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Implementing measures to manage the rapid deterioration of the Arctic

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Introduction

The Arctic refers to the region of the North Pole and is often conceptualized as a frosty sheet of ice. In reality, the ice in the Arctic is comprised of both thicker, older ice produced by long-term exposure to glacial temperatures, as well as thinner, newer ice that crystallize annually during colder seasons. Researchers from the National Oceanic and Atmospheric Administration (NOAA) have found that in the past 30 years the thicker, older ice, referred to as 'multiyear' ice, has deteriorated significantly. Originally being approximately 700cm in width and thus accounting for a major percentage of the total frozen mass of the Arctic, the NOAA has discovered it to have decreased to a mere 10% presently. An animation was designed in support of their research, which can be found under Appendix 1. According to Professor Peter Wadhams of Cambridge University, before the 20th century, the entire Arctic ice sheet compromised of multi-year ice. Presently, multi-year ice can only be found off the North coast of Greenland and Baffin Island in Canada.

The importance of multiyear ice can be suggested by the fact that its width, the result of layered sheets of ice, prevents it from melting in the warmer seasons of the year, creating what is referred to as 'summer sea ice'. This is beneficial for the survival of the Arctic during high temperatures and for the mass balance of the Arctic sea ice, which falls out of proportion when the melting rate of perennial ice is exceedingly high. Nevertheless, its deterioration is becoming increasingly common.

As the Arctic melt continues, certain 'feedback' effects are caused. The more Arctic ice melts, the more ocean water is exposed to sunlight. Dark ocean water absorbs more heat from the sun than light ice (which tends to reflect heat), causing the Arctic regions to warm even more. Eventually, the deterioration of the Arctic will develop into ice-free summers, predicted to take place 40 to 50 years ahead of the predicted schedule.

The deterioration of ice in the Arctic regions is not only harmful for the species, their habitats and the environment of the North Pole, but it also has a global impact. Warmer temperatures reduce the total surface area of the ice in the Arctic, allowing more of the ocean water to absorb heat from the sun. Eventually, this results in small increases in the average temperature of the seawater, and thus catalyzes the melting process of ice. As ice reflects sunrays back into space, a decreased quantity of ice in the Arctic regions could even contribute to the climate change of planet Earth as a whole.

Definition of Key Terms

First year-ice

First-year ice is ice that has lasts for less than 1 year and has not survived a melting season. Generally, first-year ice is no thicker than 100cm.

Second-year ice

Second-year ice is ice that has survived one melting season (the equivalent of one summer).

Perennial ice

Perennial ice is perpetual, thus it generally lasts between 1 and 3 years. National American Space Agency (NASA) defines perennial ice as: “ice that has survived at least one summer”.

Multi-year ice

Multi-year ice is ice that has survived more than one melting season. NASA distinguishes perennial from multi-year ice as: “all multi-year ice is perennial ice, but not all perennial ice is multi-year ice (it can also be second-year ice)”.

Summer sea ice

Summer sea ice refers to the ice sheet located in the Arctic that survives the increased temperatures during the summer season. This ice tends to be a combination of perennial, second-year and multi-year ice.

Arctic Circle

The Arctic Circle is a region that covers the North Pole, being a circle of latitude 66°33’45.8’ north of the Equator.

Climate change

According to the United Nations, the term ‘global warming’ is no longer a universal term that defines the changes taking place caused by greenhouse emissions and other pollutants. Thus, the term ‘climate change’ has been used to describe the change in climates all over the world.

General Overview

Research from the National Snow and Ice Data Center (NSIDC) has shown that the size of the sea ice in the Arctic has reached its lowest level since its record low in 2007. According to the Polar Science Center, the volume of Arctic ice has decreased by 40% over the past 3 decades. If the melting of Arctic ice continues at its current rate, according to the NSIDC, we could have ice-free Arctic summers by 2030, making perennial ice nonexistent.

Human influences

A study from the Environmental Research Letters has demonstrated that 70% to 90% of the Arctic melt since 1979 was caused by human activity. As a result of climate change, the Arctic region has been heating up twice as fast as our global average. Furthermore, pollutants from smokestacks in Europe and Asia are travelling up to the Arctic and settling into its snow and ice. Consequently, they absorb more of the sunlight’s heat, causing them to raise the temperature of their surroundings and speed up the melting process. Humans have significantly increased the concentration of pollutants worldwide, especially in the Arctic regions.

