

**ESTUARY EXPLORERS**

Coastal Science in Your Kitchen

# An Introduction to Climate Change and Coastal Resilience Student Workbook



**WATERFRONT ALLIANCE**

# Climate Change

## What is Climate Change?

Climate change is different than daily weather. It is the long-term change in average climate patterns caused by the burning of fossil fuels and the rapid emission of greenhouse gases (GHG) into the atmosphere. These rapid changes in global climate patterns have hugely detrimental effects on our planet's ecosystems and communities.

## Why is the Climate Changing?

Since the beginning of the Industrial Revolution, humans have generated an enormous amount of greenhouse gases (GHG) emissions due to the burning of fossil fuels in things like cars and homes. Greenhouse gases are gases that trap heat in the atmosphere, the most common of these gases being carbon dioxide (CO<sub>2</sub>), as well as methane (CH<sub>4</sub>) and nitrous oxides (N<sub>2</sub>O). The burning of non-renewable energy sources and fossil fuels such as coal, oil, or gas for agriculture, heat, and transportation has been the leading cause of these gases being released into the atmosphere.

## Effects of Climate Change

- Hurricanes
- Sea Level Rise
- Floods
- Air Pollution

# Activity 1

Draw a line between the two words or sentences that relate to each other.

**Sea Level Rise**

**Carbon Dioxide**

**A Group of  
People Living  
in the Same  
Place**

**Hurricane  
Sandy**

**Extreme  
Weather Event**

**Effects of  
Climate  
Change**

**Thin Layer of  
Gases  
Surrounding  
the Earth**

**Community**

**Greenhouse  
Gas**

**Atmosphere**

**Coal, Oil, and  
Gasoline**

**Industrial  
Revolution**

**Beginning of  
GHG  
Emissions**

**Fossil Fuels**

# Coastal Resilience

## What is Coastal Resilience?

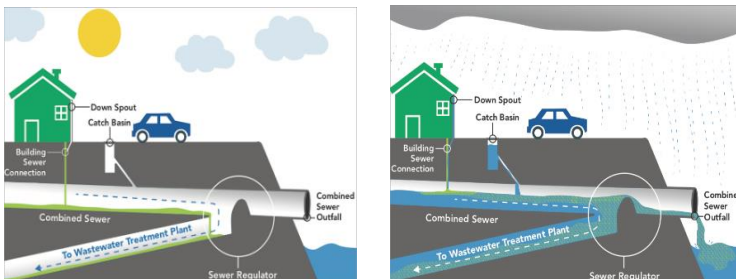
Resilience is building the ability of individuals, communities, institutions, businesses, and systems to survive, adapt, and grow in the face of immense challenges. Coastal resilience is facing challenges such as extreme storms or sea level rise along the coast.

## Obstacle to Coastal Resilience

One of the biggest threats to coastal cities is the threat of flooding from sea level rise and a lack of adaptable utilities and infrastructure to deal with it. All types of services that communities rely on are threatened by flooding stemming from climate change.

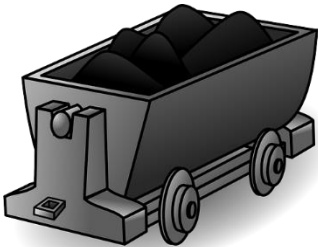
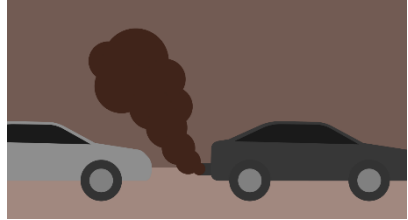
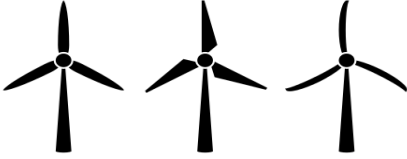
## Combined Sewer Overflow (CSO)

A combined sewer overflow system (CSO) is a system that collects stormwater and sewage in the same pipe. When it rains, stormwater, or water that originates from precipitation, and raw sewage combine and get dumped directly into the water. This can have serious effects on the health, water quality, and aesthetics of our waterways.



## Activity 2

Circle the images that represent renewable energy.



