

Esri News

for Climate & Atmosphere

Summer 2013

European Cities Are Getting Warmer

ArcGIS Online Helps Tell the Story

Climate change is affecting all regions in Europe and causing a wide range of impacts on society and the environment. The European Environment Agency (EEA) GIS team created an interactive web map that shows heat wave risk for 500 European cities. EEA shares the map through the Eye on Earth website using ArcGIS Online and has made it available for anyone to access.

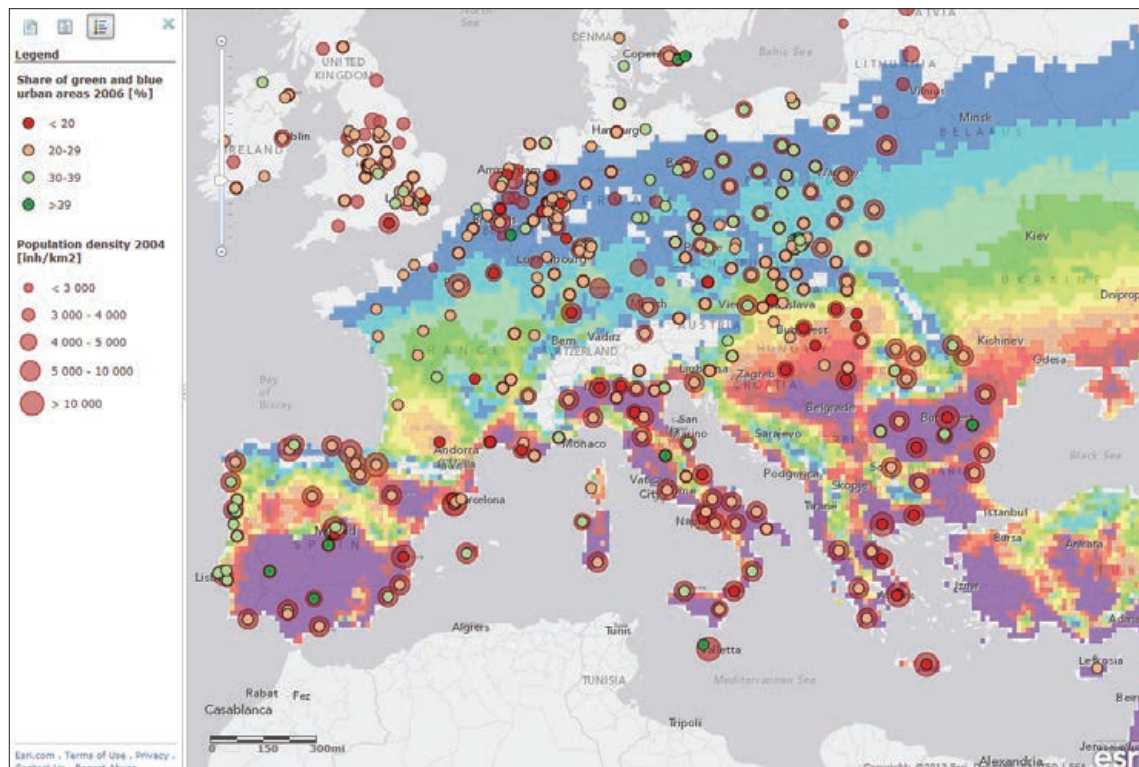
EEA uses web mapping services as a way to promote its message of sustainable environments. The web mapping platform simplifies sharing environmental data, making it easier for nations, agencies, scientists, and policy makers to view and analyze a wealth of environmental data.

The map combines a simulated number of tropical nights and hot days, population density, and vegetated and aquatic urban areas. Vegetation and water areas, along with population density, can

influence the urban heat island effect. For example, high population densities are associated with high building mass, high production of anthropogenic heat per area, and a lack of green space. The map clearly shows vulnerable areas in Italy, some parts of southern France, and southern Spain and around Belgrade, Serbia, Bucharest, and Romania.

The map is interactive, and users can combine different datasets from the EEA report; for example, they can add the number of elderly people, who are generally more affected by heat. Datasets made available by other organizations can also be added.

To view the heat wave risk map, go to eyeonearth.org or visit arcgis.com.



← This Eye on Earth map shows heat risk areas in Europe. Cities with low green (vegetated) and blue (water) areas are more susceptible to urban heat islands. Furthermore, population density may intensify the effect of heat waves.

