GK-12 Brooklyn College: City as Lab
ITAVA Group: Spring 2012: 45 minutes (2 classes)

Calculating the Car Emission of Carbon Dioxide

Objectives: Students will be able to…
- Understand how to convert length, calculate gas mileage for each car type
- Understand how to calculate the amount of carbon dioxide emitted by cars based on the type of the car and the amount of the gasoline

Materials:
- Accompanying worksheet and power point.
- Collected data from the Carbon Footprint Project.

Procedure:

Worksheet : Calculating the Carbon Footprint of the Cars

Aim: How to calculate how much $CO_2$ is being emitted by the cars.

Lesson:
The power point presentation will go through the basics of how to calculate the carbon dioxide emission of cars. The power point will explain the following:
-how to convert the length into mileage
-how many gallons of gasoline are being used per block
-how much gasoline is burned by different types of cars
-how many grams of carbon dioxide are being emitted per gallon of gasoline
-how much carbon dioxide is being emitted on the block per car

Activity:
First we will go over the power point presentation. After all of the main issues are explained in calculating the carbon footprint of the cars, the students will be divided into three groups. Each group will organize and calculate the data collected from the Carbon Footprint Project.

Assessment:
When there is about 10 minutes left in class, have the students present as much of the calculated data with the rest of the class, by comparing and analyzing their results.
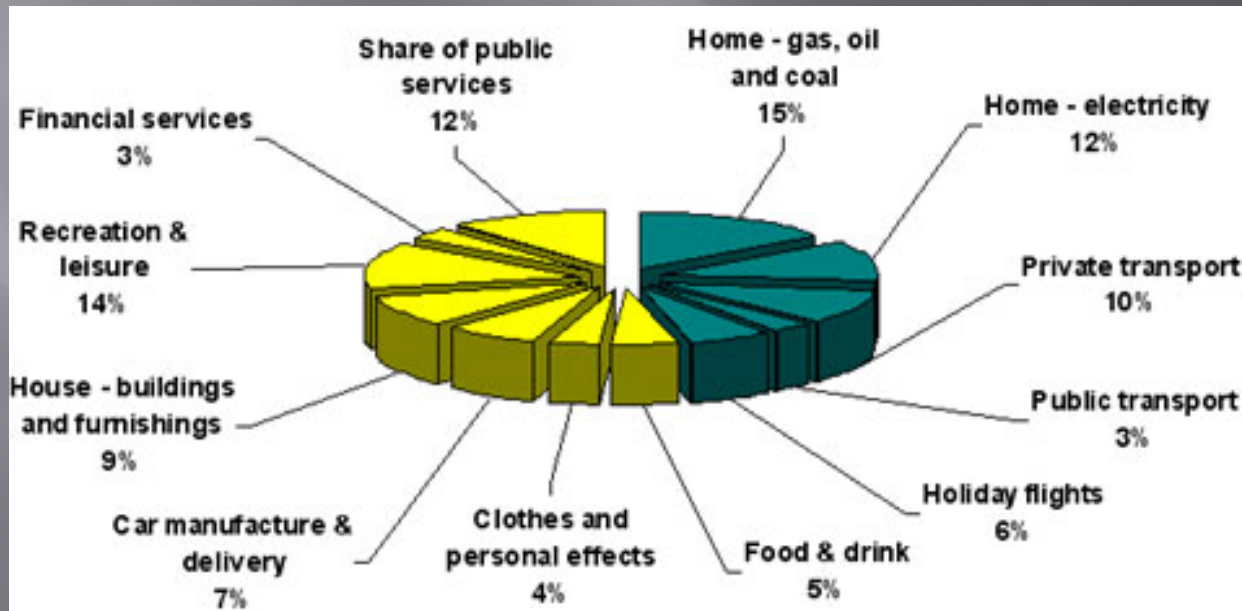
# CARBON FOOTPRINT PROJECT

# Carbon Footprint–review

- What is your carbon footprint?
  - A carbon footprint is a measure of the impact our activities have on the environment
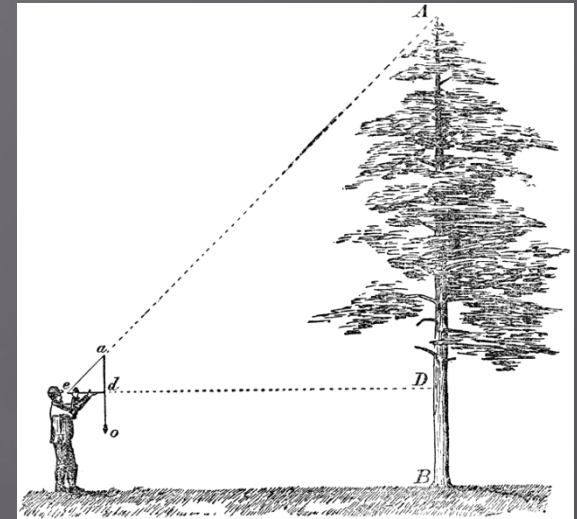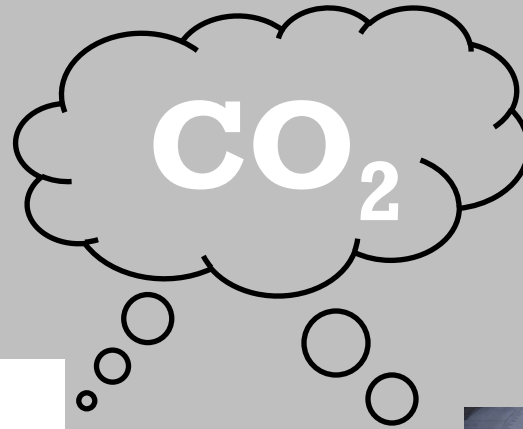
# Reducing Carbon Footprint