Pollutants

According to the Journal of Geophysical Research, black carbon is one of the most damaging greenhouse agents alongside carbon dioxide (CO_2). Black carbon, otherwise known as soot, spreads onto the snow and ice in the Arctic regions and absorbs increased amounts of light and heat from the sun, heating up the snow and ice beneath it. Whilst CO_2 remains in the atmosphere for centuries, black carbon stays for only 7 days.

Effects of natural disasters

The deterioration of the Arctic region is not only due to manmade incitements such as pollutants, but is also the result of natural influences such as natural disasters. Natural disasters often also contribute to the deterioration of the Arctic. For example, a large-scale storm in the Arctic regions in August of 2012 broke up a lot of the sea ice, exposing more surface area to the sun's heat. This caused the ice to become slushy, making it more vulnerable to changing weather conditions.

Rising ocean waters

It is often assumed that the consequences of the melting of the Arctic ice sheet will result in rising ocean waters, eventually engulfing countries located below sea level, such as the Netherlands. However, the ice floating in the Arctic Circle cannot raise the level of ocean waters, as it already displaces its own volume. Thus, once the ice has melted and changed state into liquid form, the water produced will replace the volume of the ice melted. However, as the newly 'exposed' ocean waters heat up, ice sheets covering countries such as Greenland will begin to melt, adding to the existing volume of ocean water. The U.S. Jet Propulsion Laboratory predicts that sea levels will rise by 30cm on a global scale by the year 2050. The rising ocean levels also depend on the changing temperatures and climates, as these would accelerate Greenland's ice melt.

Effects on temperatures and climates

The changes taking place in the Arctic Circle could result in extreme temperatures both in the warmer summer season, as well as the colder winter season. Jennifer Francis, a climate scientist, has discovered that the west-to-east jet stream (an air current) has slowed down, allowing for weather patterns to persist in specific areas for longer periods of time. This could explain the prolonged snowstorms in the United States and Europe between 2009 and 2010, as well as the extended heat wave in Moscow in 2010. The Arctic conditions are also changing the pattern of the west-to-east jet stream, creating more frequent blasts of cold Arctic air to spread to Europe and North America, making the winters colder and harsher.

Summer sea ice

Fluctuating temperatures and climates have had drastic effects on summer sea ice. The vast sheet of ice in the Arctic does not remain constant throughout the year, as increased temperatures cause non-perennial ice to melt during the summer season, leaving only perennial, second-year or multi-year ice behind. These are referred to as 'summer sea ice' and tend to have a smaller surface area and volume in comparison to the 'winter sea ice'. According to the European Environmental Agency, the extent of the summer sea ice in the Arctic has been declining tremendously over the past 20 years. As a comparison, the yearly average of 6.5 million square kilometers of Arctic summer sea ice has decreased to less than 4 million square kilometers in 2010. However it is needless to say that its surface area would have decreased even more since. Professor Peter Wadhams from Cambridge University estimated at the IPCC meeting in 2007, that the summer sea ice would last maximally for another 70 years.

Consequences on vegetation

The effects of the overall ice melt, as well as that of the summer sea ice, on Arctic vegetation are, surprisingly enough, both advantageous as well as disadvantageous. The polar deserts, boreal forests and tundra are the main vegetation zones in the Arctic. The polar deserts consist of patches of bare ground, the boreal forests of woodland and the tundra of low shrub vegetation. The climate change taking place is predicted to expand the boreal forests into the Arctic tundra, and the tundra into the polar deserts. The tundra will thus decrease in size, reducing bird breeding areas and grazing areas for some species. Nevertheless, the total number of species in the Arctic is hypothesized to increase as the climate becomes warmer, due to migration from the south. The expansion of the boreal forests will contribute to the warming of the Arctic, as the new forest areas are darker and will thus absorb more solar heat. However, the increase in forest area will also allow for an increase in carbon absorption by trees, reducing the concentration of carbon in the Arctic region. Furthermore, boreal forests, especially the dominant specie of black spruce, are highly flammable, which has resulted in a vast range of forest fires within the Arctic Circle. These are predicted to increase as temperatures rise. Lastly, the agricultural opportunities in the Arctic would be optimized due to the increased warming of the Arctic, allowing for the cultivation of an extended range of crops.