Cover

- 1 European Cities Are Getting Warmer

Case Study

- 3 New Map Sharpens View of African Ecosystems and Bioclimates
- 4 Understanding Climate Change and Unrest Vulnerability
- 6 Researchers Use GIS to Study Changes in Sea Level
- 7 On the Road

Esri News for Climate & Atmosphere is a publication of the Water/Wastewater Group of Esri.

To contact the Esri Desktop Order Center, call 1-800-447-9778 within the United States or 909-793-2853, ext. 1-1235, outside the United States.

Visit the Esri website at esri.com.

View *Esri News for Climate & Atmosphere* online at esri.com/industries/climate/newsletter or scan the code below with your smartphone.

Advertise with Us

E-mail ads@esri.com.

Submit Content

To submit articles for publication in *Esri News for Climate & Atmosphere*, contact Lori Armstrong, industry solutions manager, at larmstrong@esri.com or Barbara Shields, editor, at bshields@esri.com.

Manage Your Subscription

To update your mailing address or subscribe or unsubscribe to Esri publications, visit esri.com/publications.

International customers should contact an Esri distributor to manage their subscriptions.

For a directory of distributors, visit esri.com/distributors.

Circulation Services

For back issues, missed issues, and other circulation services, e-mail requests@esri.com; call 909-793-2853, extension 2778; or fax 909-798-0560.



Copyright © 2013 Esri.
All rights reserved.
Printed in the United States of America.

The information contained in this work is the exclusive property of Esri or its licensors. This work is protected under United States copyright law and other international copyright treaties and conventions. No part of this work may be reproduced or transmitted in any form or by any means, electronic or mechanical, including photocopying and recording, or by any information storage or retrieval system, except as expressly permitted in writing by Esri. All requests should be sent to Attention: Contracts and Legal Services Manager, Esri, 380 New York Street, Redlands, CA 92373-8100 USA.

The information contained in this work is subject to change without notice.

The Geographic Advantage, Esri, the Esri globe logo, 3D Analyst, ArcAtlas, ArcCatalog, ArcData, ArcDoc, ArcEditor, ArcExplorer, ArcGIS, the ArcGIS logo, ArcGlobe, ArcIMS, Arc/INFO, ArcInfo, ArcLogistics, ArcMap, ArcNetwork, ArcNews, ArcObjects, ArcPad, ArcPress, ArcReader, ArcSDE, ArcSurvey, ArcToolbox, ArcTools, ArcUser, ArcView, ArcVoyager, ArcWatch, ArcWeb, ArcWorld, ArcXML, Business Analyst Online, BusinessMAP, CommunityInfo, EDN, Geography Network, GIS Day, MapData, MapObjects, Maplex, MapStudio, ModelBuilder, MOLE, NetEngine, RouteMAP, SDE, Sourcebook America, StreetMap, Tapestry, @esri.com, esri.com, arcgis.com, geographynetwork.com, gis.com, and gisday.com are trademarks, service marks, or registered marks of Esri in the United States, the European Community, or certain other jurisdictions.

Other companies and products or services mentioned herein may be trademarks, service marks, or registered marks of their respective mark owners.



New Map Sharpens View of African Ecosystems and Bioclimates

A team of African and North American scientists led by the US Geological Survey (USGS) and NatureServe, a conservation nonprofit organization, has created a series of continent-wide ecosystem maps that offer the most detailed portrayals of Africa's natural setting yet produced.

The new maps and related data on bioclimates, landforms, geology, and vegetation can be used across Africa to perform impact assessments of climate change as well as changes in land use, such as agriculture, deforestation, and urbanization. They are useful for conservation planning and resource management.

The huge mapping project was largely accomplished with ArcGIS, the raster processing was mostly conducted with ArcGIS (GRID), and the continent-wide maps were developed using standard Esri data on county/administrative boundaries for every county in Africa. The final ecosystems map is a product of a sophisticated predictive analytics modeling process that uses multiple input data layers for the entire continent.

Experts from 18 African nations worked together to formulate new ecosystem classifications. USGS and NatureServe researchers collaborated with the Regional Centre for Mapping of Resources for Development (RCMRD), based in Nairobi, Kenya. The team mapped 126 ecosystems at a base resolution of 90 meters. These can be used for more accurate assessments.

For example, carbon stocks currently are assessed in general biome categories such as forests, grasses, shrublands, wetlands, deserts, and agricultural lands. However, the increased classification resolution supplied by the new African ecosystems maps facilitates a more robust assignment of carbon inventories to more biological sources.

