



SCHOOL'S OUT

In a time of compounding crises, America's schoolyards are packed with potential

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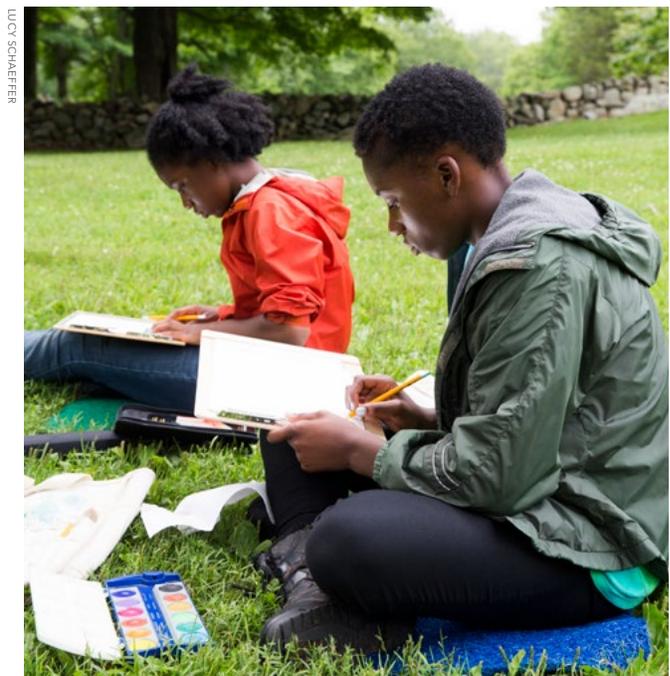
Introduction

As families count down to the first day of school, one thing is for certain: the 2020-2021 school year will be unlike any other in our collective lifetimes. The COVID-19 pandemic has put educators and school administrators between a rock and a hard place: bring kids back to the classroom, where experts say that all will be at high risk of virus transmission, or continue with distance learning, which experts agree compromises educational outcomes and accelerates inequality.

In this pivotal moment for America's kids, The Trust for Public Land is part of a growing push to proffer an alternate solution: take learning outside.

- **There are more than ninety thousand public schools across America**, and nearly every one includes a schoolyard. And yet, across the country, too few schoolyards are open to the public for use during non-school hours. And an even smaller number—as little as one percent—are designed with the kinds of green space and play features that the school and greater community need and deserve.
- Instead, the majority of schoolyards are empty expanses of asphalt, more parking lot than a play area, flooding when it rains and baking under the hot sun. This means that during this time of public health emergency, when people need access to parks more than ever for exercise, play, and safe social distancing, **hundreds of thousands of acres of schoolyards are sitting locked and largely vacant in neighborhoods nationwide. And new data reveals that 36% of American public school students attend school in a heat island.**
- For nearly 25 years, **The Trust for Public Land has led more schoolyard renovations than any other organization in the nation**, guiding thousands of students and parents in school districts from coast to coast to make the most of this resource that is hiding in plain sight. **We've transformed more than 250 underutilized schoolyards into nature-rich parks** designed to address climate, health, and educational inequities. Every schoolyard transformation includes agreements between a school district and other local agencies to allow the community to use the space when school is closed.
- Public schoolyards are a public asset, and schoolyards that double as vibrant community parks should be the national standard—for the benefit of America's 50.8 million public school students as well as the neighboring communities where they learn and play. **Opening all public schoolyards to the public during non-school hours would put a park within a 10-minute walk of more than 19.6 million people, including 5.2 million children, who currently lack access.** And utilizing those schoolyards for outdoor learning would provide a much safer alternative to bringing kids back into the classroom during COVID-19.

This report examines the hidden potential of America's public schoolyards to solve the problem of park inequity and improve student education and health outcomes—during the pandemic, and for generations to come.



LUCY SCHAEFFER

As school districts devise innovative solutions to ensure kids get what they need this year, one idea is gaining traction: moving lessons outdoors.

