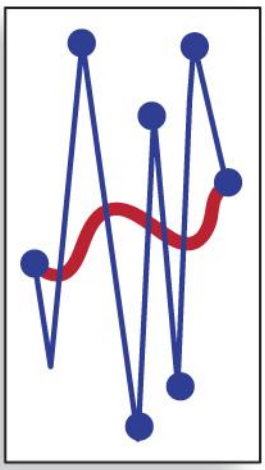

Climate Science & Services

Coastal Applications for Decision Making through Sea Grant Extension and Outreach

Examples of Existing Climate Decision-Support Resources for Potential Application in Coastal Extension and Decision Making

Examples of Existing Climate Decision-Support Resources for Potential Application in Coastal Extension and Decision Making

Prepared for the Workshop on Climate Science and Services: Coastal Applications for Decision Making through Sea Grant Extension and Outreach

NOAA Coastal Services Center • Charleston, South Carolina
April 10 to 12, 2007

This handbook was created to complement the materials and concepts discussed during the Workshop on Climate Science and Services: Coastal Applications for Decision Making through Sea Grant Extension and Outreach. It was designed to help you start exploring the range of climate information, products, tools, and technical expertise available online and in print. Inside you will find a variety of resources identified by workshop presenters, the National Oceanic and Atmospheric Administration, and other climate science professionals as those that can add value to your coastal extension activities. Programmatic activities related to hazards, ecosystems, urban planning and development, fisheries, and so on can all benefit from the incorporation of climate science data.

We anticipate that this handbook is the beginning of what will be a more comprehensive resource guide containing specific examples of the current state of our understanding of climate variability and change, including impacts and potential applications, additional decision-support materials, and products and training information related to climate impacts and adaptation methodologies.

It is our hope that as participants in this workshop you will be able to use the resources contained herein and evaluate how they may impact your policies, procedures, and mitigation strategies for climate change impacts. It is important to note that we have not conducted a systematic and independent quality-control process of the resources provided in this handbook, nor is the information comprehensive; rather we are providing examples of the types of products and information that that are currently available to help Sea Grant extension agents consider their approach to climate.

We wish to thank the following sponsors for making this workshop and handbook possible: NOAA Climate Program Office, NOAA Coastal Services Center, NOAA National Sea Grant Office, and the Sea Grant Assembly of Extension Program Leaders.

Disclaimer: The National Oceanic and Atmospheric Administration (NOAA) does not endorse the resources contained within this handbook. This handbook is intended to serve as a sample collection of existing climate science resources, and any conclusions or opinions expressed in these resources are strictly those of the host organizations and not NOAA.

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Tools

Alaska

Climate Change Overview

The Intergovernmental Panel on Climate Change (IPCC)

www.ipcc.ch

Established by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), the IPCC consists of a Task Force on National Greenhouse Gas Inventories and three working groups. These working groups assess

- the scientific aspects of the climate system and of climate change;
- vulnerability of socio-economic and natural systems to climate change, the negative and positive consequences of climate change, and options for adapting to them; and
- options for limiting greenhouse gas emissions and otherwise mitigating climate change.

IPCC publications include special reports, methodology reports, and technical papers written by teams of experts selected from universities, research centers, and business and environmental associations. Examples of publications include the following:

- *The Regional Impacts of Climate Change (1997)*
- *Land Use, Land-Use Change and Forestry (2000)*
- *Climate Change and Biodiversity (2002)*
- A Technical Paper on Climate Change and Water is to be completed in late 2007

The page www.ipcc.ch/about/faq.htm is a good starting place for exploring this Web resource because it contains direct links to the following information sections:

- Where do I find out about the scientific basis for climate change?
- Where do I find out about climate impacts, adaptation and vulnerability?
- Where do I find out about climate change mitigation?
- Where do I find a synthesis of the latest findings on climate change?
- Where do I find out more specific information about:
    - emission scenarios
    - regional impacts of climate change
    - land use, land-use change, and forestry
    - methodological and technological issues in technology transfer
    - aviation and the global atmosphere

Climate Change 2007: The Physical Science Basis: Summary for Policymakers

Author or Publisher: Intergovernmental Panel on Climate Change (IPCC)
www.ipcc.ch/SPM2feb07.pdf (PDF – 18 pages)

This summary document, a part of the *Fourth Assessment Report of the UN Intergovernmental Panel on Climate Change*, describes the progress that has been made since the *Third Assessment Report* (2001) in understanding human and natural drivers of climate change. It makes the following declarations:

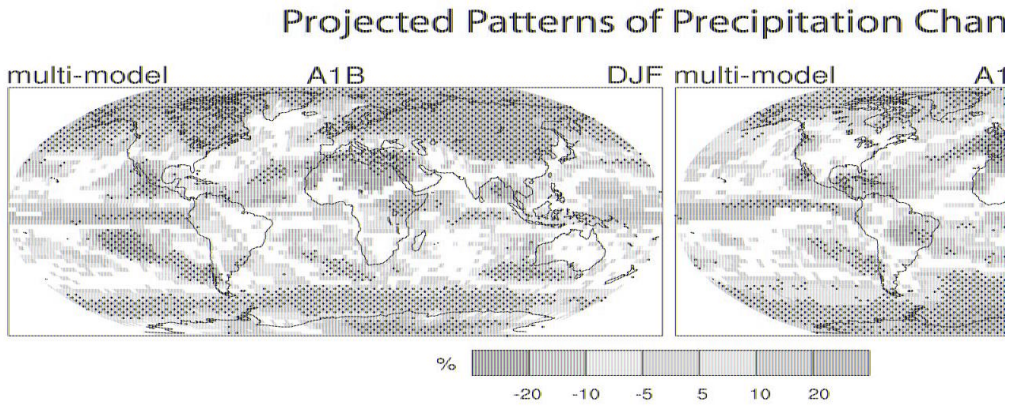
> "Warming of the climate system is unequivocal"
> "Most of the observed increase in globally averaged temperatures since the mid-20th century is very likely due to the observed increase in anthropogenic greenhouse gas concentrations."

Summaries of the document sections are below:

- **Human and Natural Drivers of Climate Change**
  Discusses changes in levels of greenhouse gases and aerosols in terms of radiative forcing, the rate at which energy is being added to the system
- **Direct Observations of Recent Climate Change**
  Discusses improvements in data sets and analysis used in observation and measurements of glaciers, snow cover, sea level, and ice sheets
- **A Paleoclimatic Perspective**
  Briefly overviews the utility and uncertainties of studies using proxy data (such as tree ring width) to infer past changes in global climate
- **Understanding and Attributing Climate Change**
  Considers that improvements in the simulation of many aspects of climate and its variability have furthered climate studies since the IPCC's *Third Assessment Report*
- **Projections of Future Changes in Climate**
  Provides scenarios and model experiments for projecting climate

This resource can be used as a reference for some commonly asked questions and can be used to ascertain what the role of a specific variable may play in future impacts (such as gas emissions, human activity, burning biofuels, etc.).

While some of the discussions are fairly technical, charts, graphs, and maps help provide basic understanding of concepts. An example map is below:



U.S. Climate Change Science Program

www.climatescience.gov

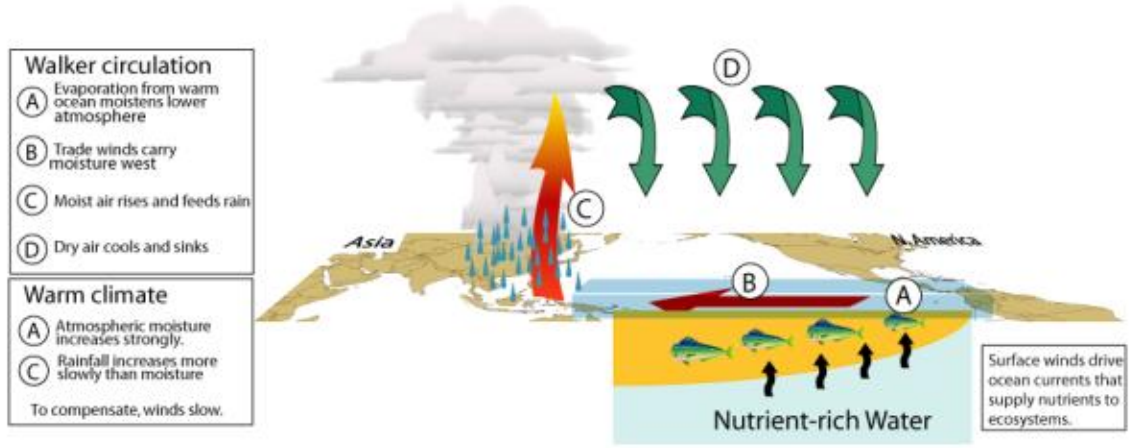
The Climate Change Science Program (CCSP) integrates federal research on climate and global change, as sponsored by 13 federal agencies and overseen by the Office of Science and Technology Policy, the Council on Environmental Quality, the National Economic Council, and the Office of Management and Budget.