Climate change scientists interested in bioclimatology can use the new isobioclimate maps to study the effects of climatic conditions on living organisms. To characterize Africa's bioclimate regions, project researchers used one-kilometer spatial resolution temperature and precipitation data from the global WorldClim dataset and the Rivas-Martinez global bioclimatology model. The isobioclimate maps show regions that have relatively similar temperatures (thermotypes) and

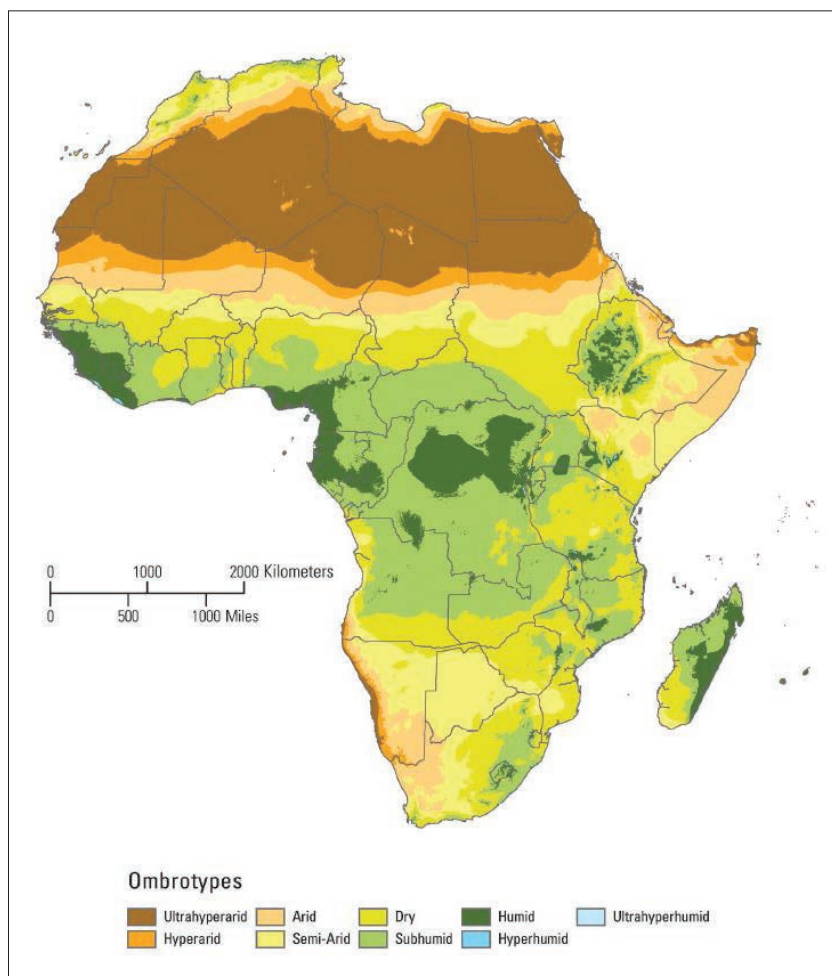
relatively similar precipitation (omobrytes). Isobioclimate regions are areas of relatively homogeneous temperature and precipitation regimes.

"This new ecosystems map and its underlying data will provide a valuable and synergistic resource for all these efforts and organizations throughout Africa," said Doug Richardson, executive director, Association of American Geographers (AAG). "The new maps also will be crucial for many conservation, biodiversity, agriculture, and resource management applications."

The AAG has published this collection of maps in a special supplement to the *African Geographical Review* called "A New Map of Standardized Terrestrial Ecosystems of Africa." The publication is available in digital form from USGS.

"This much-improved baseline of Africa's

ecosystem conditions has the potential for more accurate carbon assessment studies in Africa," observed USGS scientist Roger Sayre, lead author of the publication.



↑ This isobioclimate map shows regions that have relatively similar precipitation (omobrytes).

Understanding Climate Change and Unrest Vulnerability

Organizations Use GIS to Research Complex Issues

Earth's rising temperatures have a strong impact on African countries that are dependent on rain-fed agriculture. Climate change makes them vulnerable to drought, crop shortage, and exposure to extreme weather.

A community's level of vulnerability to climate change can be measured by assessing its capacity for resilience. Resilience is weakened when a government lacks resources and political unrest and violent conflict occur. Governments and aid organizations use GIS to better understand where and how to lower climate change vulnerability and alleviate suffering for African communities.