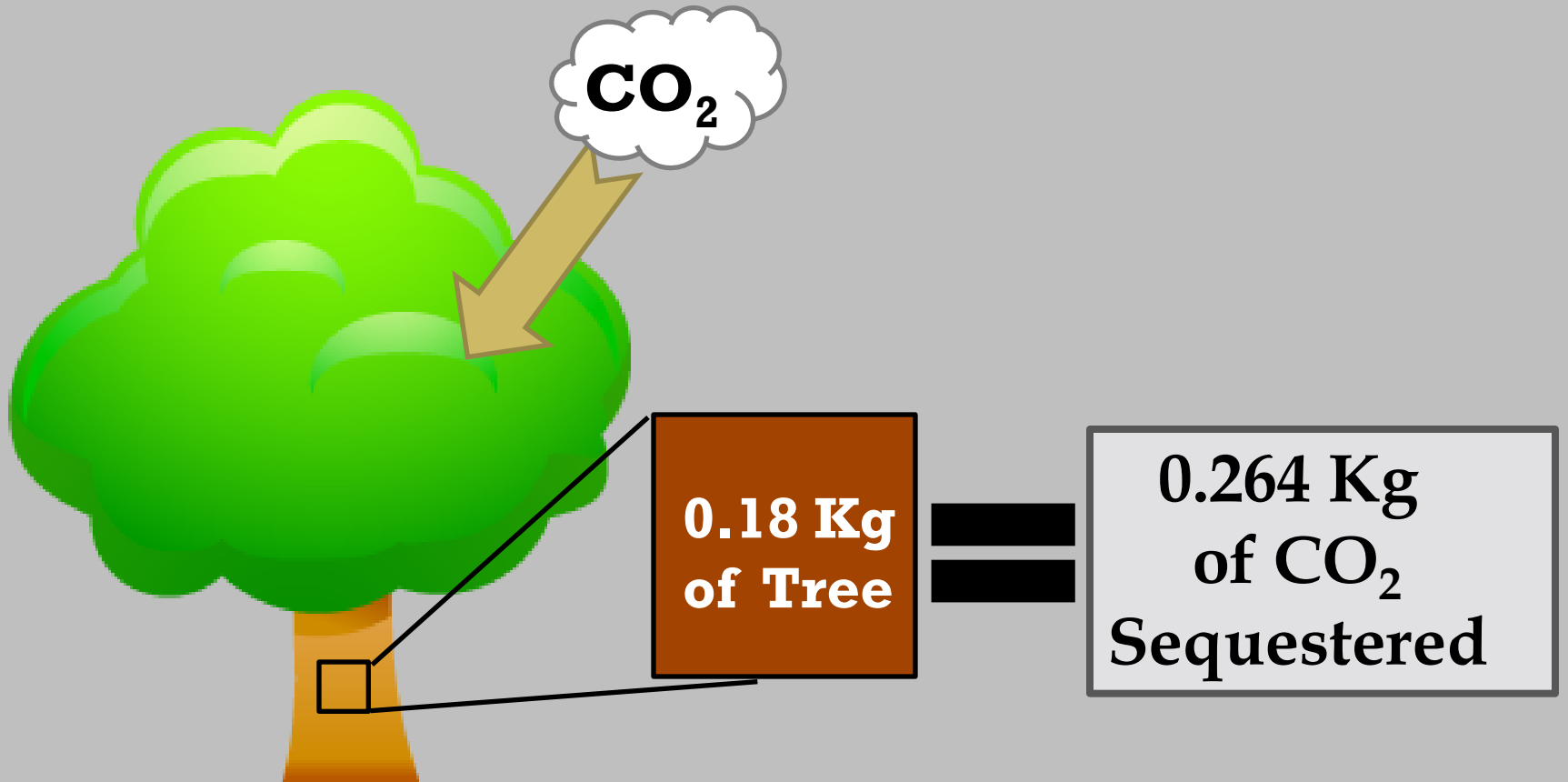What are some of the possibilities to reduce everyday pollution?

# Field Work

- Types of data we will be gathering
  - Measuring trees
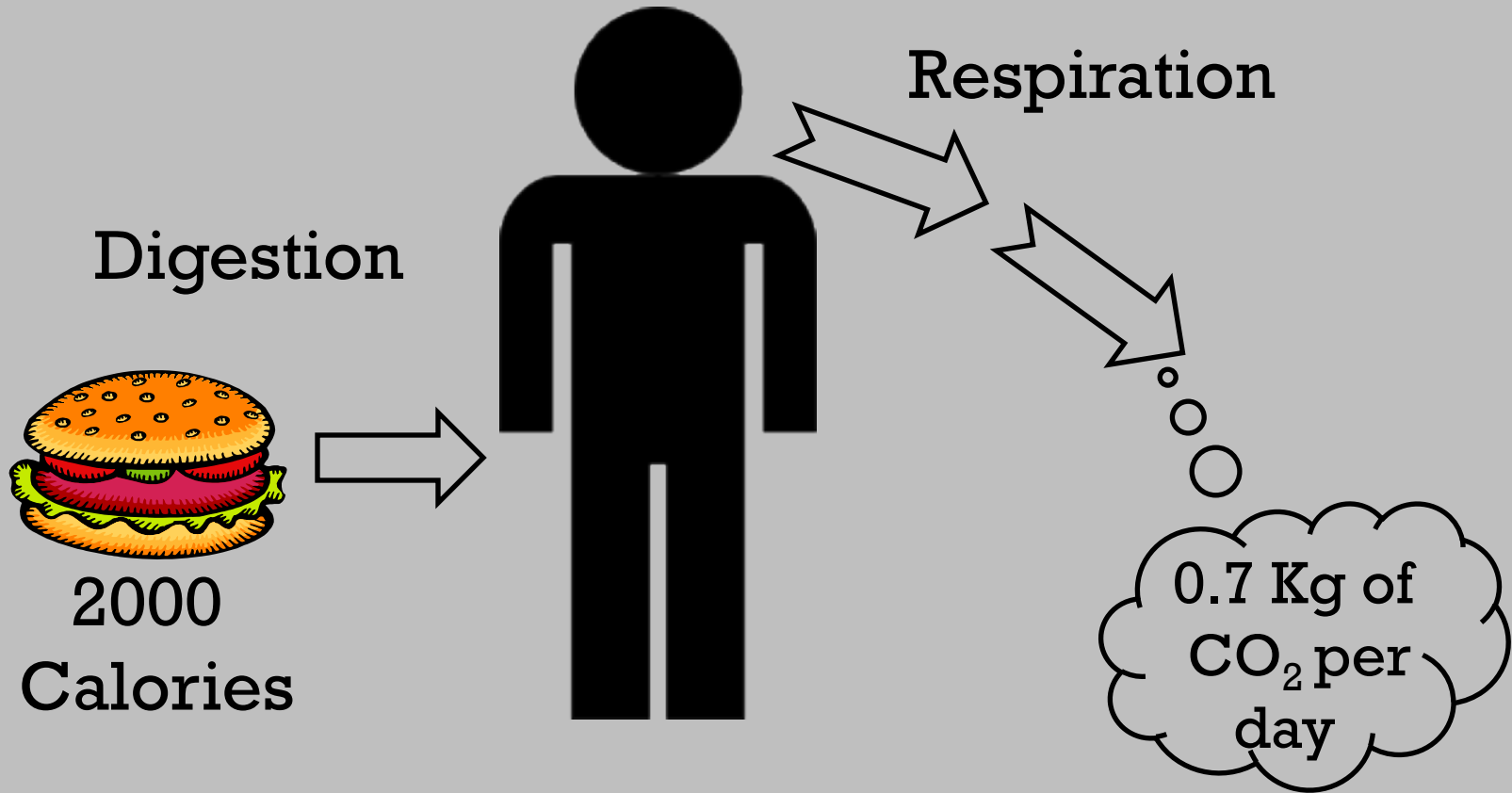  - Counting Cars
  - Measuring noise levels

# Sources of $CO_2$ we will measure

# How much CO$_2$ trees sequester

# People



Digestion

2000 Calories

Respiration

0.7 Kg of $CO_2$ per day

# Are we producing more than what the trees can sequester?

# How can we measure trees?

- In order to find the intake of $CO_2$ of trees, we need to figure out their weight. How can we get this data?