CCSP plans to create over 20 assessment reports based on the following goals:

- Improve knowledge of the Earth's past and present climate and environment, including its natural variability, and improve understanding of the causes of observed variability and change.
- Improve quantification of the forces bringing about changes in the Earth's climate and related systems.
- Reduce uncertainty in projections of how the Earth's climate and related systems may change in the future.
- Understand the sensitivity and adaptability of different natural and managed ecosystems and human systems to climate and related global changes.
- Explore the uses and identify the limits of evolving knowledge to manage risks and opportunities related to climate variability and change.

This site also links to the **NOAA GFDL [Geophysical Fluid Dynamics Laboratory] Climate Research Highlights: Summaries, Graphics and Animations** page at www.gfdl.noaa.gov/research/climate/highlights/

Included in this resource are several reports and graphics that explain climate processes. An example graphic is below:



NOAA NCDC Global Warming: Frequently Asked Questions

www.ncdc.noaa.gov/oa/climate/globalwarming.html

This page is based on a brief synopsis of the 2001 report by the Intergovernmental Panel on Climate Change (IPCC) and the National Research Council's 2001 report, *Climate Change Science: An Analysis of Some Key Questions*, as well as the National Climatic Data Center's (NCDC) own data resources. The site addresses the following questions:

- What is the greenhouse effect, and is it affecting our climate?
- Are greenhouse gases increasing?
- Is the climate warming?
- Are El Niños related to Global Warming?
- Is the hydrological cycle (evaporation and precipitation) changing?
- Is the atmospheric/oceanic circulation changing?
- Is the climate becoming more variable or extreme?
- How important are these changes in a longer-term context?
- Is sea level rising?
- Can the observed changes be explained by natural variability?
- What about the future?
- Additional Information

A representative text sample from the frequently asked questions is below:

> **Are El Niños related to Global Warming?**
> El Niños are not caused by global warming. Clear evidence exists from a variety of sources (including archaeological studies) that El Niños have been present for hundreds, and some indicators suggest maybe millions, of years. However, it has been hypothesized that warmer global sea surface temperatures can enhance the El Niño phenomenon, and it is also true that El Niños have been more frequent and intense in recent decades. Recent climate model results that simulate the 21st century with increased greenhouse gases suggest that El Niño-like sea surface temperature patterns in the tropical Pacific are likely to be more persistent.

Partner Programs

NOAA Climate Program Office Regional Integrated Sciences and Assessments (RISA)

www.climate.noaa.gov/cpo_pa/risa/

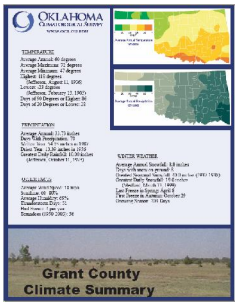
The RISA program supports research that addresses complex climate-sensitive issues of concern to decision-makers and policy planners at a regional level. The RISA research team members are primarily based at universities, though some of the team members are based at government research facilities, nonprofit organizations, or private sector entities. Traditionally the research has focused on fisheries, water, wildfire, and agriculture. The program also supports research into climate-sensitive public health issues and coastal restoration. RISA locations include the following:

- Alaska Center for Climate Assessment and Policy (ACCAP)
- California Applications Program (CAP)
- Carolinas Integrated Sciences and Assessments (CISA)
- Climate Assessment of the Southwest (CLIMAS)
- Pacific RISA
- Climate Impacts Group (CIG)
- Southeastern Climate Consortium (SECC)
- Western Water Assessment (WWA)

Oklahoma Climate Data from the Oklahoma Climatological Survey

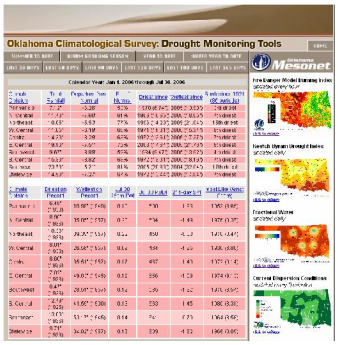
http://climate.ocs.ou.edu

The Oklahoma Climatological Survey (OCS) provided the following information to demonstrate the types of information your state climate office may be able to provide.

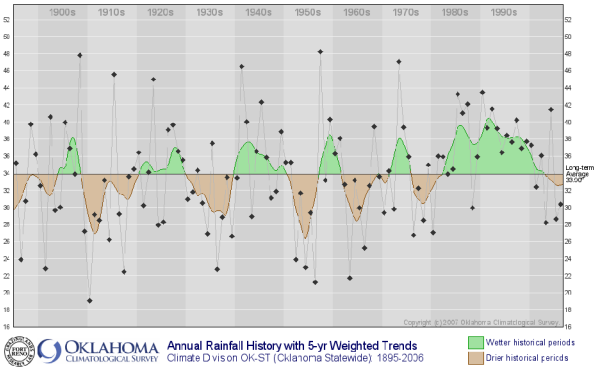


County Climate Summaries – Developed in collaboration with Natural Resources Conservation Service field offices. Each county in Oklahoma has a "quickfacts" summary, a detailed written description of the county's climate, and tables of climate means and extremes. Data include probable ranges of temperature and precipitation, freeze/frost information, prevailing wind sped and direction, humidity, soil temperatures, history of significant tornadoes, and further information.

Rainfall and Drought Update – Summary of precipitation totals and departures from normal by climate division with maps for 'drilling down' to finer resolution. Real-time data from the Oklahoma Mesonet are combined with historical cooperative observer data to provide context to what is occurring now. The maps and tables, which are available for periods ranging from 30 days to one year, are updated automatically each morning. It is a key resource for state water managers, media, and Drought Monitor authors, who have provided input into its development.



Climate Trends – Developed by the U.S. Department of Agriculture's Agricultural Research Service Grazinglands Research Laboratory (El Reno, OK) and implemented operationally by OCS. The graphs provide annual temperature and precipitation with a five-year smoothed, filled chart that highlights periods of wet/dry and warm/cold. It is an excellent tool for generating interest by senior decision-makers, as well as the media and the public.



For further information on these products, including guidance on receiving similar information for your state, contact

Mark Shafer
Director of Climate Services
Oklahoma Climatological Survey
2900 David L. Boren Blvd, Suite 2900
Norman, OK 73072
mshafer@ou.edu; (405) 325-3044

