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MIAMI-DADE CLERK
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DADE COUNTY COURTHOUSE
ROOM 242
73 West Flagler Street
Miami, FL 33130

September 25, 2007

Dear CCATF Colleagues:

RE: DISTRIBUTION OF THE CCATF'S SCIENCE COMMITTEE'S STATEMENT ON SEA LEVEL RISE IN THE COMING CENTURY

Pursuant to our work plan, the Science Committee is missioned to provide the Task Force and its other Committees with an assessment of the magnitude and timing of expected impacts to Miami-Dade County from Climate Change.

The sole purpose of this statement is to inform the deliberations now under way within the Committees which are already working to develop recommendations for the Board of County Commissioners and the Mayor as to what proactive measures need to be taken to minimize the negative effects of and maximize resiliency to the coming scenario. In order to plan both adaptive and mitigation strategies, it is essential to have as clear a picture as possible of that scenario and how it might impact our built and natural environments as well as our economic, social and cultural interests.

The state of the science has become increasingly fluid since the United Nations' IPCC assessments earlier this year. Due to emerging knowledge concerning the "feedback" effects of melting polar ice caps and defrosting permafrost methane release, it appears that the IPCC's projection of two (2) feet of sea level rise by 2100 may be alarmingly conservative. Indeed, the IPCC report predicted that we may see "open seas" at the north pole by 2070. Just the other day, 63 years earlier than predicted, we were treated to the celebratory announcements from global shipping interests that the so called "North Passage" is imminent.

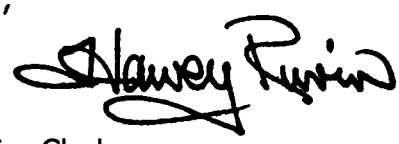
No one has a crystal ball so as to know with absolute certainty what the future will look like nor to know exactly when it will unfold.

What is clear, however, is that in the exercise of the Precautionary Principle our work should now take on the greatest sense of urgency.

As each Committee prepares their initial recommendations, I urge you to think out of the box and not be afraid to call for the bold actions that are required by both the nature of the challenge and the shrinking time needed to act effectively.

Mindful of our role as an advisory body to the Mayor and the Board of County Commissioners, I am furnishing each with a copy of this transmittal, so that they will be kept aware of the status of our work. It is our plan to have our initial recommendations to them by the end of the year or sooner.

Respectfully,



Harvey Ruvin, Clerk
Chair, Climate Change Advisory Task Force (CCATF)

cc: Honorable Charlie Crist, Governor
Hon. Carlos Alvarez, Mayor
Members of Board of County Commissioners
Steve Adams, Executive Director, Governor Crist's Action Team
Hon. Ken Pruitt, Senate President
Hon. Marco Rubio, Speaker of the House
Alex Sink, Chief Financial Officer
Hon. Manny Diaz, Mayor, City of Miami
Hon. David Dermer, Mayor, City of Miami Beach
George Burgess, County Manager
All Members of the CCATF and its Committees

P.S. I am enclosing for your review a portion of a just released report entitled "Nation Under Siege" which graphically sounds a similar alarm for all of coastal America. NOTE: South Beach is "cover-girl".

P.P.S. You have already received the study completed last month by the SFRPC which includes mapping of Miami-Dade County at 1, 2, 3, 4 and 5 feet of sea level rise. A CD of this report, including the mapping, will be distributed next week.

CLIMATE CHANGE ADVISORY TASK FORCE

James Murley, Director, Catanese Center for Environmental & Urban Solutions, FAU
Professor Hal Wanless, University of Miami, Department of Geological Science
Elizabeth Plater-Zyberk, Dean, University of Miami School of Architecture
Dr. Stephen Leatherman, Director, FIU, International Hurricane Center
Dan Kimball, Park Superintendent, Everglades National Park
Carolyn Dekle, South Florida Regional & Planning Council
Alan Farago, Everglades Defense Council
Nancy Liebman, Urban Environment League of Greater Miami
Dr. Alfredo Ravinet, Professor, FIU, Engineering Center
Sean McCrackine, Commissioner Sorrenson's Aide
Guillermo Olmedillo, Swerdlow Group (former Director of Planning Department)
Hugh Gladwin, Director, FIU Institute of Public Opinion Research, School of Journalism & Mass Communication
Dr. Adriana Y. Cantillo, Cantillo Consulting
Marcus Frankel, Architect
Tony Moss, Esquire, Law Office of Tony Moss, P.A. (former Fish & Wildlife Conservation Commission)
Leonard Abess, University of Miami, Center for Ecosystem Studies
Dr. John (Jack) Parker, FIU, Environmental Studies Department
Jose Fuentes, Water Management District
Jeff Bartel, Florida Power & Light
Ralph Rodon, The Codina Group (former Director of Building & Zoning)
Capt. Dan Kipnis, Florida Wildlife Federation
Cynthia Guerra, Tropical Audubon Society
Arsenio Milian, Engineer, Environmentalist
Richard Pettigrew, Former Chair, Commission on Sustainable South Florida
Harvey Ruvin, Miami-Dade County Clerk, Designated Chair

