CARIBBEAN DIGITAL ELEVATION MODELS
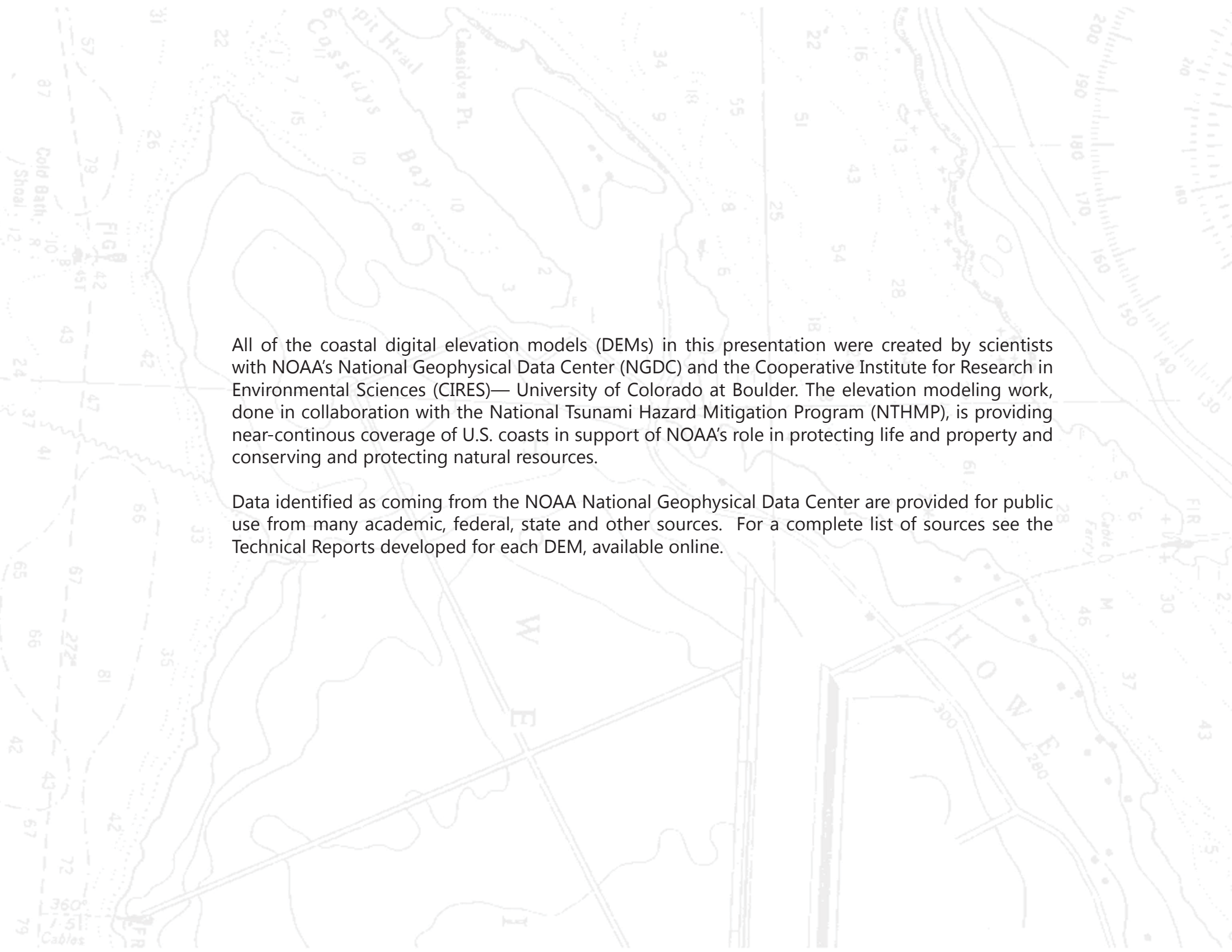
Coastal Models Supporting our Nation's Needs through Science and Technology

NOAA

NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

U.S. DEPARTMENT OF COMMERCE

All of the coastal digital elevation models (DEMs) in this presentation were created by scientists with NOAA's National Geophysical Data Center (NGDC) and the Cooperative Institute for Research in Environmental Sciences (CIRES)— University of Colorado at Boulder. The elevation modeling work, done in collaboration with the National Tsunami Hazard Mitigation Program (NTHMP), is providing near-continous coverage of U.S. coasts in support of NOAA's role in protecting life and property and conserving and protecting natural resources.

Data identified as coming from the NOAA National Geophysical Data Center are provided for public use from many academic, federal, state and other sources. For a complete list of sources see the Technical Reports developed for each DEM, available online.

CARIBBEAN ISLANDS

The Caribbean is much more famous for sun and beaches than it is for tsunamis. Puerto Rico and the U.S. Virgin Islands of St. Croix, St. John, and St. Thomas are popular tourist destinations and home to hundreds of thousands of residents. The region is rich in biodiversity, history, and culture and is located in an active tectonic area subject to large magnitude earthquakes, landslides, volcanic eruptions, and occasionally, tsunamis.

People who live in communities in the Caribbean, especially in low-lying developments along the coast are vulnerable to severe storms, coastal inundation events, hurricanes, and tsunamis. Beginning in June and stretching till the end of November - the Caribbean hurricane season brings high winds, squalls, and heavy thunderstorms. While far less frequent, tsunamis are a high hazard. The earliest known tsunami in U.S. territory occurred in the U.S. Virgin Islands in 1690 while the most deadly was the tsunami generated by the 1918 earthquake in the Mona Passage between Hispaniola and Puerto Rico. The Caribbean region also faces tsunami hazards from distant events, including trans-Atlantic tsunamis similar to the 1755 Lisbon earthquake and tsunami. These coastal inundation events can cause millions of dollars in damage and threaten island life.

NOAA's DEMs provide detailed, accurate depictions of Caribbean coasts that are used by our partners in the National Tsunami Hazard Mitigation Program. These DEMs and the underlying data can also support scientists, coastal managers, and policy makers in effectively managing marine ecosystems and coastal resources, coordinating planning and mitigation efforts, and better understanding the impacts of coastal hazards. The DEMs in this booklet provide a glimpse of the coastal relief for some of our U.S. island communities in the tropical Caribbean Sea.

1. Puerto Rico Island
2. Mayaguez
3. Arecibo
4. San Juan
5. Fajardo
6. Ponce
7. Guayama
8. U.S. Virgin Islands
9. St. Thomas - St. John
10. St. Croix

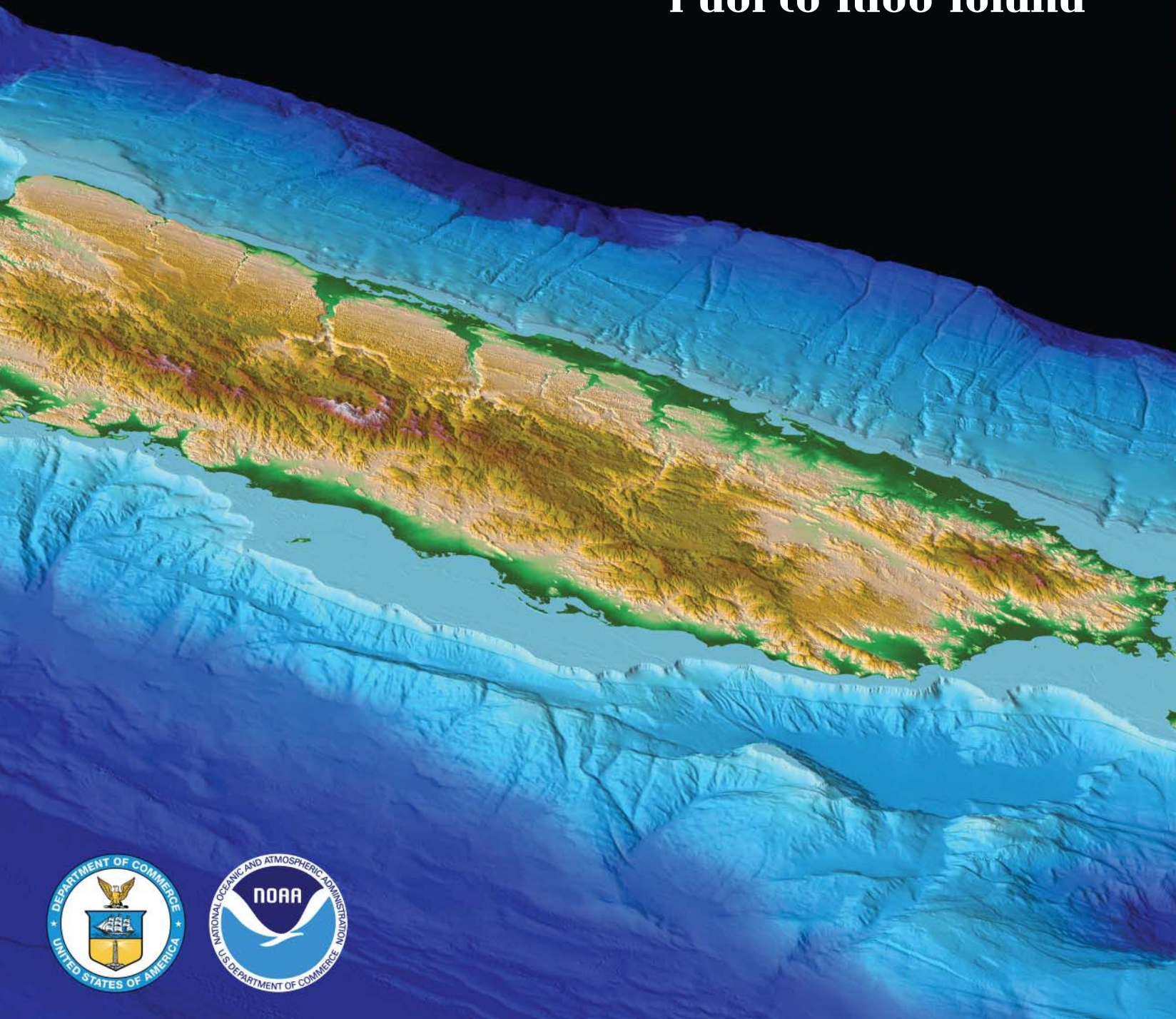DIGITAL ELEVATION MODEL
Puerto Rico Island

