Wind Speed vs Temperature: Teacher Guide

Level: Intermediate

Subject: Geography and Mathematics

Duration: 1 hour

Type: Classroom activity

Learning goal:

- Use of statistical tool (MS Excel) and real time data to find the nature of the relationship between the two parameters

Materials:

- A computer with access to internet and MS Excel
- Access to school2school.net to download hourly humidity and temperature data

Introduction:

Temperature is the intensity of heat in a substance while the wind speed is the air in motion from. A gradient in temperature occurs when two locations are at different temperatures, causing the differences in air pressure between the two spots. The atmosphere tries to equalize the air pressure at these two spots, forming wind. Generally, the larger the temperature difference, the stronger the resulting winds will be. Temperature gradients between water and land can also cause local atmospheric circulations which affect winds. During the day in summer when the land heats up more quickly than water, heat-related low pressure causes rising air over land which moves over the water and cools, then returns to land as a cooling "sea breeze". At night, the water is often warmer than the land and the reverse circulation, which includes a breeze from land to sea called a "land breeze", takes its place.

Methods:

Open the school2-school website and choose one station that you would like to use for your analysis. If you have a TAHMO station in your school then it is the best to use. Open the wind speed and temperature data by clicking the icons labeled temperature and wind speed. Tell your students to compare the values of the two parameters. How do the data compare? Is there any notable relationship?

You notice that there is a relationship between the wind speed and temperature. Can you explain the relationship? Let the students give the answers. Since the class has not completed the analysis don't ignore any answer given by the students. At this point all answers are neither right nor wrong .The accepted hypothesis is that there is a direct relationship between the temperature and wind speed or the wind speed increases with temperature.

Now you have the hypothesis. At this step your students will now be proving or disproving that hypothesis i.e. testing the hypothesis. So tell your students to record several wind speed data values on two separate columns but in the same excel sheet and name them.

As this point the students should start working on their student handout. In the student handout, instructions are given for creating a table of data, plotting the data by hand, and calculating the correlation coefficient by hand (use of calculator are encouraged). These hand plots will be verified and compared with Excel plots in the following steps. Before moving onto the Excel portion, a few discussion questions might be useful:

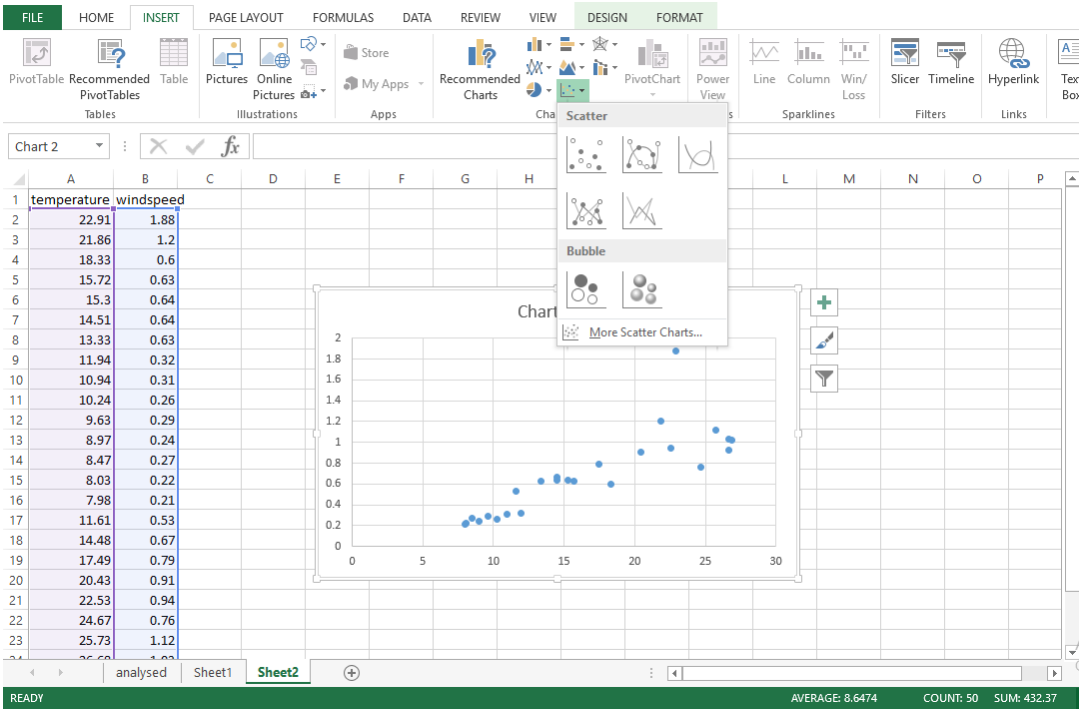
- In our hand calculations, we only included 10 data points. When we plot all of the data points using Excel, do we expect it to show similar trends? (Answer: Yes, because the 10 data points we used are a subset of the total data we do expect the trends to be similar but not exact)
- What are some advantages of making the plots and calculation by hand first before using Excel? (Answer: we can better understand the process if we do the plots and calculations ourselves, that way when Excel gives us an answer we can understand and interpret it correctly)