School's out

With families and educators preparing for the first day of school during a global pandemic, many questions remain unanswered. Hundreds of public school districts nationwide have determined it's unsafe to open schools, leaving millions of students to begin the school year at home with "remote learning." Other districts are electing for a "hybrid" schedule in which smaller groups of students attend school in person intermittently. And a number of schools that have already opened for in-person learning are immediately faltering in their attempts to prevent virus transmission. Meanwhile, in many districts, teachers unions continue to negotiate terms, even as the calendar ticks down to the first day of school.

Amidst this uncertainty, debate, and concern, one thing is for sure: the 2020-21 school year promises to be more challenging than any other in our collective lifetimes. The obstacles are immense, and with the health, wellness, and education of America's 50.8 million public school students on the line, the stakes are high. As experts in public health and education push themselves to devise innovative solutions to ensure kids get what they need this school year, one idea is gaining traction: moving lessons outdoors.

"Outdoor learning should be a priority for schools that will be reopening in the fall," said Julia L. Marcus, an assistant professor at Harvard Medical School. "The risk of viral transmission is lower outdoors than indoors. For schools that have access to outdoor space, outdoor learning could be an important risk-mitigation strategy."

Public school districts are among the largest landowners in almost every city and town across the United States. Collectively, public school districts own tens of thousands of acres across the country, and almost every school campus includes a schoolyard. In a few places—as little as one percent of public schools across the country—schoolyards are vibrant community hubs, open to the public after school hours and designed to meet the needs of neighbors as well as students. But in too many communities, schoolyards look more like parking lots than playgrounds—flooding when it rains and baking under the hot sun—and their gates remain locked to the surrounding community when school is closed.



KELLY FORTNER

Transforming schoolyards could help bring kids back to school during the pandemic while improving park access for the whole community.

With studies out of China and Japan showing that the novel coronavirus is [much less likely to be transmitted outdoors](#) than indoors, experts say that converting these underutilized spaces into outdoor classrooms could relieve pressure on school buildings and bring more students back to campus for in-person learning, which all agree is far superior to learning from home online. And once the pandemic is behind us, these schoolyard conversions could be the gift that keeps on giving to future generations, bringing parks to millions of Americans who currently lack access, helping to keep neighborhoods cool as the climate changes, and enriching learning and play for millions of kids.

"Schoolyards are an untapped resource in ordinary times," said Diane Regas, president and CEO of The Trust for Public Land. "But especially now during this public health emergency, when communities need park space more than ever and convening indoors puts public health at risk, we owe it to the rising generation to think outside the box of four classroom walls. We urge parents, school administrators, and policy makers to take learning outdoors and reimagine their schoolyards to double as community parks that remain open to the public after school hours."

A rock and a hard place

While school districts consider various back-to-school scenarios, concerns are mounting over the dire implications of another semester spent at home. Preliminary evidence from quarantine in the spring shows a loss of learning, especially among students without access to computers or reliable internet. [A recent study by Brown University and the University of Virginia](#)¹ found that the average student could begin this school year having lost as much as a third of the anticipated progress in reading and half of the expected progress in math. At the same time, [an analysis of 800,000 students by researchers at Brown and Harvard University](#)² looked at the impact of an online mathematics program called Zearn, both before and after schools shut their doors in the spring. It revealed that through the end of April, progress in math fell by half in classrooms located in low-income zip codes, a third in middle-income zip codes, and not at all in classrooms in wealthy zip codes.

At the same time, children's health experts point to growing fears about the emotional and social toll of keeping kids in isolation.

"I am really worried," said Dr. Aparna Bole, an associate professor of pediatrics at Case Western Reserve University School of Medicine. "These kids are suffering. Some of my patients have zero recreation, zero social interaction. This idea that it's safe to keep everyone at home—I totally



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disagree. We are not being creative enough in leveraging outdoor spaces."

This summer, the [American Academy of Pediatrics](#)³ (AAP) urged policy makers to "start with a goal of having students physically present in school." The AAP wrote, "Schools are fundamental to child and adolescent development and well-being and provide our children and adolescents with academic instruction, social and emotional skills, safety, reliable nutrition, physical/speech and mental health therapy, and opportunities for physical activity, among other benefits. Beyond supporting the educational development of children and adolescents, schools play a critical role in addressing racial and social inequity."

