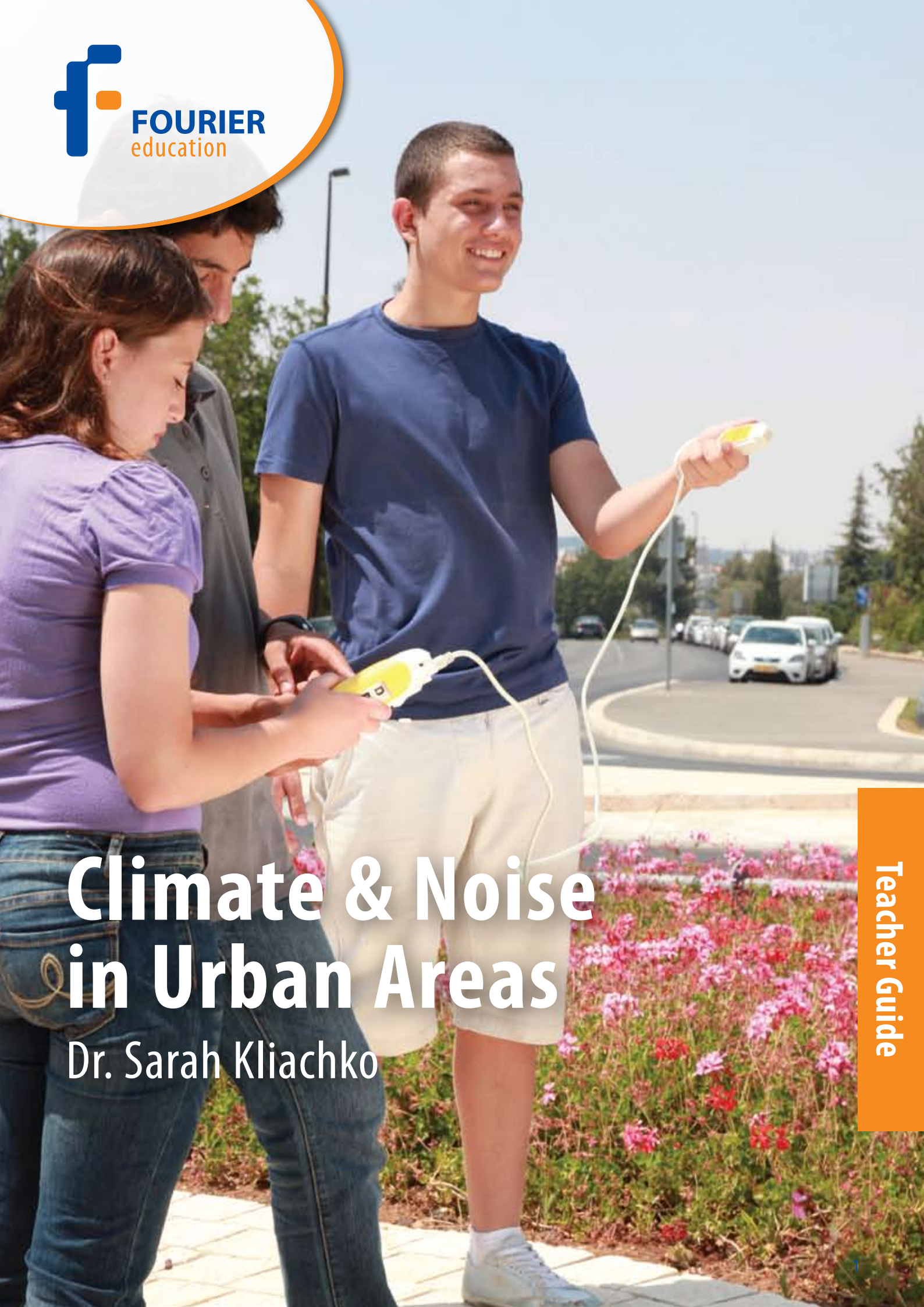
FOURIER education



Climate & Noise in Urban Areas

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Teacher Guide

Contents

Preface

Urban Areas and the Well Being of the Environment and of Humans

By 2010, humans have transformed up to half of the planet surface and used about half of the accessible fresh water sources. The number of cities with a population exceeding one million is rapidly growing. In 2010 more than 80% of the population in western countries lived in metropolitan areas. It is estimated that by 2030 about 60% of the global population will live in metropolitan areas. Sprawling metropolitan areas have formed huge agglomerations – in some the population reaches tens of millions. The huge urban areas greatly modify the local climate and hydrology, effects that increase with their size and density.

City growth modifies the environment:

- Local and regional climate change is created due to the replacement of natural surface – soil, grass and trees - by concrete at ground level and by glass and metal at different levels above the ground. The replacement of natural surfaces by artificial surfaces modifies the climate in the metropolis, since reflection and radiation of sun light and heat are immensely changed. The most dramatic effect of metropolitan growth is the creation of the urban heat island – an increase in the temperature in the metropolitan areas compared to areas around it. Heat islands increase together with the increase in the urban size. In addition to heat islands, climate change includes increases in cloudiness, fog, dust and precipitation while wind speed is reduced.
- Heavy transportation inside the metropolitan area increases the combustion of fuels and the emission of CO_2 – one of the main green house gases contributing to global climate change.
- Air pollution - Heat islands serve as trap for atmospheric pollutants and the reduction in wind speed aggravates the situation. In addition, heavy transportation adds even more pollutants to the air.
- Change in hydrology - the modification of the ground surface alters soil drainage and water flow. The total runoff increases since only part of the water is absorbed by the artificial surface. Flood frequencies increase and water quality is reduced.
- Noise pollution – densely populated areas and heavy transportation create a very noisy environment during many hours of the day and night. Long exposures to noise leads to nervousness, fatigue, lack of concentration and increase in sickness. In addition, long exposure to loud noise damages the hearing system – a common phenomenon among young people living in metropolis.

There are many actions that can help reduce these problems in urban areas: Tree planting helps limit the total surface area of artificial surface cover, allowing for groundwater recharge, reducing overall temperature, and helping purify the air.

In this booklet we present activities on three of the main issues related to urban areas: urban heat islands, noise pollution and air pollution. Following these studies the students are encouraged to suggest solutions to the problems they find from their studies.