Updated March 26, 2007

STATEMENT ON SEA LEVEL IN THE COMING CENTURY

Science and Technology Committee
Miami-Dade County Climate Change Task Force.
September 19, 2007

Significant sea level rise is a very real threat to the near future for Miami-Dade County.

BACKGROUND: Over the past 2,500 years south Florida has experienced an average rate of relative sea level rise[1] of about 1.5 inches per century. Over this time our sandy, mangrove and muddy coastlines were mostly stable or expanding seawards. The broad coastal wetlands and historically stable sandy coastlines of south Florida are a product of this prolonged period of very gradual sea level rise.

Since 1932, south Florida has had about a 9 inch relative rise of sea level. This is a rate of one foot per century and is about 8 times the average rate over the past 2,500 years. Much of this accelerated rise is the result of warming (and expansion) of water in the western North Atlantic Ocean in response to global warming. Our coastal and shallow-marine environments are now evolving in response to the stresses of this rising sea level.

EVALUATION: The 2001 report of the United Nations sponsored Intergovernmental Panel on Climate Change (IPCC) projected an additional sea level rise over the coming century of 1-3 feet (median level rise of 2 feet.). The 2007 IPCC report projected a somewhat lower level, but it did not incorporate the significantly accelerated melting being observed in the Greenland Ice Sheet (apparently because the results had not yet been published in peer-reviewed science journals). As a result, the IPCC report, which should be the guidance for the future, underestimates the amount of sea level rise that is likely to occur in this century.

Since 2000, rapid changes have been occurring to the Greenland Ice Sheet - changes that were projected to begin at the end of this century. Over this past decade, there has also been rapid loss of multiyear pack ice in the Arctic Ocean, a phenomenon not projected to occur until 2070. Simply put, climate and glacial scientists now see that models failed to predict the rapidity and quickness with which these critical changes would occur.

Both the Arctic Ocean and Greenland Ice Sheet have important 'positive feedback' effects that are driving these accelerated changes. Positive feedbacks are secondary effects that further reinforce and accelerate the primary changes. For the Greenland Ice Sheet, (a) summer melt water on the lower elevation margins of the ice sheet is forming surface pools on the ice which absorb incoming solar energy, thus accelerating melting; (b) the melted surface water is flushing down to the bottom through fractures and dissolved moulins (vertical holes) in the ice sheet, forming a lubricated layer over the rock which is dramatically accelerating the rate of the ice sheet breakup and movement towards the sea; and (c) as the ice sheet margins melt and move towards the sea, the elevations on the ice sheet are lowering, placing the surface in yet warmer conditions.

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[1] Relative sea level rise for an area is a combination of the change in ocean level and local changes in response to uplift or subsidence of the land. For example, North Carolina has a greater relative sea level rise than south Florida because the land there is subsiding faster.

Melt effects are expanding northwards on both coasts of Greenland. Even the very northern portions of Greenland have seen increased melting over the past decade.

Field observations from this summer in western Greenland have documented amazing acceleration of marginal glaciers. The Illulissat Icefjord, located 150 miles north of the Arctic Circle, is an outlet for about 7% of the Greenland Sheet. This marginal glacier had been receding in response to increased marginal glacier melt. Beginning in 2002, the ice has surged seaward and is presently moving seaward at over 9 miles per year with additional pulses as high as 3.1 miles in 90 minutes! Melt waters seeping down through the ice sheet have created a 1,600 foot thick layer of water on which the interior ice sheet is now floating, fracturing, and surging to the sea. Acceleration of melting of the Greenland ice sheet is the critical factor to the rise of global sea level in the coming century.