PUERTO RICO ISLAND

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Why Model Puerto Rico Island?

The Commonwealth of Puerto Rico encompasses an area of nearly 14,000 square kilometers and consists of the main island of Puerto Rico and several smaller islands, including Vieques, Mona, and Culebra. Located approximately 1,000 miles southeast of Miami, between the Caribbean Sea and the North Atlantic Ocean, Puerto Rico is a land of mountainous terrain, tropical rain forests, and large coastal lowlands. Agriculture, pharmaceuticals, technology, and tourism are the major economic drivers in Puerto Rico. An estimated seven percent of the Gross National Product is associated with the millions of tourists that visit the Island each year. The largest concentration of people on the island is in the San Juan – Carolina – Bayamón area where about one-third of Puerto Rico's nearly 4 million inhabitants live. Puerto Rico also lies at the boundary between the North American and Caribbean tectonic plates and is subject to earthquakes and tsunamis. The most recent deadly tsunami was the 1918 Mona Passage event that caused extensive damage along the western and northern coasts of Puerto Rico. This regional DEM can lead to more accurate mapping of inundation due to tsunamis, hurricane, and other coastal flooding events and can help local managers mitigate the impacts of coastal hazards.
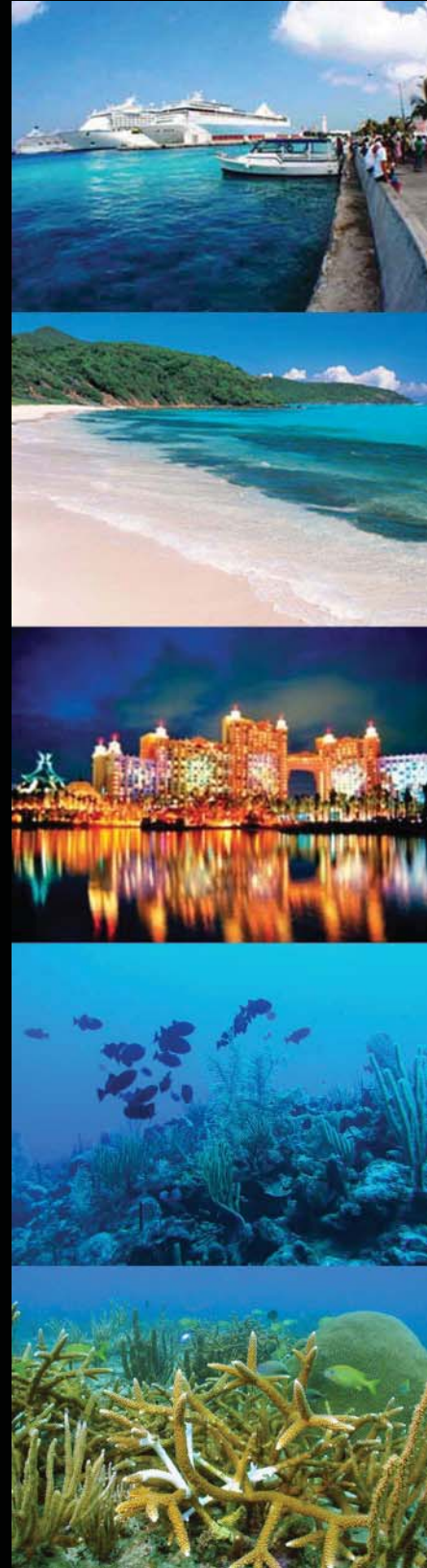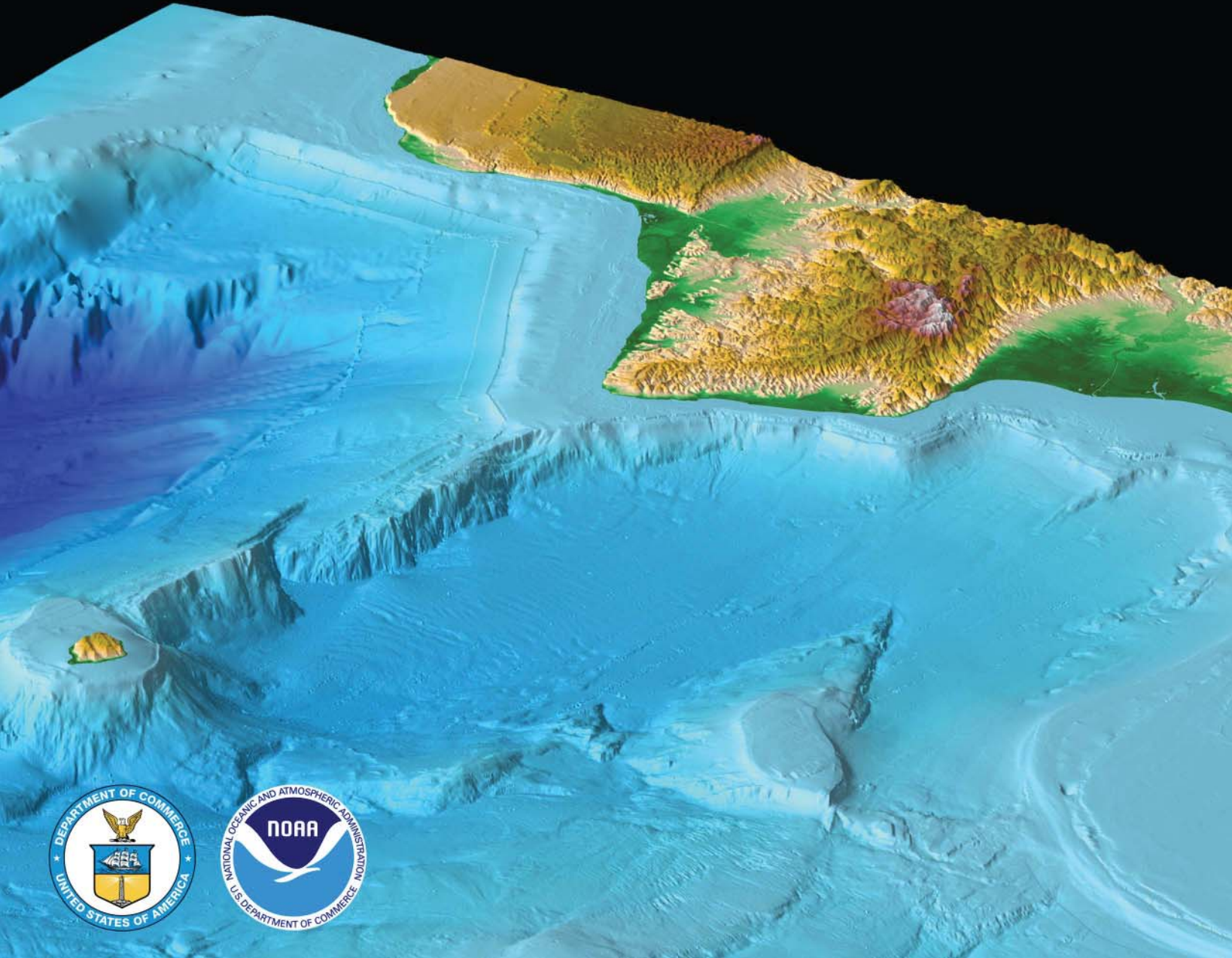
Who Provided the Data?

