it highlights the importance of adopting necessary measures aimed at respecting, preserving and maintaining indigenous and local communities' traditional knowledge, innovations and practices.

A case study focusing on adverse impacts of climate change on indigenous peoples in Samoa identifies the confluence of tropical cyclones, temperature fluctuations, lengthening periods of drought, and flooding as a cause for severe adverse impacts on indigenous communities, including reduced day-to-day food supply from traditional sources, threat to income-generating agriculture activities and food security. The study also highlights problems related to accelerated erosion from wave activities, frequent storm surges, landslides causing destruction and land loss in indigenous communities. The case study identifies a number of vulnerabilities associated with climate change, including reduced agricultural production, reduced food security, reduced water quality and quantity, reduced biological diversity, reduced health security, threat to and destruction of coastal communities, infrastructure and environment, reduced economic security etc (Elisara-La'ulu, 2006).

2.2 Summary

Table 2: The most commonly reported climate change observations, vulnerabilities, and short-term adaptation/mitigation strategies for indigenous and local communities in small island states.

Observed Changes	Vulnerability	Adaptation/Mitigation
Confluence of climate change associated weather conditions, including sea level rise, floods, storm surge and wave.	Individual homes, infrastructure, and in some instances entire indigenous and local coastal settlements	Construction of seawalls, and other preventive structures, could mitigate some of these impacts. However, indigenous

[18] See for example the Government of Sameoa's first national communication to the United Nations Framework Convention on Climate Change (1999).

	are threatened, damaged and destroyed. Relocation of entire villages or settlements, with severe adverse consequences, including of a social, cultural, economic, subsistence, health, and humanitarian nature. Relocation potentially also constitutes a threat to traditional knowledge, practices and innovations, as communities are uprooted and forced to adapt to new circumstances. Increased migration to urban areas due to climate change has a significant adverse effect on indigenous communities, as well as on the urban settlements to which they migrate. Adverse impact on tourism, which is a major economic sector in many small island states.	and local communities generally do not have the financial and technological capacity to undertake such projects by themselves. In some low-lying island territories it may not be possible to mitigate the impacts of sea level rise.
Increase in ocean temperatures.	Coral bleaching adversely affects many indigenous and local communities. Loss of coral reefs has adverse consequences for fisheries, shoreline protection, and medical plants that depend on coral reefs. Coral reefs also generate important revenue from tourism, which is vital to many communities. Livelihoods, subsistence, food security, safety, health, and traditional knowledge and practices may be adversely affected.	

Increasing temperatures and flooding in tropical regions	An increased number of people are expected to suffer from diseases, including malaria, dengue fever and water-borne diseases. Disease proliferation can also be caused by climate-related migration to high population-density areas with inadequate sewage and draining systems. Disease proliferation increases mortality risks in indigenous and local communities.	Vaccination programmes can potentially mitigate disease proliferation threats, to a certain degree.
Extreme weather conditions.	Reduces food and water security, resulting in increased threats to fresh water supplies and sewerage infrastructure.	
Worsening drought conditions.	Negative impact on agricultural practices, and the vitality of forest. Increased risk of forest fires, which has adverse impacts on traditional land use and subsistence practices.	
Increased heat stress on plants, changes in precipitation and soil moisture, salt water incursion from rising sea levels, and disease outbreaks.	Reduced agricultural production causing severe adverse impact on food security in communities. In some instances, it can lead to increased poverty and malnutrition.	Food security can in some cases be improved by reinvigorating traditional indigenous food systems that have proved to be effective, and may provide better diets and less environmental damage.
Sea temperature rise.	Decreased fish productivity, in particular in shallow lagoons, reduces foods security and economic income in communities.	
Severe rainfall and flooding.	Infiltration of sea water into freshwaters systems reduces water security.	Relocation and upgrading of freshwater systems may provide some mitigation.
Combination of various climate changes.	Multiple adverse impacts on indigenous and local communities, including on livelihoods, economy,	

	financial stability, subsistence, social life, culture. Reduction or loss of biodiversity, with severe adverse affects traditional knowledge and practices.	
Changing water tables	Increasing insecurity of fresh water for farming and human consumption	

3. High Altitudes

High altitude areas in the various regions of the world are an important component of the global climate and the ecological and biological equation.[19] An important common feature and characteristic of high altitude areas is that they provide lower-lying communities with a vital source of freshwater. Many indigenous and local communities are located in high altitudes, or are directly dependent of high altitude areas for freshwater supplies. Moreover, mountain glaciers are important for water levels in lower level lakes and rivers, which are a vital part of many communities' subsistence and economy.