# How Do We Address Climate Change and Coastal Resilience?

## Green Infrastructure

Green infrastructure is an approach that uses nature to improve and manage stormwater, heat, air quality, clean energy production, and healthy waters. It is a cost effective and resilient approach to managing impacts from large wet-weather events such as stormwater and flooding. Examples of green infrastructure include:

- Planted Sand Dunes
- Wetlands
- Coastal Forests

## Grey Infrastructure

Grey infrastructure is the more traditional system of managing the rainfall from wet-weather events. It usually refers to measures that attempt to block or move water rather than let it be absorbed. While they can be useful, these solutions are often short-term and can have negative effects on ecological processes. Examples of grey infrastructure include:

- Pipes
- Water Treatment Plants
- Seawalls

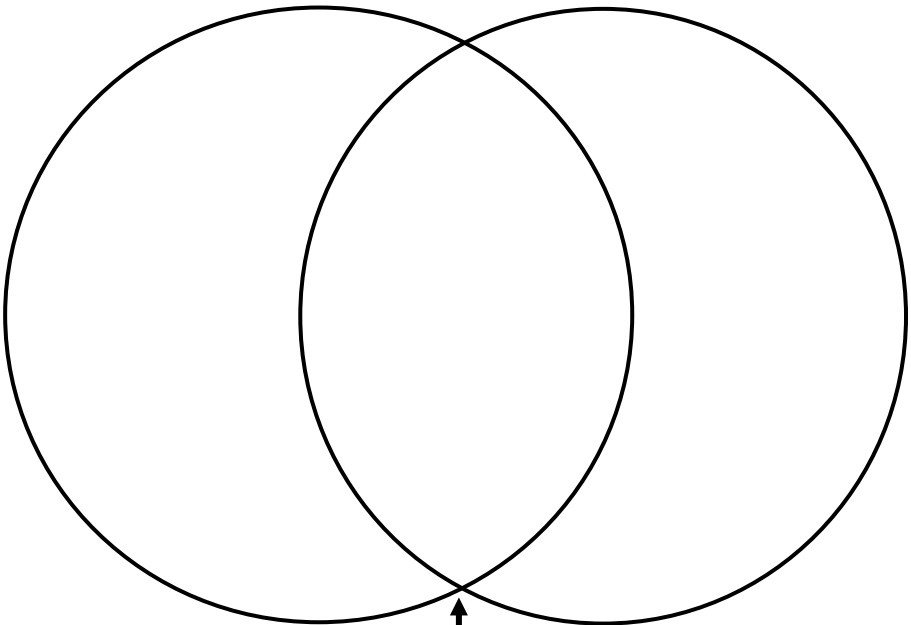


## Activity 3

Because green infrastructure brings additional benefits for the environment and the community, it should be part of building for resilience. But there are times when grey infrastructure is a more efficient choice. Remember the pictures in the presentation and use the examples from p. 6 to sort types of green and grey infrastructure. Write them in the correct circles, and place the features you would like to see in your own community in the overlapping center.

**Green Infrastructure**

**Grey Infrastructure**



**Infrastructure You Would Want on Your Waterfront**

## Activity 4

All around our city's waterfronts, old parking lots and warehouse sites are being cleaned up and replaced by new buildings. How can this be done in ways that are best for your community and that make your neighborhood more resilient? In the space below, write a letter to your community's leaders explaining what you want to see built on your waterfront. If you prefer, draw a picture of what you wish our city's waterfront could look like and label your picture.

If you would like to do both activities, there is space in the notes section at the end of this workbook to do so.



## Activity 5

Find and circle all the words listed below

D O U L E P Z K Y Y Z F S S F  
 W A T E R F R O N T C A H B F  
 B J B V G E A M X J G O E F X  
 Y M J E X V S U A E R T A M P  
 A R U L H M G I S E A M F S A  
 A A J A D J M U L M N K W R T  
 H C Z E U W O I I I Z S S Z M  
 E S G S W H N L I Z E G K E O  
 Q I P W N E C Y H H F N T M S  
 D P M E T H A N E A W U C J P  
 P P E J Q K U B Y S O E P E H  
 Q R D L A D Q F H Y P I C Z E  
 G C D Z X Y T I N U M M O C R  
 B L N W R I D T F L W J A I E  
 R C V I Q Q G F R F M Y O U K