Risk and Vulnerability

U.S. Geological Survey Sea-Level Rise Vulnerability Resources

http://coastal.er.usgs.gov/national-assessment

National Assessment of Coastal Vulnerability to Sea-Level Rise

http://woodshole.er.usgs.gov/project-pages/cvi/

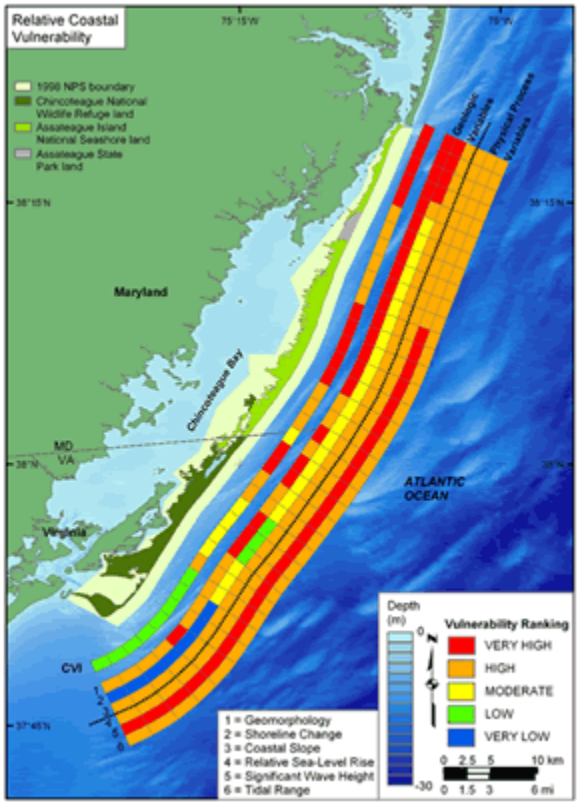
This site contains a set of reports, created from 1999 to 2000, highlighting areas that may be most vulnerable to the effects of sea-level rise in the next 50 to 100 years. The analyses utilize a coastal vulnerability index (CVI) that takes into account coastal systems' susceptibility to change and their natural ability to adapt to changing environmental conditions. Each report contains the following sections:

- Risk Variables
- Data Ranking
- Coastal Vulnerability Index (CVI)
- Results
- Discussion
- Summary
- References

Relative Coastal Vulnerability Assessment of National Park Units to Sea-Level Rise

http://woodshole.er.usgs.gov/project-pages/nps-cvi/
www2.nature.nps.gov/geology/coastal/gw_slr.cfm (additional resources)

Similar to the above resource, this project uses the same CVI index to estimate vulnerabilities for national parks and contains enhanced graphical representations. An example is below:



UKCIP Tools: Climate Adaptation: Risk, Uncertainty and Decision-Making Framework

www.ukcip.org.uk/resources/tools/risk.asp

This site, a part of the United Kingdom (UK) Climate Impacts Programme, provides a step-by-step decision-making framework to help planners, businesses, and government assess the risk posed by climate change, and work out how best to respond. A series of menu links on the left side of the page point to resources related to the following:

- Adaptation Wizard
- Scenarios Gateway
- Socio-economic scenarios
- Risk, uncertainty and decision-making framework
- Costings methodology
- Database of adaptation case studies
- Identifying adaptation options

Resources Developed by the UK Government to Manage Coastal Risk Under Climate Change Future

UK Shoreline Management Plans (UK Government, Department for Environment, Food, and Rural Affairs, or DEFRA)
www.defra.gov.uk/environ/fcd/policy/smp.htm (resources are in PDF format)

This website provides information on shoreline management plans (SMP) in the United Kingdom (UK) and guidance on producing a plan. Available documents include the following:

- Volume 1 – defines an SMP and what it should include (54 pages)
- Volume 2 – provides guidance on how to produce an SMP in line with the requirements in Volume 1 (84 pages)
- Appendix A – Stakeholder engagement strategies (35 pages)
- Appendix B – Data access and management (10 pages)
- Appendix C – Socio-economic appraisal and sensitivity testing (27 pages)
- Appendix D – Shoreline interactions and response (34 pages)
- Appendix E – Open coast SMP management boundaries (56 pages)
- Appendix F – Integration of estuaries (74 pages)
- Appendix G – Definition of issues and objectives (13 pages)
- Appendix H – Policy appraisal methodology (12 pages)
- Appendix I – SMP standard output formats (19 pages)

Flood and Coastal Defence Advice for Local Authorities from Government (DEFRA)
www.defra.gov.uk/environ/fcd/pubs/pagn/climatechangeupdate.pdf (PDF – 9 pages)

Climate Change: Counting the Cost at the Coast
www.tyndall.ac.uk/research/theme4/countingthecost.pdf (PDF – 16 pages)

This teacher workbook is designed to teach 11- to 14-year-olds about climate change.

Sustaining the Coastal Zone
www.tyndall.ac.uk/research/theme4/theme4_workshops.shtml

This series of workshops contains detailed explanations of stakeholder engagement and wider coastal management issues.

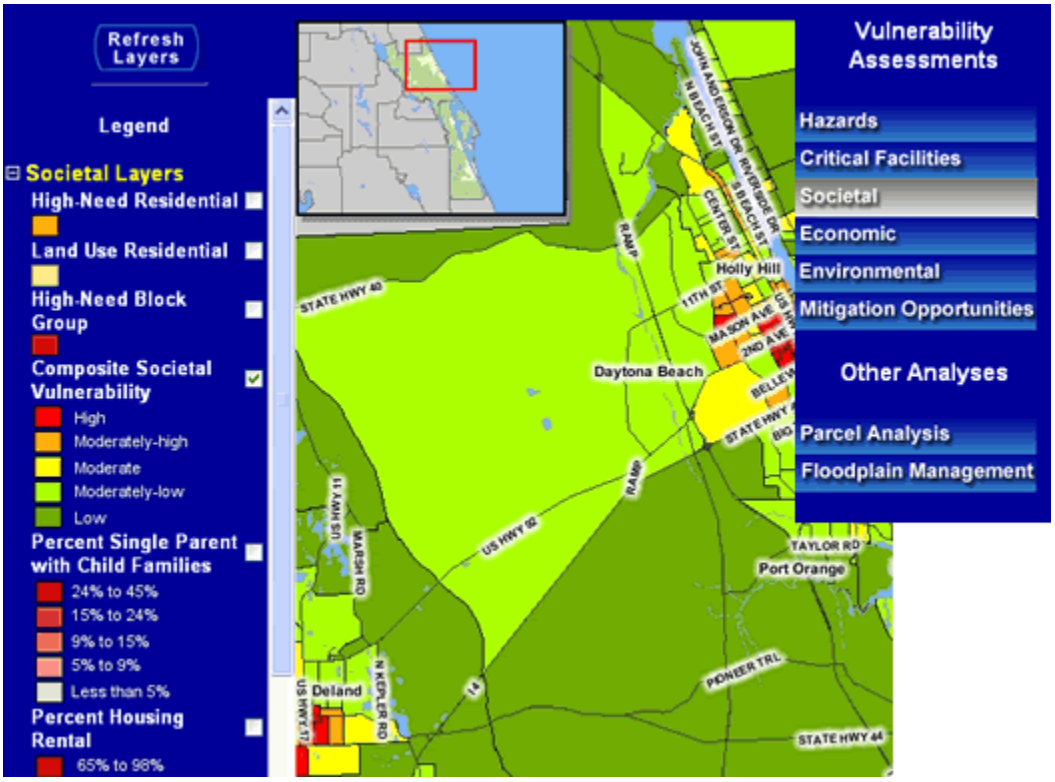
NOAA Coastal Services Center Risk and Vulnerability Assessment Tools

www.csc.noaa.gov/rva_tools/

This website provides products that can be used to determine the vulnerability of people, property, and natural resources to coastal hazards. It includes the following tools:

- **Community Vulnerability Assessment Tool** (CVAT) – An informational aid, piloted in coastal North Carolina and widely used by communities, that guides efforts to reduce hazard vulnerability.
- **Risk and Vulnerability Assessment Tool** (RVAT) – A tool that adds interactive mapping and other features to the CVAT methodology. This tool was piloted, and data exist for Brevard and Volusia Counties in Florida.
- **Vulnerability Assessment Techniques and Application**s – A website that provides information on assessments and opportunities to network with practitioners and researchers.
- **Training** – A customizable, one-day course designed to help coastal managers use CVAT to assess a community's risk and vulnerability to hazards.

Note: The RVAT tool requires your location-specific data to be used but can provide powerful analysis capabilities. A sample of the types of analysis that may be performed with the RVAT tool is captured below:



Climate Outlook and Projections

National Weather Service Climate Prediction Center (CPC)

www.cpc.ncep.noaa.gov

The CPC assesses and forecasts short-term climate variability to help in preparation for weather-related extreme events. Of special interest are the two forecast discussions listed below. These climate outlooks can be used to determine what impacts a climate anomaly may have on a region, such as cold air outbreaks during late spring, excessive heat during summer, or unusually wet or dry periods, which may lead to flooding or drought.