"This idea that it's safe to keep everyone at home—I totally disagree. We are not being creative enough in leveraging outdoor spaces."

But many public health experts are sounding the alarm about reopening schools too soon, especially in regions of the country where infections are rising. "I can tell you with one hundred percent certainty that if you open schools in communities where you have lot of COVID spreading, you are going to have to slam them shut again," Thomas R. Freiden, former director of the Centers for Disease Control and Prevention said in July. "Look at what happened in Arizona, Texas, Georgia, South Carolina, Florida. You open too soon and it's one step forward and many steps backward."

If health authorities choose to bring students back in person, the AAP urged administrators to "utilize outdoor spaces when possible." The [Centers for Disease Control and Prevention](#)⁴, for its part, advised schools to "consider using outdoor space, weather-permitting, to enable social distancing." The [World Health Organization](#)⁵ also joined the chorus, saying schools should "move lessons outdoors or ventilate rooms as much as possible." And a report in June from the [Harvard T.H. Chan School of Public Health](#)⁶, entitled "Schools for Health: Risk Reduction Strategies for Reopening Schools," echoed those organizations: "Move class outdoors, if possible, and weather permitting."

We've been here before

To find creative solutions for enlisting outdoor classes in the fight against infectious diseases, today's educators can look to the past. In the early 20th century, as tuberculosis raged in towns and cities, scores of open-air classrooms started popping up around the United States. Classes were held on rooftops, on ferries and, of course, under tents. When it was cold, children bundled up.

No one is suggesting that students be forced to master the fine points of trigonometry in the bitter cold. But across the southern half of the country, schools could offer outdoor instruction once the heat of August and September subsides. In the northern part of the United States, meanwhile, long stretches of autumn and spring are conducive to outdoor learning. And in many western states, weather is mild enough to conduct school outside for much of the school year.

Indeed, more and more educators and infectious disease experts are touting the advantages of outdoor learning in the age of coronavirus. They point to recent studies revealing the relationship between viral transmission and fresh air. A [Japanese study of one hundred cases](#)⁷ of COVID-19, for example, found that the risk of getting the virus was almost twenty times greater inside. A [review of 7,000 cases in China](#)⁸ uncovered just one example of outdoor transmission.

In New Jersey, administrators at Mastery High School of Camden, a public school on the Delaware River, hope to move students outside by using tents and old-fashioned tree shade. The school is in the midst of plans for a top-to-bottom schoolyard renovation, with assistance from The Trust for Public Land. Before the pandemic hit, administrators were set to begin work on the first phase, an outdoor classroom. But funding cuts triggered by the pandemic put that project on hold.

Still, Jennifer Cooper, the high school's assistant principal of operations, is scrambling to devise makeshift strategies for outdoor learning, whenever school resumes in person. She has purchased outdoor benches and tables, as well as three tents, at \$1,000 each. The tents were originally intended to serve as stations for screening students upon arrival, but Cooper is now thinking about using them for outdoor classrooms instead. The tents are small, 10 feet by 20 feet, and could accommodate about 12 students each. "All of our classrooms will have less than 15 students anyway so it's possible," she said. "If I can get people excited about outdoor classrooms, I will buy more tents."

The high school's 11-acre campus sits next to a park, so space is not a problem. "We have some very nice, large trees," she said. "I will ask our landscapers to carve out space over the next few months. We have some easy options for the fall, but I am really excited about planning very intentionally for the spring."



Leading health authorities urge administrators to maximize use of outdoor spaces, including schoolyards and local parks.



Experts say that teaching outside reduces the risk of virus transmission to almost zero.

Erin Bromage, a biology professor specializing in immunology at the University of Massachusetts and a father of two, has advised his children’s school on their virus protocol, telling anyone who will listen about the importance of taking school outside. “The very first thing I said to my kids’ school is, ‘Make the campus your classroom,’” he said. “If we can have half the students inside and the other half outside, we have just lowered the risk dramatically for both the students and staff. There’s no reason at all why science cannot be outside every day—there are a whole bunch of things you can do to use the weather to your advantage. If it rains, you can measure water and precipitation rates.”