- We will be using a tape measure

# Apparent Height

- By using something with a known height, we can aproximate the height of the tree using the apparent height method
- - Have a person holding a 1 meter long object next to the tree
- - Hang the tape measure vertically in front of you
- - Adjust your angle of vision to make the meter stick 1 cm on the tape measure
- -Then count upwards how many centimeters and convert to meters
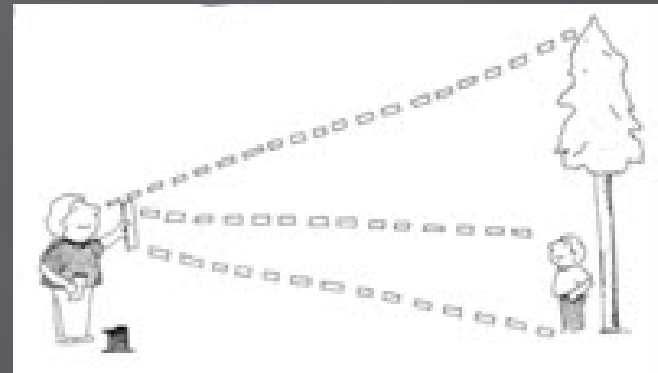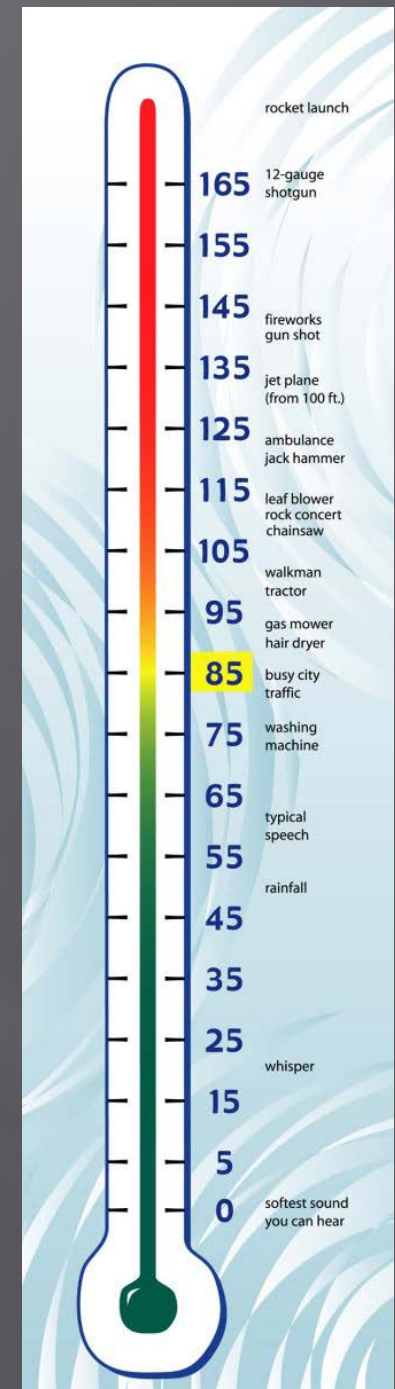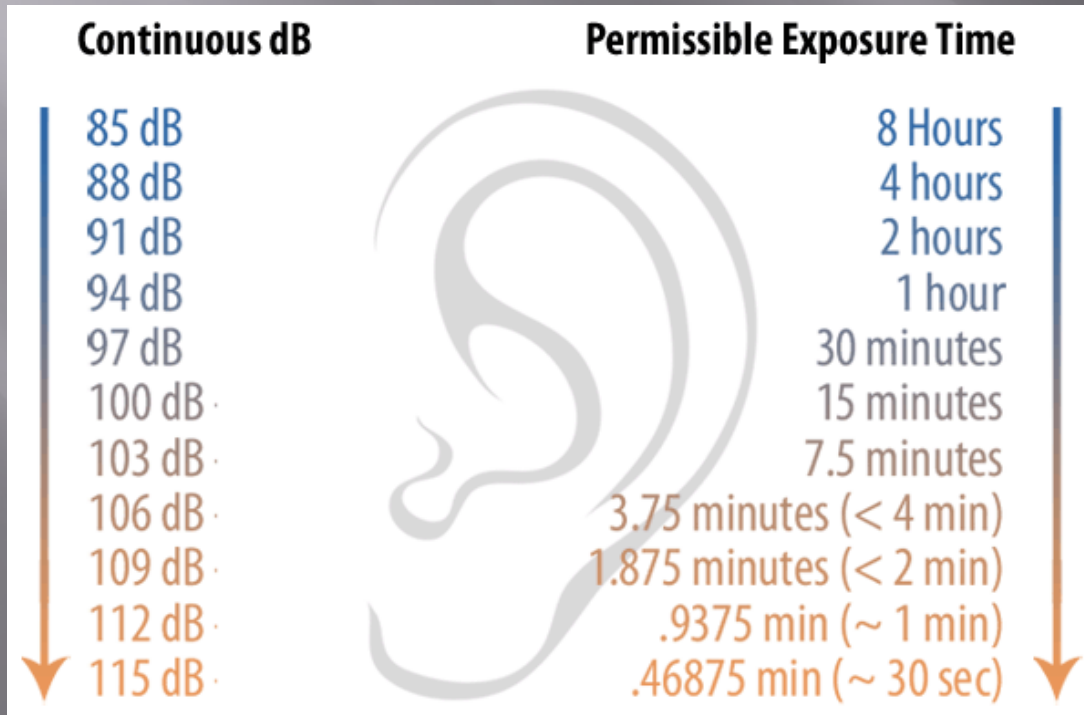
# How can we calculate car $CO_2$ emissions?

- We want to figure out how much $CO_2$ is being added to the local air from cars
- What information do we need to figure this out?
- What system can we come up with to survey the cars on our street?

# What we can do...

- We can figure out the average amount of $CO_2$ released by a car

- Classify cars into categories based on gas mileage

- Figure out how much $CO_2$ cars emit on each block

- Count how many cars in each category pass by over an hour

# NYC Subway Noise Level Survey

- We will be trying to figure out if the noise levels in the Subway system are loud enough to cause permanent hearing loss

| Continuous dB | Permissible Exposure Time |
|---|---|
| 85 dB | 8 Hours |
| 88 dB | 4 hours |
| 91 dB | 2 hours |
| 94 dB | 1 hour |
| 97 dB | 30 minutes |
| 100 dB | 15 minutes |
| 103 dB | 7.5 minutes |
| 106 dB | 3.75 minutes (< 4 min) |
| 109 dB | 1.875 minutes (< 2 min) |
| 112 dB | .9375 min (~ 1 min) |
| 115 dB | .46875 min (~ 30 sec) |



| | |
|---|---|
| 165 | 12-gauge shotgun |
| 155 | |
| 145 | fireworks gun shot |
| 135 | jet plane (from 100 ft.) |
| 125 | ambulance jack hammer |
| 115 | leaf blower rock concert chainsaw |
| 105 | walkman tractor |
| 95 | gas mower hair dryer |
| 85 | busy city traffic |
| 75 | washing machine |
| 65 | typical speech |
| 55 | |
| 45 | rainfall |
| 35 | |
| 25 | |
| 15 | whisper |
| 5 | |
| 0 | softest sound you can hear |

rocket launch

# How will we survey the noise levels

- How do you think we should survey the noise levels on the subway trains?
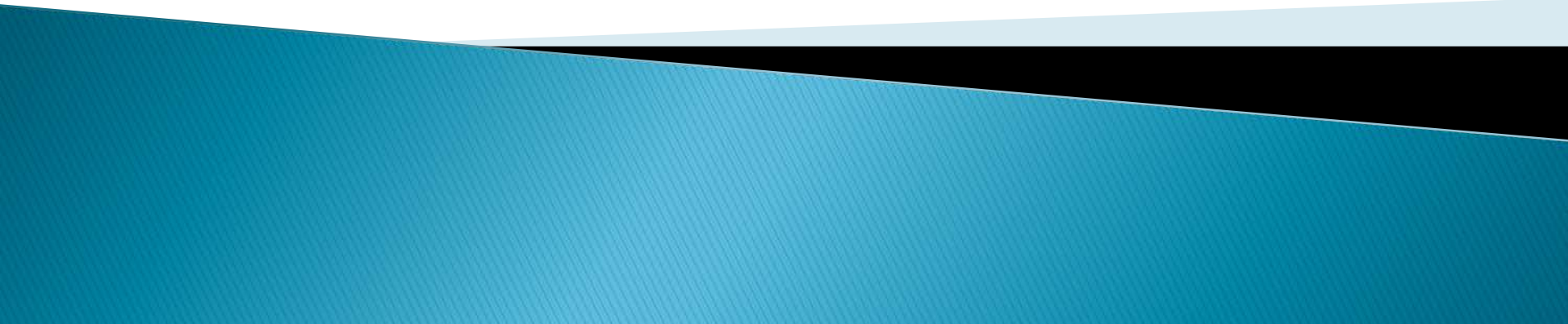
- We will be using decibel counters