The Robert S. Strauss Center for International Security and Law at the University of Texas at Austin coordinates the Climate Change and African Political Stability (CCAPS) program. Its purpose is to locate where security attention and foreign aid are most needed and offer advice about the types of intervention that best suit a situation.

Several components of CCAPS research use Esri GIS technology. For example, researchers use GIS to model climate security vulnerability, track the location of conflict events in near real time, and assess the distribution of aid for climate change adaptation.

"The complex pathways from climate change to security impacts have demanded new datasets to fill knowledge gaps but also

new ways of presenting the data to be of most use in policy planning," said Francis J. Gavin, director of the Strauss Center. "The CCAPS mapping tool allows policy makers to analyze data from multiple sources at once, providing integrated analysis of the drivers and responses related to security risks stemming from climate change."

The CCAPS Climate Security Vulnerability Model uses GIS to locate areas most vulnerable to climate change and understand the factors that contribute to that vulnerability. The model assesses four elements that impact vulnerability: physical exposure to climate-related hazards, population density, household and community resilience, and governance and political violence. Each source has its own set of indicators, which the model combines to assess how these factors coalesce to impact an area's overall vulnerability.

By adding vulnerability assessments to GIS map layers and combining them with geocoded data from other areas of CCAPS research, analysts can see problem areas and understand how these issues intersect. If analysts want to study how regional conflict patterns in Uganda intersect with climate change vulnerability, they select areas to study on a basemap and add the climate vulnerability and conflict map layers. This makes it easy to see where and how these overlap (figure 1).

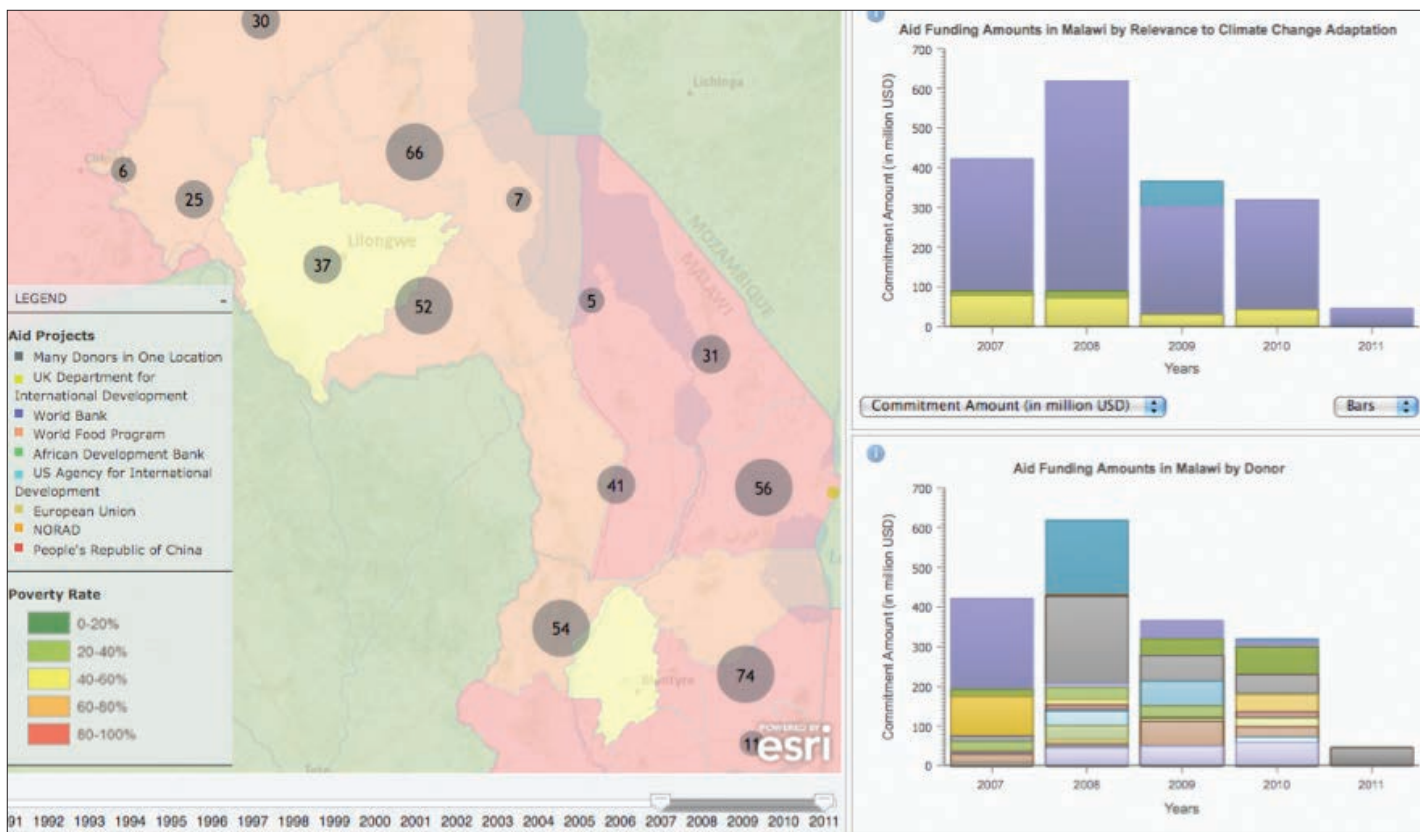
CCAPS wanted to make it easy for anyone to use model data and maps. Therefore, it partnered with Development Gateway to create map dashboards that bring together mapping, trends analysis, tabular data displays, and data downloads for a comprehensive view of the areas under study in the program. The mapping tools were built using Esri technology (strausscenter.org/ccaps/mapping-tool.html). Dashboard users can apply a suite of filters for selecting attributes in the individual datasets. They can also access robust geospatial analysis that was produced by CCAPS researchers.