Consequences on animals

The consequences of the deterioration of the Arctic not only affect Arctic vegetation, but also influences the species living in the Arctic regions. Most Arctic animals depend on the sea's biological productivity, as well as on the presence of sea ice. Polar bears, for example, reproduce, hunt and migrate on sea ice, all of which is reliant on the stability and extend of this type of ice. Less winter sea ice causes female polar bears to survive for extended periods of time without food, decreasing their reproductive rates. The complete loss of summer sea ice would force polar bears to adopt a land-based summer lifestyle, threatening their survival due to competition with other predators and interaction with humans. Seal species similarly depend on sea ice, as it provides them with accommodation as well as feeding grounds. Seabirds such as ivory gulls rely on sea ice as their sole source of nutrition, as they fly out to sea to fish through cracks in the ice, keeping them shielded from their prey and giving their hunting the element of surprise. The bottom of sea ice is the base for the marine food web and is the location where ice algae grow. The melting of ice increases the temperature and salinity of surface ocean waters, disturbing the entire marine food web. The changes taking place in the Arctic climate have a negative impact on marine fisheries and aquaculture, directly influencing the human food industry.

Consequences on Arctic people

The communities of people living in the Arctic Circle have also had to endure the consequences of the Arctic melt. An increase in temperatures has caused changes in the Arctic coastline as reduced sea ice forms stronger waves, increasing shore erosion and allowing for larger storms that affect many coastal communities. Higher sea levels flood the marshes and coastal plains, accelerate beach erosion and increase the concentration of salt water in bays, rivers and groundwater. For example, in the Alaskan village Nelson Lagoon, protective break walls on the shore and the drinking water pipeline are repeatedly destroyed by powerful coastal storms. Also Shishmaref, another Alaskan village, is facing evacuation as the coastal permafrost has melted, threatening homes, infrastructure and hunting grounds. Also the indigenous Arctic communities are experiencing the negative consequences of the melting of the Arctic. Hunters are unable to build igloos due to unstable weather conditions, changing snow quality and an increase in ‘freezing rain’. In addition, sunburns and related skin rashes are becoming common among the indigenous Arctic people. The rate at which climate change in the Arctic is occurring is too fast for the Arctic communities to be able to adapt.

General consequences of the deterioration of the Arctic

The deterioration of the Arctic has a vast range of consequences. A cold-water flood from melting glaciers and icebergs could disrupt the Gulf Stream in the Atlantic Ocean, which has the function of keeping temperatures in Europe constant. Furthermore, if the permafrost, “a thick subsurface layer of soil that remains below freezing point throughout the year, occurring chiefly in Polar Regions” (Oxford Dictionaries), continues to melt in areas such as Siberia, larger volumes of methane gas will escape into the atmosphere. A survey published in ‘Nature’ estimates that methane released from permafrost could contribute 2.5 times more to climate change than deforestation. This would accelerate the climate change taking place worldwide.

Benefits of the Arctic melt

Surprisingly, the deterioration of the Arctic not only has its consequences, but also has its benefits. The melting of Arctic ice has also been beneficial for some industries, especially the petroleum industry, where previously frozen Arctic areas has become unlocked allowing for oil and gas exploration. Northern offshore areas regions previously unreachable are now popular exploration sites for petroleum companies. For example, Shell has sent recently a drill ship to Alaska (the Chuckhi Sea) for exploration purposes. Moreover, a $500 million contract was signed between Exxonmobil and Rosneft to get to 35.8 billion barrels of oil locked in the formerly frozen Kara Sea in Russia. Yet again the chain effect is that the more ice melted, the more oil and gas is available, and the more is burnt causing greenhouse emissions. Furthermore, research has shown that the melting of Arctic sea ice and glaciers may increase the concentration of freshwater in the oceans.