Increased and faster melting of mountain glaciers may be the most serious impact of climate change in high altitude regions. This phenomenon is caused by an increase in minimum average high altitude temperatures. The losses from glaciers have exceeded snowfall accumulation (IPCC WGI 4th Assessment Report, Summary for Policymakers).

Recent studies suggest that climate change will make temperatures rise faster in high altitude regions, and that temperature changes brought about by climate change are more clearly apparent at higher altitudes (Almeida, 2006). It is suggested that Andean glaciers are "ultra-sensitive" indicators of climate change, capable of recording variations that occur even within a decade (Brahic, 2004). Melting of mountain glaciers is reportedly taking place at an alarming speed all around the world, including in Africa, South America and Asia.

Recent research in the Andes mountain range and Mount Kilimanjaro shows that the retreat of glaciers in these mountains is accelerating. Some glaciers in the Andes are melting ten times faster than they did 20 years ago (Pastino, 2007).

According to climatologist Lonnie Thompson, who has studied the Peruvian Qori Kalis glacier since 1978, the glacier could vanish in just five years. According to Thompson, in the last five years, the Qori Kalis has started retreating 60 metres (197ft) every year, a 10-fold increase. Thompson predicts that similar melting of glaciers will take place in Naimona'nyiin in Tibet, and that the glaciers of Kilimanjaro in Africa and the lower elevation glaciers in the Andes could disappear in 20-30 years (Fildes, 2007).

[19] Altitude regions are normally divided into the following categories:
a) High altitude = 1500 – 3500 m (5000-11,500 ft).
b) Very High altitude = 3500 – 5500 m (11,500-18,000 ft).
c) Extreme altitude = 5500 m – above.

3.1 Causes of Vulnerability Associated with Climate Change

Climate change is already having adverse impacts on high altitude indigenous communities. New high altitude climate and weather conditions are causing severe difficulties for many indigenous communities, and weakening their faith in a future for their communities.

The existence of some indigenous communities in the Peruvian Andes, in altitudes of 4000 - 5000 metres above sea level, is already threatened by climate change. These communities are well adapted to the inhospitable conditions in the Andes, as they have survived for thousands of years in this region. However, the impacts of climate change are so severe that their fragile existence is put at a new and unprecedented risk. Due to periods of extreme and unprecedented cold spells, their source of subsistence is threatened. Many communities have faced great losses in their sheep and alpaca herds, which are vital for their subsistence and transportation respectively.[20] The extreme cold spells have also damaged and ruined potato crops, which are part of the communities' staple diet. These communities are located in isolated areas, and they are often neglected and receive little or, in some instances, no government help.

The organization Practical Action documents that such cold spells, falling to -30˚C, have caused death of children and severe illness in indigenous communities in recent winters. For instance, in 2003 around 13,000 people suffered severe hypothermia, bronchitis and pneumonia. Indigenous communities were also faced with enormous loss of animals. Reportedly around 50-70% of their alpacas perished and many more were left exhausted and prone to disease (Practical Action, 2007). Such extreme conditions threaten the very existence of many of these indigenous communities. Loss of sheep and alpacas have created unprecedented problems as far as clothing is concerned, as the heightened levels of sheep and alpaca mortality leave less material for clothing, insulation and bedding.

In other instances, torrential rain in high altitude indigenous communities has reportedly washed away vital potato crops into rivers. Recurrent extreme weather events of this type create serious food security problems for indigenous communities in the Andes, as potato is their staple diet and for many, the only crop. According to some scientists, climate change may make it impossible for indigenous communities to survive in their traditional lands (Bolin, 1999).

The water security of indigenous and local communities situated below mountain glaciers is at risk, in particular if assessed from a longer-term perspective. Glaciers are important freshwater sources for many communities; water supplies vanish with the glaciers. Tim Barnett of the US-based Scripps Institute of Oceanography describes how global warming is disrupting the annual flow of water downstream from snowy mountainous regions: "in areas where reservoirs are absent or not big enough to hold the increased amount of water, it will be lost to the oceans." Barnett states that "it is especially clear that regions in Asia and South America are headed for a water supply crisis because once that fossil water [water from the glaciers] is gone, it is gone. This water will not be replaced." He points out that developing countries will be especially vulnerable if their water infrastructure is weak or unprepared for such changes (Shanahan, 2005).