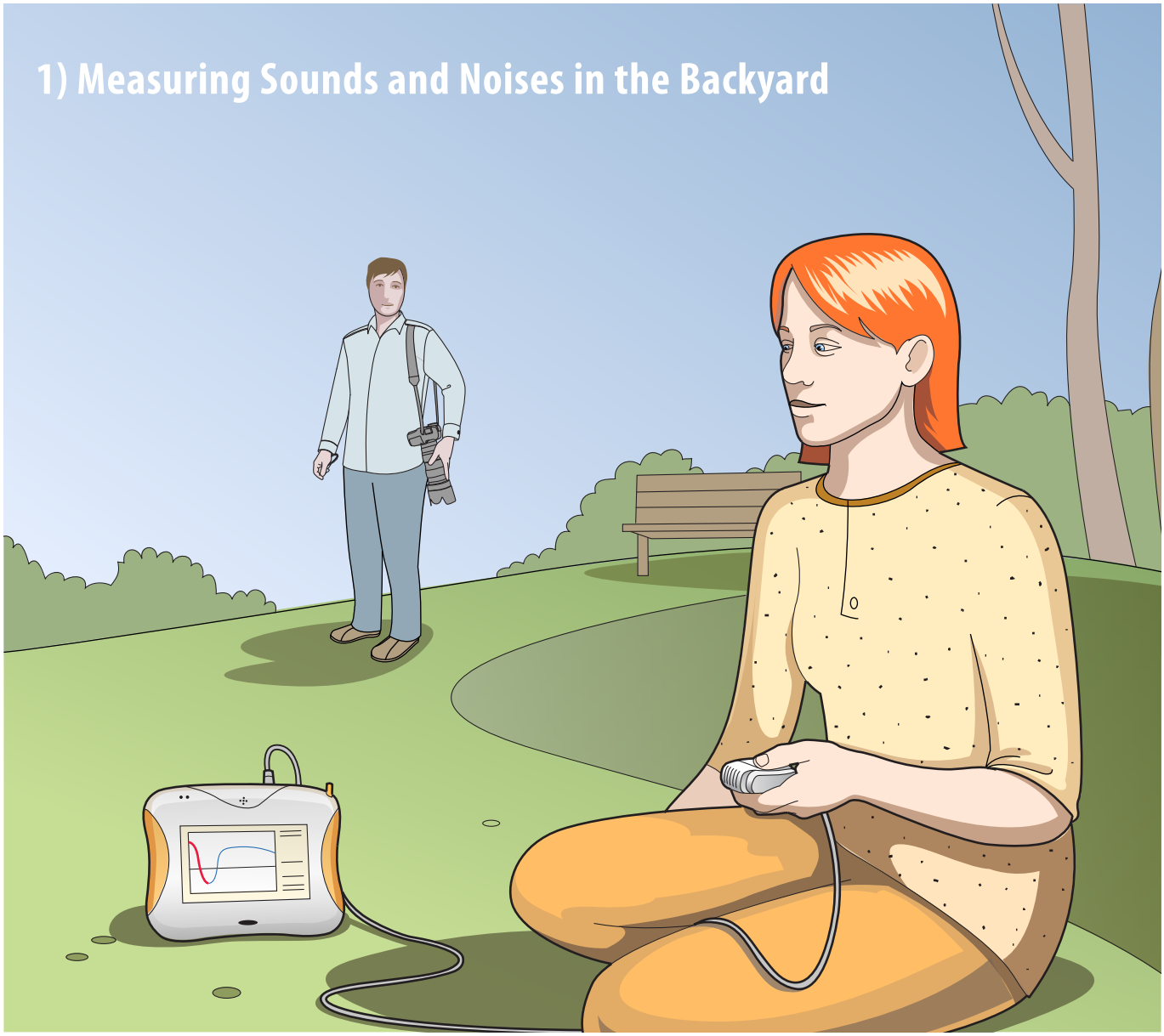
To perform the experiments you can use either Fourier's USBLink or MultiLogPRO data logging devices, with MultiLab software. For your convenience we have added the table below. It lists the activities, the relevant subject matter, and the sensors that are required to carry out the activity.

	Activity	Subject	Fourier Sensor
1	Measuring Sounds and Noise in the Backyard	Noise pollution	Sound
2	Noises we are exposed to in school	Noise pollution	Sound
3	Measuring Noise Emitted from Vehicles near Cross Roads	Noise pollution	Sound
4	Protection from Noise Pollution	Noise Pollution	Sound
5	Measuring the Impact of Urban Parks and Green Areas on Temperature and Relative Humidity	Urban Heat Islands	Temperature Humidity
6	Measuring the Temperature of Exterior Walls and Roofs Buildings	Urban Heat Islands	Thermocouple
7	The Influence of Natural Ventilation on the Indoor	Urban Heat Islands	Temperature Humidity Anemometer
8	The Influence of "Vegetation Shading" on Wall Temperatures	Urban Heat Islands	Thermocouple
9	An Examination of the Thermal Insulation of the Building Envelope	Urban Heat Islands	Thermocouple
10	Effect of Sun Light on Temperature of Pavements	Urban Heat Islands	Temperature
11	Air Pollution and Acid Precipitation	Air pollution	pH

Safety Precautions

- Follow standard safety procedures for laboratory activities in a science classroom.
- Proper safety precautions must be taken to protect teachers and students during the experiments described in this book.
- In all outdoor activities, students can work in teams of two or three and should be accompanied by an adult for security reasons.
- It is not possible to include every safety precaution or warning!
- Fourier assumes no responsibility or liability for use of the equipment, materials, or descriptions in this book.