# Noise Data collection

- We will be monitoring the Decibel Counter
- Every ten seconds we will mark the highest and lowest noise levels to figure out an average of how long we are exposed to certain noise levels

# Carbon Footprint Project

# Photosynthesis:

▸ Schematic representation of the photosynthetic reaction is given by:

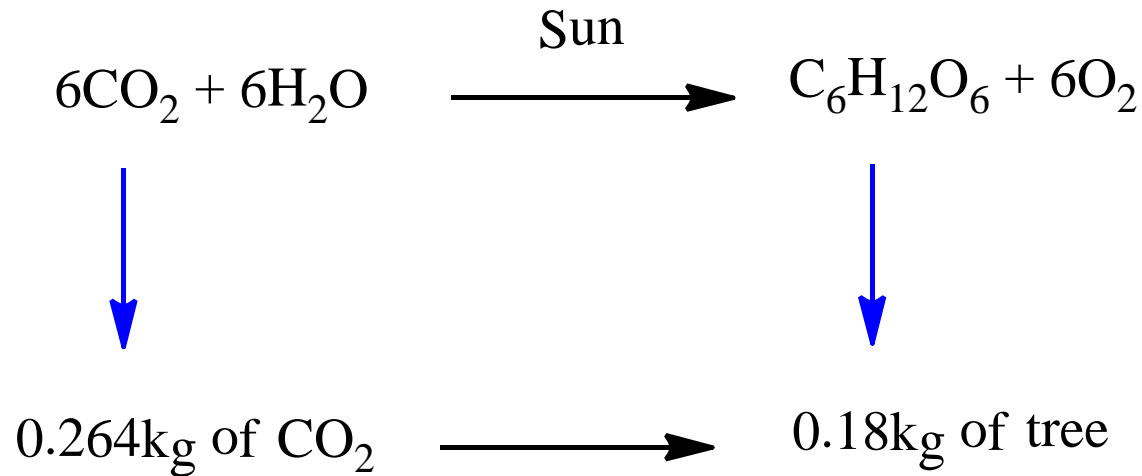$$6CO_2 + 6H_2O \xrightarrow{\text{Sun}} C_6H_{12}O_6 + 6O_2$$

From the photosynthetic reaction 0.264kg of $CO_2$ are sequestered to produce 0.180kg of tree. The weight of the Carbon Dioxide that needs to be sequestered to produce the tree is:
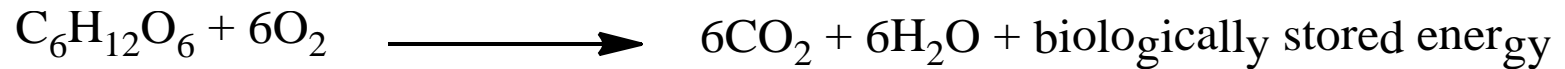
The Carbon Footprint of the tree (in kg) = (0.264kg x weight/0.18kg) =
= **1.5kg x weight**

# Photosynthesis:

- Schematic representation of the photosynthetic reaction is given by:

$$6CO_2 + 6H_2O \xrightarrow{\text{Sun}} C_6H_{12}O_6 + 6O_2$$

$$0.264\text{kg of } CO_2 \longrightarrow 0.18\text{kg of tree}$$

# Respiration:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{biologically stored energy}$$

Average person eats around 2000 Food Calories/ Day. Assuming that he gets all of his needed energy from eating sugar (glucose). The person will produce his needed energy through the respiration reaction. He will need 0.52kg/day to produce the energy that he needs and in the process he will release 0.7kg of $CO_2$/day.
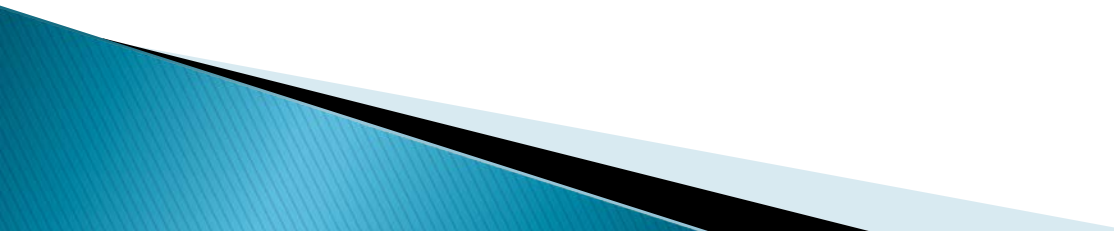
# Respiration:

$$C_6H_{12}O_6 + 6O_2 \longrightarrow 6CO_2 + 6H_2O + \text{biologically stored energy}$$
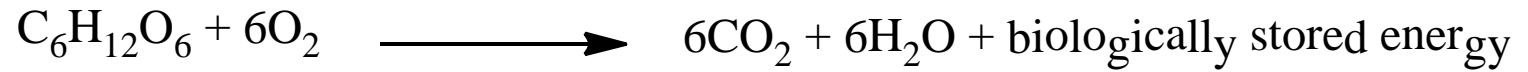
0.52kg of glucose $\longrightarrow$ 0.7kg of $CO_2$

# Sources of Error:

- We will be using an average of population density for the whole neighborhood and dividing it by the areas we measured trees and counted cars in to get a general estimate for the number of people.

- What are possible sources of error that we may encounter?