Glaciers in the Himalayan mountain range are melting and bringing the threat of floods to communities in Bangladesh, Bhutan, India and Nepal. Some suggest that in the longer term, the melting glaciers could result in water shortages throughout the region. Nearly 70 per cent of the water in the Ganges River comes from the rivers in Nepal, which are fed by the country's glaciers (www.scidev.net, 2007).

[20] The Alpaca is a domesticated breed of the South American camel-like ungulates. Alpacas are kept in herds that graze on the level heights of the Andes of southern Peru, northern Bolivia and northern Chile at an altitude of 3500 to 5000 metres above sea level, throughout the year.

The melting of mountain glaciers also creates many other problems for indigenous and local communities. For instance, as the ice melts, producing plenty of water, the communities below become reliant on it for farming, hydroelectricity and other purposes. However, when the glaciers are gone, so will be most of the water that people need for sustaining their communities.

The retreat of glaciers contributes to the formation of new high altitude lakes, and thus creates new geological and biological conditions. Melting glaciers are also creating floods affecting indigenous and local communities. This happened for instance in a valley below the Peruvian Qori Kalis glacier in 1991, when large chunks of ice fell into a lake and triggered a wave which crashed into the valley below, flooding villages (The Nation, 2007).

Landslides and floods caused by melting ice destroy important agricultural soil in communities, which in turn reduce their food and habitat security. Other phenomena are also creating serious food security challenges for indigenous and local communities; there are many instances were farmers' crops have been destroyed by unusual hailstorms in the Andes. Temperatures will also affect the yield and the type of crop indigenous and local communities in high altitude areas will be able to produce in the future. Warmer temperatures in higher areas bring more insects that carry diseases that infect animals and humans, and thus have an impact on the general health security situation in some communities.

In some parts of the world, rising temperatures in high altitude areas will have an adverse impact on tourism, as higher temperatures and melting mountain glaciers will harm winter tourism, including in the Alps, Rwenzori and the Rockies. Many communities are heavily dependent on revenue generated by tourism.

The Cordillera mountain region in the Philippines has lately experienced cold spells seriously damaging the economy of indigenous and local highland farmers. Agriculture, which is the main source for subsistence and livelihood for indigenous communities in the Cordillera, has been seriously hit by low temperatures in December 2006 and January 2007. Low temperatures and frost damaged crops, such as potato, cabbage, carrots, radish and peas. The region also faced some other climate related problems in 2006: during the summer months, from March to May, the Cordillera was hit by drought and was hit by typhoons in July to November 2006. This had serious negative impact on the indigenous communities, as agriculture is vital for their economy and subsistence. It also has an impact on other parts of the country, as the vegetable production in the Cordillera also supplies the vegetable demand from other parts of the country. As a result of the shortage of highland vegetables, vegetable prices have soared. Continued climate-related problems of this sort can potentially have severe consequences for the food security of these communities, as well as for their cash economy. These uncertainties have forced farmers to consider various options for adaptation, including building of greenhouses in order to protect their crops from future cold spells.

Moreover, the 2,000 year old rice terraces in the Cordillera mountain region are under attack by giant earthworms as a result of drought, El Niño and climate change. The earthworm menace has worsened since the early 1990s when water for the rice terraces began to dwindle. The thumb-sized two-foot giant earthworms reproduce more when there is less water. As the topsoil dries up with the lack of water, the earthworms go deeper into the soil seeking moist areas. Water seeps through the holes the earthworm bore, causing the soil and terrace walls to dry up and crack (Malanes, 2007).

Climate change can potentially also have a dramatic impact on high altitude forests, and consequently also on the biological diversity. Warmer climate contributes to elevating tree lines to higher grounds. Climate changes, even relatively short-term climate trends, can have major impacts on regeneration patterns on high-altitude forests (Peterson, 1998). Such changes in turn have an impact on communities living in these altitudes, as their way of life, livelihoods and subsistence is closely linked to the local biological diversity and environment. As the climate warms – the ecosystems and local climates of

mountains which act like biodiversity islands – moves up the slope until there is no where to go – and then vanishes.

3.2 Summary

Table 3: The most commonly reported climate change observations, vulnerabilities, and short-term adaptation/mitigation strategies for indigenous and local communities in high altitudes.

