EPA Urban Heat Island Pilot Project
City Profile: Baton Rouge (Archived Page)

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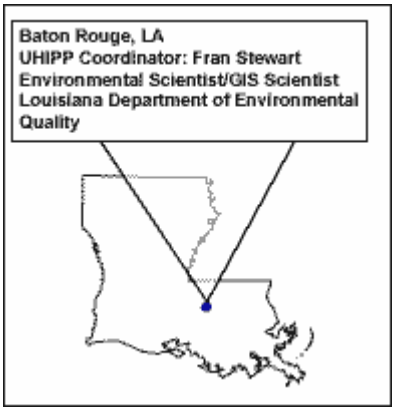

Baton Rouge is situated in East Baton Rouge Parish and is located in south-central Louisiana, on the east bank of the Mississippi River. Baton Rouge has a population of 227,818, and the Baton Rouge Metropolitan Statistical Area, which covers 1,588 square miles, has a population of 602,894.

Baton Rouge's Heat Island

In May 1998, the National Aeronautics and Space Administration (NASA) took aerial photos of Baton Rouge using Advanced Thermal and Land Applications Sensor aircraft data. These flyover photos represent a typical view of the city (left) and a thermal readout of metropolitan hot spots (right).

Aerial view of Baton Rouge (courtesy of NASA-Marshall Space Flight Center-Global Hydrology and Climate

In the thermal image, red and yellow areas indicate "hot spots" and generally correspond with roads and building roofs. Blue and green areas are cool and indicate water and vegetation.

The bright red areas in this image are about 149°F (65°C); the cooler areas are around 77°F (25°C). The solid blue swatch of color flowing down the left side is the Mississippi River. (These images have not been calibrated. Absolute temperatures will change after calibration, but relative temperature differences between surface types will not.)

Before determining how heat island reduction strategies impact an area, researchers need to evaluate existing surface characteristics. Aerial photos are useful for estimating the proportions of vegetative, roofed, and paved surface cover relative to the total urban surface

in a city. Having this urban fabric information can help researchers simulate the meteorological and air quality impacts of heat island reduction strategies.

Surface cover data also help scientists determine an area's heat island. The Department of Energy's Lawrence Berkeley National Laboratory (LBNL) modeled Baton Rouge's near surface heat island, which represents near ground air temperatures as opposed to surface temperatures measured by thermal images.

LBNL conducted this modeling analysis over a large area, several times larger than the city center. LBNL staff determined that Baton Rouge has a relatively uniform temperature field, mostly due to its elevation and terrain features. Compared to Salt Lake City, for example, LBNL simulations indicate that Baton Rouge's heat island, which ranges from 3.6-7.2°F (2-4°C), is relatively larger and better defined, particularly at night.

Baton Rouge's Climate

Baton Rouge's climate is humid and subtropical throughout most of the year. Heavy rains and high humidity are a consequence of its coastal location. However, Baton Rouge's proximity to the coast allows maritime air from the Gulf of Mexico to alleviate summer heat and shorten winter cold spells.

Baton Rouge receives an average annual rainfall of 56.92 inches per year and has an average relative humidity of 89% in the morning and 60% in the afternoon. Average monthly temperatures range from 52.1°F (11°C) in January to 82°F (28°C) in July. Based on 1961-1990 National Climatic Data Center data, Baton Rouge has, on average, 2,690 cooling degree days and 1,669 heating degree days.

Local climate data, such as cooling and heating degree days, can help researchers estimate the potential energy savings and air quality impacts from implementing heat island reduction strategies. For example, areas with long, sunny, hot summers and high cooling degree day values, generally can achieve substantial energy savings.

Information on an area's local climate also can help communities focus on heat island reduction activities that best suit their regions. For example, cities with predominantly dry climates may achieve greater benefits from increasing vegetation than would cities in humid climates. Dry-climate cities more effectively capture the cooling benefits of evapotranspiration – or evaporation of water from leaves. However, dry-climate cities also need to consider the availability and cost of water to maintain vegetation.

Baton Rouge's Urban Fabric

Before implementing heat island mitigation strategies, researchers may determine the proportions of vegetative, roofed, and paved cover to the relative total urban surface in a city. This urban fabric analysis helps identify areas that may benefit from reflective surfaces and urban reforestation. Further, information on baseline surface characteristics can help cities determine the potential for modifications.

Vegetation

Baton Rouge is a relatively vegetated city with ground and canopy vegetative cover comprising over 40% in more than 65% of the modeling domain area. According to a 58-city survey conducted in 1995, Baton Rouge had the highest percentage of tree cover of all 58 cities surveyed.