Bromage explains that indoor classrooms are a potential venue for one of the three main types of viral transmission. There is direct exposure that occurs during face-to-face conversations, whether indoors or out. Then there is transmission that results from touching infected surfaces. And, most relevant for schools, about 55 percent of all transmission happens indoors over time, as the virus gradually accumulates.

“The scenario that we’re most worried about with schools is having an infected person in the classroom,” he said. “With every breath they take or with every word they speak,

they release small droplets into the air. Then they build up and build up over time. Classrooms are fairly small and the other people in that space would be breathing in little amounts of the virus. If they got enough over time—say over the course of a day—then potentially the whole classroom could become infected.”

Bromage cautioned that even if everyone in the room wears a mask, consistently and properly, there is no guarantee of safety. “A bad mask will drop the transmission by 50 percent and a good mask by 80 or 85 percent,” he said.

One potential solution to the problem is air filtration or air exchange, whether through a building-wide system or portable air-cleaning units. But the systems are pricey, Bromage said, and very few schools have them.

“To replace out a ventilation system to handle filtration and air exchange is a very expensive endeavor,” he said. “Schools don’t have the finances or enough time to change anything right now. It might be something in their future, but it’s definitely nothing they can address for August or September.”

All of which leads Bromage to the urgent plea to move school, wherever possible, outdoors.

“Make the campus your classroom. If we can have half the students inside and the other half outside, we have just lowered risk dramatically.”

“Getting outside to teach and learn ends up taking those 55 percent of transmissions and reducing them to almost zero,” he explains. “In that situation, the infinite amount of air outside doesn’t allow for the virus to build up, so that type of infection doesn’t take place. That’s why we didn’t see a lot of transmission with the protests. Outdoor learning is so much safer than indoor learning, especially in those schools that don’t have adequate air exchange or air filtration.”

Space to spread out

While the private school in rural Massachusetts attended by Bromage's children is fortunate to occupy 45 acres, many schools do not have access to that kind of outdoor space. But educators and some elected officials insist that there is still room for expanding a school's footprint, even in the densest cities.

In New York City, perhaps the most developed urban center in the United States, public schools have access to a combined total of 29.5 million square feet of schoolyards, or 677 acres.

Noting the relative safety of the outdoors when it comes to COVID-19, Scott M. Stinger, the city's comptroller, recently called on the city's Board of Education to embrace schoolyards this fall.

"There is no excuse for failing to take full advantage of our schoolyards," Stringer wrote in an Op-Ed in the *New York Daily News*. "These are spaces that the city controls and that are literally connected to our schools, which would allow students to stay outside but still maintain easy access to bathrooms, handwashing stations, and cafeterias."

Stringer cited estimates that New York City schoolyards could accommodate about three quarters of the student body at any given time. "We should be seizing every opportunity to get our kids outside and away from the deadening computer screens that have been their only classrooms since March," he said.



Schoolyard renovations are an efficient and cost-effective way to increase park access. With every schoolyard renovation, The Trust for Public Land creates an agreement between the school and broader community to allow for public access during non-school hours.

As of press time of this report, the [City of New York announced](#) it would allow schools to hold classes in schoolyards as well as adjacent parks and streets. Within 24 hours of the announcement, [more than 200 schools applied](#) to participate in the initiative.

And the idea is circulating across the country. In Dallas, where The Trust for Public Land is currently working on several schoolyard renovations, superintendent Michael Hinojosa serves on the School Superintendents Association's COVID-19 task force. "[Holding classes outside is] an intriguing idea, especially with the kind of weather we have in Texas," he said. "Here, you can play golf 12 months out of the year because it never gets really cold.

"It's a conversation that's long overdue—COVID or no COVID ... anytime you can get a kid outside, that's a good thing."

We are now considering using hallways and gyms and auditoriums. But if we had outdoors as another scenario, it would give us more options for those students who want to come back in person."