Observed Changes	Vulnerability	Adaptation/Mitigation
Extreme and unprecedented cold spells.	Destruction of vital crops. Loss of animals important either for subsistence, transportation and/or clothing material. This reduces food security, and adversely impacts social life, culture, transportation and the overall economy of communities. Increased child mortality, diseases and illness. In some instances, such changes threaten the existence of communities.	In some areas, farmers have been forced to consider options for adaptation, including building of greenhouses to protect crops from cold spells.
Torrential rains.	Flooding and loss of vital crops, which leads to reduced food security.	
Melting mountain glaciers.	Threatens the water security of lower-lying communities. In the longer term, rapidly melting glaciers could result in water shortage in many regions. Flooding and landslides with severe adverse impacts for lower altitude communities. Communities below become unsustainably dependent on the water from melting glaciers for farming, hydroelectricity and other purposes. Adverse impact on tourism, as	

	higher temperatures and melting mountain glaciers will harm winter tourism, which many communities depend on economically.	
Creation of new lakes, caused by melting glaciers.	Creates new environmental conditions for communities, and can, in some cases, destroy valuable agricultural land. In some instances, such lakes have caused flood and landslides affecting lower altitude settlements.	
Landslides and floods caused by melting ice.	Destroy important agricultural soil in communities, which in turn reduce their food and housing security.	
Unusual hailstorms.	Adversely affecting crops. In the longer term, temperatures will affect the yield and the type of crop indigenous and local communities in high altitude areas will be able to produce.	
Warmer temperatures.	Rising temperatures in high altitude areas bring more insects that carry diseases that infect animals and humans. This will have an adverse impact on the general health security in some communities.	

4. Further Research

Indigenous and local communities have only recently been involved and engaged in research on climate change. However, this has only taken place in some regions of the world, and through a relatively small number of projects. Nevertheless, academic communities are belatedly acknowledging that indigenous and local knowledge is a valuable contribution to modern science.

Indigenous and local communities' observations of the impacts of a changing climate, combined with their traditional knowledge, provide documentation of changes and contribute analytically. Indigenous knowledge is more than a mere collection of data and facts, as it also provides an understanding of the environment and of the place of humans in the environment. Indigenous knowledge may have a certain cultural importance and value; this does not reduce its value in environmental and climate research, as indigenous and local culture is closely associated with the environment and the community's physical surroundings.

Further research is undoubtedly needed, in particular research that involves indigenous and local communities through the incorporation of their observations and application of their traditional knowledge. This will substantially enhance the understanding of local and regional impacts of climate change. Furthermore, greater research focus on questions related to how indigenous and local communities can adapt to changing conditions and on mitigation possibilities is also needed.

As far as adaptation and mitigation are concerned, current coping strategies of indigenous and local communities are mainly in the form of adjustments to their day-to-day life. Indigenous and local communities have generally not yet been able to start to elaborate long-term coping strategies, partly because there is still great uncertainty about the exact long-term impacts of climate change. However, as illustrated by examples from Alaska and the small island states, there have been some greater adaptation endeavours, such as relocation of threatened communities.

In the Arctic region, there is increasing scientific and political recognition of the value of traditional indigenous knowledge and of the fact that such knowledge offers important insight from people and communities that live close to the local environment and ecology. There needs to be an increased level of documentation and application of indigenous knowledge in climate change research, at national as well as regional levels.

Indigenous peoples actively participated in the development of the Arctic Climate Impact Assessment (ACIA), described by many as a state of the art scientific report. Indigenous peoples were engaged in this work because it is acknowledged that indigenous observations, documentation of existing knowledge on changes that have occurred and monitoring of future changes, are important in the context of climate change (Arctic Climate Impact Assessment, Chapter 3).[21]

ACIA acknowledges that greater focus on the climate parameters that directly affect local people and ecosystems will help identify critical areas for local and regional action. Moreover, it acknowledges that this should flow from the documentation and presentation of indigenous perspectives on climate change, as such knowledge is the foundation upon which individuals, communities and regions can design responses to climate change. A collaborative process, in which indigenous and local knowledge, combined with other information and expertise, is believed to be effective in identifying and addressing the challenges and opportunities brought about by climate change (Arctic Climate Impact Assessment, Chapter 3).[22]

The International Polar Year (IPY), a two-year scientific program focusing on the Arctic and Antarctic (2007-2009), is a collaborative scientific approach to climate change research. The IPY promotes constructive and respectful engagement with indigenous and local communities through community monitoring, acknowledgement and protection of traditional knowledge, inclusion of communities as valued partners in planning and conducting the scientific program, and in evaluating and assessing the results of the programme. The research will include studies of unique uses of language, such as for intergenerational understanding of sea ice, and the value of and integrity of traditional knowledge. Moreover, the research will include economic and social assessments of the impacts and opportunities related to natural resource management and energy and transportation developments (www.ip/ipy.org/about_ip-ipy).

