

Climate Change and the National Park Everglades

Renzo Massa

San Ignacio University

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Abstract

The National Park Everglades is already damaged by the warming climate. The sea level is rising and has already brought several changes to the landscape. In the future these changes will be worse. The Everglades as we call them, find their origins 3200 years ago, when the rhythm of rising seas dropped significantly from 9 inches to 1.5 inches per century. This dropped of the tide rise in the sea level allowed an urbanization of mud, shells and sand at the Florida's Southern Coast. This kind of ridge acted as a low dam and stopped ocean water from crossing over it. This natural dam hinder rainfall and overflow from Lake Okeechobee forming a freshwater environment, the Everglades. A large portion of this exceptional landscape is now protected as Everglades National Park.

Why we should conserve and take care of the Everglades.

Everglades National park is one of the largest parks (1.5 million acres) in the country. It has an extraordinary amount of significant resources inside its limits, among them we have: the largest stand of sawgrass prairie in North America, the largest protected mangrove forest in the northern hemisphere, the vast estuary of Florida Bay, and cultural resources chronicling approximately 10,000 years of human experience. In addition, Everglades National Park is the only subtropical wilderness area in North America where, by federal law, people must make no impact on the land and ecosystem. However, the influence of man is increasingly being felt on every acre of the Everglades in the form of human-caused climate change. We must protect the natural and historical living beings and objects within the park. This way present and future generations would enjoy of this fascinated place.

The Climate Change

During the last century, experts have noticed that the global temperature has raised significantly. The researchers are 99% sure that the higher global temperature is caused by human activities that increase greenhouse gases in the atmosphere:

- Water vapor (H_2O)
- Carbon dioxide (CO_2)
- Methane (CH_4)
- Nitrous oxide (N_2O)
- Ozone (O_3)
- Chlorofluorocarbons (CFCs)
- Hydrofluorocarbons (incl. HCFCs and HFCs)

The problem is that greenhouse gases are destined to cause more warming of the global climate with greater proportions than what was experienced in the 20th century. Warmer temperatures influence other aspects of the climate system as precipitation that many living things depend upon. In fact, there are many species' normal life-history patterns that have been changed because of the global warming. For instance, winter ranges of bird species have shifted northwards in over 50 parks, small mammals' habitats have shifted upslope in Yosemite, and conifer tree mortality has risen in four parks.

Because of the warmer temperatures, researchers have observed an increase in the global sea level, and of course it has a transcendental impact for South Florida. Normally, the sea level measurements were alike in the south Florida Region, until 1840s, which was one of the longest records in United States. The average rate was 5 inches per century for the period from 1846 to 1992 according to the monitoring station in Key West. This estimated was consequent with the $4\frac{3}{4}$ inches per century from the Intergovernmental Panel on Climate Change First Assessment Report in 1990. This fast rate of rise caused by the climate change is affecting the Everglades in many ways, for instance, don't let the animals and plants to adapt to their environment.

How the Climate Change is damaging the Everglades.

The surroundings of south Florida and the Everglades is distinctive because of its low altitude and subtropical climate. At all the coast, freshwater from the north encounter the continuous changes of the tides that feed several different ecosystems, as well as the buttonwood forests. These coastal ecosystems are home to many rare and scarce plants such as tropical orchids and herbs, some of which are found only in south Florida. Unluckily, these species' home is in risk because the habitat is varying, in part, due to sea level rise, generating the salinization of groundwater and the soils above.

It is uncertain whether these species can bear the increased salinity in consequence of the sea level rise due to climate change.

Experts have checked the water levels in the whole park, even the numerous inland, freshwaters habitats. The water level in these zones fluctuates with variations in rainfall, freshwater flow and ocean tides. In the last 50 years, researchers have noticed a growth in the water level at some, inland freshwater areas in the park, this is consequent with the growth detected in regional sea level. This is very dangerous because we don't know what type repercussions will bring to freshwater environments, however this means that the sea level rise would get far inland.

How the Climate Change is affecting the Cape Sable in the Everglades.

The Cape Sable is an extensive coastal area located at the southwestern of Florida. Once, was characterized by large interior freshwater marsh and connected freshwater lakes. This area has one of the major changes in landscape in the Everglades. At the beginning of the 1900s, the population started to use this area for agriculture and began extracting freshwater out to the ocean thus the ground could dry. Now, the canals built by the settlers, due to the impacts of hurricanes and the use of water farther north, have converted the coastal system of Cape Sable, and most of this change has been intensified by climate change.