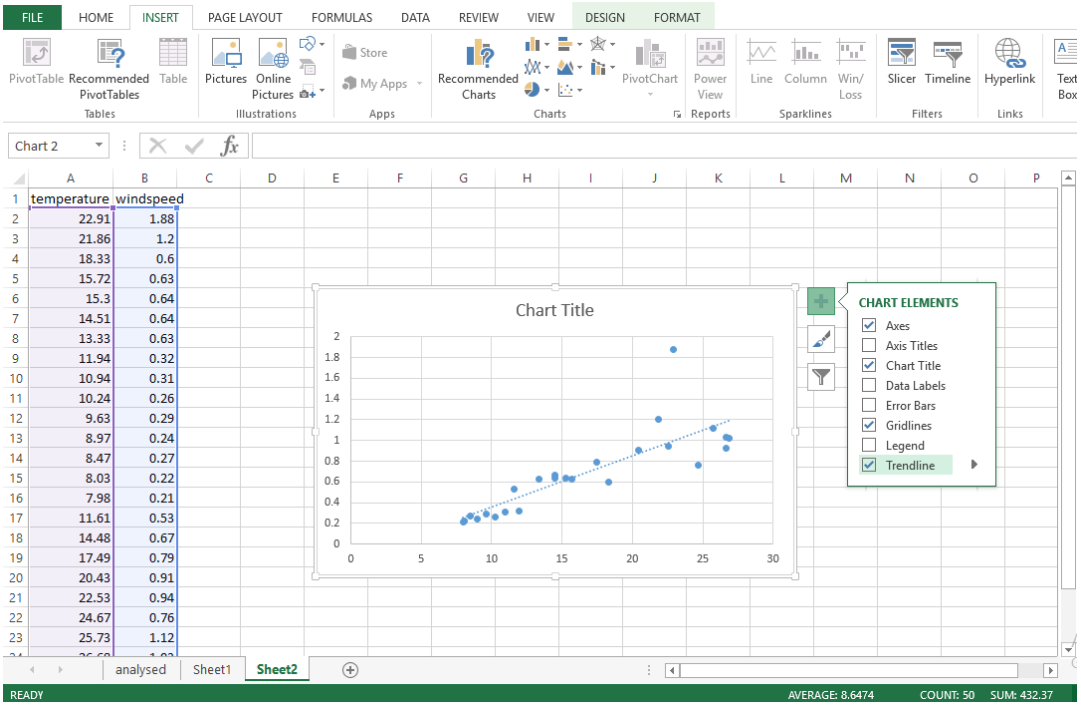
Using excel, plot the values you have on a chart (scatter plot). This chart makes it easier to see how one is affected as the other one changes. This is how to go about it:

1. Highlight both column containing temperature and wind speed. Then, navigate to charts and select the scatter plots. A graph of the plotted data will be displayed. To see the trend, click

an icon with a shape of a plus sign at the top right side of the chart and scroll down to trend line and select. A straight line will appear on the charts slanting to the direction of the change. From your graph what is the direction of the slope (Positive slope = / or negative slope = \)?

