CALIFORNIA STATE SCIENCE FAIR
2013 PROJECT SUMMARY

Name(s)

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Project Number

33790

Project Title

The Effects of Man-Made Structures on Wind Patterns

Abstract

Objectives/Goals

Urban heat islands cause uneven distributions of heat between urban and rural areas. Wind is one way to direct heat away from cities. Analyzing building structures' effect on wind flow can help select locations with maximized wind speeds for more efficient turbine use. New buildings and cities can be designed to generate wind flow that maximizes the usage of natural energy.

Methods/Materials

Data was collected from 11 locations in 2 minute intervals at the Gabrielino High School campus using anemometers, the Apple application SPARKvue, and an Airlink device that connects to the SPARKvue software through bluetooth. The data included the average wind speed, the maximum wind speed, wind direction, temperature, and barometric pressure of the 2 minute intervals. Another experiment involved using Particle Image Velocimetry (PIV), capturing the movement of neutrally buoyant particles moving across steps constructs that represented the steps of the bleachers. To parallel the PIV, 4 additional points were added on the bleachers in hopes of comparing the two experiments.

Results

The data showed that urban structures create localized areas with higher wind speeds. The taller the building, the stronger the updraft of wind is created over the structure. A difference of 3 meters in height between area B and both areas A and C induced an average increase of 2.5 km/hr in wind speed of the higher area B. When warmer areas are surrounded by cooler denser air, there are surges in velocity. The temperature of the football field causes the wind to increase in velocity by an average of 1.65 km/hr over 119 meters. A series of T-tests revealed significant differences in locations, indicating the structural impacts on wind flow. A weak correlation was found between height and wind speed with the data from the bleachers.

Conclusions/Discussion

As the temperature difference widens, wind velocity increases, as seen in the increase in wind speed across the field. General wind direction reflects the effects of local orography on wind flow. On the field, wind normally heads north or northeast due to the placement and elevation of surrounding houses.
The parallels between the data from the PIV and the bleachers are currently being analyzed. Preliminary analysis indicates that wind increases as it travels up the steps, despite creation of eddies. Thus, it is possible to predict prime locations for setting up wind turbines.

Summary Statement

Analyzing and quantifying changes in wind speed due to building structures

Help Received

Daniel Araya helped us conduct the experiment using PIV; Aiwen Miao (mother) helped us organize our data on Excel; participants in Southern Junior Academy of Sciences; Eileen Tan (sister) helped record data; Matthew Escara helped review our research paper; Kevin McClure gave us suggestions to improve