Major Parties Involved and Their Views

Greenland

As depicted in the map to the right, Greenland is close proximity to the North Pole and is located within the Arctic Circle. Greenland's ice sheet has a width of 3km and could potentially raise global sea levels by 7.5m. This could result in the drowning of countries such as Bangladesh, Papua New Guinea, the Philippines, Barbados, Kiribati, Egypt and Tuvalu and the Maldives. This will affect the trade market, industries and lives of millions of people. The melting rate of Greenland's ice sheet is accelerating significantly, losing 4 times as much mass as it previously, triggered by warmer air, rising ocean temperatures and warmer currents shaving off the edges of the ice sheet. The Jakobshavn glacier in Greenland used to pour into the Arctic Ocean at a speed of 7km/year in 2002, and has presently risen to 15km/year. More than twice the amount of Greenlandic ice is being released into the ocean, raising sea levels. Moreover, between 2003 and 2010, Greenland has lost 240 gigatonnes of ice mass per year, whereas in 2012, only 2 years later, Greenland lost over 350 gigatonnes. This is confirmed by research conducted by Professor Dorthe Dahl-Jensen from the Niels Bohr Institute of Copenhagen University.

Figure 1 Map Depicting the Arctic Circle

Map of Arctic Circle. Digital image. Beyond Penguins. N.p., n.d. Web. 19 Aug. 2015. <http://beyondpenguins.ehe.osu.edu/where-does-the-arctic-begin-end>.

Canada

Canada's federal government is monitoring of the ice caps located in Canada's High Arctic. The Natural Resources Canada (NRCan) runs a program referred to as the Climate Change Geoscience Program, which monitors the glacier mass fluctuations and sea level changes on an annual basis within Canada's Arctic. The deputy minister of the NRCan, Joe Oliver, confirms that the shrinking of ice caps has accelerated within the past 9 years, since 2005. For example, Devon's ice cap had lost 1.6%, Meighen's 11% and Melville's 13% of its mass in 1960, whereas since 2005 they had lost 30% to 40% in mass. David Burgess, a research scientist and glaciologist at the NRCan noted continuous high pressure over Greenland, which drew in more warm air from southern latitudes. This contributed to the overall warming of the Arctic. In 2009 Canada signed the Copenhagen Accord to reduce the country's greenhouse emissions by 17%. Nevertheless, carbon pollution from oil sands increased by over 62%, emitting 55 million tons of CO_2 into the atmosphere. According to Environment Canada, the oil sand emissions will reach 101 million tons by 2020.

Russian Federation

A senior NATO official has stated on the Responding to Climate Change (RTCC) website that the Russian Federation was taking advantage of the melting Arctic ice sheet for a personal strategic advantage in the region. The warming temperatures in the Arctic allow for navigation in formerly frozen sea, opening a new front for the Russian Federation. Jamie Shea, deputy assistant secretary general for emerging security challenges at NATO, claims that Russia intends to reopen former Soviet bases in the Arctic Circle. For example, in September of 2013 Russia installed a base in the New Siberian Islands, which previously were inaccessible. Furthermore, it is claimed that the Deputy Prime Minister Alexander Khloponin sees the melting of the Arctic sea ice as an opportunity for oil majors, such as Rosneft, to drill in the northern waters of the Russian Arctic Circle.

Arctic Council

The members of the Arctic Council include Canada, Kingdom of Denmark, Finland, Iceland, Norway, Russian Federation, Sweden and the United States of America. The Arctic Council has the function of protecting the environment and climate, ensuring biodiversity, safeguarding oceans and assisting the Arctic people within the Arctic Circle.

Timeline of Events

Date	Description of event
June 14th, 1991	Arctic Environmental Protection Strategy (AEPS) adopted by Canada, Denmark, Finland, Iceland, Norway, Russian Federation, Sweden and the United States.
September 19th, 1996	Arctic Council established.
March 2007	The International Maritime Organization set ‘Guidelines for Ships Operating in Arctic Ice-covered Waters’.
October 29th, 2014	The Nordic Council of Ministers adopt a new Arctic Co-operation programme for 2015-2017.
July 8th, 2015	United Nations Secretary-General Ban Ki-moon visits Norway’s Arctic region and stresses the need for the international community to take action.
August 31st to September 4th 2015	United Nations Climate Change Conference.

UN involvement, Relevant Resolutions, Treaties and Events

The United Nation’s Intergovernmental Panel on Climate Change (UNIPCC) has been an active party involved with managing the deterioration of the Arctic.