The Arctic Ocean has historically been sufficiently blocked with thick floating pack ice that navigation through the 'Northwest Passage' has remained elusive until recently. The pack ice is floating on the water of the Arctic Ocean and its melting would not in itself change sea level (like a melting ice cube in your glass). However, the white pack ice surface reflects nearly all incoming solar energy back into the air and space. Melting of the pack ice leaves areas of open water which absorb nearly 90 percent of the incoming solar energy. This warms the water, which further accelerates the rate of melting in the Arctic summer and reduces cooling in winter. Historically, the pack ice covering much of the Arctic Ocean through the summer was made of large solid masses of ice that were 4-5 years old, thickening each year. In the past decade, the pack ice has become increasingly younger and thinner. Most of the pack ice this summer is only 1-2 years old. It is thin, highly fragmented and contains many open water areas. As of mid September, this year's summer melt has left 30% less pack ice than the previous record low (in 2005). The large open water areas were 9 degrees Fahrenheit warmer than normal. Melting will continue until at least mid September. The pack ice is now so thin and fragmented that it could potentially float out of the Arctic into the Atlantic.

Climate projections had talked of the possibility of a summer ice-free Arctic Ocean in 40-80 years. Now it looks like that may happen within a decade if recent trends continue. As the pack ice diminishes over the Arctic Ocean, the adjacent land will warm, vast areas of tundra permafrost will melt releasing potentially catastrophic amounts of methane to the atmosphere[2], and melting of the Greenland Ice Sheet will even further accelerate.

In short, the recent changes occurring in the Arctic and Greenland mean that global warming and sea level rise will happen much more rapidly than had been only recently projected. Even recent model projections of future ice melt for Greenland by 2040 have already happened in 2007.

In the Antarctic, there is no inherent reason why the impacts of warming should follow the pattern of the Arctic Ocean. The Arctic is an ocean surrounded by land, whereas the Antarctic is a continent surrounded by ocean. Nevertheless, there has been a gradual loss

[2] Methane is another greenhouse gas. One molecule of methane captures 20 times the heat of a molecule of carbon dioxide. In the atmosphere, methane eventually will oxidize to carbon dioxide and water. This takes about 10 years.

of pack ice through the last half of the twentieth century, but a slight expansion in the past decade (as anticipated by climate models); about a 12% increase in the flow rate of 300 glaciers around the margin of Antarctica between 1993 and 2003; and a significant increase in summer snow melt in both marginal and interior areas of the ice sheet since 2005. Antarctica is a critical unknown to future projections; however, it is showing distinctive early signatures of accelerated ice release.

PROJECTION: A further 2-foot sea level rise by the end of the century, as projected in the 2001 IPCC report, would make life in south Florida very difficult for everyone. Spring high tides would be at about +5.8 feet[3]; storm surges would be higher; barrier islands, fill islands and low-lying mainland areas would be frequently flooded; salt water intrusion would restrict available freshwater resources; drainage would be more sluggish; Turkey Point would be an offshore island; and so on.

Unfortunately, it looks as though sea level in the coming century will rise significantly more than two feet. With what is happening in the Arctic and Greenland, many respected scientists[4] now see a likely sea level rise of **at least** 1.5 feet in the coming 50 years and a total of **at least** 3-5 feet by the end of the century, possibly significantly more. Spring high tides would be at +7 to +9 feet. This does not take into account the possibility of a catastrophically rapid melt of land-bound ice from Greenland, and it makes no assumptions about Antarctica.

The projected rises will just be the beginning of further significant releases from Greenland and possibly Antarctica[5]. Hopefully, the IPCC will quickly revisit the question of sea level rise and provide a more valid and meaningful projection; however, to date, that is not planned until about 2012. When they revisit the current estimates, we expect it will be at least in the 3-5 foot range for this century.

Developed Miami-Dade County as we know it will significantly change with a 3-4 foot sea level rise. Spring high tides would be at about + 7 to 8 feet; freshwater resources would be gone; the Everglades would be inundated on the west side of Miami-Dade

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[3] Elevations are relative to a zero, which is 'mean lower low water' (spring low tide) when originally established in the late 1920s. This is the datum used for flood elevations in Miami-Dade County. Today, mean higher high water is +3.8 feet, exceptional tides may reach over 4.5 feet, and storm tides and surges are added on to that. For considering future sea level rise, add 3.8 feet to the projected increase for mean higher high water (average spring high tide).