# Carbon Footprint Project Results

# How do figure out how much CO2 is being emitted by the cars we counted up?

☐ First we find the Length of the Block we counted.
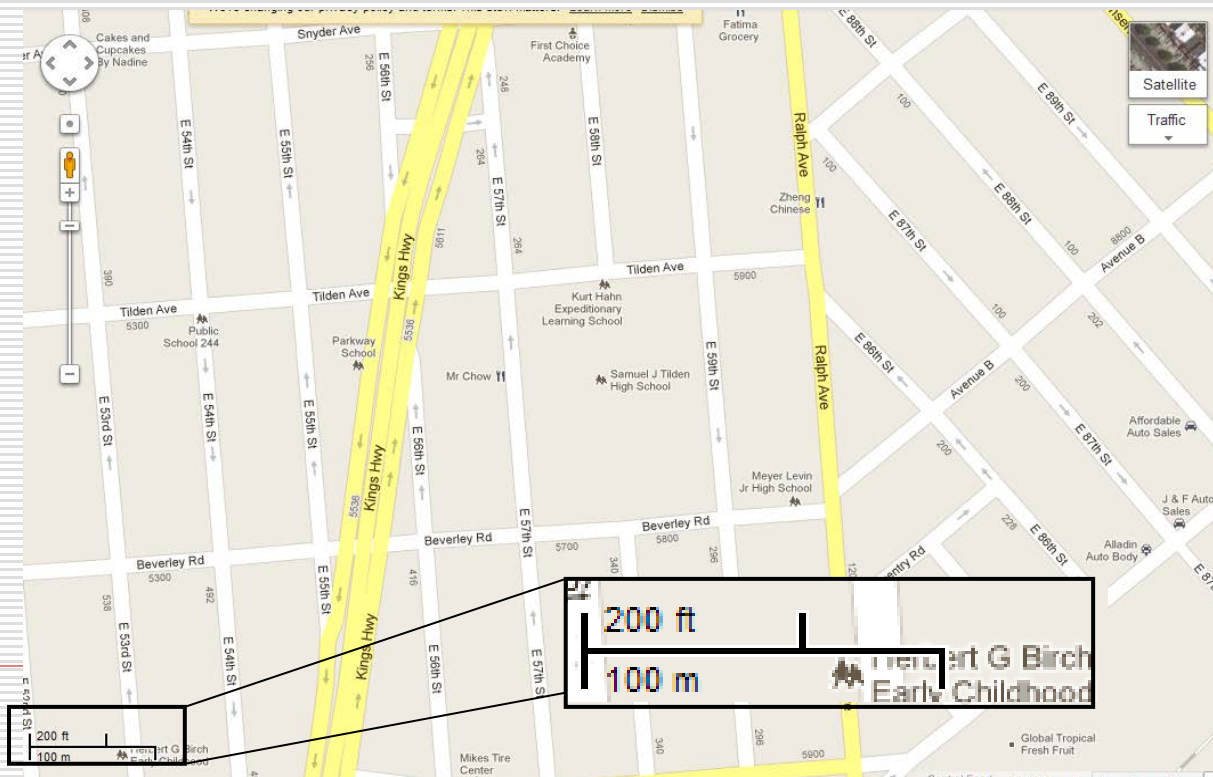
# Convert Length to Miles

- 1 mile = 5280 ft

- So… 1000 ft = ? Miles?

- $\dfrac{5280}{1} = \dfrac{1000}{?} \rightarrow \dfrac{1000}{5280} = 0.1894\text{miles}$

# Figure out the Gas Mileage for each Car Type.

- ☐ Small Car = ~22mpg
- ☐ Large Car = ~18mpg
- ☐ Box Truck = ~11mpg
- ☐ Semi Truck = ~6mpg
- ☐ Bus = ~8mpg

# How Many Gallons per block?

- ☐ For Each car type, measure the gallons of gasoline being used per block.

- ☐ $\dfrac{22m}{1gal} = \dfrac{0.1894}{?} \rightarrow \dfrac{0.1894}{22}$

- ☐ = 0.00859gallons per block for small cars

# How many grams of CO2 are being emitted per gallon of gasoline?

☐ 8920 grams of CO2 per gallon of gasoline

☐ How is this possible if a gallon of gasoline weighs about 6lbs?

# Now we can figure out how much CO2 is being emitted on the block per car.

- 8920 grams per gallon X 0.00859 gallons (for small cars)

- This equals:
  - 46.22182 grams of CO2 per small car for this block

# So, what is the final result?

Car Counting Data

sm car

| block l(ft) | block l(m) | gallons per block | grams CO2 per block |
|---|---|---|---|
| 600 | 0.114 | 0.005182 | 46.22182 |
| 1000 | 0.189 | 0.008591 | 76.63091 |
| 1200 | 0.227 | 0.010318 | 92.03818 |

lg car

| block l(ft) | block l(m) | gallons per block | grams CO2 per block |
|---|---|---|---|
| 600 | 0.114 | 0.006333 | 56.49333 |
| 1000 | 0.189 | 0.0105 | 93.66 |
| 1200 | 0.227 | 0.012611 | 112.4911 |

Box Truck

| block l(ft) | block l(m) | gallons per block | grams CO2 per block |
|---|---|---|---|
| 600 | 0.114 | 0.010364 | 92.44364 |
| 1000 | 0.189 | 0.017182 | 153.2618 |
| 1200 | 0.227 | 0.020636 | 184.0764 |

Semi

| block l(ft) | block l(m) | gallons per block | grams CO2 per block |
|---|---|---|---|
| 600 | 0.114 | 0.019 | 169.48 |
| 1000 | 0.189 | 0.0315 | 280.98 |
| 1200 | 0.227 | 0.037833 | 337.4733 |

Bus

| block l(ft) | block l(m) | gallons per block | grams CO2 per block |
|---|---|---|---|
| 600 | 0.114 | 0.01425 | 127.11 |
| 1000 | 0.189 | 0.023625 | 210.735 |
| 1200 | 0.227 | 0.028375 | 253.105 |

Beverly Rd

1200ft long

2:00-2:15

| car type | sm car | lg car | box truck | semi | bus | | total |
|---|---|---|---|---|---|---|---|
| car count | 111 | 19 | 3 | 1 | 17 | | 151 |
| g of CO2 | 10216.24 | 2137.331 | 552.2291 | 337.4733 | 4302.785 | | 17546.06 |

Tilden Ave area

Tilden Ave
1000ft long

2:35-2:50

| car type | sm car | lg car | box truck | semi | bus | | total |
|---|---|---|---|---|---|---|---|
| car count | 99 | 21 | 1 | 0 | 1 | | 122 |
| g of CO2 | 7586.46 | 1966.86 | 153.2618 | 0 | 210.735 | | 9917.317 |

Ralph Ave
600ft

12:20-12:35

| car type | sm car | lg car | box truck | semi | bus | | total |
|---|---|---|---|---|---|---|---|
| car count | 110 | 60 | 43 | 6 | 11 | | 230 |
| g of CO2 | 5084.4 | 3389.6 | 3975.076 | 1016.88 | 1398.21 | | 14864.17 |

Kings Hwy
600ft

1:43-1:57

| car type | sm car | lg car | box truck | semi | bus | | total |
|---|---|---|---|---|---|---|---|
| car count | 469 | 80 | 28 | 13 | 26 | | 616 |
| g of CO2 | 21678.03 | 4519.467 | 2588.422 | 2203.24 | 3304.86 | | 34294.02 |

E56st, E57st, E59st
600ft

2:00-2:15

| car type | sm car | lg car | box truck | semi | bus | | total |
|---|---|---|---|---|---|---|---|
| car count | 4 | 11 | 0 | 2 | 2 | | 19 |
| g of CO2 | 184.8873 | 621.4267 | 0 | 338.96 | 254.22 | | 1399.494 |

combined: 4198.482

total CO2 emissions in area over a 15 minutes time period
80820.04
in a day
7758724

# Tree Data

- ☐ Carbon Sequestration

- ☐ Based on the weight of the tree, we can figure out how much CO2 it holds.

- ☐ A tree holds .246kg of CO2 for every .18 kg of the tree.

# So...

- If we use this formula we can figure out how much CO2 each tree is holding.

- (Weight of tree/0.18kg) X .246kg

# How do the trees compensate for humans?

- ☐ An average human exhale about .7kg of $CO_2$ in a day. Therefore, we can figure out how may people are being compensated for by each tree.