The integrated CCAPS Mapping Tool (ccaps.aiddata.org) is an online mapping platform. Researchers and policy makers use it to visualize data on climate change vulnerability, conflict, governance, and aid and to analyze how these issues intersect in Africa. The mapping tool allows users to select and layer any combination of CCAPS data onto one map to assess how various climate change impacts and responses intersect.

The CCAPS Aid Dashboard helps users see where aid projects are located. This dashboard is a collaborative effort that accesses datasets from CCAPS, the African Development Bank, and the World Bank. Data have been geocoded by AidData (aiddata.org). This is the most comprehensive collection of geocoded data on aid projects in Africa.



↑ Figure 1. An examination of conflict and climate vulnerability data shows that conflict events involving the Lord's Resistance Army (red areas) have gradually diffused from Uganda into areas with less stability and more climate security vulnerability such as South Sudan and the northern portion of Democratic Republic of the Congo. (Source: The Armed Conflict Location and Events Dataset sponsored by Trinity College, Dublin, Ireland, CCAPS Climate Security Vulnerability Model, CCAPS mapping tool.)



↑ Figure 2. The CCAPS Aid Dashboard allows users to explore trends in aid allocation by donor, sector, and demographics within a country.

Using the dashboard’s tools, analysts filter aid data by year, sector, donor, recipient, and so forth, and see it on the map (figure 2).

They also see official donors located in each sector of a given country.

CCAPS and AidData published a geocoded and climate-coded dataset for Malawi. CCAPS rated aid projects according to their relevance to climate change adaptation and used the results to make a map layer. The user selects an area on the basemap and adds a map layer of climate adaptation-related projects. The user can then see if projects that are highly relevant to reducing vulnerability are actually located in areas that are vulnerable.

The CCAPS Conflict Dashboard gives a comprehensive view of emerging and historical conflict trends. This dashboard allows users to analyze conflict dynamics by actor, event type, issue, intensity, and so forth. By overlaying map layers, one can understand how conflict exacerbates climate change vulnerability and see where and how aid programs are trying to reduce conflict problems.

Development Gateway built the dashboards on ArcGIS for Server. Using ArcGIS API for JavaScript, developers added functionality

that allows users to easily interact with maps and perform GIS tasks. Users can filter data to see the results displayed on the dashboard as maps, charts, and tables.

Development Gateway designed the online dashboards so organizations that host them on their GIS servers can easily manage them on the back end. Organizations’ site managers select the datasets they want to include, preset filter defaults, set the year range, and specify donor organizations.

CCAPS datasets are available for download from the CCAPS program at www.strausscenter.org/ccaps/data. The dashboard applications and geographic data layers are hosted on Development Gateway’s server. Once developers have finished developing and testing map applications, they will move them, along with the code and data layers, to the Strauss Center’s GIS servers.

Global aid organizations are using the map application to target resources, be transparent, and assess the effectiveness of their projects.

