# http://sos.noaa.gov/Docs/NOAA-Transparent-Logo.pngClimate Change and Health

*By: Eryka Thorley CIRES Intern 2013*

This Science On a Sphere® script explores the relationship between climate change and health. It was developed for a target audience of high school-aged and beyond but can be adapted for any audience. Audience interaction and discussion is beneficial to this script as it will increase understanding of the general relationship between health and climate. Familiarize yourself with the script directions prior to presenting as there are various pauses, overlays, and annotate features that are beneficial to the flow of the script.

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| **Dataset Title:** | **Script:** | **Directions:** |
| 1. Blue Marble (23 degree tilt)
 | *(Introduce SOS according to your location’s procedures.)*1. Welcome to Science On a Sphere®! Science On a Sphere® is a unique and powerful way to view the world. It uses complex data to visualize what’s going on as our planet changes over time. This first picture is called the Blue Marble and it is the first of numerous datasets that we will be exploring on the sphere. The Blue Marble was created by images collected from satellites orbiting the Earth. True to color, this is much like an astronaut’s view of the Earth from the window of a space shuttle.
2. Today we will explore the relationship between health and climate change. According to the World Health Organization (an international group that follows the health of the world) human health is affected by climate change. These effects include things such as clean air to breathe, safe water to drink, enough food to eat, and reliable shelter.
3. Has anyone heard of Maslow’s hierarchy of needs? *(discuss)* American Psychologist Abraham Maslow developed a pyramid to explain and illustrate human needs. At the bottom of his pyramid are the most basic human needs: air, food, water, shelter, warmth and sleep. As people are able to fulfill these needs they can then move to the next layer of the pyramid. This pattern continues until people reach what Maslow calls “self-actualization” or the top of the pyramid.
4. Climate change will have a large impact on human health, and specifically the “essentials” or the lower layers of Maslow’s pyramid. U.S. President Barack Obama recognizes how important climate is to health and in July of 2013 appointed 11 people to the White House “Champions of Change” program. These doctors and public health advocates were chosen for their significant work in the field of health and climate change. These people are researching things from increasing rates of asthma in children to increased risk of heat stroke for the elderly. Climate change is a global event that affects individual health. Because of this, climate change is the largest health threat of the 21st century.
 | 1. *Direct the audience’s attention to the sphere.*
2. *Overlay Maslow’s Hierarchy Pip. Point to the bottom level of the pyramid with the arrow annotate feature. Illustrate the progress up the pyramid as people achieve their needs.*
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| 1. Earth with Vegetation
 | 1. First before we dive into health it is important that we explore the relationship between people and the environment. Do you believe that we have impacted our environment? Do you believe that we have done this on a small scale? Or a large scale? Take note of the vastness of the Sahara desert, the dark green of the Amazon rainforest in South American, and the tundra of the arctic in the north including big white Greenland. These environments are very different and each one will have some kind of impact on the people that live there. Have you ever thought about your impact on your environment? Let’s check out human impact on the Earth with the sphere. We’ll begin by using our *country names with population* overlay to explore this relationship. With this overlay the larger the font of the country name, the larger its population. As you can tell, Mexico, India, and China, all have lots of people that live there. With many people living in one place, people are sure to impact their environment with buildings, garbage, and other pieces of city living. Next let’s overlay the roads feature on top of country names (*roads overlay*). Are there any places in the world that have very few or no roads? \*Yes, Antarctica, Greenland, Northern Canada and Russia, to name a few. What are some reasons that you think fewer people choose to live in these places? \*Climate, temperature, accessibility. Yes people are impacted by their environment. Fewer people choose to live in locations with extreme temperatures or weather because of its significant impact on their lives and overall health.