[4] For example: Dr. Robert Corell, a key contributor to the IPCC and chair of the Arctic Climate Impact Assessment, said this September that there is a consensus that new data collected since the IPCC report (i.e., the last two years) shows a 'massive acceleration' in the loss of ice mass in Greenland, and the consequences are outstripping the capacity of scientific models to predict it. Dr. James Hansen, director of NASA's Goddard Institute for Space Studies, suggests that sea level could rise by one to several meters (1 meter = 3.25 feet) by the end of the century.

[5] Total melting of the Greenland ice sheet would add about 23 feet to global sea level. In Antarctica, the collapse of the West Antarctic Ice Sheet would result in another 20 feet. With the warming we have caused and will cause from greenhouse gas buildup, melting of both of these is a distinct possibility in the future. During the previous interglacial period 130,000 to 120,000 years ago, sea level was about 25 feet higher than present.

Were the ice on Antarctica to totally melt, sea level would rise over 200 feet, but that seems unlikely.

County; the barrier islands would be largely inundated; storm surges would be devastating; landfill sites would be exposed to erosion contaminating marine and coastal environments. With a five foot rise (spring tides at nearly +9 feet), Miami-Dade County will be extremely diminished.

REALITY FOR OUR FUTURE: Miami-Dade County, like all other coastal and low-lying counties, is now facing much more challenging decisions than ever imagined. We will work to provide more carefully documented projections, but we hope you see the urgency of reconsidering nearly every aspect of the county's management, zoning, infrastructure, and planning.

One urgent effort is to look at what Miami-Dade County will need to do to remain inhabitable and functional at benchmarks of a further 1, 2, 3, 4 and 5 foot rise in sea level – and at what point portions of the county will need to yield to the rising sea. This will require a detailed documentation of the elevations of infrastructure elements and roadways; susceptibility of coastal, wetland and artificial fill areas to erosion; defining areas of potential pollution and contamination release; determining changing drainage and storm surge risks; assessing structural viability of buildings and levees with changing groundwater levels and saline water intrusion; looking at the future of fresh potable water sources; defining the modifications necessary to maintain connectivity of roadways; and many other aspects.

It should be pointed out that the highly porous limestone and sand substrate of Miami-Dade County (which at present permits excellent drainage) will limit the effectiveness of widespread use of levees and dikes to wall off the encroaching sea.

Respectfully submitted,
Science and Technology Committee[6]