- The U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Science (NCOOS)

DIGITAL ELEVATION MODEL
Mayaguez

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Why Model Mayaguez?

The city of Mayagüez is located on the west-central coast of Puerto Rico, covering almost 200 square kilometers, with a population of roughly 104,557 people. Mayaguez was founded in 1760 and is now one of the largest municipalities on the island. The area has local universities, a few large companies, and is a popular tourist destination. Geographically, two large rivers have helped carve the now coastal plains, river valleys, and marshlands of the region. The Añasco River to the north and the Guanajibo River to the south of Mayagüez both empty into the Caribbean Sea and flow into the Mona Passage. The Mona Passage was the site of the deadly 1918 magnitude 7.3 earthquake that generated a tsunami that caused extensive damage along Puerto Rico's western and northern coasts, killing 100 people in Mayagüez. Offshore islands include Mona Island and Monito Island. The Mayaguez DEM will serve as an important tool for hazard managers in the region to help determine the effects and mitigate the impacts and risks associated with future tsunami and severe storm events.
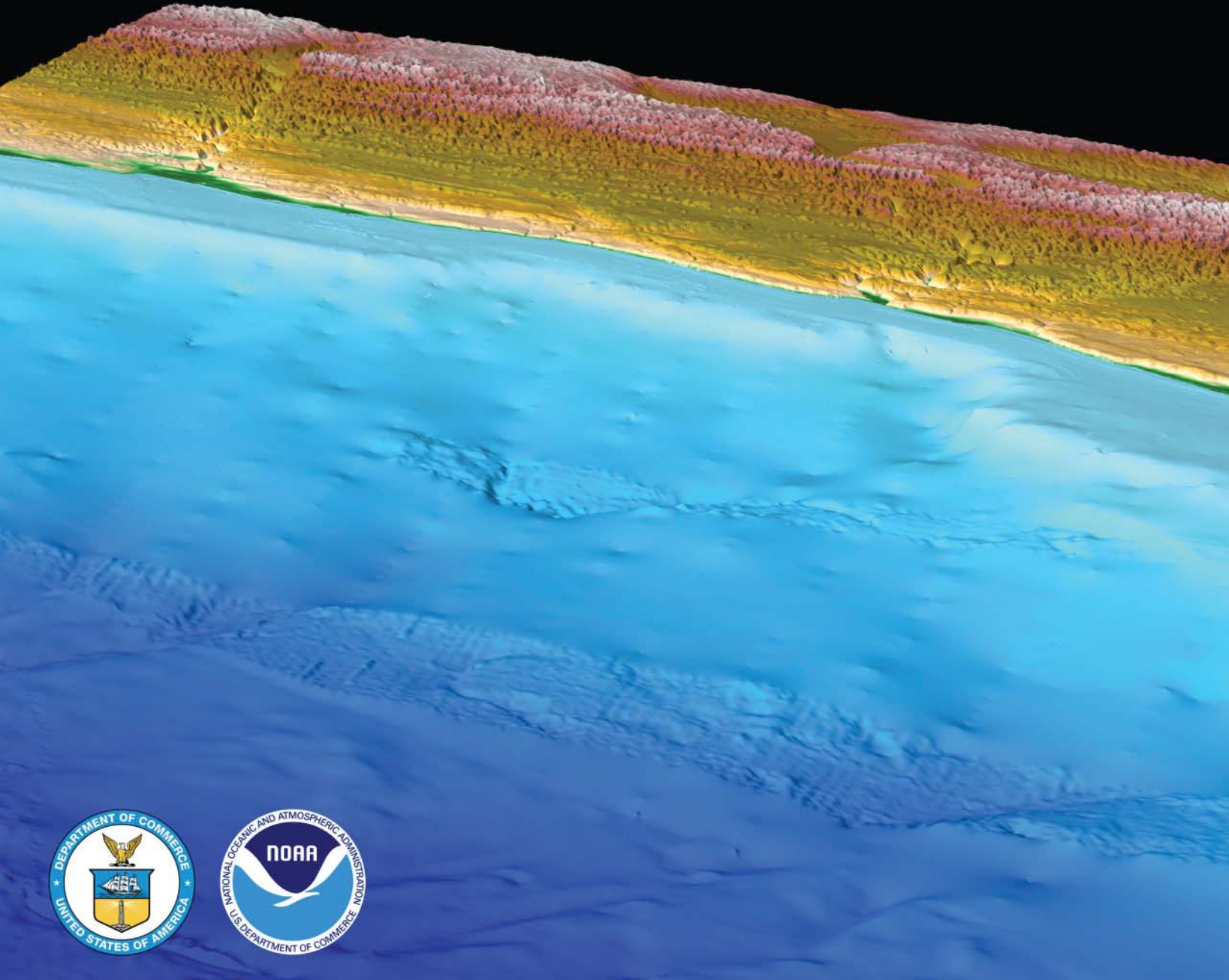
Who Provided the Data?

- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Service (NCOOS)

Photo Credit: mayaguezvacations.com

DIGITAL ELEVATION MODEL
## Arecibo

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Why Model Arecibo?

The city of Arecibo is located on the northern mid-west coast of Puerto Rico north of Utuado and east of Hatillo. The city was founded in 1616 and is home to over 100,000 residents. The municipality has the largest land mass in Puerto Rico and is an official U.S. port of entry. The town has two major rivers flowing through it – the Grande de Arecibo and Tanama– which flow through the Northern Coastal Valley. The town is most famous for hosting the Arecibo Observatory, which has the world's most powerful radar-radio telescope. The national research center is operated by Cornell University in agreement with the National Science Foundation. Each year, over 200 scientists visit the Observatory to pursue research opportunities. In 1918, the Mona Passage tsunami caused 40 deaths in this region of Puerto Rico. Elevation modeling of Arecibo is important for hazard managers in the region to help determine the effects and risks associated with future tsunami, inundation, and severe storm events.

Who Provided the Data?

  - U.S. Department of Agriculture (USDA)
  - U.S. Geological Survey (USGS)
  - NOAA National Ocean Service (NOS)
  - NOAA National Centers for Coastal
    Ocean Service (NCOOS)

DIGITAL ELEVATION MODEL
San Juan

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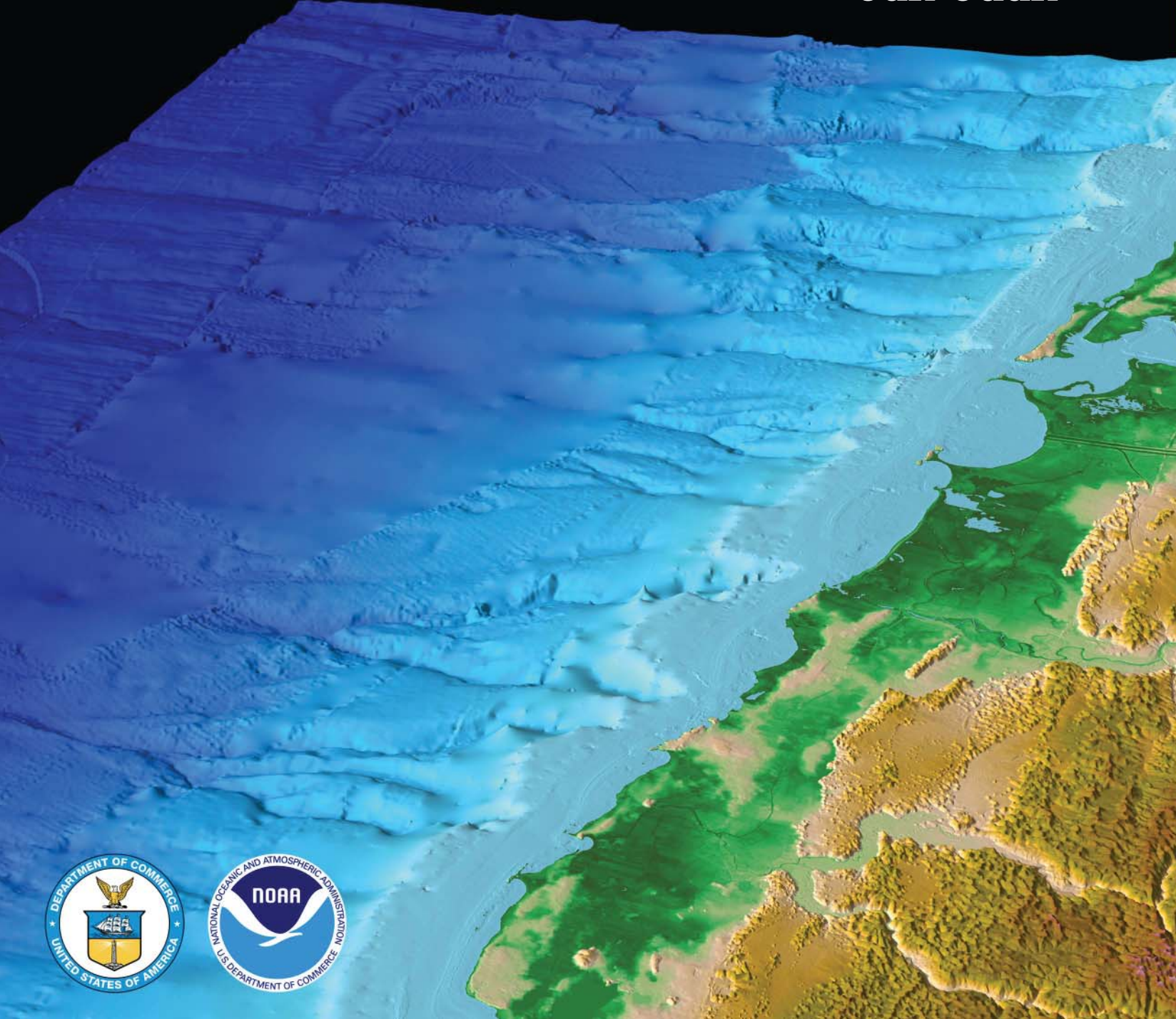
Why Model San Juan?

