How Can Health Professionals Use NASA Data: Acquiring and Using Environmental Data for Health Applications

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Outline

• Working with the Environmental Public Health Community
• Project Examples
• You have a health issue and want to determine if remote sensing data can be beneficial
• Acquiring remote sensing data
• Acquiring health data
• Linking remote sensing and health data
• Homework
Challenges Working with the Environmental Public Health Community (International & Domestic)

• Sharing data between agencies with different missions and mindsets
• Protecting confidentiality of information
• Ensuring high quality geocoded data
• Ensuring appropriate spatial and temporal resolution of environmental data
• Developing sound resources and methods for conducting data linkages and data analysis
Observations to Applications

Satellite Measurements

Satellite Products

Environmental Applications
Examples of Data Applications
Environmental Public Health

• Remote sensing and modeling data, along with other sources of data, are used for a variety of applications, either:
  – directly
  – in statistical or physical modeling tools

• Remotely sensed data can be used:
  – to identify the hottest areas
  – improve identification of locations most vulnerable during extreme heat events
Examples of Data Applications
Fires, Smoke, and Public Health

- This environmental data can be combined with public health data to evaluate the effect of fires and smoke on Asthma rates in Florida or other U.S. regions.
Examples of Data Applications

Relationship Between Living Environment and Blood Pressure

Landsat data was used at the native resolution of 30 m and resampled at other resolution to determine the optimal scale to distinguish urban, suburban, and rural living environments in the metropolitan Atlanta region.

<table>
<thead>
<tr>
<th>Living Environment</th>
<th>Mean SBP</th>
<th>Mean DBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban</td>
<td>131±0.54</td>
<td>78±0.31</td>
</tr>
<tr>
<td>Suburban</td>
<td>127±0.42</td>
<td>77±0.24</td>
</tr>
<tr>
<td>Rural</td>
<td>127±0.76</td>
<td>76±0.44</td>
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</table>

*p-Value* <0.0001 >0.0001
Health Problem

• What question or questions are you trying to answer?
• What type environmental data products do you need that NASA could provide?
  – Land Cover/Land Use: blood pressure
  – Vegetation Extent: urban heating/heat stroke
  – Slope: natural disasters/landslides
  – Air Quality: respiratory illnesses
  – Water Quality (fresh or marine): red tides, respiratory, gastrointestinal illnesses
  – Precipitation: flooding and disasters
  – Soil Moisture: mosquito, vector borne diseases
  – Land Surface Temperature: extreme heat
Acquiring Remotely Sensed Data

- NASA
  - Reverb – ECHO NASA  [https://reverb.echo.nasa.gov/reverb](https://reverb.echo.nasa.gov/reverb)
  - EARTHDATA (EOSDIS)
    - Browse and download processed data

- USGS
  - Global Visualization Viewer (GloVis)
  - Earth Explorer (USGS)
Reverb

http://reverb.echo.nasa.gov/reverb/

• Next generation metadata and service discovery tool
• Developed using modern web development technologies and presents you with an interface for discovering Earth Science data
• Updated on a monthly basis taking into account your user feedback and other, currently planned enhancements
Spatial & Temporal Search
Science Key Words
Science Key Words
Granule Results
Ordering Granules

• Click on shopping cart icon to retrieve files of interest
  – Order, download or request services
• Using as a guest requires completion of a form each time. If you have an account this will not be needed
• Submit order to begin processing
• Will get order tracking number by email
• ftp links will follow for data download

• HDF format is ingestible into ArcMap/QGIS without data conversion to a geotiff
REVERB Data Retrieval and Ordering Overview

- Search for data using temporal and spatial constraints, specific data attributes, and processing levels
- Use map to drag a bounding box over the region of interest
- Platform and instrument search options menu
- Use calendar widget to set temporal range
- Can add keyword using text field
- When finished, click “search for granules” radio button
- Select granules for shopping cart and order
Earthdata
http://earthdata.nasa.gov/

• The Earth Observing System Data and Information System (EOSDIS) is a key core capability in NASA’s Earth Science Data Systems Program

• It provides end-to-end capabilities for managing NASA’s Earth science data from various sources
  – satellites
  – aircraft
  – field measurements
  – various other programs
Earthdata: Public Health
Earthdata: Human Dimensions

Human Dimensions Data at EOSDIS

Within the Human Dimensions discipline, EOSDIS DAACs hold a wide variety of socioeconomic data (e.g., population, infrastructure, economic resources) and products concerning human interactions in the environment (e.g., natural hazards, human impacts). Most of these data sets are provided by the Socioeconomic Data and Applications Center (SEDAC), whose mission is to develop and operate applications to support the integration of socioeconomic and Earth science data, and to serve as an “information gateway” between the Earth and social sciences. Several other DAACs also hold Human Dimensions data as they relate to their respective disciplines.