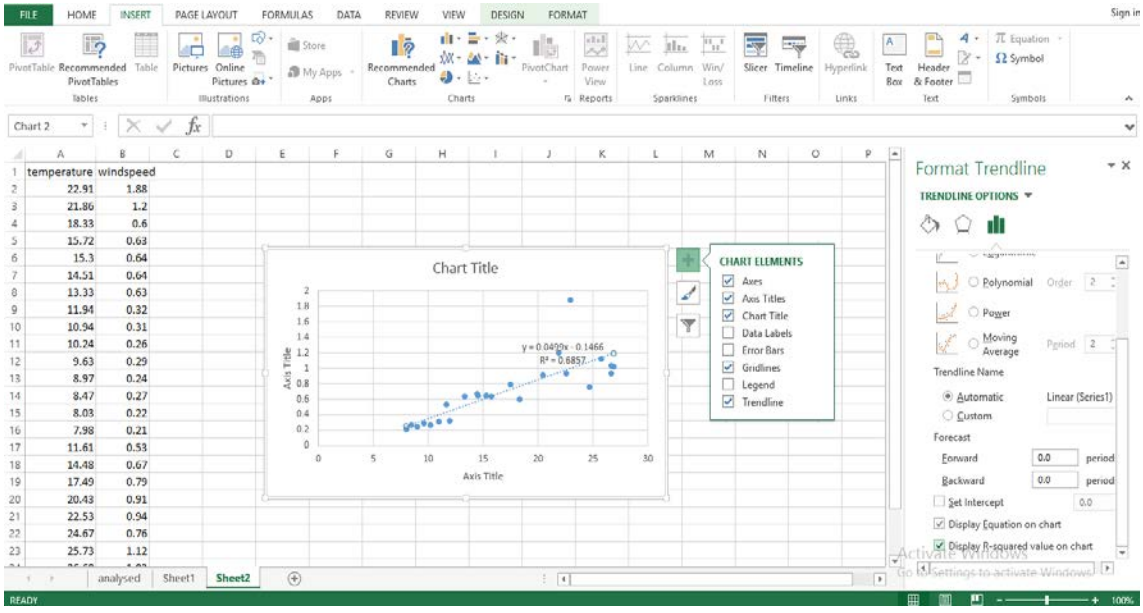
[Answer: it is a positive slope, which means temperature and wind speed are proportional]





2. You may find it interesting to label the axis and to give your chart a title actually it is important to do so. To do this click on your chart. On the same plus sign icon you used when adding the trend line, you will see an ‘axis title’ click on that option. Two boxes will appear on both axis of the chart with the name ’axis title’. Click inside those boxes and delete whatever is in them and type your titles including the units.