A 1997 GAP Analysis by the U.S. Geological Survey-National Wetlands Research Center found that the East Baton Rouge Parish had a total forested area, including wetland and upland forest, of 151 square miles, or 32% of the Parish. (A GAP analysis is an assessment of the extent to which native animal and plant species are being preserved.) The total vegetated urban area included 89 square miles, or 19% of the Parish.

The most popular tree species found in East Baton Rouge Parish are the loblolly pine, crape myrtle, live oak, baldcypress, pecan, water oak, bradford pear, and black willow.

Roofs

Roofed surfaces comprise approximately 20-24% of Baton Rouge's surface area. Demand for highly reflective roof products is relatively low in Baton Rouge as roofs are conventionally valued for protection, particularly waterproofing, rather than for promoting energy-efficiency and cost savings.

In the commercial sector, the reflective roofs that have been used include reflective roof coatings on built-up roofs (BUR), single-ply roof membranes, and spray polyurethane foam roofs. In the residential sector, in part due to lack of residential cool roof products, researchers found no reflective roof applications.

Pavement

Baton Rouge has a total paved area of approximately 1,600 miles, which includes 303 miles of major interstate highways and state-maintained roads. The remaining 1,300 miles include City-maintained major and secondary roads.

Baton Rouge and East Baton Rouge Parish use asphalt cement concrete (ACC)and portland cement concrete (PCC) in highway, street, and parking lot paving. Both types of pavement use primarily limestone or sandstone aggregate sources.

In Baton Rouge, PCC is used for major roads and highways and ACC is used for secondary streets, including subdivision roads. For parking lots and driveways, both materials are used with cost often determining selection. Only the State Department of Transportation and Development is currently doing any whitetopping projects within the City and Parish. The Baton Rouge Department of Public Works estimated that 85 to 90% of the streets and highways under its jurisdiction are paved in ACC.

Baton Rouge's Energy Savings Analysis

Baton Rouge has an April through October cooling season. Most residential buildings are one story, while commercial buildings are low-rise. Air conditioning saturation in the Baton Rouge Metropolitan Statistical Area (MSA) is high with a total air conditioned roof area in 1998 of 245 million (M)ft² residential, 13 Mft² office, and 18 Mft² retail. Residences accounted for 89% of air-conditioned roof area in Baton Rouge.

Modeling Methodology

The Department of Energy's Lawrence Berkeley National Laboratory (LBNL) analyzed the energy savings potential (direct and indirect effects) of heat island reduction measures on cooling energy use in Baton Rouge. Determining direct energy impacts involved modeling the effects from placing eight mature deciduous shade trees around residential buildings, eight shade trees around office buildings, and four shade trees around commercial buildings to provide 10% summertime (April - October) transmittance and 90% transmittance for the remainder of the year.

In addition, determining direct impacts involved modeling the effects from increasing solar reflectance– or albedo on residential and commercial roofs from 0.2 to 0.5 and 0.6, respectively, using an infrared emittance of 0.9 to calculate savings. (Emittance is the percentage of energy a material can radiate away in the form of heat.) This modeling was performed using DOE-2 building energy software, which is an advanced computer program that simulates hourly building energy use.

The indirect impacts were modeled by analyzing the ambient cooling from the placement of four or eight shade trees per building and from the reduced rooftop temperatures due to the albedo changes discussed above. LBNL captured these indirect effects by using the Colorado State Urban Meteorological Model (CSUMM). The CSUMM outputs were used to modify the typical meteorological year 2 data, which was fed into the DOE-2 building energy model.

Modeling Results

LBNL calculated the following annual results for the total Baton Rouge MSA:

- $15M of energy savings in 1997 dollars ($18M in annual electricity savings less a natural gas deficit or winter heating penalty of $3M);
- 133 megawatts of peak power avoided (89% from residential, 4% from office, and 7% from retail); and
- 41,000 tons of annual carbon emission reductions.

Baton Rouge's Air Quality

Ground-level ozone is one of Baton Rouge's biggest air quality problems. The Baton Rouge metropolitan area has been classified as a serious nonattainment area for ozone. View a map highlighting the nonattainment area.

Modeling Methodology

In 1999-2000, the Department of Energy's Lawrence Berkeley National Laboratory (LBNL) used the Colorado State Urban Meteorological Model (CSUMM) and the Urban Airshed Model (UAM-IV) to model the impacts of heat island reduction measures in Baton Rouge on the area's meteorology and ozone air quality.