Prognostic Discussion for Monthly Outlook

www.cpc.ncep.noaa.gov/products/predictions/long_range/fxus07.html

This discussion provides some technical details regarding the climate forecast followed by a generalized description of climate trends for the next 30 days. See the excerpt below:

> SEA SURFACE TEMPERATURE (SST) ANOMALIES IN THE CENTRAL AND EASTERN EQUATORIAL PACIFIC HAVE STEADILY DECREASED SINCE THE BEGINNING OF THE YEAR... WITH NEGATIVE ANOMALIES OBSERVED BY THE END OF FEBRUARY AND INTO EARLY MARCH BETWEEN 140W AND 100W.
>
> PROBABILITIES FOR ABOVE NORMAL TEMPERATURES WERE REDUCED ACROSS PORTIONS OF THE NORTH-CENTRAL ROCKIES DUE TO SIGNIFICANT SNOWPACK AND THE EXPECTATION OF A PROLONGED MELTING PERIOD OF SNOW AND ICE.

Prognostic Discussion for Long-Lead Seasonal Outlooks

www.cpc.ncep.noaa.gov/products/predictions/long_range/fxus05.html

This discussion starts with a generalized summary for non-technical users, followed by separate sections on

- Current Atmospheric and Oceanic Conditions
- Prognostic Discussion of SST Forecasts
- Prognostic Tools Used For U.S. Temperature and Precipitation Outlooks
- Prognostic Discussion of Outlooks – AMJ [April-May-June] 2007 to AMJ 2008
- Temperature
- Precipitation

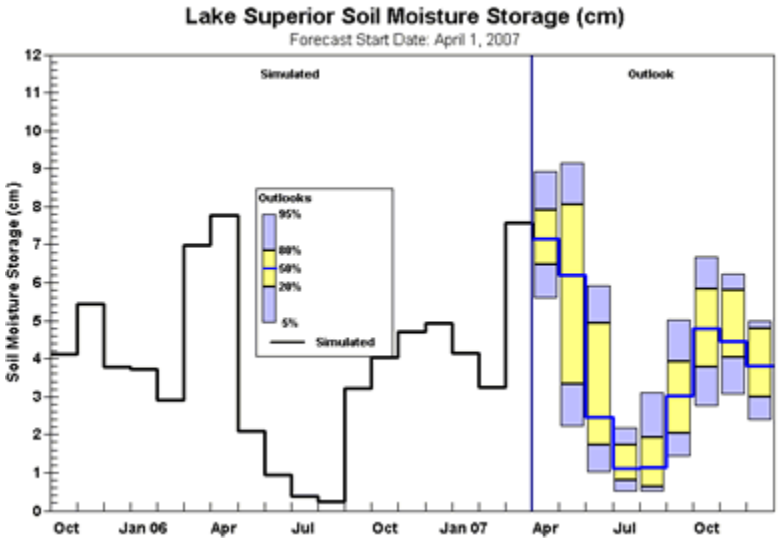
Excerpt from this document:

> EQUATORIAL SEA SURFACE TEMPERATURES (SST) IN THE PACIFIC OCEAN ARE NEAR THEIR LONG-TERM AVERAGE DURING THE MONTHLY PERIOD JUST ENDING. THE EL NINO PERIOD OF LAST WINTER CAME TO A VERY QUICK END. THE ATMOSPHERIC INDICATORS DURING THE PAST TWO MONTHS WERE ALSO CONSISTENT WITH VANISHING EL NINO CONDITIONS.

Great Lakes Water Level-Related Resources

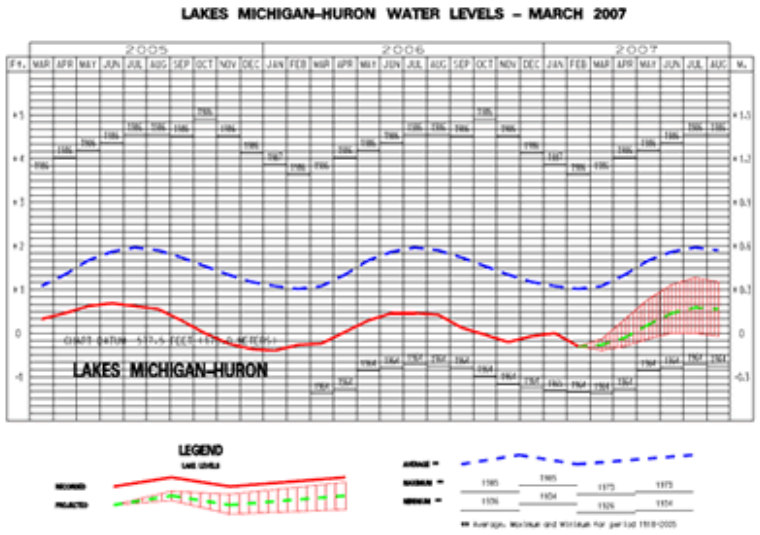
Great Lakes Advanced Hydrologic Prediction System (AHPS) Products
www.glerl.noaa.gov/wr/ahps/curfcst/

This resource provides data and forecasts for monthly values of hydrology and meteorology variables such as lake inflow, outflow, total supply, mean lake level, water surface temperature, over-lake air temperature, over-lake cloud cover, and soil moisture storage. Nine-month outlooks provide information for future conditions. A typical image from this resource is below:



Monthly Bulletin of Great Lakes Water Levels
www.lre.usace.army.mil/_kd/go.cfm?destination=page&pge_id=1135
(Note: products are in PDF format)

This page contains the official forecasts from the U.S. Army Corps of Engineers for Great Lakes water levels. While the main products of interest are the six-month forecasts for each of the Great Lakes, a menu on the left side of the Web page provides links to additional resources. An example image of the products available is below:



Climate Change in the U.S. Northeast: A Report of the Northeast Climate Impacts Assessment

Author or Publisher: Union of Concerned Scientists (UCS)
www.climatechoices.org/assets/documents/climatechoices/NECIA_climate_report_final.pdf (46 page PDF)

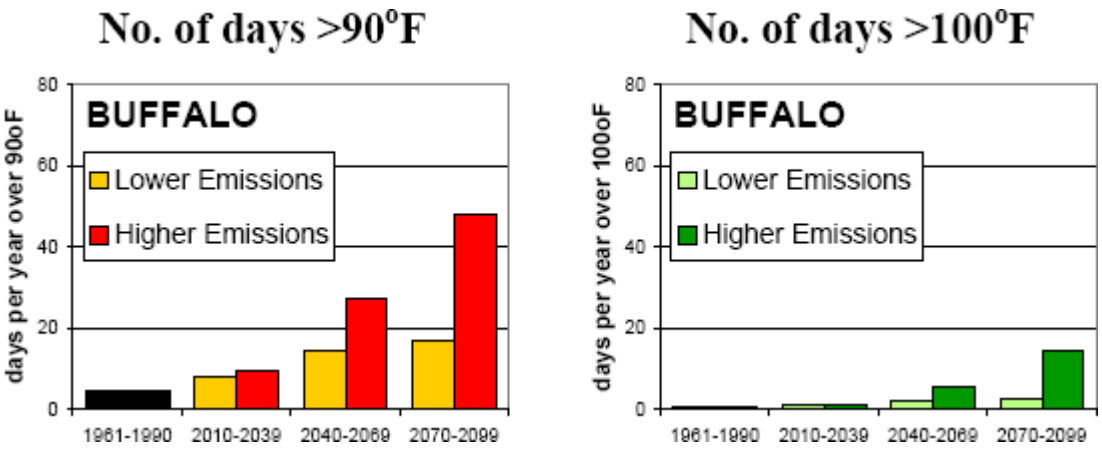
A summary of the above document is available at
www.climatechoices.org/assets/documents/climatechoices/The-Changing-Northeast-Climate.pdf (8 page PDF)

Main Web page is at http://northeastclimateimpacts.org

This resource was developed by UCS and a team of independent experts to develop and communicate a new assessment of climate change and associated impacts on key climate-sensitive sectors in the northeastern U.S. Using projections from three state-of-the-art global climate models, researchers compared the types and magnitude of climate changes that will result from higher versus lower further emissions of heat-trapping gases. The resource is designed to provide analysis and materials to be used in outreach efforts. It contains the following chapters:

- **Chapter 1: Climate Change in the Northeast: An Introduction**
- **Chapter 2: Data Sources and Model Projections**
- **Chapter 3: The Changing Northeast Climate: Current and Future**
- **Chapter 4: Confronting Climate Change in the Northeast**

This can be used as an aid in teaching and learning about the potential impacts of climate change while addressing the many "what if" questions that are commonly asked about climate change. An example graphic from this document is below:



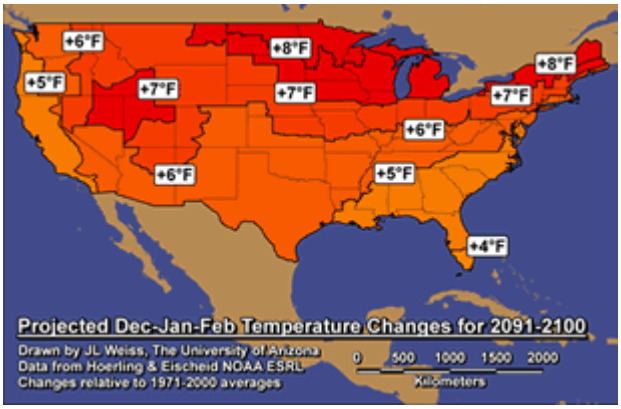
Climate Change Projections for the United States

www.geo.arizona.edu/dgesl/research/regional/projected_US_climate_change/projected_US_climate_change.htm

This set of maps shows projections for climate change in the conterminous (contiguous) United States during the years 2091 to 2100, broken into three periods:

- December through February
- June through August
- Annual

An example image is shown below:

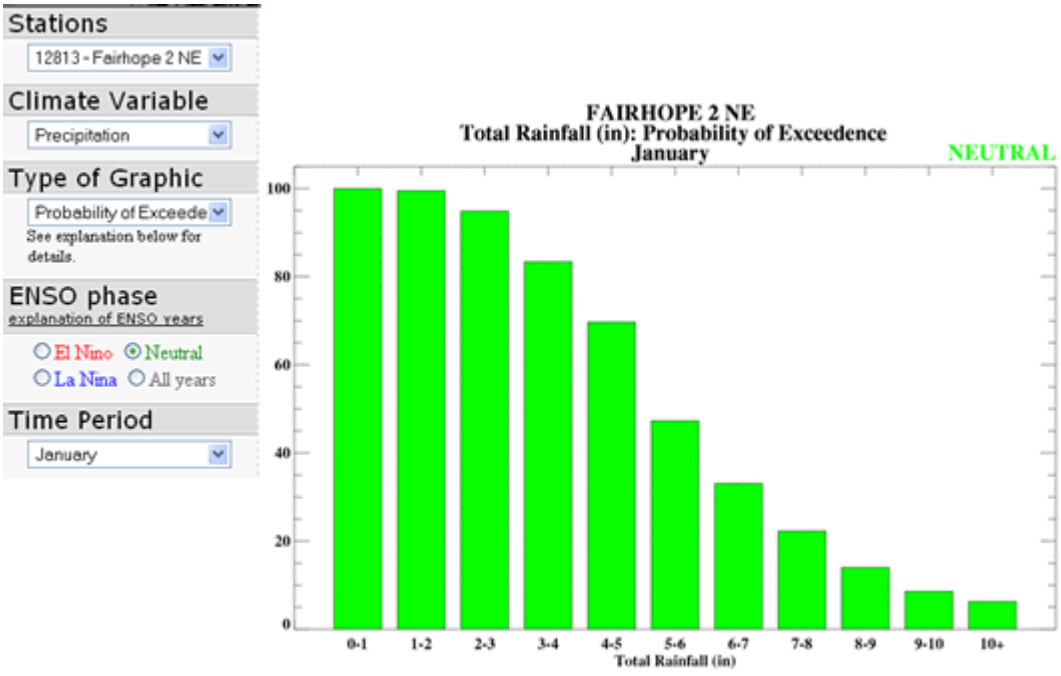


Data

Southeast Coastal Climate: Information for Recreational and Commercial Fisheries, Along with Other Coastal Interests

www.coastalclimate.org

Southeast Coastal Climate is a set of interactive geographic information system (GIS) decision-support tools that allow users to explore climatological information for terrestrial and marine locations within 100 kilometers of the coast from North Carolina to the Alabama/Florida border. The tool provides resources on climate variability linked the El Niño Southern Oscillation (ENSO), which has a great impact on the region. Information on coastal tides and climatologies of land-falling hurricanes along the coast are also presented. An example graphic generated from the interactive mapping tool is below:



The applications on Coastal Climate are currently being used by commercial and recreational fishers, emergency managers, scientific researchers, local chambers of commerce, and tourists for the following:

- Economic development
- Environmental management
- Education
- Hazard Mitigation

Contacts:

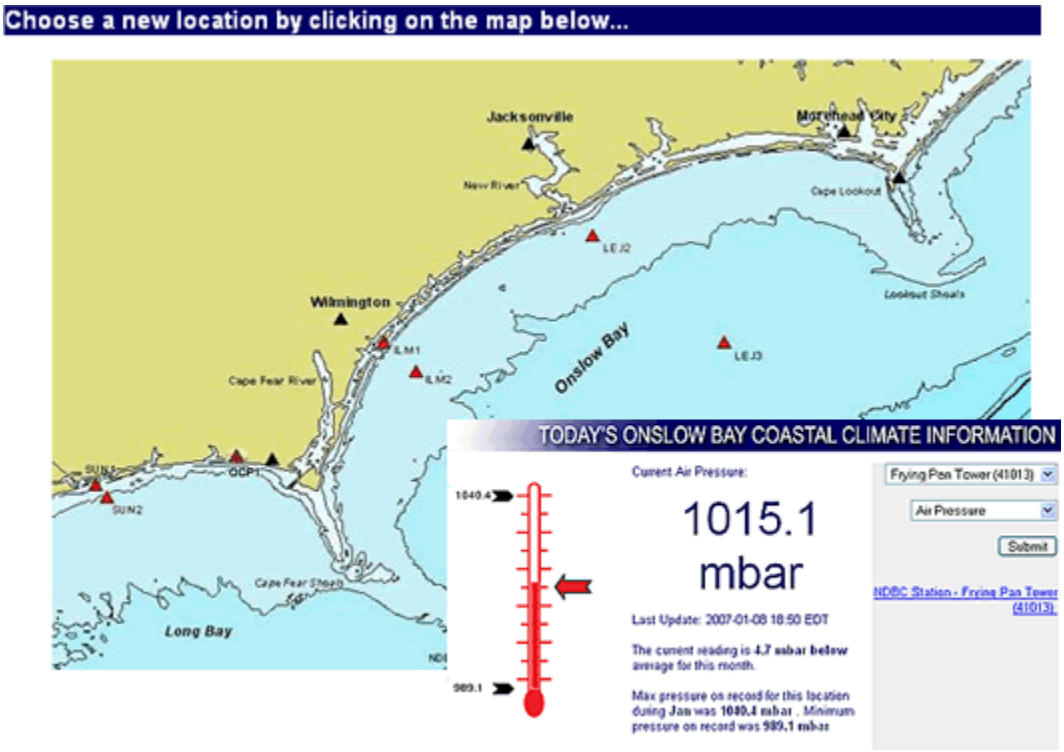
Dr. David Stooksbury, University of Georgia, stooks@engr.uga.edu
Melissa L. Griffin, Florida State University, griffin@coaps.fsu.edu

Coastal Climatology: Onslow Bay (North Carolina) Coastal Climate Information

http://cormp.org/climate/index.html

This site describes the coastal climatology of Onslow Bay and is of particular interest for individuals involved in tourism and recreation in the Wilmington through Morehead City, North Carolina coasts.