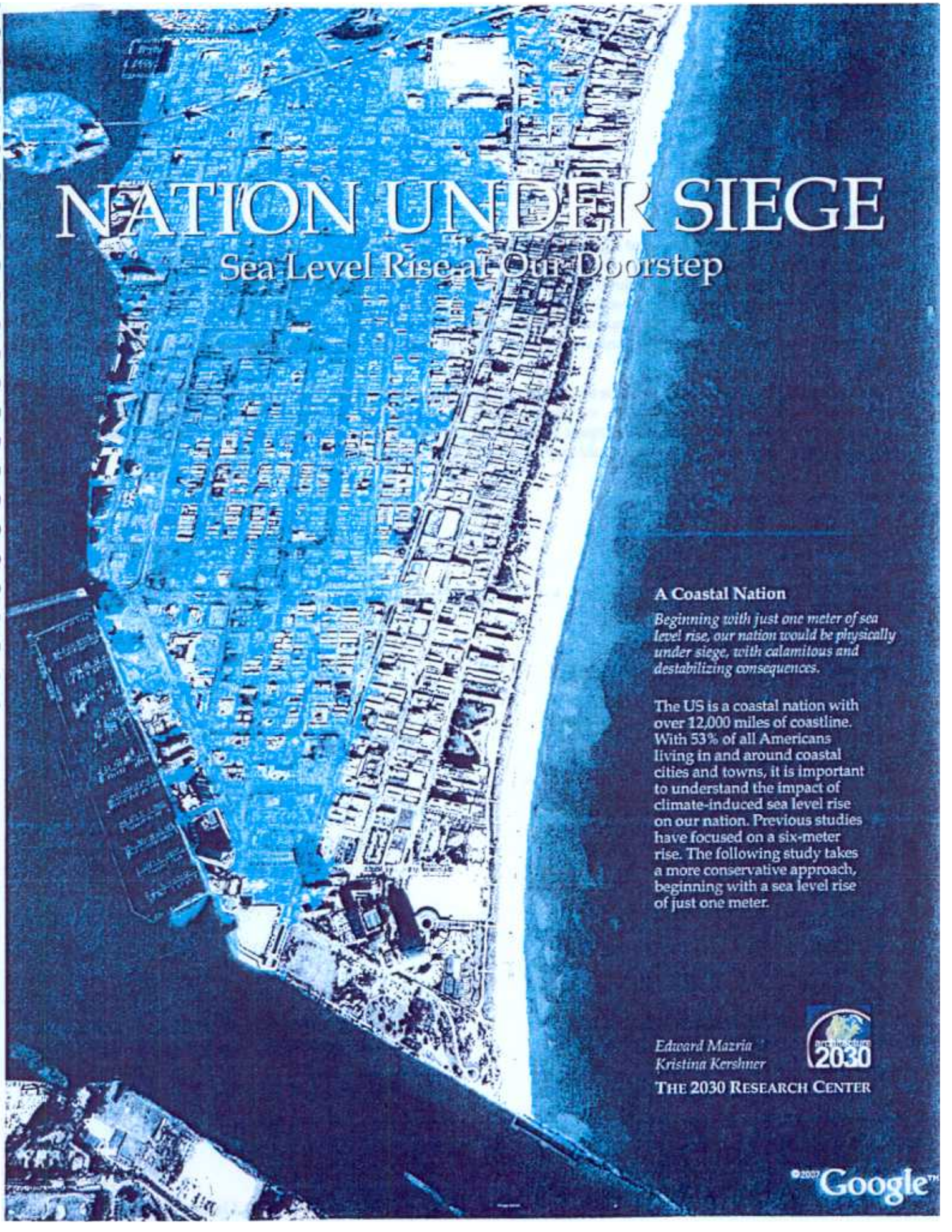
Co-Chairs

Dr. Harold R. Wanless	University of Miami, sedimentology, coastal processes
Dr. Stephen Leatherman	Florida International University, sedimentology and coastal processes

Committee Members

Dr. John R. Bethea	Community Consultant, conflict resolution and public policy
Dr. Adriana Cantillo,	Scientist, chemistry
Ms. Diana Cornley	Miami-Dade County, coastal ecosystem restoration
Dr. Will Drennan	University of Miami, ocean-atmosphere interaction
Dr. David Enfield	Scientist, climate variability
Mr. Peter Harlem	Florida International Univ., sedimentologist, wetlands ecologist
Dr. James S. Klaus	University of Miami, coral reef paleoecologist
Mr. Orestes Lavassas	South Florida Biodiesel, renewable energy
Dr. John F. Meeder	Florida International Univ., sedimentologist, wetlands ecologist
Dr. Georgio Tachiev	Florida international University, hydrology, water resources
Dr. John Van Leer	University of Miami, physical oceanography
Mr. Doug Yoder	Miami- Dade County

[6] All members of the committee have worked together to develop this statement, and all have signed on.



NATION UNDER SIEGE

Sea Level Rise at Our Doorstep

A Coastal Nation

Beginning with just one meter of sea level rise, our nation would be physically under siege, with calamitous and destabilizing consequences.

The US is a coastal nation with over 12,000 miles of coastline. With 53% of all Americans living in and around coastal cities and towns, it is important to understand the impact of climate-induced sea level rise on our nation. Previous studies have focused on a six-meter rise. The following study takes a more conservative approach, beginning with a sea level rise of just one meter.

Edward Mazria
Kristina Kershner
THE 2030 RESEARCH CENTER

Forward

We are at the crossroads of the most significant crisis of modern times. Two profound, life changing events are converging to create this crisis - the warming of the earth's atmosphere by burning fossil fuels, and the rapid depletion of global petroleum and natural gas reserves. We have all heard about the alarming planetary events that will occur if we fail to take decisive action to dramatically reduce greenhouse gas emissions, from species extinction and intensified weather events, to food and water shortages and rising sea levels. What we have failed to acknowledge is the severity with which this crisis will impact the United States.