Available Measurements

Click on one of the measurements below to explore the data in Earthdata Search:

- Boundaries
- Economic Resources
- Environmental
- Governance/Management
- Environmental Impacts
- Habitat Conversion/Fragmentation
- Human Settlements
- Infrastructure
- Natural Hazards
- Population
- Public Health
- Social Behavior
- Socioeconomics
- Sustainability

Learn more about Human Dimensions Data at EOSDIS

Learn more about Human Dimensions Data at EOSDIS by reading Sensing Our Planet articles that feature research utilizing Earth Observing data from the NASA Earth Observing System Data and Information System (EOSDIS) Distributed Active Archive Centers (DAACs) and watch NASA Earthdata Webinar videos to learn more about NASA Earth science data sets, services and tools to discover, access and use these data. There is also an human dimensions discipline reference sheet available from the Outreach Products page.

Strange bedfellows

Read this Sensing Our Planet article to find out if the delicate relationship between fire and plants are changing.
Earthdata: Environmental Sustainability Example
URL Direct Download
Sustainability Indicator Example

The 2014 EPI ranks 178 countries on 20 performance indicators in the following 9 policy categories: health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, and climate and energy. These categories track performance and progress on two broad policy objectives, environmental health and ecosystem vitality. Each indicator has an associated environmental public health or ecosystem sustainability target. The full report including a complete description of the EPI, underlying data sets, and methodology is available online at the NASA Socioeconomic Data and Applications Center (SEDAC).


http://dx.doi.org/10.7910/D44-44855.


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Example of EPI data for one air pollutant category

### Air Pollution (PM2.5) - Population weighted exposure to PM2.5 (micro-grams per cubic meter)

Source: Aaron van Donkelaar (in prep), 2014 (embargoed)

Notes: NA = Not Applicable

<table>
<thead>
<tr>
<th>Country</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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<td>10.64</td>
<td>10.81</td>
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<td>13.77</td>
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<tr>
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<td>8.74</td>
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<tr>
<td>American Samoa</td>
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<td>3.08</td>
<td>3.13</td>
<td>3.13</td>
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<tr>
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<td>3.59</td>
<td>6.66</td>
<td>6.41</td>
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<tr>
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<td>0.7</td>
<td>0.97</td>
<td>0.97</td>
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<tr>
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<td>2.56</td>
<td>2.7</td>
<td>3.05</td>
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<td>Argentina</td>
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<td>5.33</td>
<td>5.34</td>
<td>5.25</td>
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<tr>
<td>Armenia</td>
<td>12.24</td>
<td>9.17</td>
<td>13.36</td>
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<td>Austria</td>
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<tr>
<td>Azerbaijan</td>
<td>12.93</td>
<td>12.62</td>
<td>11.57</td>
<td>10.49</td>
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<tr>
<td>Bahamas</td>
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<td>6.31</td>
<td>5.93</td>
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<tr>
<td>Bahrain</td>
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<td>10.37</td>
<td>10.37</td>
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<tr>
<td>Bangladesh</td>
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<tr>
<td>Barbados</td>
<td>2.89</td>
<td>2.88</td>
<td>2.99</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Earthdata Menu
USGS Data Retrieval Tools

• Global Visualization Viewer (GloVis)
• Earth Explorer
USGS Global Visualization Viewer (GloVis Next)

http://glovis.usgs.gov/next/
GloVis Next
Coverage Area and Scene Selection
Review Metadata and Download
EarthExplorer (EE)

http://earthexplorer.usgs.gov/

- Spatial search with map
- Select dataset
- Select results
  - Footprint
  - Browse
  - Metadata
  - Download
- Additional Criteria (cloud cover, etc.)
- Must login to download data
Using Earth Explorer
Direct Download of Files
Data Order
Linking Environmental and Health Data

• Problem: how do I get environmental and health data in the same geographic space for analyses?
  – Open Source Geospatial Tools (R, python, etc.)
  – ArcGIS
  – ArcGIS online (https://www.arcgis.com/home/index.html)
  – Erdas/ENVI
  – **Google Earth Engine (GEE)**
GEE

http://earthengine.google.com/

A planetary-scale platform for Earth science data & analysis
Powered by Google’s cloud infrastructure

Meet Earth Engine

Google Earth Engine combines a multi-source catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities and makes it available for scientists, researchers, and developers to detect changes, map trends, and quantify differences on the Earth’s surface.