The two main sources of climate data for Onslow Bay are the Wilmington Airport and the Frying Pan shoals oceanographic buoy. Data available from these two stations and incorporated in this website include air temperature, water temperature, wave height, wind speed and wind direction, atmospheric pressure, and rainfall. An example image from this page is below:

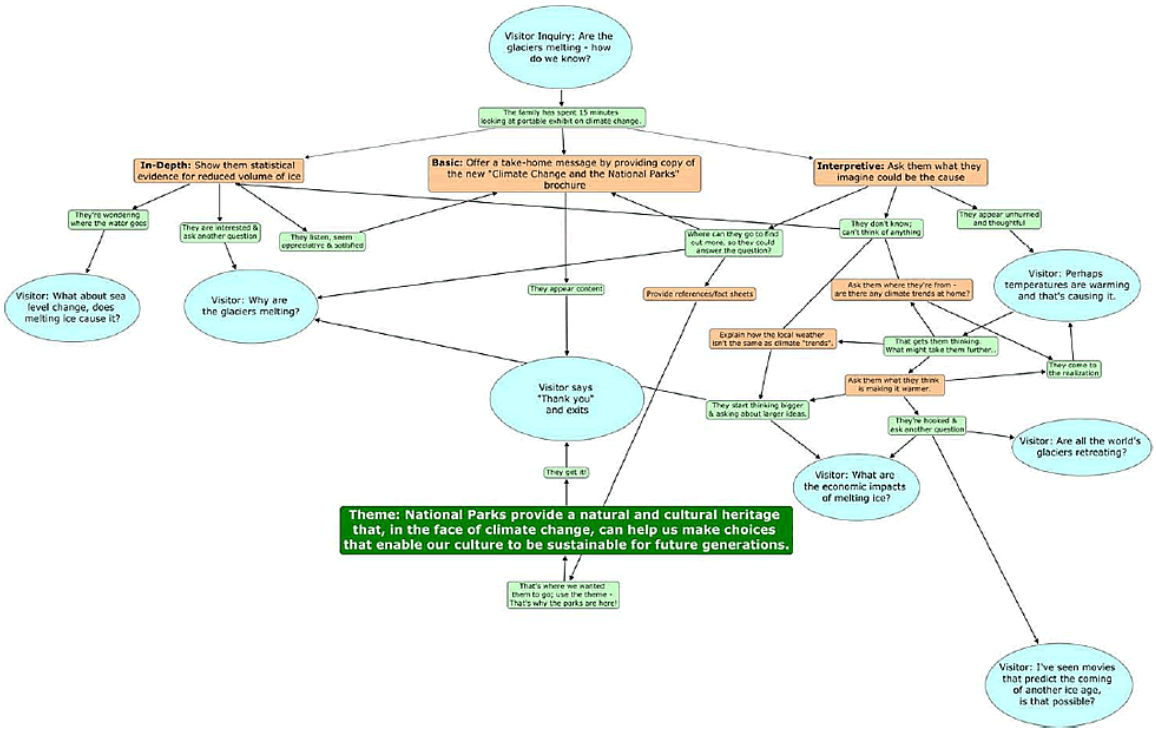


Training

Earth to Sky – Global Climate Change

www.earthtosky.org/products/globalclimatechange_main.php

A collaboration between NASA and the National Park Service (NPS), this interactive training tool provides in-depth references and appropriate techniques for explaining climate change and its implications. A 34-page PDF provides a concept model for dealing with questions regarding climate and includes several decision-tree models like the following (image reduced in size to fit page):



This tool will also include a database of questions that visitors to national parks are asking. These questions and responses will be grouped into the following sections:

- Global warming at unprecedented rate
- Melting ice has worldwide implications
- Vegetative zones are shifting
- Wildlife ranges and diversity are changing
- Coastal and marine changes bring impacts
- Wildfire frequency and duration increase
- Thawing permafrost has impacts
- Impacts to indigenous people are severe
- Atmospheric chemistry is changing
- Multiple influences combine into large impacts

AAAS-Related Climate Resources

www.aaas.org

Communicating and Learning about Global Climate Change: An Abbreviated Guide for Teaching Climate Change, from Project 2061 at AAAS

Author or Publisher: American Association for the Advancement of Science (AAAS)
www.aaas.org/news/press_room/climate_change/mtg_200702/climate_change_guide_2061.pdf
(PDF – 32 pages)

Designed for K-12 educators, this guide provides an overview of Project 2061's recommendations for the ideas and skills that are central to understanding the science of climate change, the process of scientific inquiry, and the trade-offs and constraints implicit in making choices about technology. It provides basic information on the scientific concepts that explain real-world phenomena such as rising sea levels, melting glaciers, and the increased likelihood of severe heat waves, floods, and droughts. An excerpt from this document is below:

> Depletion of energy sources can be slowed by both technical and social means. Technical means include maximizing the usefulness that we realize from a given input of energy by means of good design of the transformation device, by means of insulation where we want to restrict heat flow (for example, insulating hot-water tanks), or by doing something with the heat as it leaks out. Social means include government, which may restrict low-priority uses of energy or may establish requirements for efficiency (such as in automobile engines) or for insulation (as in house construction). Individuals also may make energy efficiency a consideration in their own choice and use of technology (for example, turning out lights and driving high-efficiency cars)—either to conserve energy as a matter of principle or to reduce their personal long-term expenses. As always, there are trade-offs. For example, better-insulated houses stay warmer in winter and cooler in summer, but restrict ventilation and thus may increase the indoor accumulation of pollutants.

This resource can be used to demonstrate the scientific method to non-scientists, and to outline the advantages and disadvantages of incorporating technology into complex and interrelated factors for decision making.

Communicating and Learning About Global Climate Change: An Event for Teachers, Students, and Other Communicators and Learners
www.aaas.org/news/press_room/climate_change/mtg_200702/

This section of the American Association for the Advancement of Science (AAAS) website contains the video presentations, PowerPoint files, and papers from a Town Hall event conducted on February 7, 2007. The topics from the town hall meeting include the following:

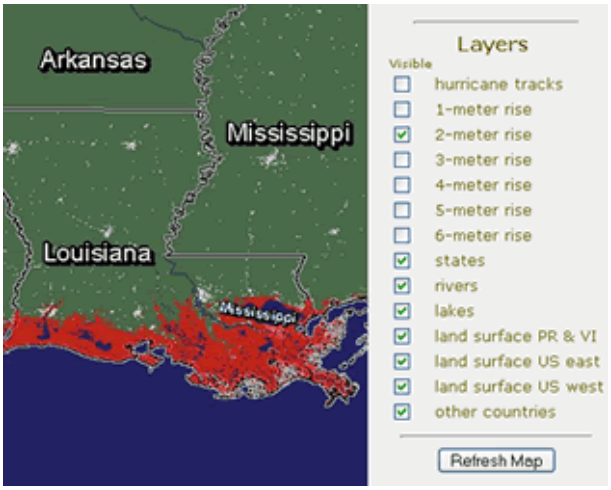
- Understanding Climate Science
- In Search of Solutions
- Profitable Climate Protection
- Cutting Carbon Emissions
- Teaching Future Innovators

Sea Level Rise

Climate Change and Sea Level Projections

www.geo.arizona.edu/dgesl/research/other/climate_change_and_sea_level/sea_level_rise/sea_level_rise.htm

This dynamic map depicts areas that may be susceptible to sea level rise from 1 to 6 meters. A sample map from the site is below:



Decision-Support Frame: A Tool for Assessing Sea Level Rise Impacts in the Baltic Sea Region

www.gtk.fi/slr/

Designed for the Baltic Sea region, this website contains an example of a decision-support framework for assessing the impacts of sea level rise. It outlines tasks and tools that are necessary to communicate and analyze data and information within a decision-support framework. Case studies include areas that face different levels of sea level rise, and also differ in coastal morphology, socio-economic structure, population density, and landscape characteristics.