San Juan is the capital of Puerto Rico, and is located on the northeast coast with one of the largest harbors in the Caribbean. It was founded in 1521 and has become one of the major tourist destinations and cultural areas in the West Indies. Currently, San Juan is the island's financial hub, greatest processing center, and largest metropolitan area. San Juan covers 200 square kilometers and has a population of roughly 442,400 people. This Spanish colonial city is well known for its historical squares, cultural museums, boutiques, and restaurants. Geographically, the Bayamón River lies west of San Juan and empties into the Atlantic Ocean. The San Juan DEM and other detailed information about the terrain surrounding the city can help local managers to prepare for future storm and hazard events that are associated with inundation, large wave events, and geologic changes.
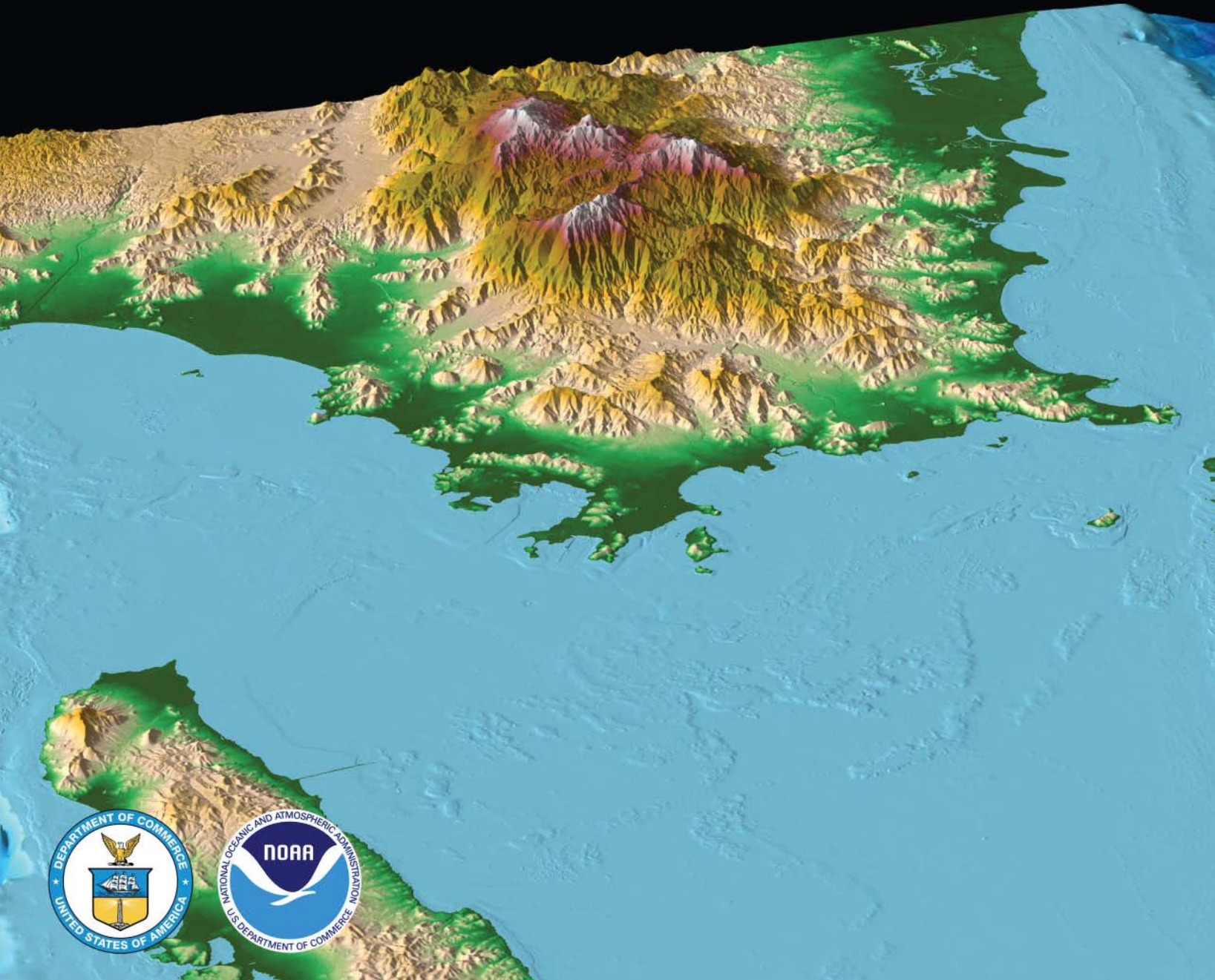
Who Provided the Data?

- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Service (NCOOS)

Photo Credit: www.nps.gov, http://sanjuan.pr/default.aspx

DIGITAL ELEVATION MODEL
Fajardo

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Why Model Fajardo?

Fajardo is located on the eastern coast of Puerto Rico, to the east of Luquillo and north of Ceiba. The city was founded in 1772 and is home to more than 40,000 people. This coastal hub serves as one of the principal recreational boating centers and harbors in Puerto Rico – transporting both people and goods between local ports and shipping hubs including the Virgin Islands, Vieques, and Culebra. Fajardo boasts Puerto del Rey- the largest Marina in the Caribbean. The small city is a popular tourist attraction for locals and visitors because of its beaches, boating opportunities, seafood, nearby coral islands, scuba, and headlands. Las Cabezas de San Juan Nature Preserve – one of the most popular and important conservation areas on the island, is home to a variety of endangered species. The preserve features mangroves, coral reefs, beaches, bioluminescent lagoons, and many small islands. The Fajardo DEM is an important tool for hazard managers in the region and can also support habitat characterization and coastal planning efforts.
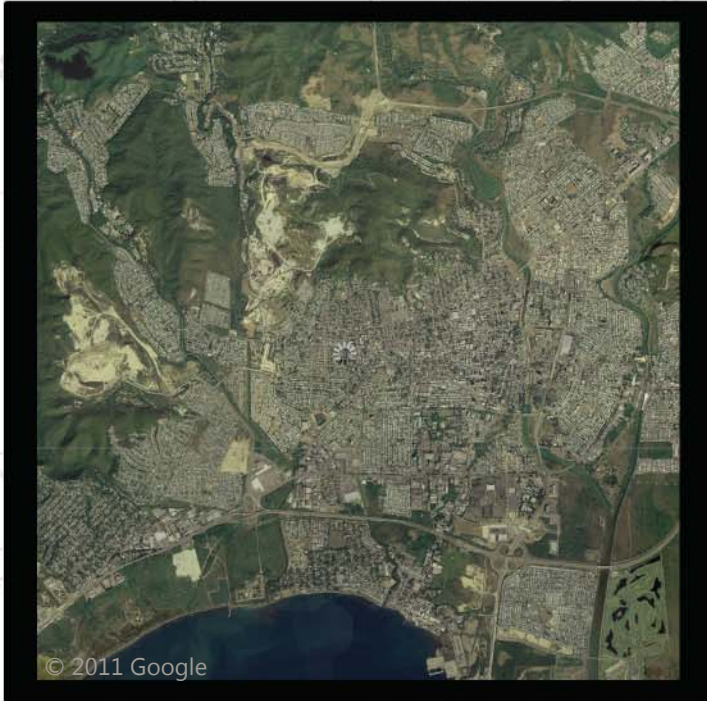
Who Provided the Data?

- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Service (NCOOS)

DIGITAL ELEVATION MODEL
Ponce

NOAA Knows....
PONCE

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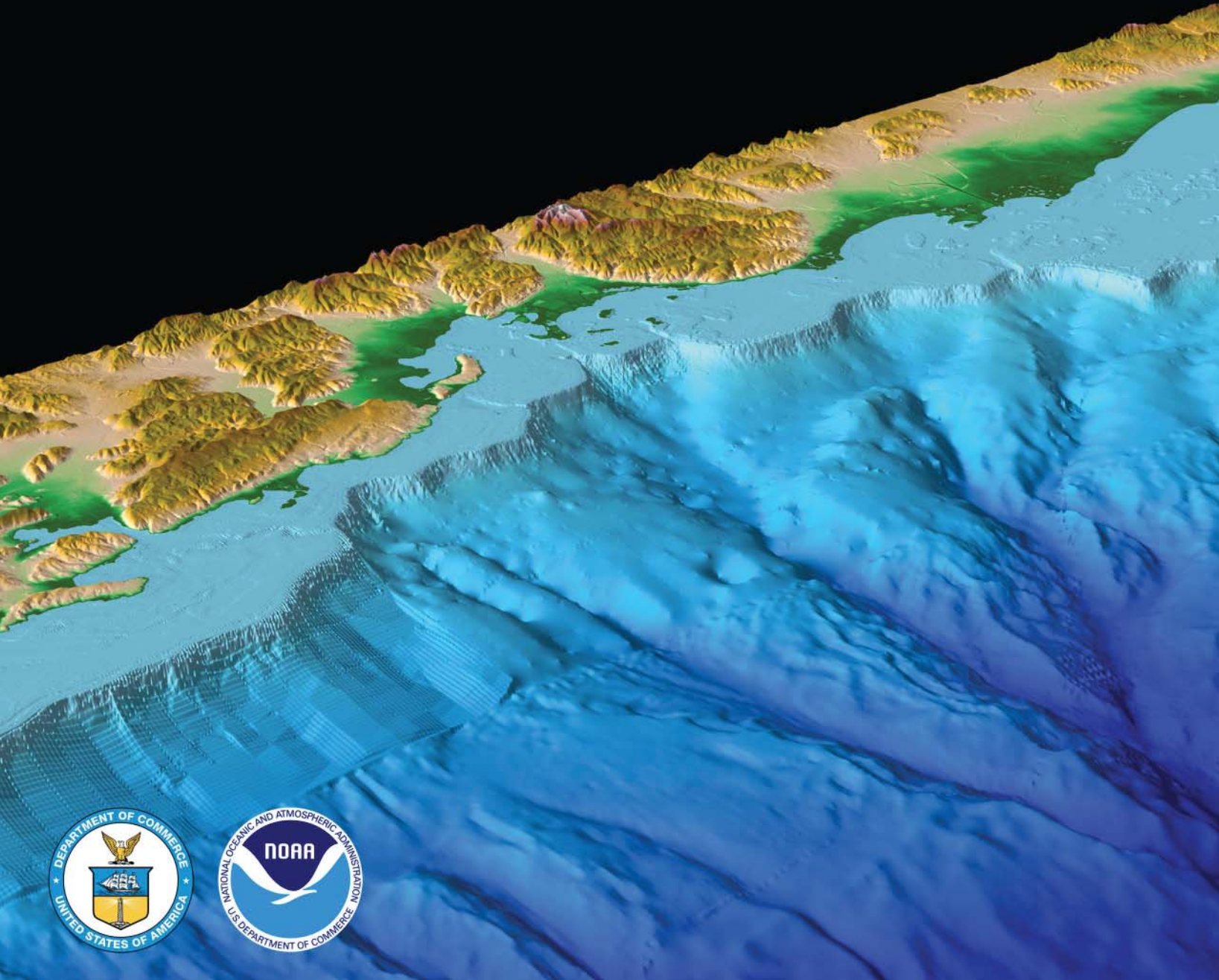
Why Model Ponce?

Ponce is located in the Southern Coastal Plain region of Puerto Rico between Penuelas and Juana Diaz. The city covers about 120 square kilometers and has a metropolitan population of roughly 442,220 people – making it the second largest city in Puerto Rico after San Juan. Economically, traditional sugar cane and coffee industries have been surpassed by the retail, manufacturing sector, and tourism industries. The city serves as a center for commonwealth and federal government agencies and is the seat of the local municipal government. Ponce's cityscape is rich in history, culture, and architecture with museums, squares, eateries, and bustling shorelines around every corner. The land area is made up of various rivers systems, coastal inlets, and keys. In 1918, Ponce lost four people to the tsunami generated by a strong earthquake in the Mona Passage. This DEM and detailed information about the terrain can help local managers prepare for future storm and hazard events that are associated with inundation, large wave events, and geologic changes.

Who Provided the Data?

- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Service (NCOOS)

DIGITAL ELEVATION MODEL
# Guayama

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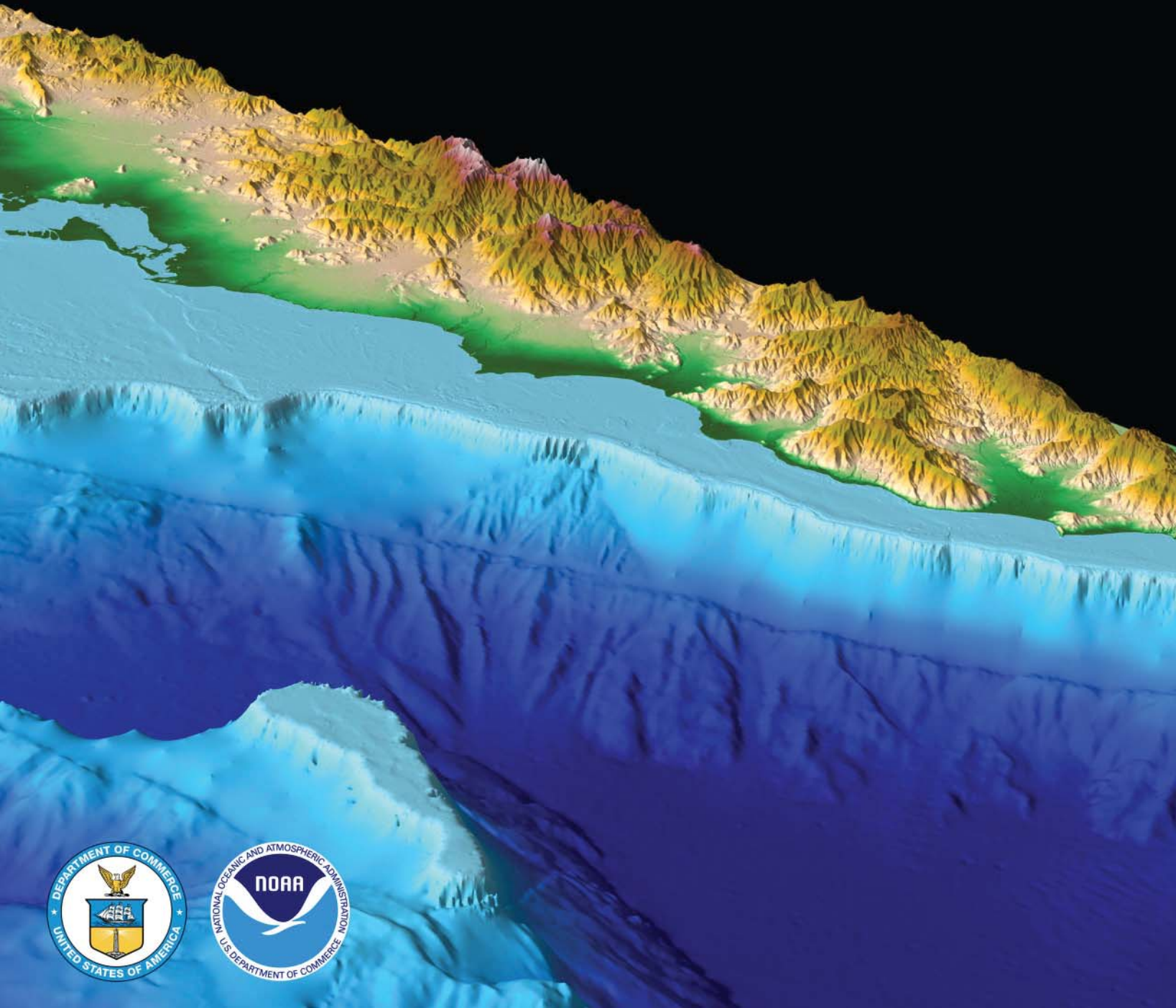
Why Model Guayama?