- ☐ <u>Carbon footprint of tree</u> = # of ppl
         0.07kg              compensated

# Results

- ☐ Combined Tree data
  - ■ Total CO2 sequestered:  6483146.40kg
  - ■ Total # of ppl compensated for: 9261638ppl

  - ■ In the area we measured, there are about 255 people.
  - ■ The trees can make up for the people's CO2 emissions in the direct area for 36392 days or about 100 years! (not including cars)

# Calculating $CO_2$ emissions from Cars

# Step 1: Measure the length of the block we are investigating and convert to miles.

# Step 2: Figure out how many gallons of gasoline are being used on the measured block.

- Small Cars travel roughly 22 miles with one gallons of gasoline. Therefore, How many gallons do they use on this block?
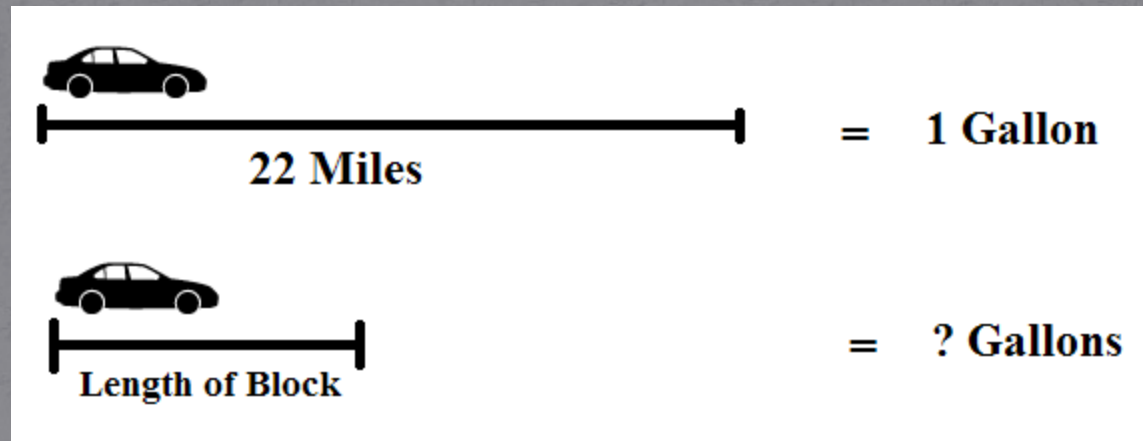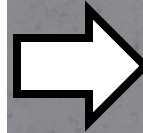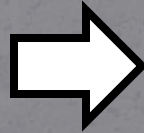
# Step 4: Find out how much $CO_2$ is being emitted by ALL cars on this block.

- Now that you know how much 1 car emits on the block, simply multiply that number by the amount of cars that were counted on this block in 15 minutes.

# Step 5: Find out how much $CO_2$ is being emitted by ALL cars on this block within an entire day.

- We only counted cars for 15 minutes on each block. However, to be able to compare this data to the tree data, we need to how much CO2 is emitted per day.

- How many 15 minute periods are there in a day?

- There are 4, 15 minute periods in an hour, and 24 hours in a day, that makes for 96, 15 minute periods in a day
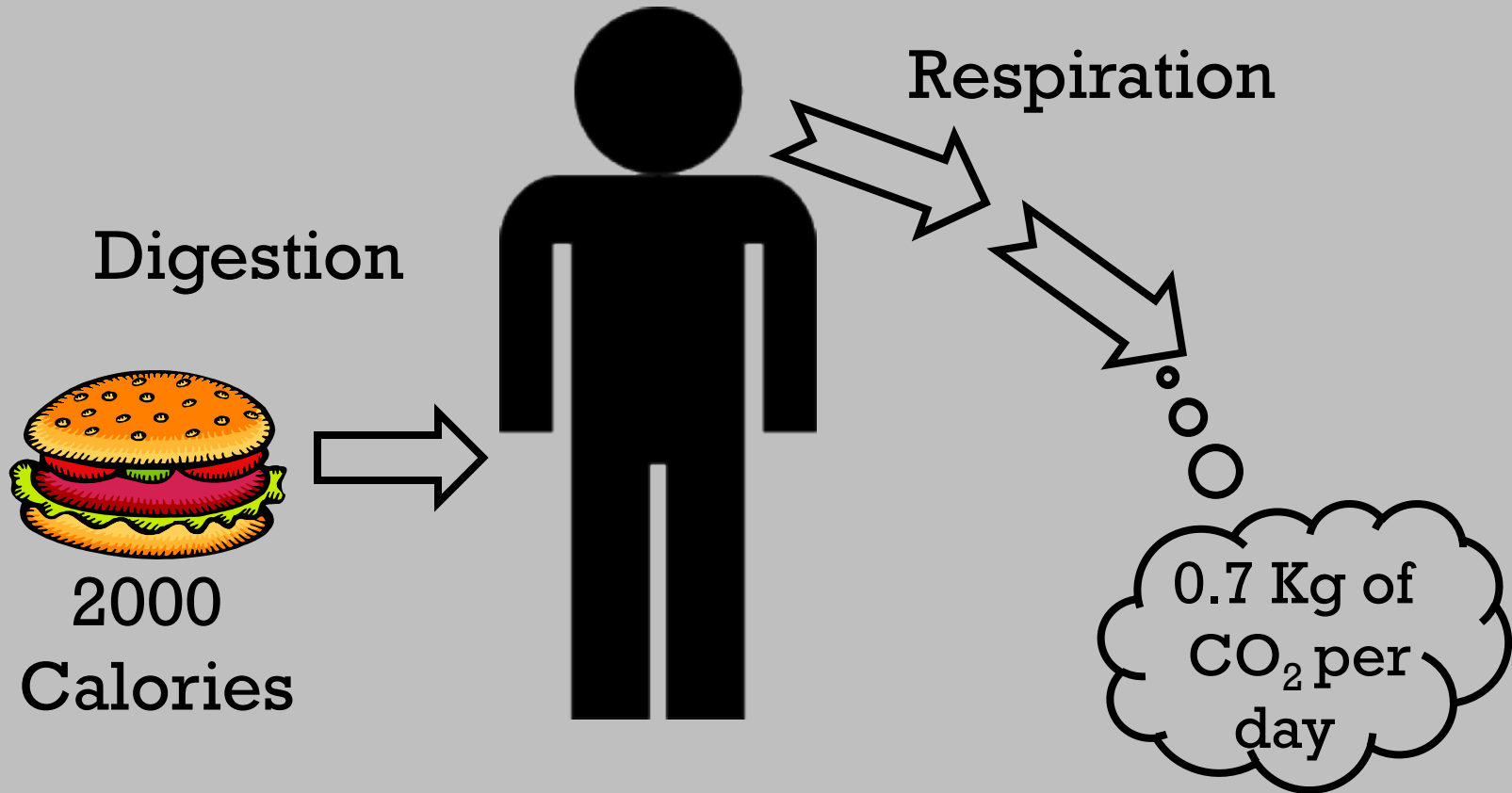
- Multiply your answer for Step 4 by 96