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The EALÁT-Network study has been launched within the framework of the IPY. It is an interdisciplinary and intercultural study that will assess the vulnerability of reindeer herding.[23] This project actively involves reindeer herders, linguists, lawyers, anthropologists, biologists, geographers, economists, philosophers, as well as indigenous institutions and organisations, relevant industrial enterprises and management authorities. The main focus of this project is the adaptive capacity of reindeer pastoralism to climate variability and change, particularly integration of reindeer herders' knowledge in the study and analysis of their ability to adapt to environmental changing conditions (www.ip/ipy.org/about_ip-ipy/cms/3/3hent_artikkel/82).[24]

A vast amount of scientific information and documentation is available concerning climate change impacts to small island States. Many crucial projects and processes related to biological diversity and climate change have been initiated by small island States and their regional organizations in cooperation with various partners.

The Caribbean Community Centre for Climate Change is currently implementing a programme concerning mainstreaming adaptation to climate change, in cooperation with external partners. The projects' main objective is to mainstream climate change adaptation strategies into sustainable development agendas of the low-lying states. It includes several project components, including capacity building to identify climate change risks, reduction of vulnerability to climate change, and resource utilization (www.caricom.org). Likewise, the Pacific Environment Programme is currently executing a large number of projects relevant to climate change, impacts of climate change, vulnerability, adaptation, and mitigation (www.sprep.org).

The information which is publicly available does not indicate that the specific vulnerabilities of indigenous and local communities due to climate change, to their traditional knowledge, innovations and practices, is yet to be given due attention. Only limited research concerning specific and local impacts of climate change to indigenous and local communities, to their culture, social structures, traditional livelihoods, economy, knowledge, innovations and practices, has been published.

However, the United Nations University (UNU) - the Institute of Advanced Studies - is in the process of establishing a UNU Research and Training Centre on Traditional Knowledge (TK) in Australia (UNU TK Institute). The institute will focus on research and training in many aspects of the traditional knowledge of indigenous and local communities from a global perspective, grounded in local experience. The impact of climate change on the traditional knowledge and sustainable livelihoods of indigenous peoples will be an important part of the research and training program focus, including issues such as (United Nations University, 2007):

- How the international community can work best with indigenous peoples regarding the value and importance of their expert knowledge;
- Whether indigenous peoples will be successful in adapting to climate change, and at what costs to livelihoods, to the transmission of traditional knowledge and to culture;
- The impact of climate change on the traditional knowledge systems of indigenous peoples, and whether traditional knowledge will disappear or adapt;
- Impact of changes in traditional knowledge systems to the sustainability of livelihoods and communities;
- How the interests of indigenous peoples on the traditional knowledge- related aspects of climate change issues may best be represented on the international scene;

[23] Ealát is a Sámi word with a multi layered meaning; Ealát signifies 'Pasture', but related words Eallu means 'Herd' while Eallin menas 'Life' in the Sámi language.
[24] The Ealát project is Project Number 399 in the International Polar Year Scheme.

- The implications of the UN Declaration on the Rights of Indigenous peoples, adopted by the UN Human Rights Council, for States and indigenous peoples in relation to climate change.

The situation in high altitude areas is somewhat similar to the situation in small island States, as limited research has been conducted on the specific vulnerabilities to climate change of indigenous communities in high altitudes, in particular social, cultural, economic and human aspects. The research that has been undertaken in high altitude areas tends to focus on the physical aspects of climate change and little on the human aspects

Increased collaborative projects in small island States and high altitudes, which engage indigenous and local communities in climate change research, would be beneficial for physical climate change research as well as for the development of future adaptation strategies. As experience in the Arctic region shows, indigenous and local communities can provide observations and traditional knowledge that can be of great importance in this regard.

5. Conclusions and Recommendations

5.1 Climate Change Associated Vulnerabilities

Climate change is causing various forms of vulnerabilities for indigenous and local communities in the Arctic, small island states and high altitudes. In some situations, the impacts of climate change are so severe that they threaten the very existence of communities. Many indigenous and local communities have already been forced to relocate due to extreme and unprecedented weather conditions. Climate change has adverse impacts on the biological diversity and keeps many indigenous communities from developing sustain ably.