Guayama is located in the Southern Coastal Valley region on the south-central coast of Puerto Rico, north of the Muertos Trough in the Caribbean Sea. Also known as "Pueblo de los Brujos," or the city of witches, it was founded in 1736 and was a major player in the Spanish-American war. The city covers about 200 square kilometers and is home to roughly 45,000 people. Guayama is a large producer of tobacco, sugar, coffee, and livestock. The city is home to the Aguirre Forest and the well known Jobos Bay National Estuarine Research Reserve – which includes 2, 883 acres of freshwater wetlands, mangrove forests, lagoons, and coral reefs. The Guayama DEM and the underlying data provide essential information that can help coastal managers and scientists understand and plan for the many uses and challenges facing their coastal region.

Who Provided the Data?

- U.S. Department of Agriculture (USDA)
- U.S. Geological Survey (USGS)
- NOAA National Ocean Service (NOS)
- NOAA National Centers for Coastal Ocean Service (NCOOS)

DIGITAL ELEVATION MODEL
U.S. Virgin Islands

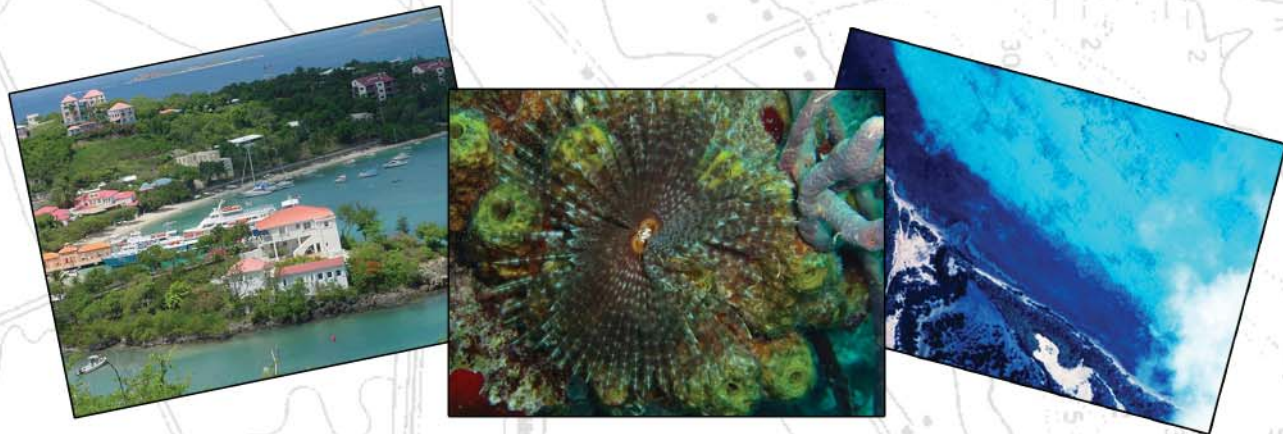# U.S. VIRGIN ISLANDS

© 2011 Google
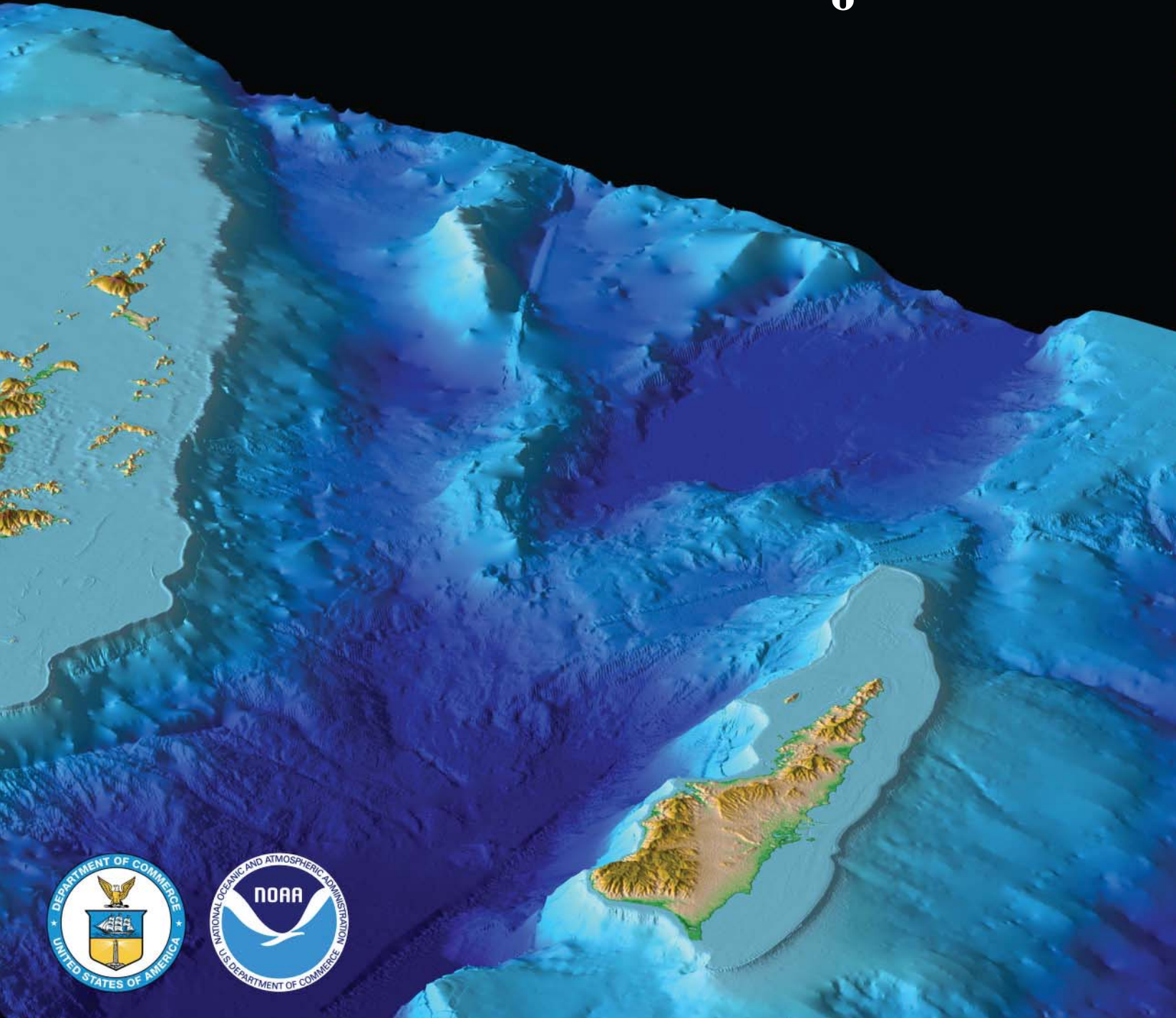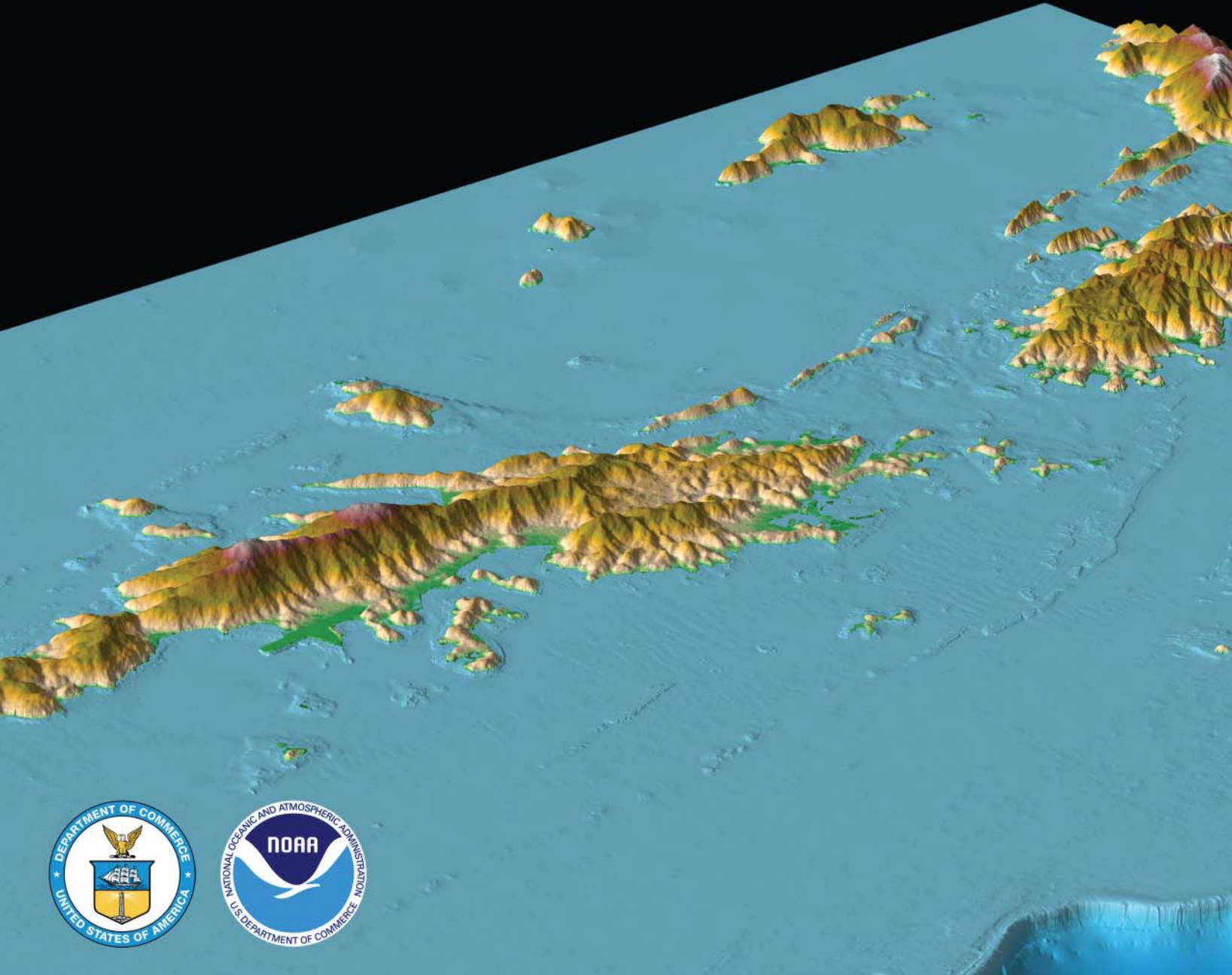
Why Model the U.S. Virgin Islands?