### Words

Atmosphere

Climate

Coast

Community

Greenhouse Gas

Sea Level

Methane

Resilience

Waterfront

## Activity 6 Test Your Knowledge

1. A combined sewer overflow is:
  - A.) When the sewers are clogged
  - B.) When stormwater and sewage mix and overflow in the same pipe
  - C.) When many sewers overflow at the same time
  - D.) None of the above
  
2. Methane is the most common greenhouse gas.
  - A.) True
  - B.) False
  
3. Flooding can be caused by:
  - A.) Hurricanes
  - B.) Sea level rise
  - C.) Heavy rains
  - D.) All of the above
  
4. What is resilience?
  - A.) The ability to survive, adapt, and grow no matter what stress is faced
  - B.) How strong a substance is
  - C.) A study of climate change
  - D.) None of the above
  
5. New York is the only city being threatened by sea level rise.
  - A.) True
  - B.) False

6. What is social resilience?
  - A.) Your social network
  - B.) Adapting to changes in your social life over time
  - C.) Having strong adaptable community networks
  - D.) All of the above
  
7. Cars burn fossil fuels to function
  - A.) True
  - B.) False
  
8. Sea levels are expected to rise by how many feet by 2100.
  - A.) 1 to 2
  - B.) 3 to 4
  - C.) 8 to 10
  - D.) 4 to 6
  
9. You can improve your community's resilience by:
  - A.) Getting involved in a local environmental organization
  - B.) Eating more red meat
  - C.) Hugging a tree
  - D.) A and C
  
10. City utilities are critical to the function of communities. In the space below, write down an example of a utility that you use every day and why it is important.

# Notes

## **Workbook Answer Key**

### **Activity 1, p.3**

Sea Level Rise – Effects of Climate Change  
A Group of People Living in the Same Place –  
Community  
Extreme Weather Event – Hurricane Sandy  
Thin Layer of Gases Surrounding the Earth –  
Atmosphere  
Greenhouse Gas – Carbon Dioxide  
Coal, Oil, and Gasoline – Fossil Fuels  
Beginning of GHG Emissions – Industrial Revolution

### **Activity 2, p. 5**

Top Left Image (Wind Turbines)  
Middle Right Image (Dam)  
Bottom Right Image (Solar Panel)

### **Activity 3, p. 7**

Green Infrastructure – Wetland, Green/Vegetated Roof,  
Rain Garden, Bioswale  
Grey Infrastructure – Seawall, Pipelines, CSOs,  
Wastewater Treatment Plants  
Infrastructure You Would Want in Your Community –  
Any Example Listed  
\*Answers are not limited to these examples

### **Activity 4, p. 8**

Letter – The letter written can use vocabulary such as  
climate change, coastal resilience, green infrastructure,  
grey infrastructure, etc.  
Link to Look Up a Students Local Council Member:  
<https://council.nyc.gov/districts/>  
Picture – The picture can include an example of green  
infrastructure and/or grey infrastructure, with labels.

**Activity 5, p.9**

D O U T E P Z K Y Z F S  
W A T E R F R O N T C A H B F  
B J B V G E A M X J G O E F X  
Y M J E X V S U A E R T A M P  
A R U T H M G I S E A M F S A  
A A J A D J M U L M N K W R T  
H C Z E U W O I I I Z S S Z M  
E S G S W H N T I Z E G K E O  
Q I P W N E C Y H H F N T M S  
D P M E T H A N E A W U C J P  
P F E J Q K U B Y S O E P E H  
Q R D L A D Q F H Y P I C Z E  
G C D Z X Y T I N U M M O C R  
B L N W R I D T F L W J A I E  
R C V I Q Q G F R F M Y O U K

**Activity 6 Test Your Knowledge, p. 10**

- 1. B.) 2. B.) 3. D.) 4. A.) 5. B.) 6. C.) 7. A.) 8.
- 9. A.)

10. Utilities – Water, Electricity, Phone Service  
\*Answers to question 10 are not limited to the examples provided

For additional activities visit:

[waterfrontalliance.org/what-we-do/education](http://waterfrontalliance.org/what-we-do/education)