Todd L. Brist, a middle school principal in South Dakota, is also planning to stymie the coronavirus by taking advantage of his schoolyard. Rather than buy tents, he has surveyed the shadow cast by the school building itself. He envisions students using the shade to have lunch outside, while teachers can hold classes in the morning and afternoon.

"It's a conversation that's long overdue—COVID or no COVID," Brist pointed out. "Physical activity and fresh air are important in and of themselves. So anytime you can get a kid outside, that's a good thing."

The Trust for Public Land is part of a coalition of organizations including Green Schoolyards America, Ten Strands, The Lawrence Hall of Science, and the Environmental Literacy and Sustainability Initiative working to help educators tap outdoor spaces during the pandemic. The so-called National COVID-19 Outdoor Learning Initiative has held webinars and organized a number of working groups. Trudy Garber, a senior program manager at The Trust for Public Land, heads up a working group focused on parkland. "The idea is to help school administrators that might not have a schoolyard access public parks near their schools so they, too, can hold outside classes," Garber said. "It's one more way to help students spread out."

Super-powered schoolyards

Long before the global pandemic cast its shadow on education, schoolyards had become the focus of a national movement to achieve a number of objectives: improving student health and educational outcomes; bolstering hands-on learning; mitigating flooding; curbing neighborhood temperatures; strengthening community bonds; and redressing park inequity.

Today, very few schoolyards are designed with vegetation, trees, and play features that encourage healthy recreation among students and, according to multiple studies, boost physical fitness, academic performance, mood, and concentration.

So far, The Trust for Public Land has helped more than 250 schools—from New York to Philadelphia to Oakland, California—transform their blank asphalt schoolyards into green, inviting learning spaces that remain open to the neighborhood as community parks.

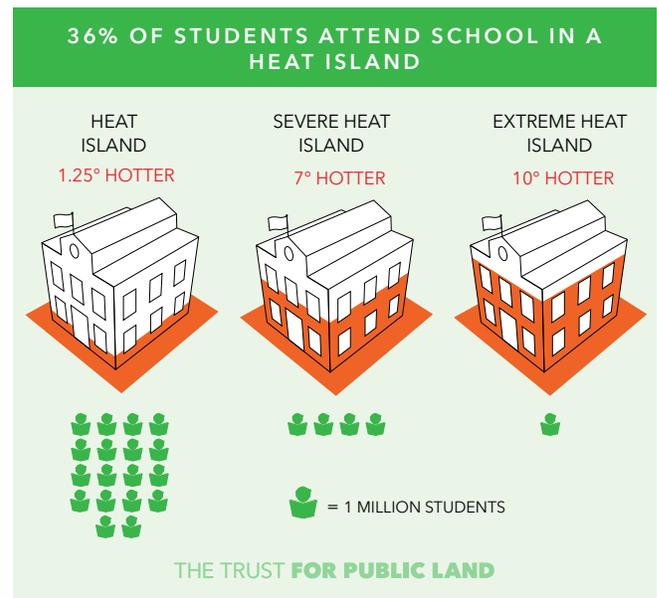
Smart schoolyard conversions have the potential to deliver multiple long-lasting benefits to the surrounding community. Schoolyards renovated by The Trust for Public Land are designed to soak up storm water—using rain gardens, native plants, absorbent turf, engineered soils, and porous surfaces that serve as sponges.

In New York City, for example, where the sprawling “combined” sewer system handles both wastewater and stormwater, even a small amount of rain can overwhelm treatment plants, leading raw sewage to discharge directly into rivers and bays. But the 210 schoolyards that The Trust for Public Land has designed capture an estimated 19 million gallons annually—the equivalent of diverting more than 28 Olympic-sized swimming pools of waste from polluting New York waterways each year.

During warmer months, well-designed schoolyards can help neighborhoods stay cool. Unbeknownst to most parents and educators, blank asphalt schoolyards create their own “heat islands,” raising temperatures for not only the school community, but the entire neighborhood.