Architecture 2030's mission is to examine the Building Sector, the single largest contributor to global warming, to construct and offer real, achievable, measurable solutions to the climate change crisis. Therefore, this study begins with a sober look at the impact of sea level rise on the US, and then provides a two-pronged solution that, if begun immediately, would avert dangerous climate change.

Edward Mazria
Executive Director
2030, Inc. / Architecture 2030

NEW ORLEANS, LOUISIANA - 1-meter sea level rise
Population: Unknown Data Source: USGS 10M NED

Sea Level Rise

In order to accurately determine sea level rise along the US coast, base maps were constructed using United States Geological Survey - National Elevation Datasets (NED) for selected areas of interest. The NED is a seamless raster dataset of US elevations. Within the NED, the US is divided into 10 meter-by-10 meter squares, whose elevations correspond to the average elevation within a square. The NED is a compilation of elevation data from many sources, including LIDAR and USGS digital elevation models.

The Sea Level datum within the NED does not necessarily coincide with local mean sea level (MSL) along the US coastline. The elevations in the NED are based on the North American Vertical Datum, 1988 (NAVD88). The NAVD88 fixes Sea Level (zero elevation) at a particular point in Quebec, Canada. All US elevations within the NED are calculated relative to that zero point (adjusted for the curvature of the earth). For most purposes, the NAVD88 represents an acceptable standard for deciding elevations above Sea Level. Along a coastline, however, the level of the sea does not everywhere correspond to zero on the NAVD88. A correction was applied to the NED to bring it in line with actual local tidal conditions.

Once corrected sea levels were established, a flood-fill algorithm was used to determine contiguous inland access from the coastline for increased sea levels. For each area studied, the land-water edge, based on corrected sea level, was determined. The algorithm used this edge as the starting point of the flood-fill and moved inland. From each flooded point, the algorithm selected neighboring pixels that were at, or below, the corrected sea level. The algorithm continued from these neighboring points until no new points were selected.

Flood maps generated using the flood-fill algorithm were then superimposed over Google Earth images to illustrate in detail how localities will be flooded on a calm, rain-free day at high tide at various increments of sea level rise [7].

Visual Imaging

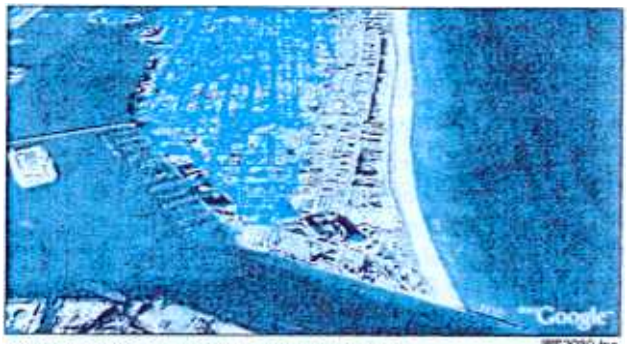
It can be difficult to visualize and grasp the implications of sea level rise. This is due in part to the way mapping is presented, i.e. as a two-dimensional image. Two-dimensional maps provide little, if any, visceral connection for the viewer. To overcome this disconnect, we chose to present our data in a familiar format, that of looking out an airplane window at a city or town when making the approach for landing. By illustrating sea level rise mapping as an aerial, three-dimensional snapshot of a city or town, the images take on a sense of familiarity and immediacy, and by connection, gives the viewer a more realistic understanding of the physical impacts of sea level rise.

With a business-as-usual approach, where fossil-fuel consumption and GHG emissions continue to increase, we will likely see a warming of 2 °C to 3 °C this century with a planetary energy imbalance sufficient to melt enough ice to raise sea level by several meters.