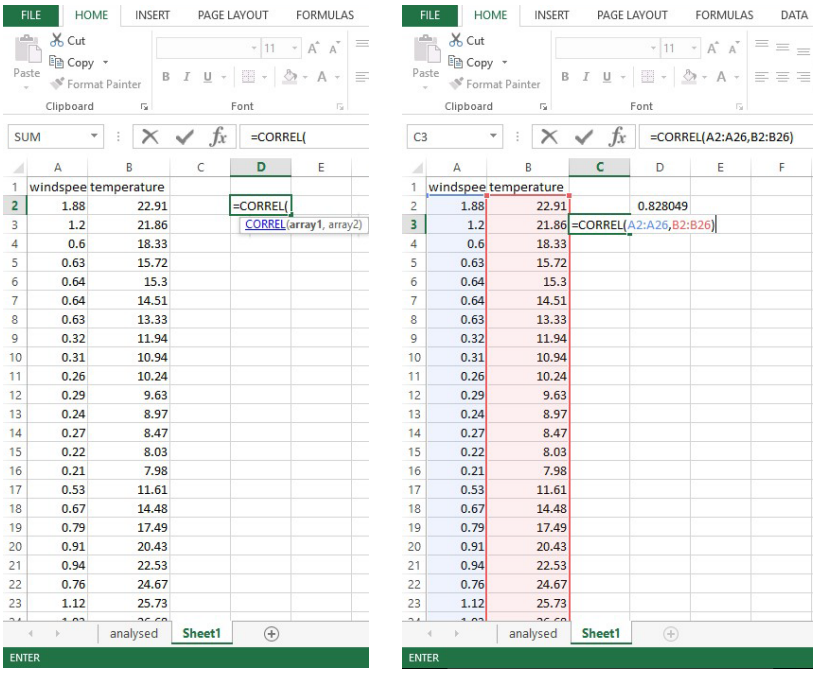
3. To add the equation of the trend line and the r^2 value, click on the trend line to highlight it. When you select the trend line a panel on the right hand side of the screen will open. Then right click and when you will be prompted to options pane scroll down to format trend line and then go to trend line options. Scroll down and tick both ‘display Equation on the chart’ and’ display R-squared value on the chart’



4. To calculate the strength of the relationship between your two parameters commonly referred to as correlation coefficient. In Excel, click on any cell in your sheet. Enter an equals’=’ sign. Immediately behind the equals sign type the word ‘corr’, excel will immediately below bring an icon with the word’ correl’ Double click on it. It will inside your working cell write “correl (“and just below it ‘CORREL (array 1, array2). Array is the data sets you want to perform the correlation. The number 1 and 2 indicates that you have two data sets that you want to perform the correlation.

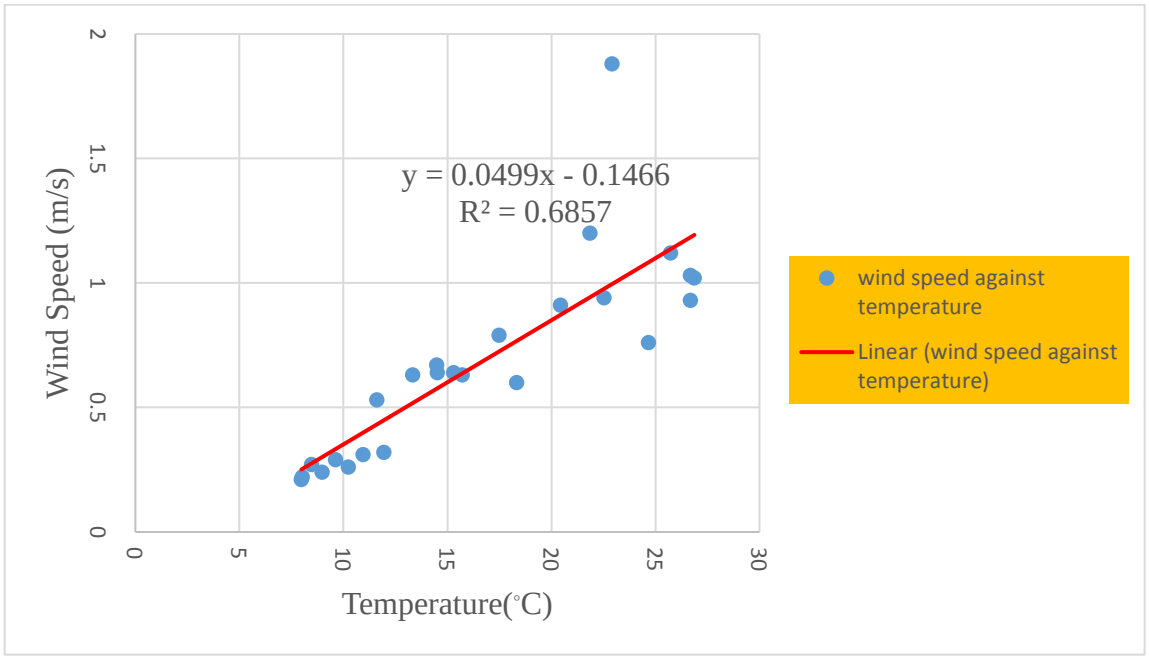
5. So to perform the correlation click on ”correl (“ inside your working cell, highlight your first column and insert a comma”,” then highlight the second column and close the bracket, then press enter. A correlation value should appear. That tells you the strength of the relationship