SATellite IMAGERY + YOUR ALGORITHMS + REAL WORLD APPLICATIONS

LEARN MORE
Tabs for Timelapse and Datasets

Google Earth Engine

Timelapse

Landsat

Landsat, a joint program of the USGS and NASA, has been observing the Earth continuously from 1972 through the present day. Today, the Landsat satellites image the entire Earth’s surface at a 30-meter resolution about once every two weeks, including multispectral and thermal data. Earth Engine makes this data available in its raw form as TerraSAR compressed reflectance, and in natural color to use computed products such as NDVI and EVI vegetation indices.

View Landsat data in Earth Engine.

Sentinel

The Sentinel-1 mission uses radar to image the Earth in all weather conditions, even at night. The satellites capture C-band synthetic aperture radar (SAR) image data at 30- to 120-meter resolution in several polarization modes. Earth Engine includes a growing collection of Sentinel-1 data preprocessed using the Sentinel-1 Toolbox.

View Sentinel data in Earth Engine.

MODIS

The Moderate Resolution Imaging Spectroradiometer (MODIS) sensors on NASA’s Terra and Aqua satellites have been acquiring images of the Earth’s land since 1999. The Earth Engine catalog includes a variety of data products that NASA produces from MODIS data, including daily imagery, 8-day BRDF-adjusted surface reflectance, and derived products such as vegetation indices and snow cover.

View MODIS data in Earth Engine.
Data Catalogue
Open Sensor of Interest

Landsat
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Search Landsat data in Earth Engine

Sentinel
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View Sentinel data in Earth Engine

MODIS
The Moderate Resolution Imaging Spectroradiometer (MODIS) sensors on NASA’s Terra and Aqua satellites have been acquiring images of the Earth daily since 1999. The Earth Engine catalog includes a variety of data products that NASA produces from MODIS data, including daily imagery, 16-day BRDF-adjusted surface reflectance, and derived products such as vegetation indices and snow cover.

Search MODIS data in Earth Engine.
Case Studies

Reported Malaria cases increased from 2014 to 2015 in the following 12 countries: Algeria, China, Dominican Republic, Indonesia, Iran, Iraq, Malaysia, Philippines, Republic of Korea, Saudi Arabia, and the Solomon Islands.

Dr. Hugh Sturrock, UCSF Global Health Group, Digital Epidemiologist

Collect Earth

Collect Earth: implemented by the Food and Agriculture Organization (FAO) of the United Nations, is a free open-source platform.

Regional Progress

Global malaria eradication will be achieved region by region, requiring greater collaboration among neighboring countries. The biggest challenges to eliminating malaria are cross-border transmission and importation. Malaria cases carry the malaria parasite into new territories. Regional collaborations enhance political commitment, build consensus, and engage stakeholders.

Reported Malaria cases by country in the Indonesia region
Sign up for Earth Engine
https://earthengine.google.com/signup

Earth Engine is free for research, education and non profit use
Acquiring Health Data

- NASA doesn’t collect health data
- CDC, hospital admissions and emergency department records are good sources
- Mortality and morbidity plus location of death or illness are essential data to evaluate linkages between health outcomes and the physical environment
- The Centers for Disease Control WONDER website provides health data on a county wide scale for the U.S. http://wonder.cdc.gov/
Wrap-up

• Two NASA and two USGS based search and retrieval tools presented
  – All tools have features for spatial, temporal and thematic searches for data and information.
  – Which tool is best for you maybe a combination of personal preference and the type data you need.
• Google Earth Engine is a powerful resource for both data retrieval and geoprocessing analysis
  – Also a portal to various type of health related information
Homework: Reverb

1. Do a global data search, so no need for a bounding box
• Set the temporal criteria for July 1-5, 2016
• Set key science words as land surface temperature
• Select this dataset from the list: MODIS/Aqua Land Surface Temperature/Emissivity 8-Day L3 Global 0.05Deg CMG V041
• Search for granules
• Compare side by side the two browse images one from June 25 to July 2 (1st image) and the other from July 3 (2nd image) to July 10 to answer these questions:
  – Q: Is the regional temperature for the Southeast United States warming, cooling or about the same between the 2 8-day composite images?
  – Q: Is the regional temperature for north Africa warming, cooling or about the same between the 2 8-day composite images?
Homework: Search, Acquiring, and Using Earthdata

Use the EARTH DATA tool to locate the dataset for Environmental Performance Index 2014 and access the health impacts file to answer the questions below

• Q: Is child mortality higher or lower in the year 1990 in the United States of America or Guadeloupe?
• Q: Same question in 2014?
Homework: GloVis

3. Use GloVis to find a L8 OLI/TIRS scene from 2016 that has less than 10% cloud cover for Metropolitan Atlanta (all areas inside I-285, the loop road)
   • Write down the Landsat Scene Identifier
   • Note the Cloud Cover Percent
• 4. Use Google Earth Engine to determine the following:
  – 4a. Since 1990 when did Malaria cases peak in Paraguay, South America?
  – 4b. What was the cause of this outbreak?