HOLLYWOOD, FLORIDA
Population: 139,357

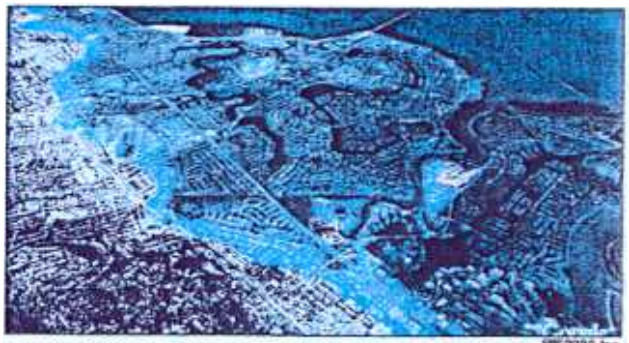
HOLLYWOOD, FLORIDA - 1-meter sea level rise
Population: 139,357 Data Source: LIDAR and USGS 10M NED

MIAMI BEACH, FLORIDA
Population: 87,933

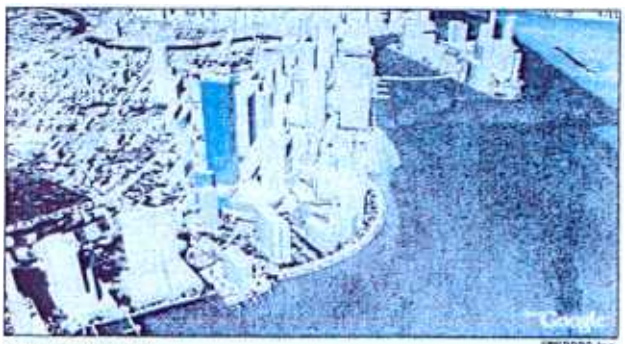


MIAMI BEACH, FLORIDA - 1-meter sea level rise
Population: 87,933 Data Source: LIDAR IHRCS

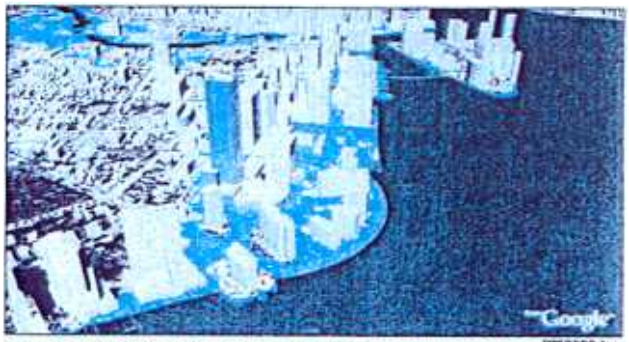
FOSTER CITY, CALIFORNIA
Population: 23,803



FOSTER CITY, CALIFORNIA - 1.25-meter sea level rise
Population: 23,803 Data Source: LIDAR 2M BCDC (USGS 10M verified)



MIAMI, FLORIDA
Population: 362,470

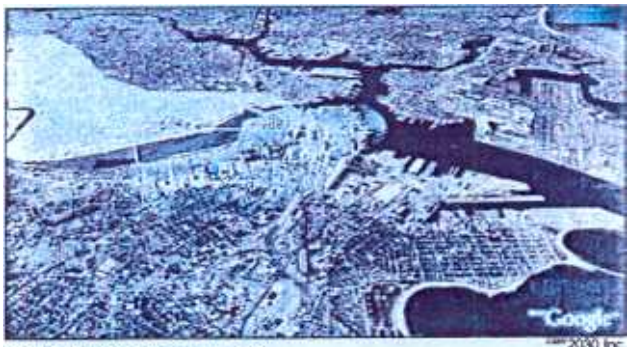


MIAMI, FLORIDA - 1.25-meter sea level rise
Population: 362,470 Data Source: LIDAR IHRCS

During the last interglacial period, 125,000 years ago, when the earth was this warm, sea level was four to six meters higher than today.

SAN FRANCISCO, CALIFORNIA
Population: 776,733

SAN FRANCISCO, CALIFORNIA - 2.25-meter sea level rise
Population: 776,733 Data Source: USGS 10M DEM



BOSTON, MASSACHUSETTS
Population: 589,141

BOSTON, MASSACHUSETTS - 3-meter sea level rise
Population: 589,141 Data Source: LIDAR and USGS 10M NED