The Virgin Islands are a group of islands located in the Leeward Islands of the Lesser Antilles in the Caribbean Sea. The U.S. Virgin Islands consist of the main islands of St. Thomas, St. John, and St. Croix, and include many smaller islands. In 1690 an earthquake in the Leeward Islands resulted in the earliest record of a tsunami affecting any present U.S. territory. The region is at risk from tsunami by several different mechanisms: teletsunamis, or tsunamis that originate from earthquakes in far away regions; local earthquakes along the North American and Caribbean tectonic plate margins; volcanic eruptions; and local landslides. There have been two significant tsunamis from local earthquakes, one in 1867 and the other in 1918. Both caused considerable damage. The 1867 tsunami— generated from a violent earthquake 15 to 20 kilometers southwest of St. Thomas— is the deadliest tsunami for the U.S. Virgin Islands to date. Thirty people died as a result of the tsunami. There are also two recorded tsunamis that have hit the Virgin Islands region from far-field sources, one in 1755 and another in 1761, both from earthquakes near Lisbon, Portugal. Frequent hurricanes are of major concern to residents of the Virgin Islands. It is very important to assess how the community may be affected by a storm surge or tsunami wave, and DEMs help local planners and researchers prepare the community for a possible disaster.

Who Provided the Data?

- NOAA National Geophysical Data Center (NGDC)
- NOAA National Ocean Service (NOS)
- NOAA Office of Coast Survey (OCS)
- NOAA Center for Coastal Monitoring and Assessment (CCMA)
- U.S. Geological Survey (USGS)
- National Aeronautics and Space Administration (NASA)

DIGITAL ELEVATION MODEL
St. Thomas - St. John

ST. THOMAS - ST. JOHN

National Oceanic and Atmospheric Administration
U.S. Department of Commerce

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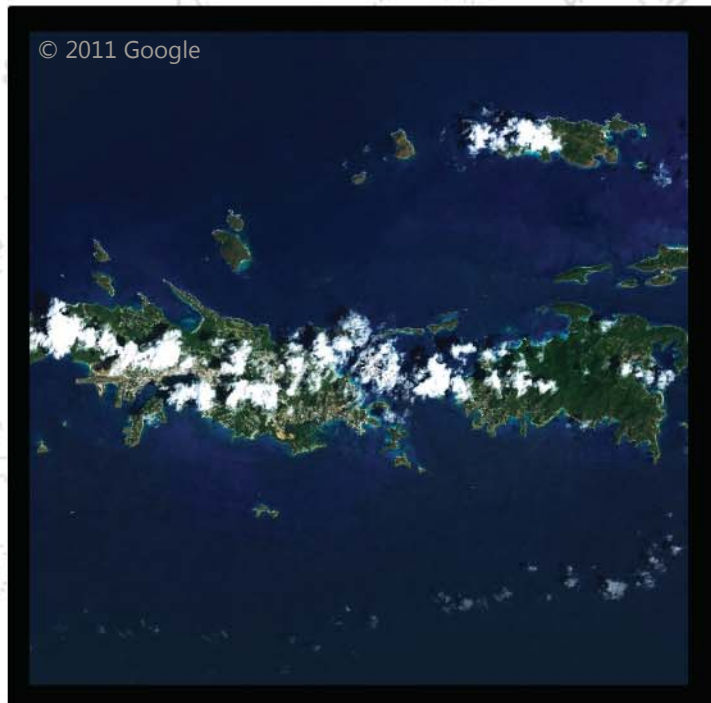
Why Model St. Thomas and St. John?