2. Human health can be traced geographically. So let’s explore how you impact your environment and in turn the environment impacts you and your health.
 | 1. *(1) Introduce the Earth with Vegetation dataset. Like the previous Blue Marble, this dataset is a true depiction of the world as seen from space.*
2. *(2) Overlay Country Names (By population) from the overlay menu (explain its significance from the script). Add the Roads overlay (again explain its significance from the script).*
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| 1. Global Average Temperature Anomaly 2012
 | 1. One large piece of the climate change and health conversation is rising global temperatures. This dataset was developed by NOAA and illustrates the currently increasing global temperatures; specifically the temperatures of 2012, which was the 10th warmest year on record since 1880. Worldwide temperatures have risen over the past 100 years with a dramatic acceleration from the 1950’s onward. In fact 2005 and 2010 tied for the warmest years on record.
2. Let’s watch the temperatures of 2012. This dataset shows the monthly averages as well as the overall average for 2012. (*Rotate dataset to show the U.S. to your audience*) What color is the majority of the U.S.? \*It is more red. What does this mean? Is the world warmer than it has been in the past? *(discuss)*
3. Increasing temperatures both directly and indirectly impact Maslow’s basic human needs like health, security, food, water, and air. Reasons for this include: 1. Heat is hard on the human body and can increase the chances for heat strokes as well as heart attacks. Specific groups such as the elderly and poorer populations are especially vulnerable to this. 2. Temperatures affect food production by increasing the prevalence of droughts. Rising temperatures are expected to reduce the production of staple foods for much of the world. Specifically, Africa could lose 50% of its food production by 2020. This could devastate Africa as it is currently the hungriest continent in the world with 1 out of 4 of its people hungry today. 3. Rising temperatures also increase the spread of infectious diseases, especially vector borne diseases, which are diseases transmitted by mosquitoes, like malaria. The connection between environmental changes and vector borne diseases is a large part of this presentation and will be more thoroughly discussed with later datasets.
 | 1. *Play the dataset. Pause it on the average temperatures for 2012, the last frame. Rotate the dataset to show the US to your audience.*
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| 1. Impact of 6 meter sea level rise (red)
 | 1. Another large piece to the climate change and health conversation is sea level rise. As temperatures increase, ice all over the world is melting. This melting increases sea level along with a number of other factors. This dataset shows in red what current land will be under rising water with up to 6 meter sea level rise or roughly 20 feet. If all of Greenland were to melt, the world would be looking at a sea level rise of 23 feet or about 6 meters; this is therefore the change we would see on the coastlines of the world.
2. *(Play the dataset)* Rising sea level will affect people in many ways with one of the largest impacts being displacement from their homes. Security in one’s location is another of Maslow’s physiological or basic needs. More than half of the world’s population lives within 37 miles (60km) of the ocean with 600 million people living between 0-~33 feet (0 to 10 meters) above sea level. When people have to move, many aspects of their lives are disrupted, including their access to health care. This instability results in a dramatic change in people’s health and quality of life.
 | *B. Play the dataset. On the second run through stop the dataset at the point of maximum sea level rise (greatest red).*  |
| 1. FIM Chem Model- Three Aerosol Species
2. *Overlay* Earth at Night- Black Marble 2012
 | 1. Now that we’ve laid the groundwork, let’s move on with Maslow’s “essentials” and talk about air. Has anyone taken a first aid class? What does the A in the ABC’s of first aid stand for? \*Yes… it actually stands for airway. It is the first thing a first aid responder will check on when someone is injured or ill. Without air a person will die. This dataset is based on the Flow-following-finite-volume Icosahedral Model -- that’s a mouthful. This model was developed at NOAA for weather forecasting. In this dataset the model is used along with aerosol and atmospheric data to produce an estimate of global aerosol, or air particle, movement for 10 days in 2009.
2. Black carbon, dust, and organic carbon are the air particles illustrated. The pink clouds that you see here are a mix of both black carbon and organic carbon, and come from fossil fuel emissions like gasoline combustion in cars. Green signifies dust in the air, while the purple represents emissions from fires, which is also a mix of both black carbon and organic carbon. Fire can be both natural, like wildfires, and unnatural, like slash-and-burn farming.