Experts have studied the landscape to analyze the sea level in South Florida. The study demonstrate that the sea level rise was slow through the past 3200 years. However, current equipment has documented an increase rate of rise over the past century, which had evident effects on Cape Sable. The canals are today a conduit of salty water and sediments aimed to inland, mainly for the period of high tides or with the support of strong wind and surge from tropical storms. These

last years, the interior freshwater marsh has practically vanished and the closest lakes have almost been filled with marine sediments. These changes in the Cape Sable have repercussions for the mangrove trees that are situated at the edge waters. Due to the growth of the sea level and the several flooding, the trees are moving inland where the habitat is more appropriate for them. In addition, throughout the coast high tides and storm surge have contributes to removethe sediments from their roots and have facilitated the erosion in the Cape Sable.

How the climate change is affecting the Saline Glades in the Everglades.

The saline glades is anextensive linear area scarcely vegetated marsh, most of which is inside Everglades National Park. This zone receives limited freshwater flow and it is out of range of the Tides, this characteristic is not good for the development of the majority of inland and coastal plant species. There are just some plant species that can survive there: stunted red mangroves, sawgrass, and spike rush.

In the last 50 years the vegetation of red mangroves has extended its reach inland (upon 1km in some zones) and has moved other freshwater species. The red mangrove can grow in the inland due to the trade of freshand saline water in the marsh helped by roads, canals, and sea level rise. This progressively more salty environment makes it easier for saline species to develop, and diminishes the whole area of freshwater marsh.

How to strive against the Climate Change.

A way to checked if our environment is varying is to identify how it was in the past. Researchers persistently measure these changes through the time. These interpretations are made by indicators as: coral health, nesting of wading birds, vegetation communities, fish abundance and diversity, hydrology and water quality, threatened and endangered species, and cultural sites.

As well we have to adapt our landscape to the inclemency of the climate change. For instance, through 20th century, many canals were made to drain the freshwater marsh of Cape Sable.

During the last century, these canals in conjunction with the sea level rise made an evident change to the former freshwater environment. To break the incursion of salt water to Cape Sable, The National Park Everglades has plugged some of the canals, the last one was executed in 2011 with the expectations to intensifythe resilience against sea level rise as a result of climate change.

The Comprehensive Everglades Restoration Plan (CERP) is a multibillion dollar project approved by Congress in 2000. Since then, the work has increasingly been observed as south Florida's outstandingplan against climate change.

Will take over forty years to carry out by the U.S. Army Corps of Engineers and the South Florida Water Management District. CERP hopes to increase freshwater storage, improve water quality, and restore the natural water flow through the greater Everglades ecosystem. If it is achieved, these struggles will keep out subterranean aquifers from salt water invasion, postponed the effects of sea level rise along the coast, and get valuable time for wildlife to deal with their fluctuating environment.

Researchers are working in two renovation plans to recover flow in the everglades. One is the C-111 canal pump stations to the east of the park. A pump will aim water from the C-111 canal to a confinement area that will aid to avoid the leak of water from Taylor Slough and the eastern portion of the park. The other one is the L-29 canal dam and one-mile bridge on Tamiami Trail. Rise a one-milepart of Tamiami Trail, this way water can passeasily into the park without harming the road.

How contribute against Climate Change.

Strategies:

At the Ernest Coe Visitor Center, the Park uses solar power to light the parking lot when dark. Operating lights on solar energy helps decrease the contribution of greenhouse gases from the use of fossil fuels. As well, at the Flamingo campgrounds, the Park uses solar powered heaters to provide hot water for showers. Hot water was not available until the solar heaters were installed in 2010.

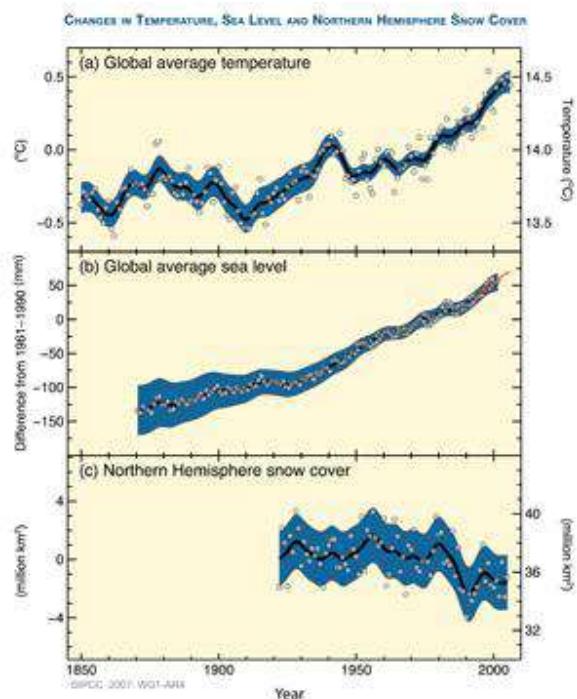
In addition, in 2012, Shark Valley Tram Tours replaced its fleet of petroleum diesel trams with biodiesel trams. Biodiesel fuel is made from vegetable oil, animal fats, or recycled restaurant grease and must meet certain standards to be used. Using biodiesel fuel significantly reduces the emission of greenhouse gases and harmful pollutants, bringing the Park closer to achieving its goal to make operations more sustainable. A finally, replaced most of the park's vehicles with hybrid cars - Replaced old air conditioning systems with higher energy efficiency systems -Adopted an energy conservation strategy for all park facilities