St. John and St. Thomas are two U.S. Virgin Islands located in the Caribbean Sea and Atlantic Ocean. Originally part of the Danish West Indies, the islands were sold to the United States in 1916 as part of the Treaty of the Danish West Indies. The islands are popular vacation destinations that host millions of visitors each year. Tourism drives the local economy, along with petroleum, rum, and small commercial industries. Overall, the islands are known worldwide as an exclusive travel destination and honeymoon location. Unlike St. Thomas, more than half of the sparsely developed St. John is protected through the National Park Service. The earliest recorded tsunami impacting these islands was due to an 1867 earthquake along the north scarp of the Anegada Trough approximately 15-20 kilometers southwest of St. Thomas. The tsunami caused twelve deaths and extreme damage in Charlotte Amalie, on St. Thomas, and a total of thirty deaths across the U.S. Virgin Islands. In addition, large wave events, hurricanes, and ocean storms threaten island communities, making integrated coastal elevation models and the underlying data a useful tool for hazard managers and community planners. DEMs can help to determine potential inundation from future tsunami and storm events.
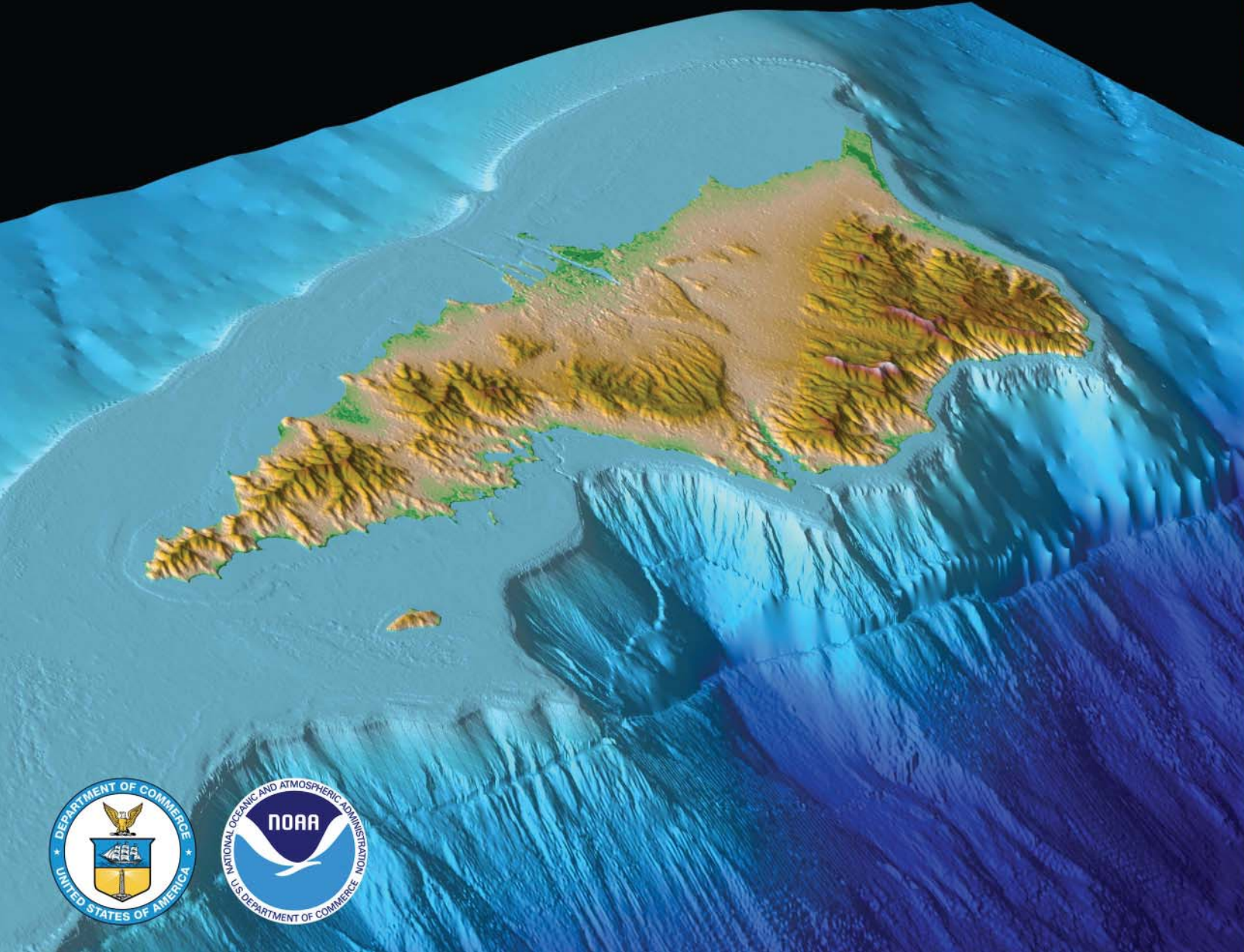
Who Provided the Data?

- NOAA National Geophysical Data Center (NGDC)
- NOAA National Ocean Service (NOS)
- NOAA Office of Coast Survey (OCS)
- NOAA Center for Coastal Monitoring and Assessment (CCMA)
- U.S. Geological Survey (USGS)
- National Aeronautics and Space Administration (NASA)
- University of Virgin Islands (UVI)

Photo Credit: www.stjohnbeachguide.com

DIGITAL ELEVATION MODEL
St. Croix

NOAA Knows....
ST. CROIX

National Oceanic and Atmospheric Administration

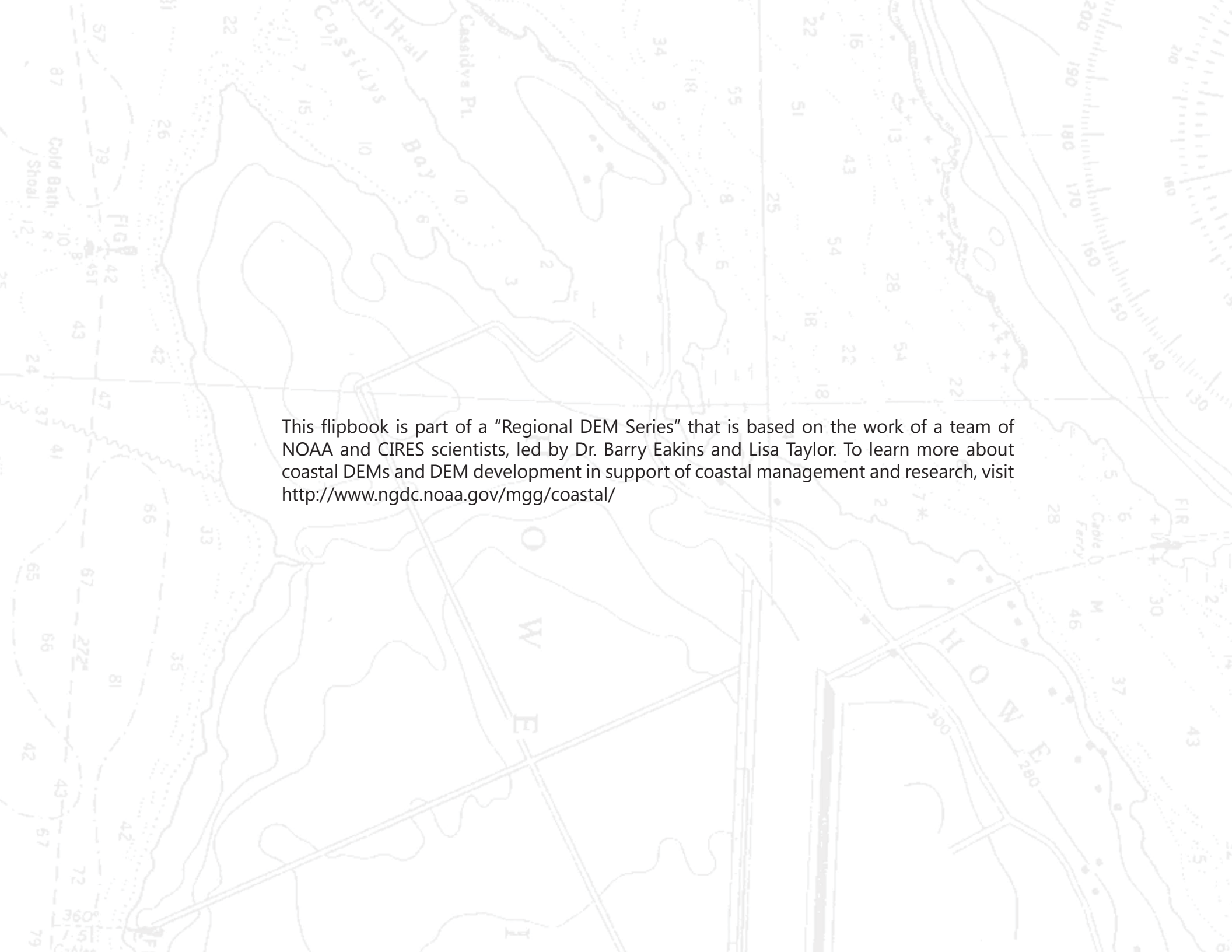U.S. Department of Commerce

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Why Model St. Croix?

St. Croix is the largest of the U.S. Virgin Islands and has a total population of roughly 60,000 people. The island's two towns- Christiansted and Frederiksted, serve as the main cultural centers. A large majority of St. Croix's economy is driven by tourism. Around the island, diving and snorkeling outfitters cater to tourists seeking to see coral reefs, tropical fish, sea turtles, and sharks. Cane Bay, on the islands north shore, is perhaps one of the most popular locations to dive as the underwater topography changes from corals and sands to an abrupt drop into a deep trench. In addition, the Buck Island Reef National Monument, Sandy Point National Wildlife Refuge, Christiansted National Historic Site, and Green Cay National Wildlife Refuge are "go-to" local attractions. Other industries on St. Croix include oil refineries and the infamous dark rum distilleries. The tsunami generated by an 1867 earthquake southwest of St. Thomas caused five deaths and significant damage in Frederiksted, including stranding the USS Monongahela on a rocky wharf. Occasional coastal storms, high winds, and inundation events threaten communities and visitors on the island. This DEM and the underlying data provide essential information that can help coastal managers and scientists understand and plan for the many uses of and challenges facing their coastal region, including future storm and hazardous events.

Who Provided the Data?

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- NOAA Center for Coastal Monitoring and Assessment (CCMA)
- U.S. Geological Survey (USGS)
- National Aeronautics and Space Administration (NASA)
- University of Virgin Islands (UVI)

http://www.ngdc.noaa.gov/mgg/coastal/

dem.info@noaa.gov

This flipbook is part of a "Regional DEM Series" that is based on the work of a team of NOAA and CIRES scientists, led by Dr. Barry Eakins and Lisa Taylor. To learn more about coastal DEMs and DEM development in support of coastal management and research, visit http://www.ngdc.noaa.gov/mgg/coastal/

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