LBNL used a modeling domain of approximately 16,900 km^2 or 6,601 square miles, which is an area several times larger than the Baton Rouge Metropolitan Statistical Area.

LBNL first determined that the solar reflectance– or albedo– in the modeling domain is relatively low, ranging from 0.06 over water to 0.2, due to the abundance of vegetation, marshes, and wetlands.

LBNL simulated heat island reduction measures by increasing the solar reflectance and vegetative cover inputs into the meteorological model, CSUMM. LBNL increased albedo levels and vegetative cover in the city center area by approximately 0.11 and 0.14, respectively.

Modeling Results

Using a May 24 and 25, 1990 modeling period, LBNL found decreases of ground-level ozone up to five parts per billion (ppb) in urbanized areas and ground-level ozone increases of up to two ppb. Within the entire modeling domain there were net ozone decreases, in general.

The largest simulated air temperature decrease was 1.4°F (0.8°C). In Baton Rouge, this temperature decrease resulted primarily from increased solar reflectance. The higher surface moisture in the area tends to limit evapotranspiration – or evaporation of water from leaves – from increased vegetative cover, which is why the solar reflectance changes had a larger impact.

Thus, LBNL's modeling indicates that there is potential for heat island reduction strategies to decrease air temperatures and improve air quality in Baton Rouge. Urban fabric and energy savings studies also indicate that Baton Rouge can reduce energy use and carbon emissions by using strategies to lower urban temperatures.

Baton Rouge's Heat Island Reduction Activities

Below are highlights of some of the activities Baton Rouge is involved with that help to reduce the heat island effect.

1994 Landscape Ordinance

The Department of Public Works strengthened the 1994 Landscape Ordinance that requires tree planting on all new developments, excluding single family residential developments. The improved 1998 provision requires two shade trees for every 10,000 square feet of site versus the previous requirement of one shade tree.

The provision also requires one shade tree per 60 feet of street frontage and contains new requirements for parking lots. These requirements include one shade tree per 25 parking spaces for a lot with one to 50 spaces; one shade tree per 18 parking spaces for a lot with 51 to 100 spaces; and one shade tree per 12 parking spaces for a lot over 100 spaces.

In addition, the revised Landscape Ordinance requirements no longer stand alone. For example, a 10,000 square foot site with 60 feet of storefront and 100 parking spaces would require 21 shade trees (i.e., two for the square footage of the site, one for the store frontage, and 18 for the parking lot).

East Baton Rouge Historic Tree Ordinance

The City of Baton Rouge/East Baton Rouge Parish Office of Landscape and Forestry in 1997 helped enact the first East Baton Rouge Historic Tree Ordinance to note and mark important trees and protect them through publicity.

Baton Rouge Green's Education and Urban Reforestation Programs

Baton Rouge Green conducts an urban reforestation project in East Baton Rouge Parish based on research and professional guidelines. Programs and activities of the nonprofit organization include tree planting programs for interstates, highway corridors, schools, parks, and neighborhoods; a tree conservation program; education conferences and symposia on urban forestry and related topics; Tree power for Greenstreets; and a "Trees for our Children's Future" education program. On April 16, 1997, the 20,000th Baton Rouge Green tree was planted.

Evaluating Tree Cover

The Louisiana State University Forestry Department is participating in a project to improve the imagery in its aerial photo data to further evaluate the existing tree cover in the Baton Rouge metropolitan area. The aerial data will be used in conjunction with a geographic information system-based model. The model will permit researchers to input current data and then manipulate tree cover factors to predict the effect that changes in the forest canopy will have on storm water runoff. Although the project's purpose does not focus on shade, the information contained in the cleaned photographs and the model may be useful for heat island reduction purposes.

Seedling Project

The Hilltop Arboretum participates in a project with the National Tree Trust to grow seedlings and donate them to public places in exchange for their maintenance and care by the municipality or local authority. Through this initiative, the Arboretum has given trees to a variety of public places throughout the State, including Pearl River, New Orleans, and western parts of the state.

Cool Roofs

The Baton Rouge Recreational and Park Commission (BREC) is replacing all of its built-up roofs, which require re-roofing, with light-colored metal roofs and reflective coatings. While these metal roofs may not maximize their cooling potential, because they may have low thermal emmittances, BREC has reported energy savings up to 17%. Of BREC's 300 buildings, 18 roofs had been replaced as of January 2002.