While climate change may still be a distant threat for some people, for many indigenous and local communities, it is already a grim reality. Climate change brings additional vulnerabilities to indigenous and local communities, which add to existing vulnerabilities, including political and economic marginalization, land and resource encroachments, human rights violations, discrimination, unemployment and substance abuse.

5.2 Traditional Knowledge, Innovations and Practices

Indigenous and local communities' traditional knowledge, innovations and practices are an inseparable part of their culture, social structures, economy, livelihoods, beliefs, traditions, customs, customary law, health and their relationship to the local environment. It is the totality of all such elements that makes their knowledge, innovations and practices vital in relation to biological diversity and sustainable development.

Consequently, serious adverse climate change impacts on indigenous and local communities, in particular multiple impacts, will also have adverse consequences on the elements that the Convention on Biological Diversity identifies as their "knowledge, innovations and practices".

In light of the accelerated threats caused by climate change, Party States should adopt necessary political, administrative and legal measures to protect and maintain the knowledge, innovations and practices of indigenous and local communities. Such measures should be developed with full and effective participation of the representatives of indigenous and local communities.

5.3 Mitigation

It has been scientifically proved that the changing climate is most likely due to the increase in greenhouse gas concentrations. Widespread climate change can no longer be explained without referring to such greenhouse gas emissions.

Indigenous and local communities are amongst the communities that have possibly contributed the least, per capita, to the emission of carbon dioxide and other greenhouse gases, yet they are among the first to face direct adverse consequences of climate change.

It should be expected that States, promptly adopt necessary measures to reduce greenhouse gas emissions, taking into account their common but differentiated international responsibilities in achieving their quantified emission limitations and reduction commitments. This is undoubtedly the most urgently required mitigation measure.

Climate change already has a human face. Indigenous and local communities are generally the last on the list when it comes to any contingency planning, despite the fact that they are already facing the impacts of a changing climate. They are the first to suffer when there is less water, fewer fish and animals and extreme weather conditions.

Greater focus on possible local mitigation options is thus required, in order to reduce the impacts of climate change. States should urgently consider possible mitigation measures, in cooperation with indigenous and local communities. Indigenous and local communities will in many cases need financial and technical assistance from the State to develop and implement such measures. Indigenous and local communities must be ensured full and effective participation in the development and implementation of mitigation measures affecting them.

5.4 Adaptation

Dramatic changes in climate are already taking place. It is beyond any reasonable doubt that the projected changes in climate are inevitable. Therefore, it is urged that special focus be placed on how indigenous and local communities may best be able to adapt to these new conditions.

In many instances, adaptation to new conditions requires additional financial resources and the transfer of technological capacity that most indigenous and local communities do not possess. Indigenous and local communities need to be provided with additional necessary resources and assistance in order enable them to undertake necessary adaptations.

It is of crucial importance that developed countries, in accordance with their international obligations assist developing countries in meeting the costs associated with adaptation to the adverse impacts of climate change, including the impacts faced by indigenous and local communities.

Further collaborative research, which engages indigenous and local communities, their organizations and institutions and which is aimed at studying and analysing possible adaptation, is required. Indigenous and local communities' traditional knowledge needs to be an integral part of any process, study and analysis aimed at elaborating on such communities' ability to adapt to changing environmental conditions. Indigenous and local communities should be ensured full and effective participation in all adaptation options analysis and decisions affecting them.

Indigenous and local communities have already been forced to adjust their lives to new climate realities. However, at present, most communities have only adopted short-term coping strategies by making necessary adjustments to their day-to-day life. There are also limitations to indigenous and local

communities' possibility to adapt. It is crucial that future research and policies also focus on possible long-term mitigation and adaptation strategies.

5.5 Further Research

Traditional knowledge provides important insight and accumulated knowledge about the local environment. Indigenous and local communities thus need to be engaged in climate change research through collaborative projects which seek to draw upon both traditional knowledge and expertise and scientific expertise.

Indigenous peoples have only recently become involved in research associated with climate change. This is partly because people outside indigenous communities often have had the tendency not to recognize or respect the value of indigenous knowledge. The ability of indigenous and local communities to adapt to changing climate conditions is an area that urgently requires further research.