- ‘Climate change and its possible security implications’, General Assembly Resolution 63/281
- Kyoto Protocol, adopted on 11 December 1997 and entered into force on 16 February 2005
- Declaration on the Establishment of the Arctic Council, 19 September 1973
- Agreement on the Conservation of Polar Bears, signed by Canada, Denmark, Greenland, Norway, the Soviet Union, the United States, 15 November 1973
- Letter from the United Nations Secretary General Ban Ki-moon, “The ice is melting”, The New York Times, 17 September 2009

Evaluation of Previous Attempts to Resolve the Issue

Black carbon remains in the atmosphere for up to only 7 days, which allows for effective short-term solutions with beneficial results. In the past, California has successfully implemented tighter air-quality regulations on diesel emissions reducing black carbon emissions by over 50% between 1990 and 2008, according to research conducted by Argonne National Laboratory published in 2011.

225 000 letters were sent to President Obama of the United States of America requesting Shell not to conduct exploration and drilling in the Arctic region, due to its consequences for the Arctic environment, wildlife and populates. Nevertheless, Shell was permitted to drill in the Chukchi Sea, northwest of Alaska. According to Greenpeace, the chances of an oil spill as a result of drilling in the Arctic Circle are higher than 75%, and despite this risk factor, Shell wishes to continue with their original plans. Although this attempt to preserve the environment of the Arctic failed, the initiative of Greenpeace was supported.

In November of 2011, Australia set up a carbon-trading plan (the world's largest with the exception of Europe), where Australia's 500 worst polluters were forced to pay taxes on each ton of carbon emitted. Similarly, Japan launched a cap-and-trade plan in 2010 that forced 1300 businesses in Tokyo to reduce their carbon emissions. Running since July of 2012, the Australian project has been very prosperous, reducing Australia's carbon footprint extensively. Australia intends to initiate a full-fledged market-based carbon trading system in collaboration with New Zealand by the end of 2015.

China currently produces and consumes the most coal worldwide, making it the largest emitter of greenhouse gases and the second-largest consumer of energy. Nevertheless, China strives to become 40% more energy efficient by the end of 2015. This is being worked towards by having non-fossil fuels account for 15% of the nation's energy sources by 2020 and passing a law in 2005 obliging Chinese power grid companies to depend on renewable energy sources for a specific percentage of their total power supply. It also provides government subsidies for renewable energy sectors and is also experimenting with a carbon-trading plan.

The European Union launched the largest carbon-trading market worldwide in 2005, working with regulated carbon permits. Major factories and power plants, for example, are given permits specifying how much carbon they are allotted to emit. Companies that manage to emit less than their specified amount can sell their carbon credits to firms that surpass their limit, creating a beneficial system for all involved parties. The result thereof is a significant reduction in greenhouse gases all over Europe. Similarly, flights taking off or landing in Europe are also required to purchase carbon permits, however these regulations may be retracted as they breach international law.

India will increase its energy efficiency by 20% by the end of 2015 by earning credits under the Clean Development Mechanism (CDM) for undertaking emission-reducing projects. These credits are then sold to industrialized countries that use them toward their emission-reduction commitments under the Kyoto Protocol. India is especially involved in wind power and biomass projects, and has set the goal of achieving 20 gigawatts of solar power by 2022. They have also set a carbon tax on coal to subsidize renewable energy projects.

An interesting attempt to solve the melting of the Arctic sea ice was to, quite literally, turn the oceans white. This would have been achieved by floating white grains on the surface of the ocean water, or create micro bubbles with the function of reflecting the sun's rays and heat back into space. However, being extremely costly and requiring a lot of effort, this solution has proven to be ineffective. Researchers at the Carnegie Institution for Science in Stanford discovered that the melting of permafrost will not be reduced, thus the emission of methane will continue to increase. Furthermore, whitening the ocean could cause warmer, rainier winters in the north and colder seasons in the south. Additionally, environmental campaigners claim that floating white grains may damage the marine ecosystem and ocean wildlife. The technological feasibility is also questionable.