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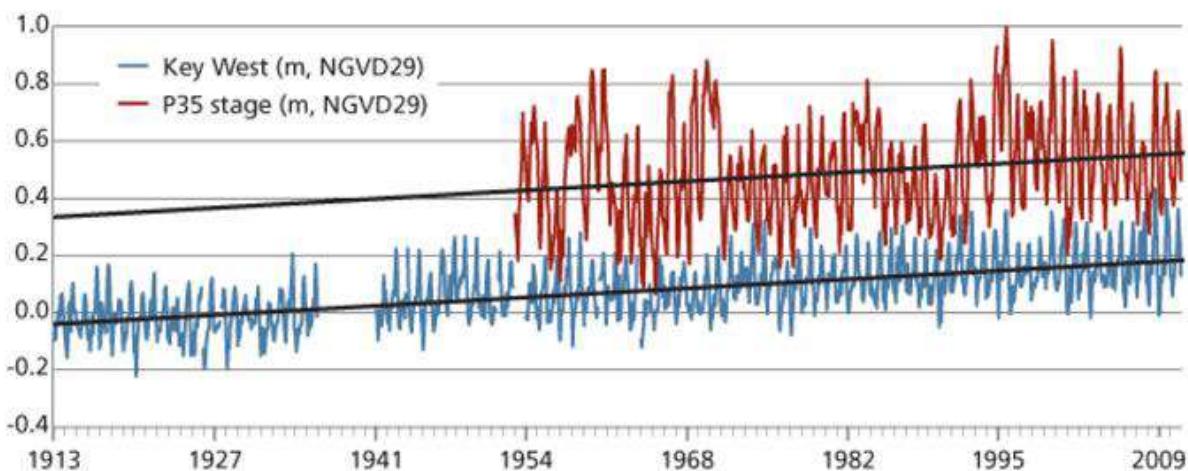
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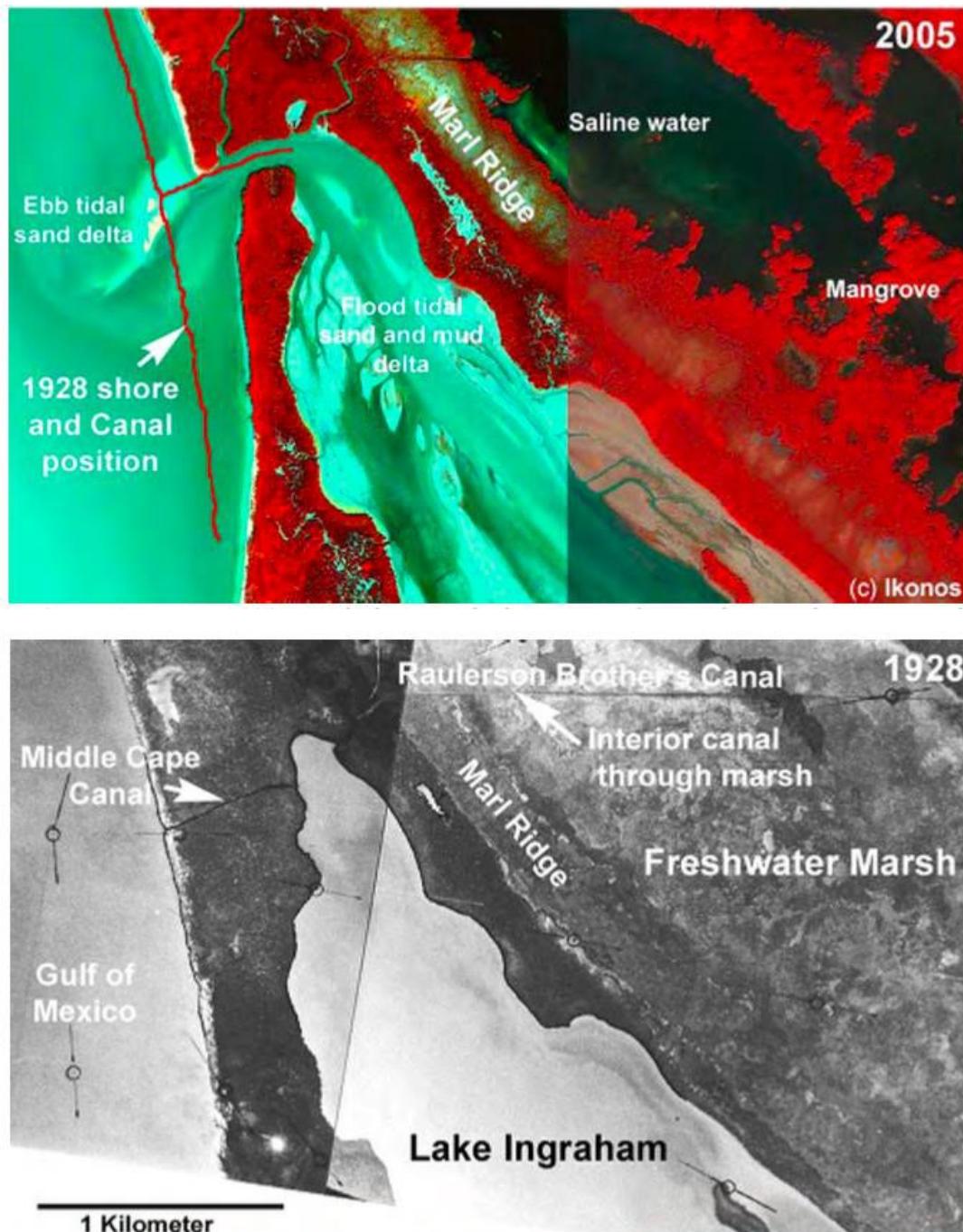
Graphics