Project Sponsors

The Robert S. Strauss Center for International Security and Law, based at the University

of Texas at Austin, is known for addressing complex global problems with innovative ideas driven by policy-related research across many disciplines. The College of William and Mary in Williamsburg, Virginia; Trinity College Dublin, Ireland; the University of North Texas in Denton, Texas; and Development Gateway in Washington, DC, are collaborators on the CCAPS program. As the lead organization, the Strauss Center receives funding from the United States Department of Defense through the Minerva Initiative. This initiative is a university-based, social science research program that focuses on areas of strategic importance to national security policy.

Works Cited

Weaver, Catherine, Justin Baker, and Christian Peratsakis, “Tracking Climate Adaptation Aid: Methodology” (University of Texas at Austin, 2012).
 Ramirez, Diego Joaquin Cruz, “Mapping the Future of Climate Change in Africa” (University of Texas at Austin, 2012).

Researchers Use GIS to Study Changes in Sea Level

Researchers and decision makers use geographic information systems to answer important questions and take action. How is the ocean changing? What will the US coastline look like? Which cities need to be ready for it? Researchers at the University of Arizona use Esri ArcGIS to answer these questions and publish their findings as an online mapping application.

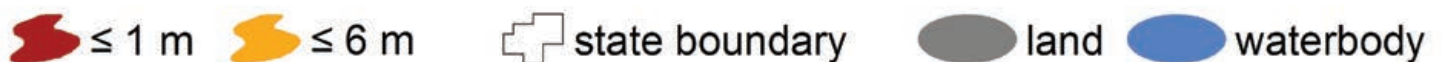
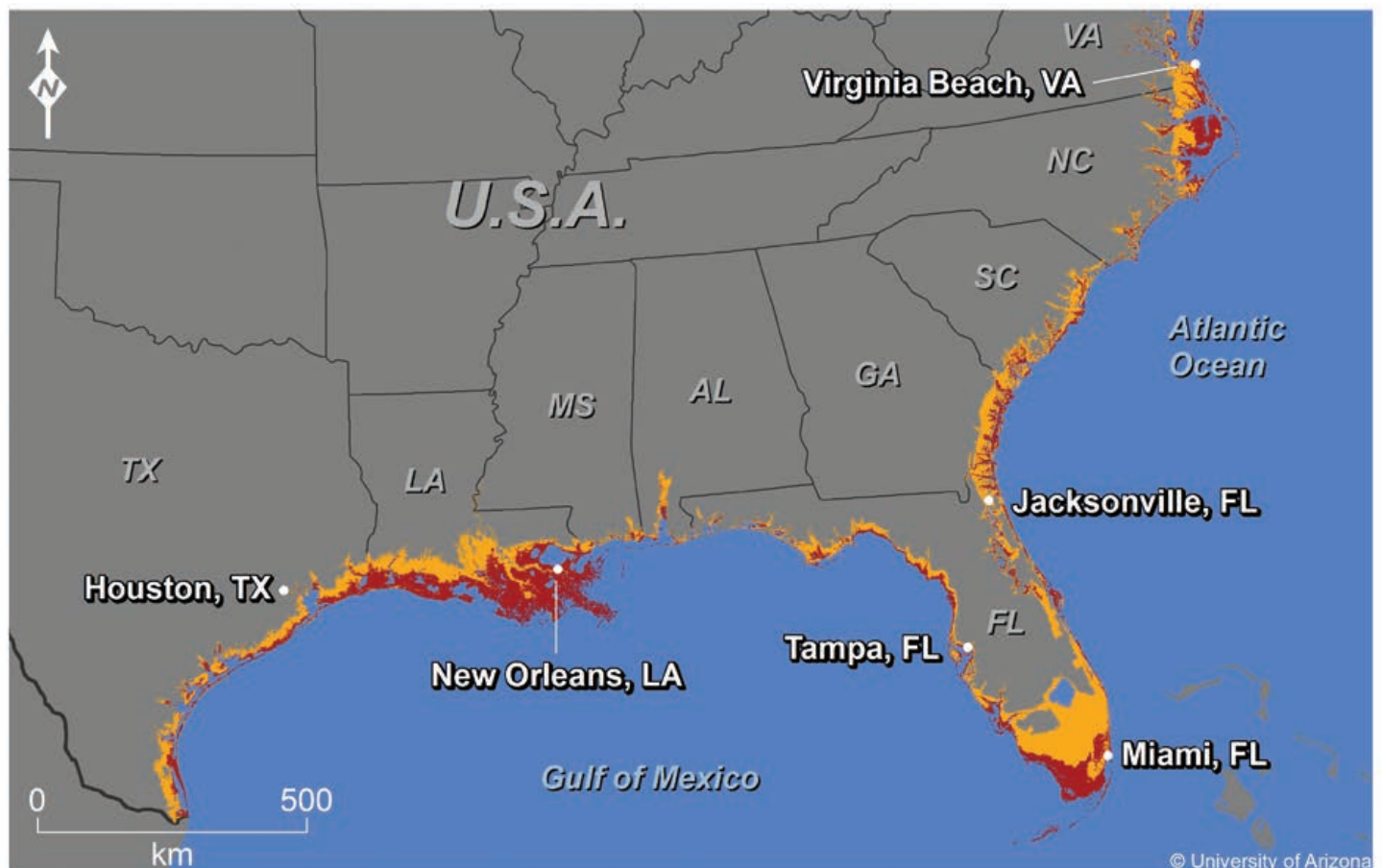
Because US coastlines have become embattled by unprecedented weather-related disasters, people are taking a hard look at the results of climate change such as sea level rise (SLR). Independent scientific studies are confirming current predictions of a one-meter rise in sea level by 2100. Furthermore, global greenhouse gas emissions over the