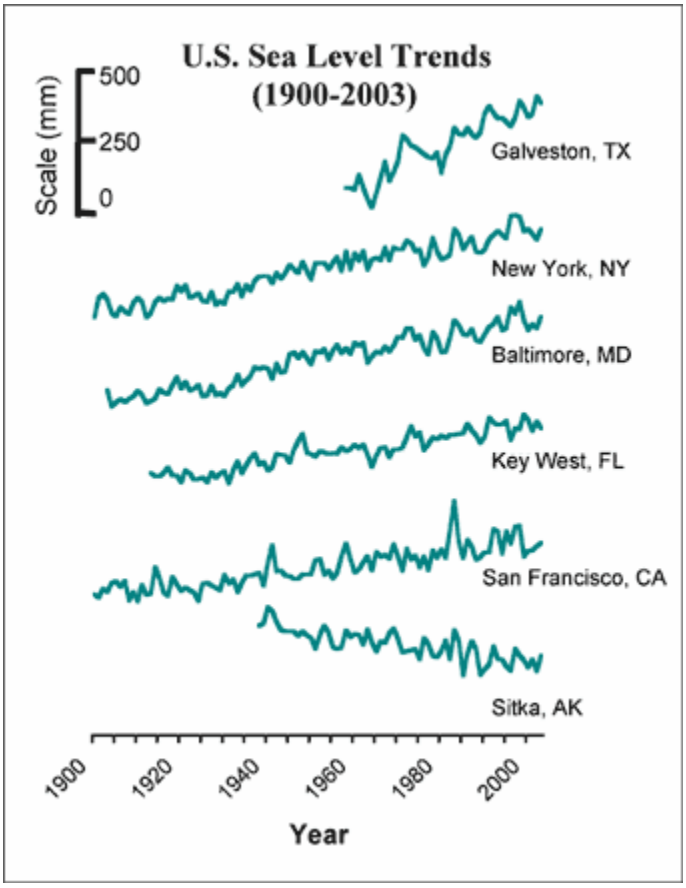
Climate Change – Health and Environmental Effects: Coastal Zones and Sea Level Rise

http://epa.gov/climatechange/effects/coastal/index.html

This section of the U.S. Environmental Protection Agency's (EPA) Climate Change website looks at how coastal zones are particularly vulnerable to climate variability and change. Key concerns include sea level rise, land loss, changes in maritime storms and flooding, responses to sea level rise, and implications for water resources. The site can be used to demonstrate what impacts sea level rise will have on a specific locale, community, or region based on the current projections for climate change, and may help to outline the importance of future legislation concerning marine areas, conservation, and land-use strategies. Additional links point to EPA reports on shoreline erosion in Florida and New Jersey.

A text and graphic sample from this website are below:

> Nationwide, about 5000 square miles of dry land are within two feet of high tide. Although the majority of this land is currently undeveloped, many coastal counties are growing rapidly. Land within a few feet above the tides could be inundated by rising sea level, unless additional dikes and bulkheads are constructed. A two foot rise in sea level would eliminate approximately 10,000 square miles of land (including current wetlands and newly inundated dry land) (PDF, 26 pp., 267 KB, About PDF), an area equal to the combined size of Massachusetts and Delaware. (EPA, 1989)



Hurricanes

FAQ – Atlantic Hurricanes and Climate

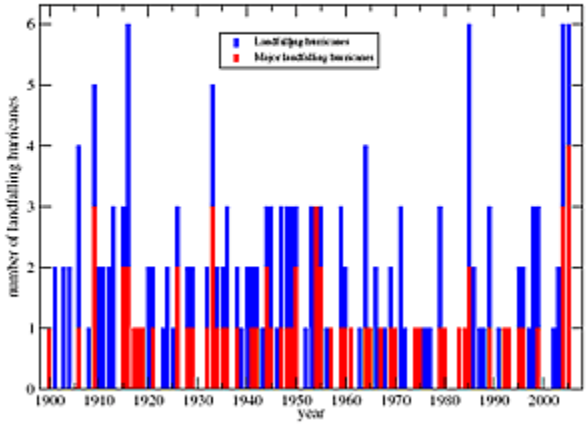
Author or Publisher: NOAA
http://hurricanes.noaa.gov/pdf/hurricanes-and-climate-change-09-2006.pdf (PDF – 2 pages)

Dated September 2006, this brief document responds to frequently asked questions on the topic of Atlantic hurricanes and climate. It reflects the current state of the science, which is based on official data sets and results presented in peer-reviewed publications. It does not contain any statements of policy or positions of NOAA, the Department of Commerce, or the U.S. government. Questions addressed include these:

- Has hurricane activity changed in the 20th century?
- What factors influence hurricanes?
- What key research is NOAA working on?

An example graph from this document is below:

Figure 2: Landfalling Hurricanes and Major Hurricanes (cat. 3-5) in United States



RISA Hurricane Education Materials

www.climate.noaa.gov/index.jsp?pg=./education/hurricanes/materials.jsp

This Web page provides links to a range of K-12 educational materials related to hurricane science and emergency preparedness. Most of the items are in PDF format and include teacher resources, fact sheets, posters, and at-home science activities.

A secondary link menu points to additional resources:

- Climate Literacy Education Plan
- Education Resources for Students
- Education Resources for Educators
- Multimedia Resources
- Opportunities for Educators and Students
- Teacher at Sea Program

Resilience

Buying Time: A User's Manual for Building Resilience and Resistance to Climate Change in Natural Systems

Author or Publisher: World Wildlife Fund
www.panda.org/downloads/climate_change/buyingtime.pdf (PDF – 246 pages)
or
www.panda.org/news_facts/publications/index.cfm?uNewsID=8678 (individual chapters)

This publication was developed for managers of protected areas dealing with ecosystems in the face of climate change. It provides an approach for developing, implementing, and testing appropriate adaptation strategies for different habitats. Each chapter is a guide to a particular habitat type; the Introductory Overview, Temperate Marine, Tropical Marine, and Arctic chapters will be of particular interest.

An excerpt from the Temperate Marine section (Chapter 5) provides an example of the tone and content within this resource:

> **Indicator Species, Communities, and Processes**
> As we head into an uncertain climate future, it would be useful to know which species, communities, or processes might serves as harbingers of changes to come. Identifying species most sensitive to climate change ("indicator species") would give us early warning signs of ecosystems on the brink of collapse, or early indications of successful conservation approaches. Identifying the most sensitive elements of ecosystems may also help us anticipate unexpected or indirect effects of climate change on ecosystems. Species that live in variable environments (e.g., seasonal, intertidal) tend to have broader latitudinal ranges and occupy more biogeographic provinces than species from more stable environments. Species with broad geographic ranges also tend to be more longlived on a geological scale than species with restricted ranges. Thus it might be expected that species naturally occurring in stable habitats or with geographically restricted ranges would be more susceptible to some aspects of climate change, and might make a good first guess as indicator species (Harley et al., in press).

Note: paper copy is available from
Lara Hansen
1250 24th Street NW
Washington DC 20037
lara.hansen@wwfus.org

Surviving Climate Change in Small Islands – A guidebook

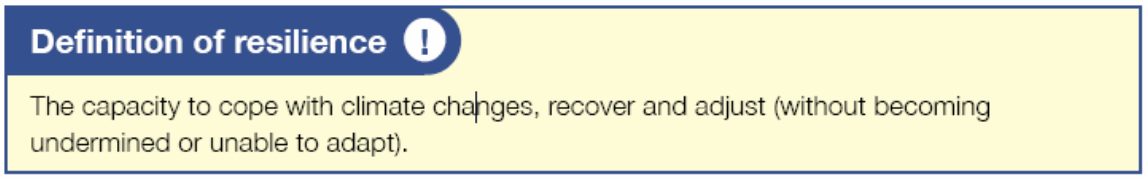
Author or Publisher: Tyndall Centre for Climate Change Research
www.tyndall.ac.uk/publications/surviving.pdf (PDF – 132 pages)

This guidebook explains how existing social, economic, and environmental vulnerability can magnify the risks associated with climate change. Created to assist United Kingdom overseas territories, it describes actions that can be undertaken to prepare for climate change, provides a basic scientific understanding of climate issues, and is applicable in many contexts, not just small islands. The appendices include a glossary and links to resources organized by subject area.