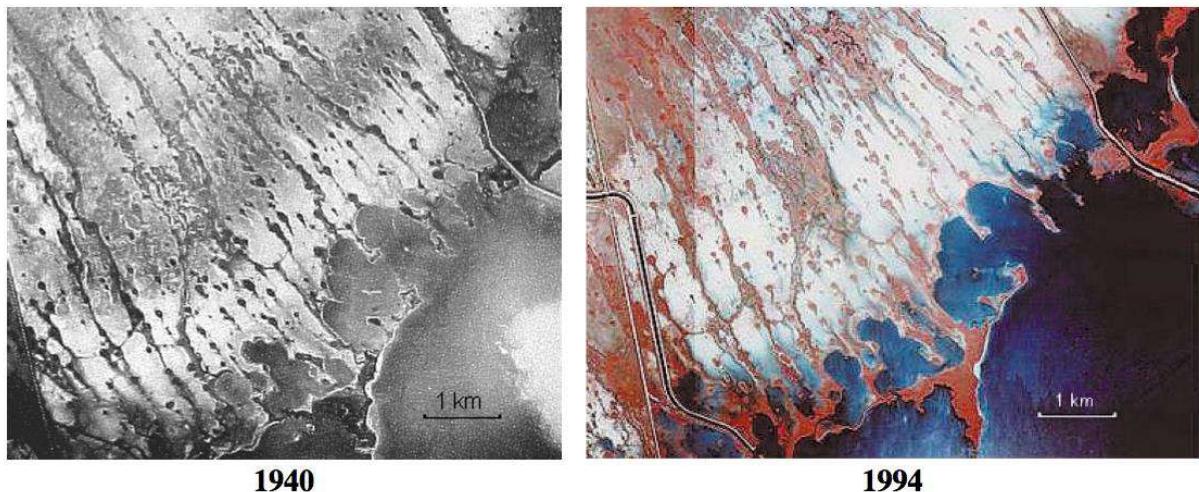
- a) Shows observations of global average surface temperature; (b) shows global average sea level from tide gauges, (the red line is from satellite data); (c) shows Northern Hemisphere snow cover for March and April. The differences are calculated from the 1961-1990 averages.



Graph shows that the rate of marsh water-level rise in the park is like the rate of sea level rise observed in Key West. The black line is the trend line for the time series.



These images show the expansion of Middle Cape Canal, the retreat of the shoreline, and the conversion of freshwater marsh to saline water and mangroves from 1928 to 2005.



The red line in the photographs show the interior boundary of the saline glades has moved inland from 1940 to 1991.



A view south from the plug at East Cape Canal looking towards Florida Bay.

Note the difference between the silted tidal water to the south of the plug, and the clearer freshwater behind it.



The C-111 canal pump stations became operational in early 2013.