The Secretariat of the CBD should consider initiating further research into the impacts of climate change and accelerated threats on traditional knowledge, innovations and practices, focusing on the specific vulnerabilities of indigenous and local communities in other highly vulnerable areas, including low-lying river deltas, semi-arid and arid lands (grasslands). Furthermore, the possibility of initiating research into the specific vulnerabilities of certain highly vulnerable groups, including nomadic and semi-nomadic indigenous communities and fishing communities.
Future research into the impacts of climate change and accelerated threats on traditional knowledge, innovations and practices should also aim at identifying indirect adverse impacts, and possible mitigation and adaptation options.

Also, future research should include a critical evaluation of adaptation strategies, as some are deemed to have an adverse effect on ILCs. For instance, biofuels, although they may serve to reduce greenhouse gas emissions, may entail monoculture and reduced food security. The issue of climate refugees and urbanization of indigenous and local peoples in this context could also be raised in the course of this research.

Future research could also include research into vulnerabilities experienced by ILCs due to the loss of biodiversity. In this sense, some have pointed out that adaptation should not merely be compensation as there is no compensation for culture loss.

It would also be useful to do some research into the potential areas of cooperation between the CBD and the UNFCCC.

Preferably, all further research should be conducted with the participation of ILCs, especially considering that information relating to certain areas is difficult to access or not available.

5.6 Working Group on Article 8 (j)

The Working Group on CBD Article 8 (j) should consider ways and means of addressing and redressing the specific problems and vulnerabilities of indigenous and local communities that are associated with climate change, in particular long-term adverse impacts of climate change adaptation to their traditional knowledge, innovations and practices.

The Working Group should also consider the possibility of establishing institutional cooperation with organisations and institutions that are conducting research on issues related to the impacts of climate

change to the traditional knowledge, innovations and practices of indigenous and local communities, in order to enhance its capacity to address such issues within the framework of the Convention.

The Working Group, and the secretariat of the CBD, should consider transmitting this report to the Secretariat of the UN Framework Convention on Climate Change, Secretariat of the UN Convention to Combat Desertification, UN Commission on Sustainable Development, the UN Permanent Forum on Indigenous Issues and the Inter-Agency Support Group of the Permanent Forum, with a view to contributing to their work on these issues, and the possibility of increasing synergies and further collaboration in further research and action.

Bibliography

Almeida, Carla, 2006, *Andes study shows it gets hot faster at high altitude*, http://www.scidev.net/news/index.cfm?fuseaction=readnews&itemid=2935&langauge=1
Arctic Council (2004), *Arctic Climate Impact Assessment* (Cambridge University Press)
Arctic Council Ministerial Meeting, *Climate Impact Assessment; Policy Document*, Issued by the 4th Arctic Council Ministerial Meeting, Reykjavik, Island, 24 November 2004
Barnet, Jon and Adger, Neil, 2001, *Climate Change and Atoll Countries*, Tyndall Centre for Climate Change Research
Bhalla, Nita (2007), *Warming to Spread Disease, Hunger in South Asia – WHO*, Article, http://www.planetark.com/avantago/dailynewsstory.cfm?newsis=40373
Bolin, Ingw, 1999, *Survival in Marginal Lands; Climate Change in High Peruvian Andes*, http://www.inwent.org/E+Z/1997-2002/de599-4.htm
Brahic, Catherine, 2004, *Ecuador's glacier meltdown linked to EL Niño*, http://www.scidev.net/news/index.cfm?fuseaction=readnews&itemid=1681&langauge=1
Buddemeier, Robert W., Kleypas, Joan A. and Aronson, Richard B., 2004, *Coral reefs & Global Climate Change; Potential Contributions of Climate Change to Stresses on Coral Reef Ecosystems*, Pew Center on Global Climate Change
Caldwell, Alison, 6 December 2005, *Vanuatu Village relocated due to rising sea level*, http://www.abc.net.au/worldtoday/content/2005/s1524755.htm
Chicago Sun-Times, 2 February 2007, O*fficials issues worrying climate* report, http://www.suntimes.com/news/world/240605,020207climate.article
Cochran, Patricia 2007, *Alaska natives left out in the cold*, Viewpoint, BBC News, 4 January 2007. http://news.bbc.co.uk/2/hi/science/nature/6230731.stm
Elisara-La'ulu, Fiu Mataese, 2006, *The Samoa Case Study: An Assessment of Impacts, Vulnerability, and Adaptation to Climate Change in Samoa*, http://www.international-alliance.org/documents/Climate%20change%20-%20Samoa.pdf
FAO News, 2005, *Small Island Developing States struggle to survive*, www.fao.org/newsroom/en/focus/2005/1000142/index.html
Fildes, Jonathan, 2007, *Mountain glacier could vanish*, BBC News, 16.02.2007, http://newsvote.bbc.co.uk/mpapps /pagetools/print/news.bbc.co.uk/2/hi/science/nature/636..
Helander, Elina (2004), *Climate change and the Saami*, Arctic Climate Impact Assessment, included in Chapter 3 (Cambridge University Press)
Intergovernmental Panel on Climate Change (2001), Working Group II: *Impacts, Adaptation and Vulnerability*
Intergovernmental Panel on Climate Change (2007), *Climate Change 2007: The Physical Science Basis; Summary for Policymakers*, WMO (Geneva)
Johnson, C, *South Florida Water Supply Danger*, http://mb-soft.com/public/waterfl.html
Malanes, Maurice (2007), *Tourism killing world's eighth wonder*, TWN Third World Network, http://www.twnside.org.sg/title/mm-cn.htm