This handbook is divided into the following sections:

- **Why be concerned about climate change?**
- **Understanding climate change risks**
- **Assessing vulnerability and structuring an adaptation plan**
- **Developing an adaptation strategy**
- **Implementing a climate change adaptation strategy**
- **Further information**

Written in non-scientific and jargon-free language, the guidebook highlights key messages, examples, and definitions to emphasize the "take home" messages. Example of a highlighted item is below:



This resource provides insight into what other coastal and island locations are doing to mitigate climate change impacts on their region. An example of a graphic from this resource is below:

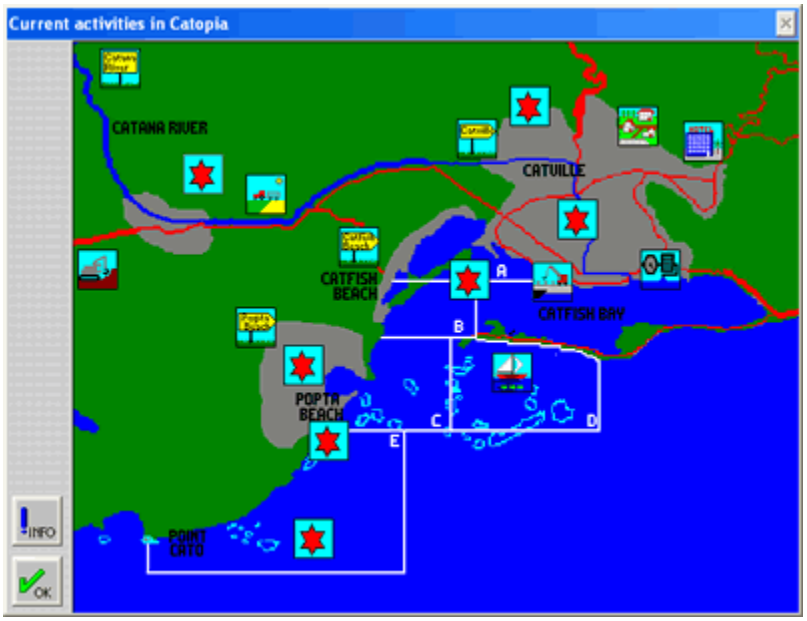
Tools

Coastal Zone Simulation Model (COSMO)

www.netcoast.nl/tools/cosmo.htm

COSMO is a computer-based decision-support model that allows coastal zone managers to evaluate potential management strategies under different scenarios, including long-term climate change. The tool takes the user through the process of evaluating coastal zone management plans for a fictitious country called Catopia. It calculates various criteria, including long-term effects of climate change, reflecting the use of the coastal zone. A demo version of this resource is available from the link above. Please note the full version is priced at $150 USD.

This product is useful as an educational tool to convey the relationship of adaptation to climate change in coastal zone management. An image from this tool is below:



National Center for Atmospheric Research (NCAR) GIS Climate Change Scenarios

www.gisclimatechange.org

This project is aimed towards geographic information system (GIS) users interested in global climate change and provides access to free global data sets of climate change scenarios that are being generated for the upcoming *Fourth Assessment Report of the UN Intergovernmental Panel on Climate Change* (IPCC) by the Community Climate System Model (CCSM).

The data sets can be downloaded in a common GIS shapefile format or as a text file and used for further visualization, analysis, and mapping of global climate change. Both ESRI and other commercial and open source GIS packages can use data in shapefile format.

Note: this site requires registration and login for accessing the data.

Alaska

Alaska-Specific Polar and Ice Studies

Catalogue of Arctic Sea Ice from 1979 to 2003
www.oc.nps.navy.mil/NAME/name.html

This resource provides movie files in .AVI format that trace the evolution of sea ice from season to season and the changes from year to year. The movies make it easy to see the changes occurring in Arctic sea ice parameters and may be useful in such applications as hazard mitigation along the Bering Sea coast, ecosystem management activities, and assessing economic impacts.

Contact information:

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International Polar Year 2007-2008: Resources on Polar Research in the NOAA Central Library Network: A Selected Bibliography
Author or Publisher: NOAA Central Library
http://docs.lib.noaa.gov/rescue/Bibliographies/IPY2007.pdf (PDF – 182 pages)

This document provides links and references a very large number of documents related to polar research that can be found in the NOAA Central Library.

Alaska Native Villages: Villages Affected by Flooding and Erosion Have Difficulty Qualifying for Federal Assistance
Author or Publisher: U.S. General Accounting Office
www.gao.gov/cgi-bin/getrpt?GAO-04-895T (PDF – 21 pages)

From the introduction of the document:

> Flooding and erosion affects 184 out of 213, or 86 percent, of Alaska Native villages to some extent. While many of the problems are long-standing, various studies indicate that coastal villages are becoming more susceptible to flooding and erosion caused in part by rising temperatures.

Alaska-related Resources as Referred by Alaska Center for Climate Assessment and Policy

Air Temperature, Weather, Hazards

- **Temperature, Precipitation, and Hazard Forecasts**: The National Weather Service Climate Prediction Center provides temperature and precipitation forecasts with 6-10 day, 8-14 day, one-month, and three-month outlooks, as well as hazard forecasts in temperature/wind, precipitation, and soil/wildfire and the U.S. drought assessment. www.cpc.ncep.noaa.gov

- **Marine Hazard Forecast**: The National Weather Service Alaska Region Public and Marine Hazard Forecast includes satellite and radar maps, as well as surface analysis. www.arh.noaa.gov

- The National Weather Service Forecast Office, Alaska Region, provides the following products:
    - Daily climate report, (temperature/precipitation): observed weather reports in specific locations (Anchorage, Bethel, Cold Bay, Gulkana, Homer, King Salmon, Kodiak, McGrath, St. Paul, Talkeetna, Valdez) with two-month archive.
    - Record event report in specific locations (Cold Bay, King Salmon, Kodiak, McGrath, St. Paul, Valdez) with 6-month variable archive.
    - Monthly weather summary (Anchorage), one-year archive.
    - State summary, one-month archive.

  www.weather.gov/climate/index.php?wfo=pafc

Sea Ice

- **Sea Ice Advisory, Graphics, and Forecasts**: The National Weather Service Forecast Office, Alaska Region, also provides sea ice advisory, graphic analyses of sea surface temperatures and sea ice, and five-day sea ice forecasts year-round. http://pafc.arh.noaa.gov/ice.php

- **Sea Ice Charts and Maps**: The National Ice Center provides regionally specific ice charts and GIS, metadata, and coverage files for the entire Arctic. Regional maps covering the Alaska coast from south central counter-clockwise to the north coast are Cook Inlet, East Bering Sea, West Bering Sea, Chukchi Sea, and Beaufort Sea. www.natice.noaa.gov/products/arctic/index.htm

- **Ice Concentration and Snow Extent**: The National Snow and Ice Data Center provides maps of ice concentration and snow extent. www.nsidc.org/cryosphere/glance/index.html

- **Ice Breakup Dates**: The North American Ice Service provides past and projected ice breakup dates, with 2006 breakup dates found at http://ice-glaces.ec.gc.ca/prods/ARCTIC001/20060602000000_ARCTIC001_20060602150221_0002582687.pdf

Fisheries and Ecosystem Management

- **Bering Sea Fisheries and Ecosystem Management**: The Alaska Fisheries Science Center provides an overview of the state of the Bering Sea, including monthly temperature and sea ice anomalies (1990-2004), vertically averaged ocean temperature (1995-2006), pollock total biomass and recruits (1960-2002), crab total biomass (1980-2004), and northern fur seal pups born (1973-2004). The site provides links to NOAA National Marine Fisheries Service Stock Assessment and Fishery Evaluation (SAFE) Reports by North Pacific Fishery Management Council; 2004 fur seal pup production on the Pribilof Islands; National Marine Mammal Laboratory; 2005 Report of the Study Group on "Fisheries and Ecosystem Response to Recent Regime Shifts" by the North Pacific Marine Science Organization; and the Ecosystem considerations chapters for current and past SAFE reports. This site also includes a link that shows physical and biological indicators for change (1960-2005). www.beringclimate.noaa.gov/about.html

Other

- **River Conditions.** The National Weather Service, Alaska-Pacific River Forecast Center provides spatially explicit information on Alaska rivers and hydrology, precipitation and weather, river ice and breakup, and climate and history. http://aprfc.arh.noaa.gov/