1) Measuring Sounds and Noises in the Backyard



Introduction

Nature is rich in sounds such as roaring thunder, tree branches shaking in the wind, flowing water and sea waves. Sounds are an important way for animals to communicate. Artificial sounds are emitted from man-made machines.

Noise is an unwanted sound. However the definition of sounds as noise is a subjective distinction since it depends on the reaction of each of us to the sounds: one person enjoys loud rock music while others may call it noise.

Sound levels are measured in units of decibels (dB), which is a logarithmic unit: the addition of one decibel means a 10 times increase in the sound level. The intensity and the duration of the sound affects our senses. Normal voice level is about 60 decibels. Quiet conversation emits sounds in the range of 50-60 decibels. Loud music in clubs can reach levels above 120 decibels. Cars running on the road emit sounds in the range of 70-80 decibels. Continuous exposure to sound levels above 55 decibels during night hours is forbidden in many countries, while during the daytime levels of 60-65 decibels are allowed.

In this experiment we will use a Sound Sensor to measure sound levels in our backyard or school yard and look at their sources: natural and artificial.

Learning Objectives

1. Learn to use a Sound Sensor to measure sound levels.
2. Conduct a research study on different aspects of sounds (sources, levels, changes of levels at different hours, effect of different uses on levels (conversation, arguments etc.).
3. Study different sound sources in our neighborhood and the level of sounds they emit (preferably in the form of a research study).

Time Frame

Two different approaches can be used:

- Short measurements (1-5 minutes) of a defined sound source.
- Continuous measurements of different sound sources (30-60 minutes) – the name of the sound source should be written in the correct place on the graph.

We recommend that two or three lessons be dedicated to the subject:

- First lesson - An introduction: learn about the types of sounds we hear the role of sound in communication of animals and of humans, definition of noise and sources of noise around us, design of a research study on measurements of sound levels in the yard, the appropriate way to conduct the study, and the use of the Sound Sensor.
- Second lesson - Research: Measuring sounds in the yard, and data analysis.
- Second or Third lesson - Summary: Compare different sources of sound – natural and artificial - their effect on us, and the role of sounds in our life.

Concepts Students Have to Know

- Various sounds are emitted from natural sources – inanimate (waves, flowing water, wind, thunder) and animate (animal, human and machine sounds).
- Sounds are an important means of communication in the animal kingdom.
- Changes in sound levels help us express feelings and transfer messages (warnings, anger, fear, love, etc.).
- Unpleasant sounds are considered to be noise. This is an individual feeling since each of us reacts differently to sounds.
- Decibel - the unit used for measuring sounds is a logarithmic scale – an increase of one unit means a 10 times increase in sound level.

Equipment

- Nova5000™
- Sound Sensor
- Sensor cable

Equipment Setup Procedure

1. Launch Multilab CE.
2. Connect the Sound Sensor to Input 1 (I/O 1) of the Nova5000.
3. Click Setup  on the main toolbar and configure the data logger according to the setup specified below.

Data Logger Setup

Input	Sensors	Rate	Samples
1	Sound	10 samples per second	10000

Technical Notes About Equipment and Setup Procedure

1. Point the Sound Sensor at the sound source throughout the measurement.
2. If possible – it is recommended to stay about three meters from the sound source in order to receive louder sounds.
3. The sampling rate of 10 samples per second enables us to observe very short sounds (like those of bird calls) and fluctuations in sounds emitted from different sources.