In contrast to trees and grass, brick and asphalt absorb heat and hold onto it, making many school properties hotter than their surrounding towns and cities. Using

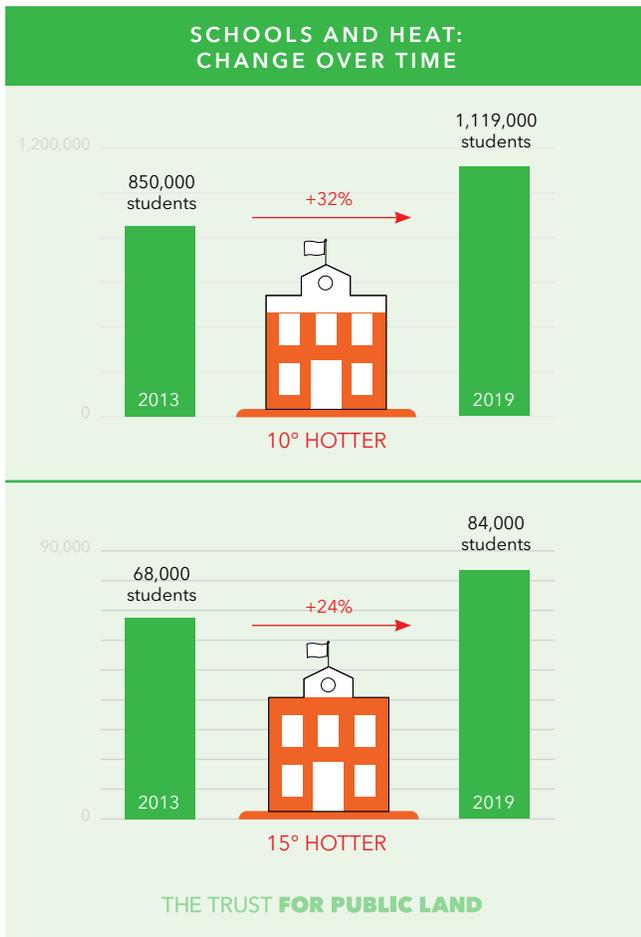
satellite imagery and computer modeling, new research by The Trust for Public Land has found that nationwide, 36 percent of the nation’s 50.8 million public school students attend school in a heat island, which is defined as 1.25 degrees Fahrenheit or more, on average, than the surrounding town or city. Among that group, 4.1 million students go to a school in a severe heat island of 7 degrees or more, while 1.1 million attend school in an extreme heat island of 10 degrees or more. In some communities, the heat anomaly—the difference in average temperature between the schoolyard and the community—exceeds 20 degrees.



Analysis of heat maps across 14,000 towns and cities also reveals a strong correlation between heat and income. Students in the lowest income bracket attend schools with heat anomalies that are, on average, more than double those of schools serving students in the highest income bracket.

The problem of heat and schools has grown worse in just the last several years, which were among the hottest on record. The number of students in a heat island of 10 degrees or more rose from 850,000 in 2013 to 1,119,000 in 2019, a 32 percent increase, according to Trust for Public Land data analysis. The number of students in a heat island of 15 degrees or more climbed from 68,000 to 84,000 during the same period, or 24 percent. (Thermal band data from Landsat 8 became available in 2013.)

The Education Trust, a national nonprofit organization that promotes educational opportunities for students of



color and students from low-income backgrounds, said special attention must be paid to the impact of heat on marginalized communities.

"Far too many students struggle to learn when outside temperatures hit high levels, which makes concentrating on their classroom lessons more difficult and can negatively impact their health," stated John B. King Jr., tenth U.S. Secretary of Education and president and CEO of The Education Trust. "We need to call attention to the correlation between heat islands and our nation's public schools, as well as the need for all children to have safe places to learn and play as temperatures rise in a changing climate."

"When you have a thousand kids in a school with no air conditioning on a 90 to 100 degree day, the asphalt schoolyard magnifies the heat," said Danielle Denk, who leads the schoolyards initiative at The Trust for Public Land. "That makes it difficult to concentrate on learning and can even make it downright unsafe. What's sad is we used to have snow days, and now we are having 'heat-wave days' in June and September."