3. Black carbon is otherwise known as “soot” and has a large impact on the increasing temperature of the planet. This soot is directly linked to areas of higher population such as China and India. Let’s overlay another dataset to more clearly see this connection between human populations and aerosols. Where do you see the highest amounts of aerosols? Is there any relationship between where these high amounts are and the number of lights in that area? \*Yes. Aerosol levels are higher where there are more people.
4. Air particles affect people’s health in various ways. Dr. Yadira Caraveo, one of President Obama’s recent “Champions of Change,” noticed that more people visited her clinic when there was greater smog or air pollution in her city of Albuquerque, NM. On these days, she prescribed more albuterol, a medicine that improves people’s breathing, as well as used more oxygen and wrote more prescriptions for respiratory therapy.
5. Smog or air pollution is contributing to an increase of asthma, a respiratory illness that affects roughly 50 million people in the US today with a large percentage of its impact affecting children because of their still developing lungs. Allergies are also on the rise with pollen seasons longer than ever before. Climate change is increasing because of by-products of human activities. Similarly these by-products are also increasing the number of asthma, allergy, and other respiratory sufferers worldwide.
 | 1. *Illustrate the pink, green and purple aerosols on the dataset.*
2. *Overlay Earth at Night-Black Marble 2012 dataset. Reduce its transparency to about half so that the aerosols data is clearly visible. If beneficial for your audience please overlay the country borders and point out the large amount of pink over both China and India. You can also illustrate the large amount of dust from the Sahara and Gobi deserts.*
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| 1. Global Epidemic and Mobility Modeler-H1N1 scenario
 | 1. The spread of disease is also changing as a result of climate change. An outbreak of H1N1, or swine flu, began in La Puebla, Mexico on February 18th of 2009. It was quickly recognized as a pandemic and by the start of 2010, there were 17,000 deaths worldwide due to H1N1. Changing precipitation patterns, increased temperature and extreme weather events are increasing the geographic spread, number of people infected, and the speed of transmission.
2. This dataset was developed by GleaM. GleaM is a group of researchers that model the spread of infectious diseases. This model was developed weeks before the global spread of H1N1. Unlike most influenza’s, which peak in January or February, H1N1 peaked in the fall of 2009. Thanks to this model, GleaM was able to predict the early seasonal peak, giving public health workers a heads up for intervention and preparation strategies for this unique flu virus.
3. The red lines that you will see on this dataset illustrate airplanes that carry infected individuals into a previously unaffected area. Once they have arrived to a new location the disease spreads and the color for that area turns reddish.
4. Let’s watch the model. *(Play the dataset)* Again H1N1 began in La Puebla, Mexico *(point to this location on the Sphere).* As infected people travel around the world we can watch the disease spread. The color bar indicates an infection rate from 0 to 10,000 people. Let’s look back to November of 2009 when the number of people with H1N1 peaked. What do you see in both the U.S. and Europe at this time? \*Yes, there is a lot of red throughout these areas in the model. This is the early peak that GleaM was able to predict. In doing this, this model potentially saved a lot of lives.
 | 1. *Play the dataset. When it is time to discuss the height of this flu virus please reverse back to November of 2009 to show the peak of the influenza in both Europe and the U.S. at this time.*
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| 1. Malaria

 Plasmodium falciparum | 1. Continuing with our exploration into Maslow’s hierarchy of needs, let’s look deeper into the transmission of disease and how this will be changing with changing climate. Although disease exists within the second rung of Maslow’s pyramid, the safety level, it still has large effects on people’s ability to take care of their basic needs. If someone is so sick that they are unable to feed themselves, the disease will quickly put them into a struggling situation.