twenty-first century will not only influence SLR in the relatively near term of the next ~90 years but will also continue to drive SLR over subsequent centuries. Temperatures by 2100 may be warm enough to commit earth to at least four to six meters of global SLR over following centuries as the polar ice sheets adjust to the comparatively rapid and largely irreversible global warming that will occur this century.

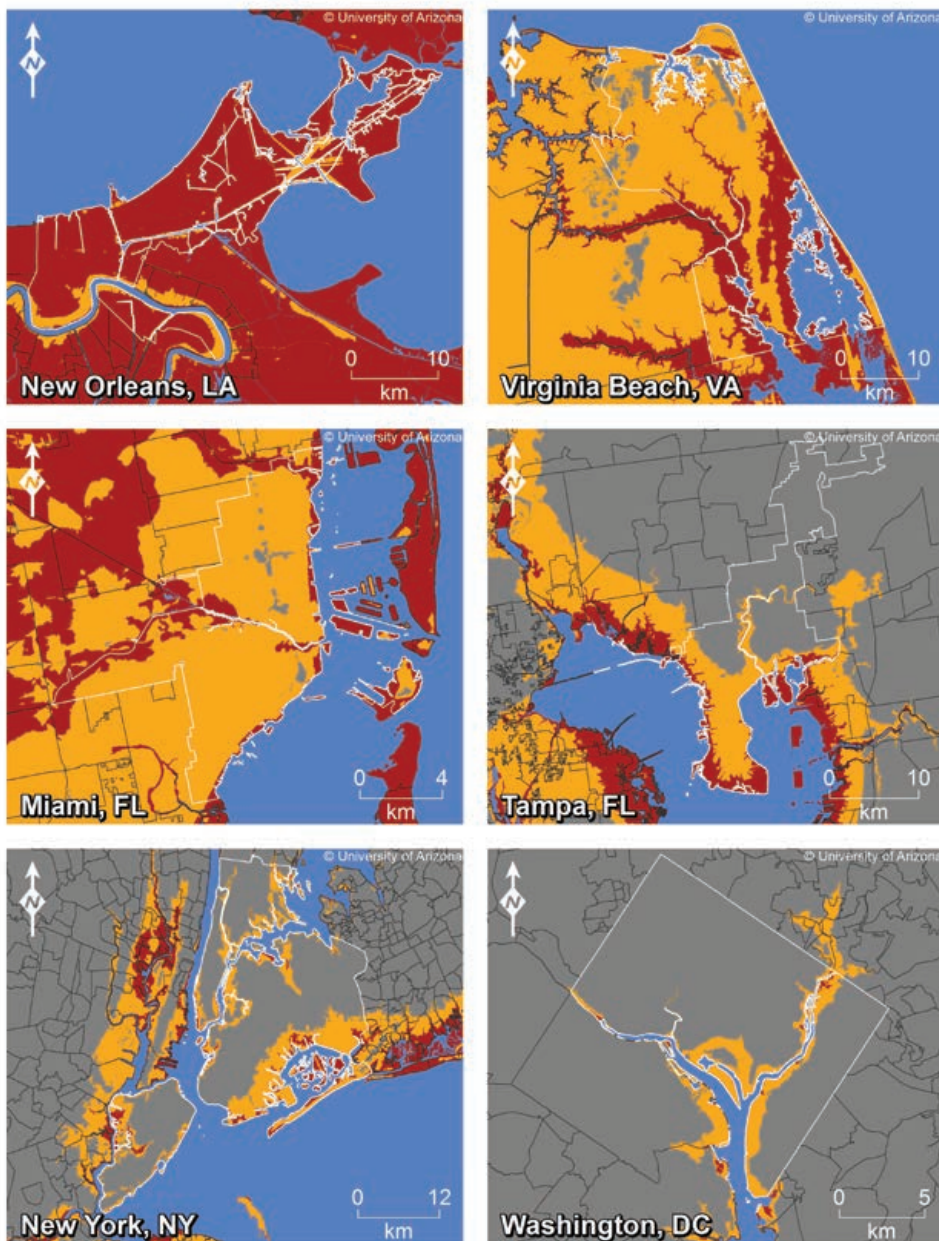
Jeremy Weiss, PhD, research scientist, Department of Geosciences, University of Arizona, Tucson, and his team used Esri ArcGIS to create scientifically sound geospatial datasets of low-lying coastal areas.