As the pandemic drives home the importance of close-to-home green spaces, schoolyards have the potential to solve the problem of park access for millions of people. Currently, more than 100 million Americans—including 28 million kids—don't have a park within a 10-minute walk of home. Opening all public schoolyards to the public during non-school hours would provide access to public open space for at least 19.6 million people, including 5.2 million children.

"As we've seen during this public health emergency, safe, close-to-home places to play are essential for community health and well being," Denk said. "At the same time, kids need a safe way to get back to school. Meanwhile, tens of thousands of acres of public school grounds are sitting locked and unused. Improving our schoolyards and then opening them for outdoor learning and to the neighborhood for park space is a win-win-win that could come at a much lower cost than building a new park."

While schools are naturally focused on how to safely get students back on campus this year, educators and parents will likely appreciate the longer term benefits of investing in greening school grounds. A [study published in the journal Health & Place](#)⁹ examined the relationship between childhood obesity and access to parkland. Researchers collected data on more than 3,000 children aged nine to ten in Southern California and followed them for eight years. The children who lived less than a third of a mile from a park had a reduced risk of being overweight or obese by age 18.

Other studies have uncovered the power of nature to improve memory, sharpen focus, alleviate stress, and induce a sense of well-being. One [study in the journal Landscape and Urban Planning](#)¹⁰ found that simply seeing trees through a classroom window helped students in Illinois pay attention and recover from stress more quickly than peers who had a view of asphalt or no windows at all.

"The COVID-19 crisis is forcing educators and decision-makers to get creative to support learning right now," said Sadiya Muqueeth DrPH, MPH, director of community health at The Trust for Public Land. "We know, however, that more threats are coming, including extreme heat. We should take this emergency as a call to action, not only to respond to the pandemic but also to address climate-induced public health needs through the development of greener schoolyards."

From parking lot to outdoor classroom, one schoolyard at a time

To date, The Trust for Public Land has enlisted some 7,000 students as co-designers to redesign more than 250 schoolyards nationwide. Before the renovations in New York, about 50 were active parking lots. School staff used to place orange cones to cordon off a so-called “play area.”

In Oakland, California, where The Trust for Public Land is partnering with the public schools on a number of schoolyard renovations, Kat Romo, who coordinates learning gardens for the district, is overseeing two pilot schoolyards for outdoor learning this fall. So far, they are just models, but The Trust for Public Land is sketching out how many students each schoolyard might accommodate in outdoor classes.

“Considering the fact that most schools weren’t developed with the ventilation necessary for dealing with a virus like this, the outside classroom is a perfect space for having the students come back in the safest way possible,” she said. “You’re in the sun and have the wind and there’s potential for better spacing.”



By redirecting federal funding toward schools and communities, we could renovate schoolyards nationwide. The Trust for Public Land is calling on Congress to include a one-time investment of \$500 million for close-to-home parks in any future coronavirus stimulus bill.

The district already knew that school would start remotely in mid-August, so administrators are now studying the use of schoolyards in the event that students are able to return later in the school year. Under the model, a school could have six to eleven classrooms in the schoolyard at a time, allowing 108 to 121 students to learn outdoors given six-foot spacing. Pop-up canopies would delineate each class and provide protection from the elements.

While the district is exploring no-cost, low-cost, and moderate-cost options, Romo has found canopies available for about \$200 apiece.

“We need to invest in building outdoor spaces that will enhance learning now and well into the future and support educators to get kids outside, COVID or not.”

The cost of transforming schoolyards into community parks with multi-use recreation fields and student-designed play equipment and outdoor classrooms is considerably greater, ranging from \$300,000 to \$1.2 million. But The Trust for Public Land believes there is potential to renovate many more schoolyards nationwide with federal funding that is likely to come in the form of a major economic stimulus package later this year.

In fact, schoolyards could benefit from a few key sources of funding. The House of Representatives recently passed its version of the budget for fiscal year 2021, which includes \$100 million for local parks and schoolyards. The Land and Water Conservation Fund, which was fully and permanently funded in early August at \$900 million a year, contains provisions for schoolyard renovations, through the Outdoor Recreation Legacy Partnership. In addition, more immediate recovery funding designed to help schools reopen could finance short-term infrastructure needs like tents and canopies for outdoor classes.