# Final Results
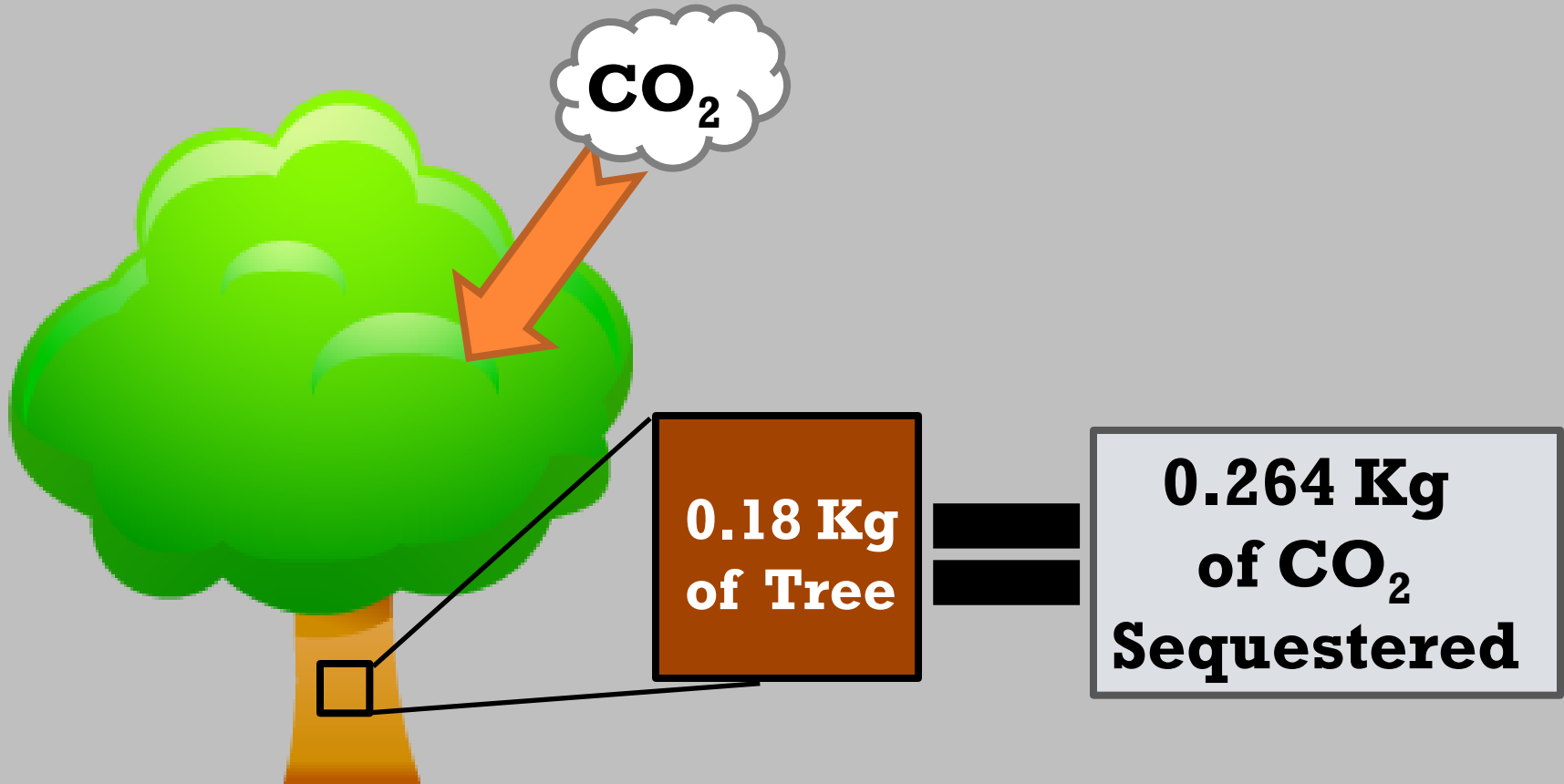
# Sources of CO$_2$ we measured
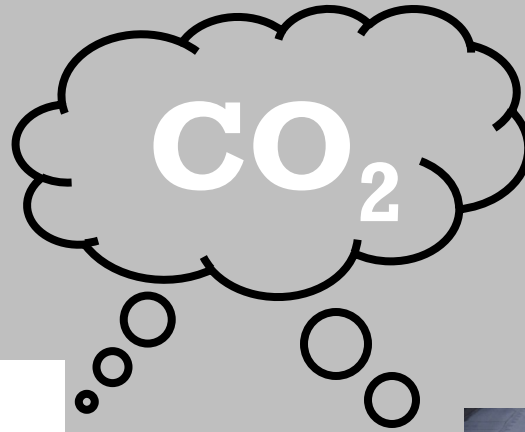