Experimental Procedure

1. Choose a random location in the yard.
2. Click Run  on the main toolbar.
3. For a few minutes, record the sounds that are heard.
4. Follow the sound level recorded on the screen.
5. While recording sounds, write the sources of the sounds in your notebook.
6. Click Save  to save the data.
7. Click First Cursor  to choose the graph.
8. Click Add Annotation  and insert the name of the sound source.
9. Choose a place in the yard where you can hear birds.
10. Click Run  on the main toolbar.

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11. Follow the sound level recorded on the screen.
12. On the graph, try to locate the birds and identify them (use a suitable bird guide).
13. Note if the birds are in groups, in couples or apart from each other.
14. Click Save  to save the data.
15. Click First Cursor  to choose the graph.
16. Click Add Annotation  and insert the source's name.
17. Move to another location in the yard, close to a road with running cars.
18. Click Run  on the main toolbar.
19. Follow the sound level recorded on the screen.
20. Note the sources of the sounds: size of cars, bus, trucks etc.
21. Click Save  to save the data.
22. Click First Cursor  to choose the graph.
23. Click Add Annotation  and insert the source's name.
24. You have now completed the procedure and are ready for data analysis.

Pedagogic Notes About the Experimental Procedure

1. It is recommended to record bird sounds during hours of maximum bird activity: in the morning when they look for food or in the afternoon when they prepare for night rest.
2. The best hours to record noise emitted from vehicles on the roads are rush hours: in the morning when people go to school and work, and in the afternoon on their way back home.
3. It is best to separately follow each sound source – that is why we divide the measurements into three parts.
4. The best hours to measure bird sounds are in early morning up to 10:00 or 11:00, when they are most actively looking for food. Rush hours are the best times to follow traffic sounds.

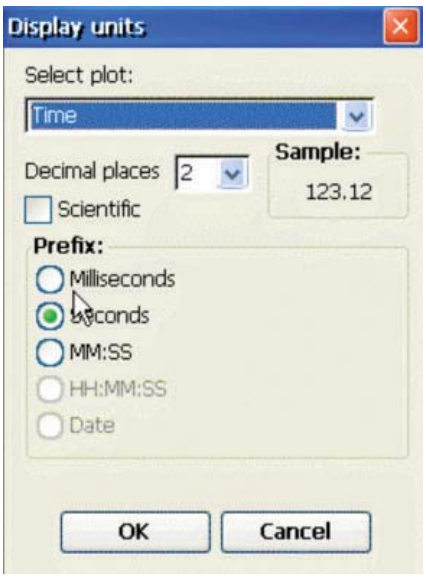
Data Analysis

1. Click the First Cursor to read the sound level at a chosen point from the graph.
2. In order to read other points – click the cursor and move it along the graph (to cancel your selection and start over, click the First Cursor again).
3. To read another sound level from the graph, choose another point on the graph and then click the First Cursor to read the sound level at that chosen point.
4. Complete the following table: write ranges of sound levels recorded during the measurements:

Different sources in the yard (write the name of each source and the noise level it emits)