between the parameters. In our case the correlation coefficient is 0.828049. The following pictures shows the steps described in this step 2 respectively.



Results:

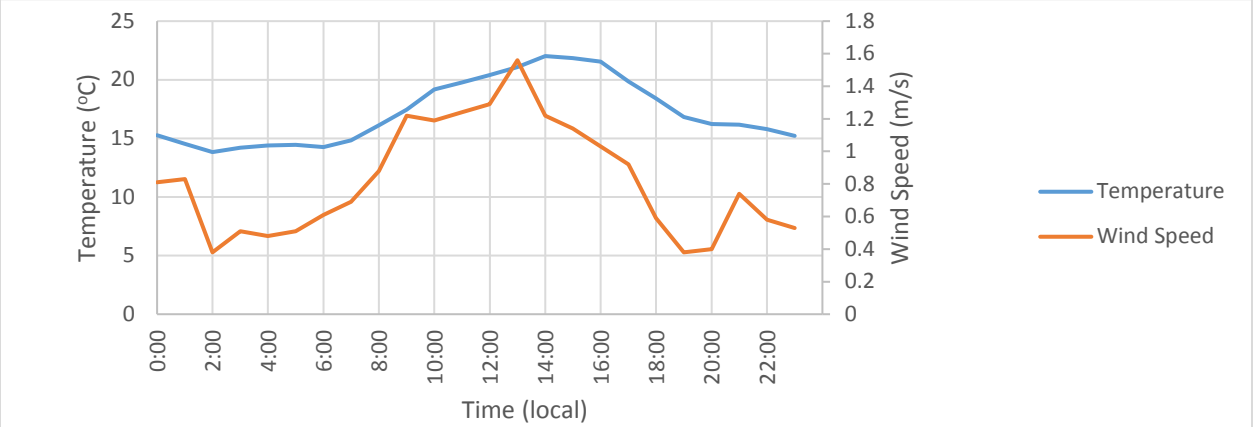
Have a look at our chart below. Ask the students what conclusion they can make from the chart. Can they now see clearly the relationship between our two parameters? What type of relationship? Does the chart have the answer to our correct hypothesis?



Discussion

What is the relationship between the correlation coefficient that we calculated and the R-squared that the Excel trend line gives us? What do each mean? [Answer: The correlation coefficient is "R" and if you square that values you get the "R-squared". From our correlation analysis our relationship strength is 0.828049. Our correlation coefficient is positive meaning that as temperature increase wind speed increase and the opposite is true. This is also supported by the fact that the trend line (the red line in our chart) has a positive gradient. Our R- squared value is 0.6857 which means that 69% of wind speed depends on temperature.]