The Arctic Council is one of the most active bodies in the prevention of the deterioration of the Arctic. With a Task Force for Action on Black Carbon and Methane (TFBCM), the Arctic Council actively reduces emissions within the Arctic Circle and improves the health of Arctic inhabitants affected by black carbon emissions. The Arctic Council has also created an Arctic Biodiversity Assessment (ABA), used by its Conservation of the Arctic Flora and Fauna (SAFF) group to evaluate trends in Arctic species and publish these to the Arctic Species Trend Index. The data collected is used to compare the trend in Arctic species, with trends in the changing Arctic ecosystem. The Circumpolar Biodiversity Monitoring Program has also been implemented, with updates published regularly on the Arctic Council website. The Arctic Council also has its own independent Search and Rescue team, and example of which took place on the 10th of September 2012 along Greenland's east coast to test communications, equipment and procedures in an emergency situation, taking into account the increasing tourist industry and cruise ships in the Arctic. Moreover, a

Sustainable Development Working Group (SDWG) was established to create a Circumpolar Health Systems Report (CircHSR), initiate an Arctic Human Health Initiative (AHHI) and an International Circumpolar Surveillance (ICS) all with the aim of improving the living conditions and health standards of the Arctic people.

Possible Solutions

Preventing the deterioration of the Arctic has become close to impossible. For example, the climate blogger Joe Romm stated that if we intended to prevent the Arctic summer sea ice from disappearing, we would have to cut our greenhouse gas emissions by over 60%, which would destroy our industries, markets, economies and so on. Nevertheless, the management of the melting process of the Arctic ice sheet is viable. As described in the 'Evaluation of Previous Attempts to Resolve the Issue', the management of the deterioration of the Arctic is closely linked with the management of climate change, especially carbon emissions (with CO_2 and black carbon).

As mentioned previously, black carbon, also known as soot, has proven to be one of the primary causes of the deterioration of the Arctic. In 2003, Dr. James Hansen stated that: "Soot in snow and ice, by itself in an 1880-2000 simulation, accounted for 25 percent of observed global warming" (Washington's Blog). Thus, an effective short-term solution would be to reduce black carbon concentrations in the Arctic Circle. The main causes for black carbon emissions are diesel exhaust, jet fuel and burning (waste, biofuel, forest etc.). A solution to black carbon emissions would be rerouting airplane flights to reduce the amount of emissions in the Arctic region. A study in 2010 demonstrated that over 50,000 cross-polar flights had taken place. From a financial perspective, rerouting flights would cost approximately $100 million per year, however this is 47% to 55% less than the costs of global warming in the United States alone. The cost of rerouting on a global scale is only one fifth of the total climate costs. According to Dr. Jacobson, the head of Stanford's Atmosphere and Energy Program, jet fuel emissions of black carbon are reduced by 83% in the Arctic Circle. Consequently, the average rate of climate change worldwide would be reduced by 2%.

CO_2 emissions similarly contribute to global climate change. CO_2 emissions are caused by transportation, especially by cars. Research published in 'The Economist' has proven that over 70% of emissions in Europe and America are the result of diesel engines. These can be reduced significantly simply by installing exhausts that trap carbon particles before they are emitted. Furthermore, the scrapping and recycling of old, highly polluting vehicle models could also provide a short-term solution. To summarize, replacing fossil fuels with renewable energy is an excellent long-term solution to reducing the greenhouse gases that cause climate change and the deterioration of the arctic.

By collaborating with bodies such as the Arctic Council, assistance to the Arctic population needs to be provided, as well as the protection of species living within the Arctic Circle needs to be ensured. This can be done, by having special task forces work together with Arctic communities and indigenous people to ensure they have access to basic living conditions, as outlined in Article 25 of the Universal Declaration for Human Rights, being: “Everyone has the right to a standard of living adequate for the health and well-being of himself and of his family, including food, clothing, housing and medical care and necessary social services, and the right to security in the event of unemployment, sickness, disability, widowhood, old age or other lack of livelihood in circumstances beyond his control” (Universal Declaration of Human Rights). It is also important to ensure a means of evacuation in case of emergency, by either expanding or strengthening the Arctic Council’s Search and Rescue team. Similarly, collaboration with the World Wide Life (WWF) will improve the living conditions of animals, by monitoring, securing and maintaining the habitats of animals, especially those dependent on Arctic sea ice as shelter or as a source of food.

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Appendix

Appendix I

Animation created by the NOAA that summarizes the deterioration of the multiyear ice in the Arctic regions between 1987 and 2014 <https://www.youtube.com/watch?v=FDRnH48LvhQ>