GIS uses different data resources

- For this study, low-lying coastal areas were identified by using the US Geological Survey (USGS) National Elevation Dataset with about 30-meter horizontal resolution (NED_{1arc}). The USGS digital elevation models (DEMs) are digital representations of elevation information, which are downloadable from the web.
- Land area within coastal cities at or below one to six meters of elevation was created using GIS shapefiles of municipal boundaries from US Census Bureau.
- Data about municipal land areas where estuarine and marine wetland types appear came from the US Fish and Wildlife Service.



↑ Sea level rise is predicted to change the look of the US coastline by the end of the century.



■ ≤ 1 m
 ■ ≤ 6 m
 municipal boundary
 land
 waterbody

↑ Sea level rise maps depict areas where residents and city planners need to give immediate attention.

GIS performs calculations

The team created a geoprocessing algorithm that performs an iterative, cell-by-cell analysis of DEMs. It selects all cells with elevation values less than or equal to a particular value and with locations adjacent to or connected by cells of equal or lesser value to the sea. Team members applied this algorithm to the NED_{1arc} data for each integer value from one to six meters to delineate areas potentially impacted by SLR over the current and following

centuries. The team members selected coastal cities meeting their criteria. They separated out the portions of municipalities that only occur over areas designated as land by removing parts where estuarine and marine wetland types appear. They overlapped the land portion of each municipality with their datasets of areas with elevations at or below one to six meters. They calculated the land portion of each municipality with elevations at or below one to six meters.

GIS creates maps

"Maps are the best medium for telling the story of the potential impacts of climate change and sea level rise," said Weiss.

The maps show where one-meter increments of sea level rise could affect coastal areas. Users can see municipal land boundaries, land, water bodies, and color-coded coastal elevations from one to six meters.

GIS serves maps online

To raise awareness about the possible implications of SLR, Weiss decided to publish the data on the web. First, he built a GIS web application by using ArcGIS tools. He selected the map layers, functionality, and map layout he wanted to include. Next, he published the map application on a GIS server. Weiss's operation is small, so he keeps his GIS server under his desk. If he decides to expand its capacity, he could add another server, join the campus network, or publish to the Esri map service ArcGIS Online.

The climateGEM SLR web application has been live for over two years. Since the website's launch, Weiss has received very positive feedback.

On the Road

Mark Your Calendar

COP 19
 November/December 2013
 Warsaw, Poland
www.polandcop19.org

American Geophysical Union (AGU)
 Fall Meeting
 December 9–13, 2013
 San Francisco, California USA
fallmeeting.agu.org/2013

American Meteorological Society
 Annual Meeting
 February 2–6, 2014
 Atlanta, Georgia USA
annual.ametsoc.org/2014



esri[®]

380 New York Street
Redlands, California 92373-8100 USA

Presorted
Standard
US Postage
Paid
Esri

137084 QUAD4.8M9/13k



Smart Now, Sustainable Forever

Esri[®] Technology gives you the power to plan your future. With mapping, modeling, and data analysis solutions, Esri has the complete platform to start your smart community today for a sustainable tomorrow.

Learn more at esri.com/climate.