Why is wind speed directly proportional to temperature? [Answer: Wind is caused by temperature difference between two layers of the atmosphere. Warm air rises and becomes less dense. As the warm and light air rises it starts to cool down it will become denser and start to sink. The maximum speed of the motion is at the maximum temperature as you can see in the chart below both occur at mid-day]



What time of the day when wind speed is at its peak? [Answer: Wind speed is at its peak when the temperature is maximum and this is normally at noon]

Where is the wind speed higher between ocean and land surface and why? [Answer: Land .Temperature gradient over the land is greater the over the ocean and therefore making wind speed over the land higher than over the ocean]

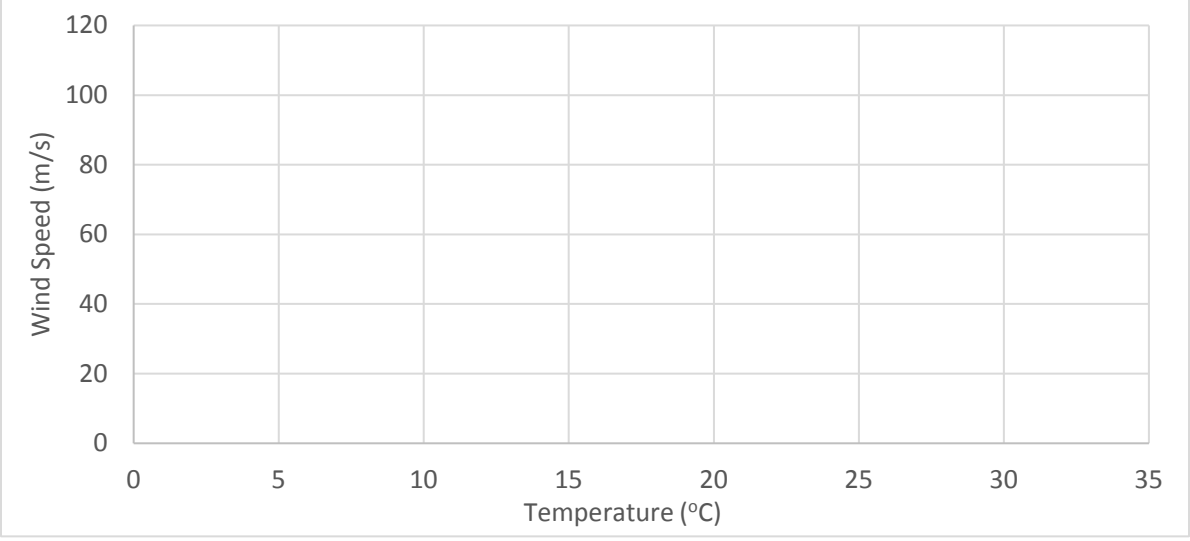
What are some of the natural phenomenon caused by the wind- temperature relationship? [Answer: Some of the phenomenon caused by the wind-temperature relationship are like katabatic and anabatic wind (winds that move down and upslope of a valley due to temperature difference between the floor and ridge of the valley), land and sea breeze (wind caused by temperature difference between land and ocean).]

Wind speed: Student Worksheet

Download the data from your local TAHMO weather stations from the School2School.net website. Open the hourly data in an Excel spreadsheet. Record the first ten data points onto the table below, writing down the hourly data for time, temperature, and wind speed for now (keep the last three columns empty).

Time	Temperature(°C)	Wind speed (m/s)	x^2	y^2	x*y
Sum=					

Using the completed table above, by hand make a plot with temperature as the y-axis and wind speed as the x-axis. Draw a line of best fit.



Use the following formulae to determine the strength of the relationship between temperature and wind speed using the correlation coefficient:

Where n= total number of variables in our case (20) and $\sum$ is the summation.

$$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[\, n\Sigma x^2 - (\Sigma x)^2 \,][\, n\Sigma y^2 - (\Sigma y)^2 \,]}}$$

Correlation coefficient = _____

Discussion:

From your graph what is the direction of the slope (Positive slope = / or negative slope = \)? Explain what that means about the relationship between temperature and wind speed.

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Where is the wind speed higher between ocean and land surface and why?

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What are some of the natural phenomenon caused by the wind- temperature relationship?

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