McCarthy, J., Canziani, O., Leary, N., Dokken, D and White K., Eds, 2001, *Climate Change 2001: Impacts, Adaptation & Vulnerability* (Cambridge University Press, Cambridge).
Nation, (Thailand), 2007, Thailand, 17 February 2007, *Global Warming; Vanishing glaciers are melting fast*, Article
Nieminen, Mika (2004), *Sapmi: the communities of Purnumukka, Ohcejohkka, and Nuorgam*, Arctic Climate Impact Assessment, included in Chapter 3 (Cambridge University Press)
News independent (2007), http://news.independent.co.uk/environment/article2251362.ece 09.02.07
Nurse, Leonard A., 2002, *Climate Change and Coastal Vulnerability in small Island States*, Presentation at AOSIS Inter-Regional Preparatory Meeting for WSDD, January 7-11, 2002
Pastino de, Blake, 2007, *Mountain Glaciers Melting Faster than Ever*, http://news.nationalgeographic.com/news/2007/02/070216-glaciers-melting.html

Practical Action, 2007, *Surviving the Friaje; Freak freeze conditions in Peru*, http://practicalaction.org/?id=climatechange_friaje
Rosenthal Elisabeth and Revkin Andrew C. (2007), *Global warming called unequivocal*, Article, International Herald Tribune, 2 February 2007 , http://www.iht.com/articles/2007/02/02/news/climate.php
Rudolf, John Collins, 17 January 2007, *Melting ice keeps Arctic mapmakers busy*, International Herald Tribune
Samoa, Government of Samoa, 1999, *First National Communication to the United Nations Framework Convention on Climate Change*, Prepared by Samoa's National Climate Change Country Team (Apia)
Science Daily, 26 February 2007, *Global warming spurs disease outbreaks*, www.sciencedaily.com/upi/index.php?feed=Science&article+UPI-1-20070225-191
Shanahan, Mike 2005, *Millions face water shortage due to climate change*, http://www.scidev.net/News/index.cfm?fuseaction=readNews&itemid=2483&language=1
Solholm, Rolleiv, March 2007, *Climate change may change reindeer herding*, Article, The Norway Post, http://www.norwaypost.no
(Terva Jyrki,, Muustonen Tero and Zavalko Sergey, 2004, *Kola: the Saami community of Lovozero*, Arctic Climate Impact Assessment, included in Chapter 3 (Cambridge University Press)
UNEP/GRID-Arendal, *Climate Change 2001: Working Group II: Impacts, Adaptation and Vulnerability*, http://www.grida.no/climate/ipcc_tar/wg2/627.htm
United Nations Convention on Biological Diversity Secretariat, http://www.biodiv.org/programmes/socio-eco/traditional/default.shtml

United Nations Millennium Ecosystem Assessment
United Nations Convention on Biological Diversity
United Nations Framework Convention on Climate Change
United Nations Kyoto Protocol to the Framework Convention on Climate Change
United Nations University, 2007, *Update on the Establishment of the UNU Traditional Knowledge Institute*
World Watch Institute, 2006, *Climate Change Imperils Pacific Ocean Mangroves*, http://www.worldwatch.org.node/4426
www.scidev.net, 2007, *Melting glaciers threaten communities in South Asia*, (Source: BBC Online), 16 November 2004, http://www.scidev.net/News/index.cfm?fuseaction=readNews&itemid=1742&language=1