People

Cars

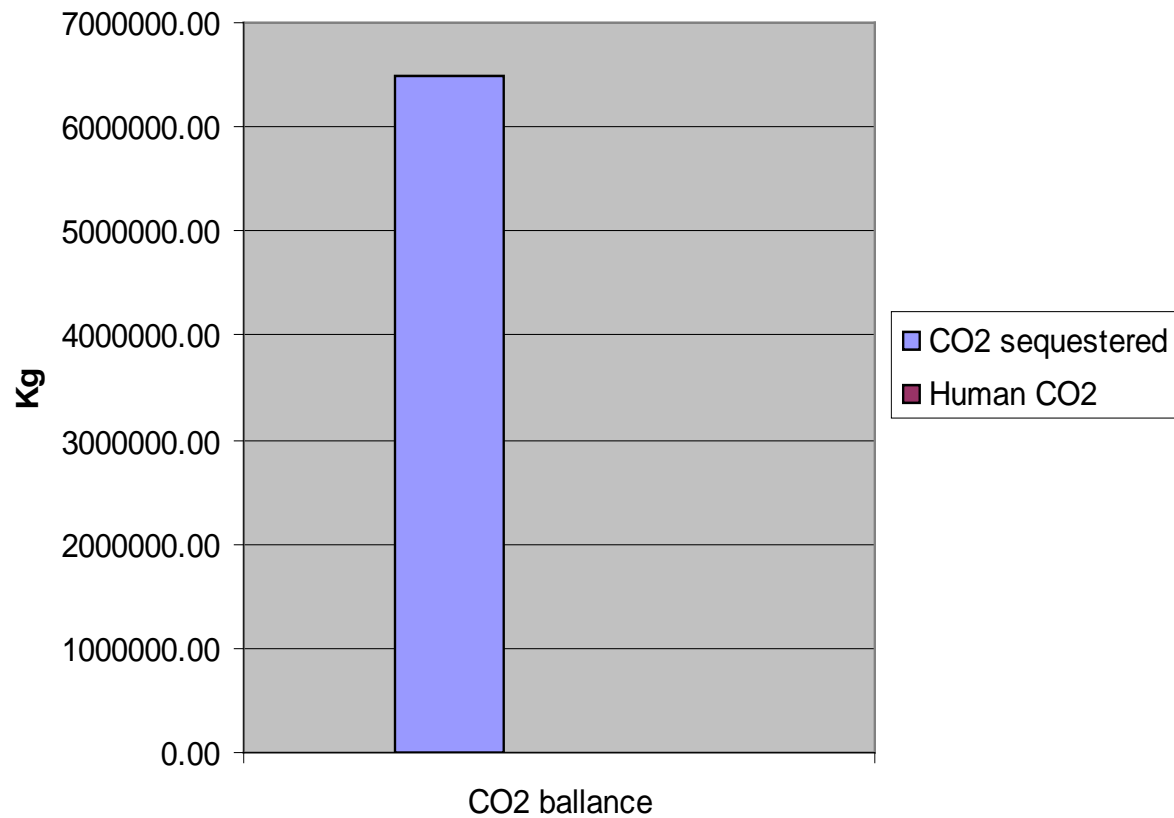# Are we producing more than what the trees can sequester?
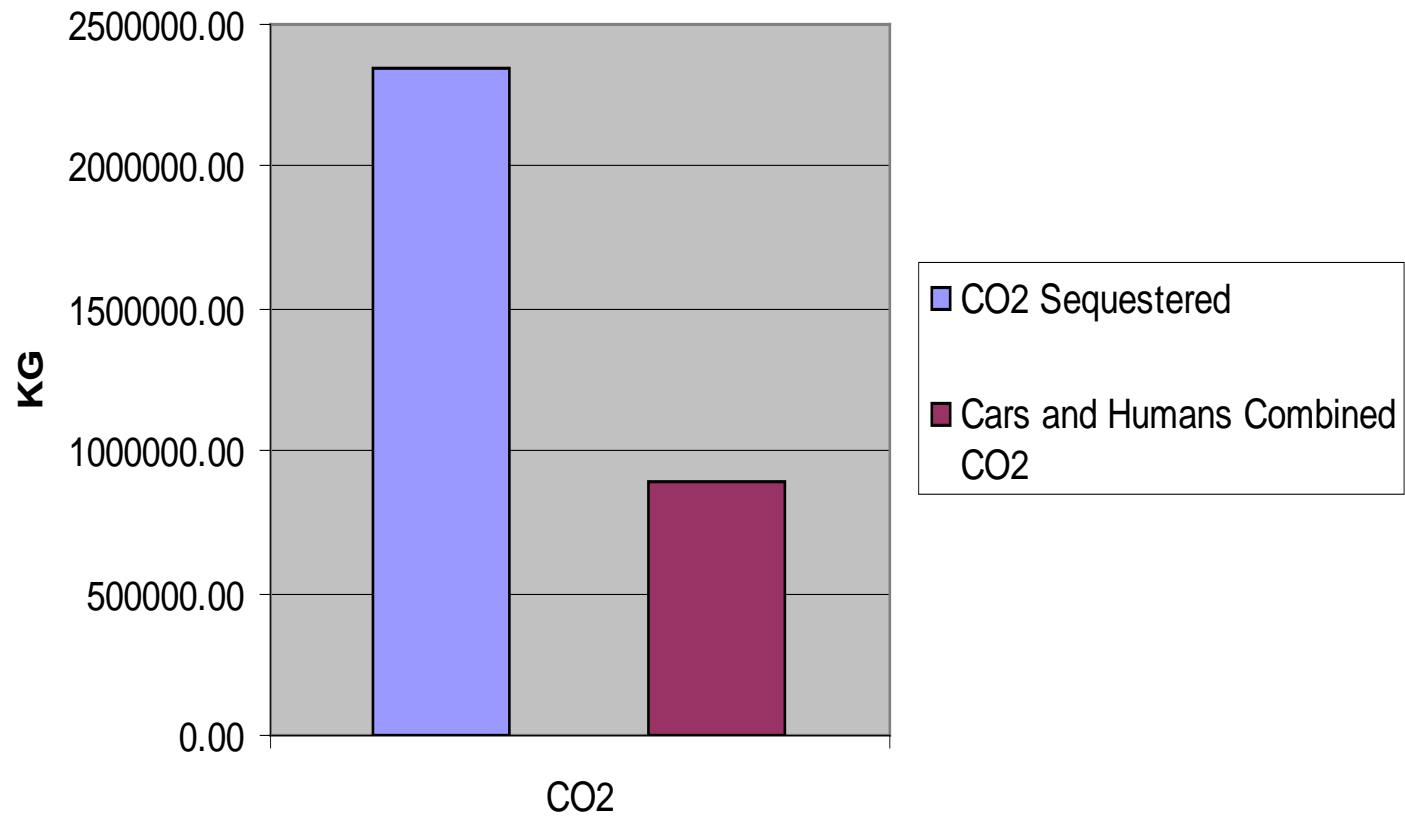
# Cars and People
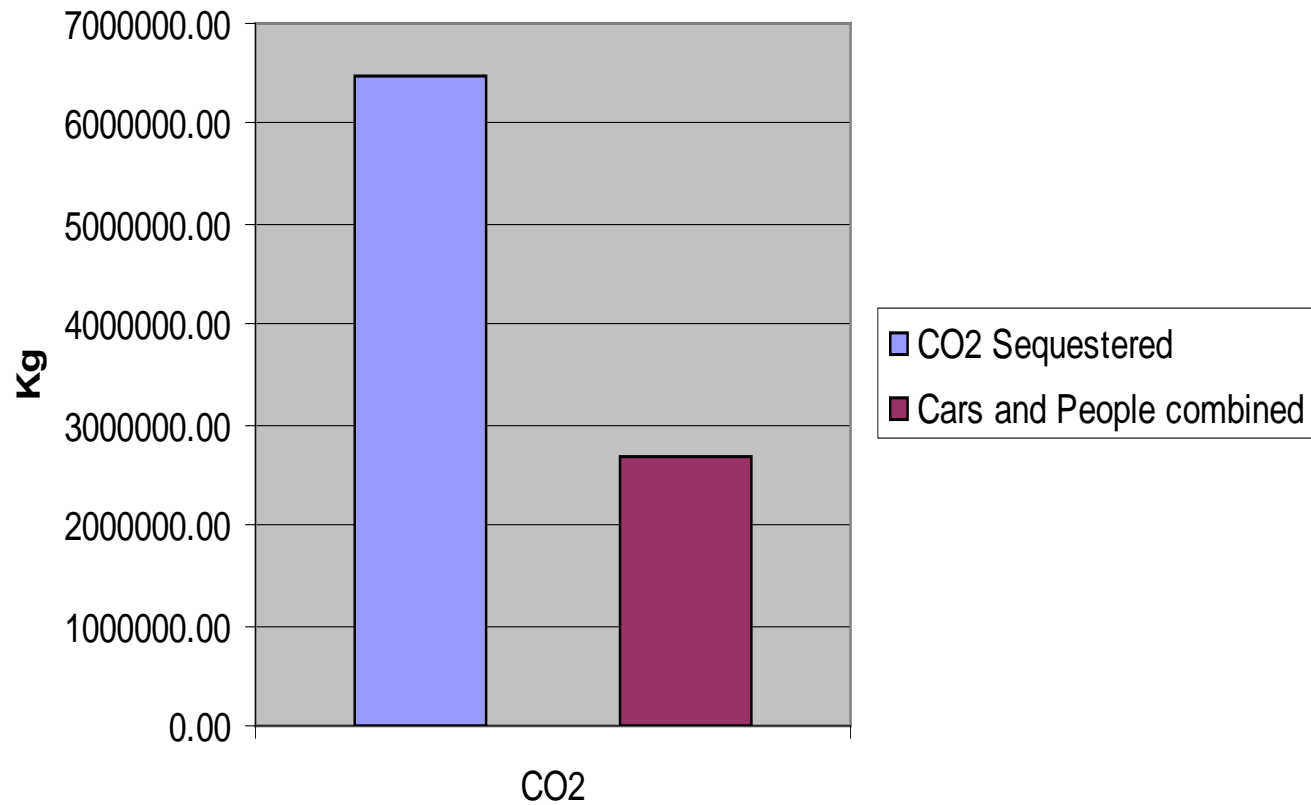
# Church Ave area

# What do you think?

- Is our data accurate?

- Is there anything else we should consider?

- What can we conclude with this data?

- Do changes need to be made?