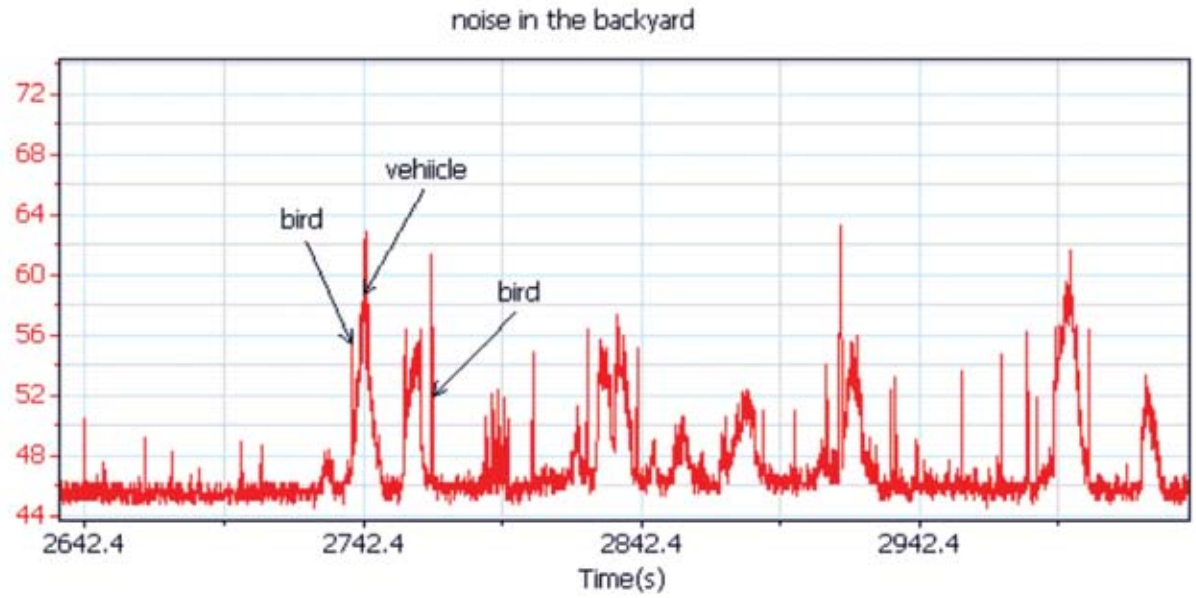
Source of sound	Level of sound (dB)
Birds:	
Bird a	
Bird b	
Bird c	
Vehicles:	
Private car	
Bus	
Truck	
Other	
Other Sounds	

5. When the experiment is completed,
   you can adapt the time axis to the date and hour of your experiment:
6. Make sure that your Nova shows the correct current day and hour.
   Perform the following steps:
   a. On the Tools menu, select Unit Settings.
   b. In the Display Units dialog that appears,
      choose the plot for formatting from the
      Select Plot drop-down menu.
   c. Select a prefix option Date.
   d. Click OK.



Data Analysis- Samples and Expected Results

A graph of the measurements recorded during early morning hours (7:00-8:00) is presented below.



Birds emit short sounds that are recorded as very narrow peaks, as shown in the above example graph.

The sound level may reach 70-75 decibels – quite a loud sound.

Vehicles emit a wider peak – it rises when the vehicle approaches the point of measurement,

reaches a peak at the closest point and declines when the vehicle gets further away (see example graph).

The noise level depends on the speed and size on the vehicle - buses and trucks emit strong sounds that can reach 80 decibels.

Horns, sirens and alarm systems emit really high sounds – above 90 decibels.

Questions

1. What is the range of sound levels recorded in your measurements?
    b. What is the highest sound and from which source?
    c. What is the most annoying sound that you can define as noise?
1. Describe the shape of the recorded curve.
    a. Did you receive identical curve shapes for all sound sources? Explain.
    b. What kinds of sounds would you define as noise?

Answers

1. Usually, the sound level range in our backyard or at school is 40-80 decibels. Loud sounds from birds may reach levels of 70 decibels. Buses and trucks may create louder sounds reaching levels of 80 decibels.
2. The curve has a fluctuating pattern because the sound level is constantly changing.
3. Different sources emit different types of sound patterns: very short sounds from birds create narrow peaks, while a moving car creates a wider peak (the sound increases while the car approaches and decreases when the car is getting further away). Sometimes sounds are successive and one peak is built on top of the preceding peak. It is recommended to mark the sources of sounds while recording them in order to compare them.
4. Examples: loud sounds emitted from cars, screaming people, loud music.

Further Suggestions

1. Record sounds from sources inside your house: TV, computer games, music heard from different sources and from different types of music.
2. Record sound levels in different locations in school during intermissions and compare them to sound levels inside classrooms.
3. Compare attitudes of friends towards different types of music: which type of music do they consider to be noise?