2. *(Turn on mosquito PIP)* What do you think of when you hear the word mosquito? In some parts of the world mosquitoes can transmit dangerous pathogens. Can you think of a pathogen that is spread by mosquitoes\*? *(discuss)* This mosquito is the female Anopheles albimanus mosquito and she is responsible for spreading the pathogen that causes malaria. She prefers to lay her eggs in dirty, stagnant water close to her potential victims and is a night feeder.
3. This is a map drawn together by MAPs or the Malaria Atlas Project. Their ultimate goal is to “produce a comprehensive range of maps and estimates that will support effective planning of malaria control at national and international scales”. This map, based on multi-dimensional models, illustrates the distribution of falciparum. P. falciparum is the most deadly of the five types of human transmissible malaria. Much like the flu, malaria causes fever, chills, sweats, headache, and body aches. Let’s just say that you wouldn’t want to catch it.
4. This is the average distribution of falciparum in children age 2-10 years old in environmentally stable distribution areas. Within the stable transmission regions, red represents 70% or more of the population in 2010 having P. falciparum while the blue represent closer to 0 % of people with the disease for that area.
5. Because malaria often occurs in remote places, people do not always seek medical care. Because of this, models are important as reported cases alone can’t even tell half of the real story!
 | 1. *Overlay mosquito PIP. Turn off mosquito PIP after explanation.*

*\* Malaria, Dengue Fever, West Nile Virus, Dog Heartworm, yellow fever, etc.* |
| 1. Malaria Plasmodium vivax
2. *Overlay* Duffy Negative- Blue
 | 1. This is a similar map that displays a different type of malaria, P. vivax malaria.
2. The colors of this map illustrate the average distribution of P. vivax within environmentally stable transmission areas. The colors indicate a 0% in blue to >7% occurrence in red. What do you notice about this map that is different than the previous malaria map? Hint: Where in the world were the highest estimates of malaria in the last dataset? (discuss)
3. \*Yes, there is limited occurrence of vivax in Africa. What is interesting about this type of malaria is that there is low occurrence of P. vivax within African populations. This is partly thanks to a protein called Duffy. When someone does not have the Duffy protein on their red blood cells they are considered to have a Duffy-negativity. Interestingly enough with a Duffy-negativity, like large populations in Western Africa, a person tends to have a natural resistance to vivax malaria!
4. Science On a Sphere is the best place to explore the relationship between individuals with Duffy-negativity and vivax – check this out! Although Duffy-negativity is prevalent throughout the world, this map displays its probability of occurrence in malaria “at risk” areas. The darker the blue, the greater the probability of Duffy-negativity: - 0% to 100%.
5. So now let’s reduce the transparency of the Duffy-negativity estimates to see its relationship with vivax malaria. As you can see there are low estimates of vivax in African populations. And look at South America: the coastal regions of South America where there is a higher percentage of Duffy-negativity there are almost no cases of vivax malaria, while the interior, with a lower percentage of Duffy-negativity, has high estimates of vivax. This is just one example of the complex relationship between geography, evolution, and health.
6. Today 3.3 billion people, ~ ½ the population of the world live in locations where malaria can be transmitted. This number is expected to increase to 5-6 billion people by 2080 with rising temperatures.
 | 1. *Overlay the Duffy Negative map. Using the arrow annotate feature point out the high occurrence of Duffy Negative in parts of Africa.*
2. *Reduce the transparency of the Duffy-negativity dataset to let the underlying vivax map show through.*
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| 1. Change in Tropics
 | 1. In fact, climate is changing more rapidly than it ever has before. This dataset illustrates the changing boundaries of the tropics. The tropics are defined by prevailing winds called the easterly trades. It is the central belt of the world that is known for its moist, warm climate. The blue line represents the boundary of the tropics for 1880-1884 and the red line the boundary for 2008-2012. In just over 30 years the tropical zone has expanded on average 10 degrees latitude or roughly 4 degrees north and 6 degrees south. This change affects the precipitation patterns where the majority of the people in the world live, causing major human health impacts. One example of this is the increasing transmission rates of vector borne diseases like malaria and dengue fever.