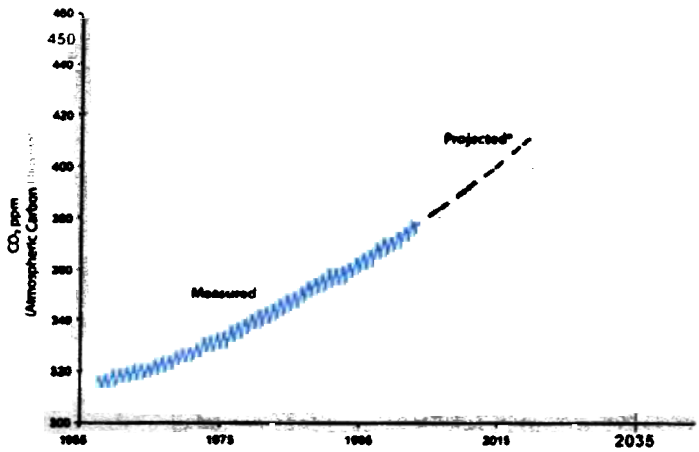
BOSTON, MASSACHUSETTS - 5-meter sea level rise
Population: 589,141 Data Source: LIDAR and USGS 10M NED

irreversible glacial melt and sea level rise "out of humanity's control". The amount of CO_2 in the atmosphere affects our planet's temperature. With concentrations of CO_2 currently at 383 ppm, the planet is now approximately 0.8 °C warmer than pre-industrial levels. Concentrations of 450 ppm corresponds to approximately 2 °C global warming above pre-industrial levels [8].

Timeline

Atmospheric concentrations of CO_2 are increasing at 2 ppm each year [9]. At this growth rate, we will reach 450 ppm in 2035.

Continued growth of CO_2-producing infrastructure and emissions for another 10 years will make it impractical, and most likely impossible, to avert exceeding this threshold [10].



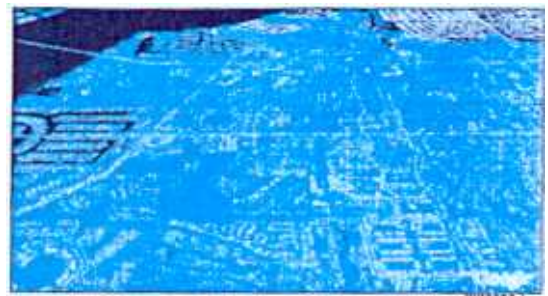
ATMOSPHERIC CO_2 TREND

Source: Adapted from Scripps Institution of Oceanography and National Oceanic and Atmospheric Administration
*1958-1974 Scripps Institution of Oceanography
1974-2008 National Oceanic and Atmospheric Administration
*2009-2035 2030, Inc. Projected trend based on Atmospheric CO_2 as measured at Mauna Loa Observatory

Fossil Fuels and Climate Change

During the "fossil fuel era", from ca. 1750 to the present, enough coal, oil and natural gas have been burned to increase CO_2 concentrations in the atmosphere from 260 ppm to 383 ppm. We are now reaching the peak in global oil production (US oil production peaked in 1970, natural gas in 1973). The global static lifetime of conventional oil is approx. 40 years, natural gas 60 years. As oil and gas peak their price will increase dramatically and alternatives will become more economically attractive. Oil and gas consumption will decline after the peak, being consumed more sparingly with their depletion rate stretching out over many years.

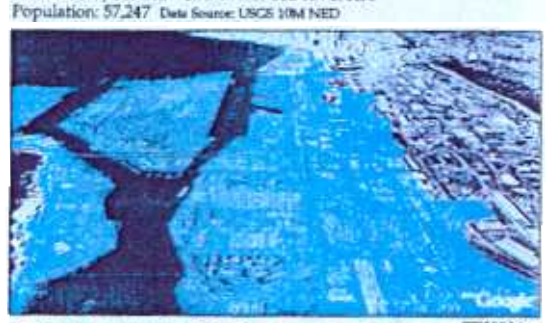
Because it is plentiful and inexpensive, the current trend is to meet the projected and increasing global demand for energy with coal. The US alone has 151 new conventional coal plants in various stages of development [11]. Globally, at least one new conventional coal-fired power plant is being added each week.



CYPRESS LAKE, FLORIDA - 1.25-meter sea level rise
Population: 12,072 Data Source: USGS 10M NED

NAPLES, FLORIDA - 1.5-meter sea level rise
Population: 66,878 Data Source: USGS 10M NED

FREEPORT, TEXAS - 1.75-meter sea level rise
Population: 57,247 Data Source: USGS 10M NED



SEATTLE, WASHINGTON - 3-meter sea level rise
Population: 563,374 Data Source: USGS 10M NED (LIDAR VERIFIED)

MARINA DEL REY, CALIFORNIA - 5-meter sea level rise
Population: 84,084 Data Source: USGS 10M NED