“We are leading a coalition of more than one hundred community and environmental organizations calling on Congress to include a one-time investment of \$500



P.S. 19, NEW YORK, NY
AFTER

The Trust for Public Land has transformed more schoolyards than any other organization nationwide. Each schoolyard doubles as a community park, preventing flooding and helping keep neighborhoods cool.

million for close-to-home parks in any future coronavirus stimulus bill,” said Bill Lee, senior vice president of policy, advocacy, and government relations for The Trust for Public Land. “We need to invest in building outdoor spaces that will enhance learning now and well into the future and support educators to get kids outside, COVID or not.”

Such an investment will give the economy a boost. In 2017 alone, local parks and recreation agencies generated \$166 billion in economic activity and supported more than 1.1 million jobs nationwide.

By renovating and investing in our community parks, playgrounds, trails and schoolyards, these funds could preserve up to 100,000 seasonal jobs, provide at least 8,000 new permanent jobs, and renovate more than 500 sites, Lee added. If all \$500 million in stimulus funding went to renovate schoolyards, at an average cost of \$700,000, more than 700 schoolyards could be transformed, serving hundreds of thousands of students and putting millions of people within a 10-minute walk of a green place to play.



P.S. 19, NEW YORK, NY
BEFORE

“The challenges presented by COVID-19 are shedding new light on the potential of schoolyards, highlighting their ability to hinder the virus’s spread in the short term while enhancing communities in the long term,” said Diane Regas. “America’s public school yards are public land, and have the potential to do so much public good. As Congress determines how best to provide economic relief at this time of crisis, there is an opportunity to reimagine the nation’s schoolyards, improving the lives of children and putting new parkland within reach of millions of Americans.”

Methodology

To determine whether schoolyards lie in a heat island, The Trust for Public Land prepared data for town and city boundaries by converting United States Census Bureau-based borders into an open-standard format representing geographical features. We then accessed NASA's Landsat 8 thermal band data for 14,000 towns, cities and census-designated places, focusing on the period from June 1 to September 30, 2019. Satellite data measure the temperature at the surface, rather than ambient temperatures, which are typically taken about six feet above the ground. While ambient temperature is a more accurate measure of how people experience heat, we used satellite data because it is more widely available and can reveal heat island information for all 14,000 towns and cities nationwide.

The Trust for Public Land wrote software that converts thermal data into a heat value, expressed in degrees Fahrenheit, for every 30-meter by 30-meter geographic area, or pixel. The heat values were used to calculate the mean temperature value for a given municipality. The difference between the mean temperature value for an entire town or city and the heat value of a single pixel was then calculated. This difference is known as the heat anomaly. To determine heat anomalies for individual schools, we used public school district data from the National Center for Education Statistics, including school addresses and enrollment numbers. Each school was represented by a single point,

and we assigned each school a heat anomaly value that corresponded to the pixel containing that point. From the heat anomaly values, we determined the heat severity of schools within a district on a scale of 1 to 5, with 1 representing the least severe and 5 the most, according to the Jenks Natural Breaks classification method. To illustrate the relationship between income and school heat islands, we used Census Bureau data to align mean household income values to the schools, based on the census block in which the school is located.

After performing a quality check on a statistically significant sample size, we detected a very small percentage of the output datasets (about 1.5 percent) showing errors along Landsat scene boundaries. The temperatures captured by the two scenes were different enough that the edges of the scenes were reflected in the output data. For cities such as these where we could not find two 2019 scenes that were close enough in temperature to not show the scene boundaries, we went back to summer MM2018 data and used those pixels in conjunction with the 2019 data to smooth the output data and eliminate the scene boundary errors. Since the output data consists of billions of pixels, it would be impossible for the Trust for Public Land team to locate every error, so it is likely that a very small percentage of errors still exists in the output data.



New data from The Trust for Public Land show that more than a third of American students play on schoolyards that are hotter than their surrounding communities. The problem has accelerated in the past decade, and low-income students are most vulnerable to the health and academic consequences of hotter schools.

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