 | 1. *Using the arrow annotate feature point out the blue 1880’s line. Then the red 2008 line.*
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| 1. Dengue Fever by Area with grey background
 | 1. Similar to malaria, dengue fever is transmitted by mosquitoes. This is an image of the female *Aedes aegypti* mosquito. She can transmit the virus that causes dengue fever. Unlike the malaria mosquito, she prefers to lay her eggs in artificial containers with clean water and will bite during the day making her more difficult to defend against. Like malaria, half of the world’s population is vulnerable to dengue fever and this number is increasing.
2. This dataset illustrates the 2010 estimate for dengue fever. The scale is 0% in white to 100% probability of occurrence in dark red. We can see that there are places in Central and South America, West Africa, Madagascar, India, and other tropical islands that are likely riddled with this terrible disease. Similar to malaria, dengue is underreported and as a result, researchers again rely on models for a more accurate picture of its impact. Dengue is known as “break bone” fever because of its intense symptoms including a high fever (105 F), headaches, and muscle, bone, and joint pain.
3. Current modeled estimates for dengue are close to 390 million infections per year with only 100 million of these infections showing signs in the people that it affects. This is three times the estimate generated by the World Health Organization and is important because this increase by a factor of three, indicates a much higher potential transmission for the disease.
4. With climate change, increasing global trade and travel, and urbanization, mosquito habitats are expanding. This is the result of warmer climates and changing rainfall patterns, conditions that are essential for mosquito breeding. With this expansion, transmission rates will likely increase as well as the overall rate of malaria and dengue fever.
5. Climate change and its impacts are not just a product of the future, Florida is already reporting dengue fever for the 2013 summer as well as Russia and Portugal. Future predictions put dengue fever in places as far north as Chicago and much of the low-lying regions of the East and West coasts of the United States.
 | 1. *Turn on dengue fever mosquito PIP. Turn off mosquito PIP after explanation.*

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| 1. Aurora with Air Traffic
 | 1. This is the final dataset for today. To conclude, let’s take a slightly different angle. This dataset illustrates the changing world and the balance of the natural world with human adaptations. Who knows what the green glow at both the north and south poles represents? How about the small yellow lights moving all over the world. *(discuss)* \*Yes… the green glow is the lights of the aurora (Borealis in the north and Australis in the south) and the little moving lights below are airplanes.
2. The aurora occurs when energized electrons from the Sun bombard our atmosphere. Oxygen and nitrogen atoms get excited when they come into contact with these electrons and as a result they emit photons. These photons become the visible colors of the aurora and can be seen lighting up the sky in purple, orange, and green in the high latitude regions of the world. The aurora illustrates the natural world.
3. Air traffic, these little lights traveling all over the globe, illustrates human behavior. Air traffic has increased dramatically over the last 50 years and is expected to increase about 2.5% every year. With every technological advance, it seems that we’re losing touch with the natural world. It’s important to remember that humans are a large part of the natural world and human health is one of the most important pieces in this relationship. The environment directly affects Maslow’s bottom layer or the essential needs for life. The next time that you hear the cascade of a fresh mountain stream, feel the warmth of the summer sun, or take in a big breath of fresh air, remember that the environment is responsible for a large part of your health; and you are responsible for your environment. Climate change impacts the number of children suffering from asthma, the risk of heat strokes for the elderly, the spread of nasty tropical diseases, as well as many other aspects of health. Climate change is the result of our actions and ultimately if we don’t change our behaviors, our personal health will suffer. We must take care of our environment and in turn it will take care of us.

*\*(Give your location’s customary farewell. Below is a sample.)*1. Thank you all for coming, I hope you enjoyed this presentation of Science On a Sphere®. Please feel free to stick around for a few minutes and ask any questions.
 | 1. *Let the dataset play.*
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