THE NEXT GENERATION OF SCHOOLYARDS: LESSONS FROM THE WATERSHED DISCOVERY CAMPUS

AMIGOS DE LOS RIOS, LOS ANGELES COUNTY

EARTH ECONOMICS

The Next Generation of Schoolyards: Lessons from the Watershed Discovery Campus

Amigos de los Rios | Los Angeles County

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Introduction

Children in Los Angeles County are already living with the impacts of climate change, especially extreme heat, air pollution, and wildfire smoke[1]. Cal-Adapt's *Climate Change Snapshot Tool*[2] shows that children in 2035 will likely experience 19 to 23 days on average of excessive heat days. A 2023 Los Angeles County Public Health report on climate change describes several ways in which children are at increased risk from heat waves and unhealthy air quality. Such risks are particularly dangerous for overburdened and under-resourced neighborhoods because so many lack trees and other green space. Increasing green space extent and access can help families cope with heat and air pollution while providing multiple co-benefits. This report highlights these benefits by measuring the value of a schoolyard greening project in Altadena implemented by Amigos de los Rios.

Since 2003, Amigos de los Rios has been building an "Emerald Necklace," a network of green spaces, green schools, parks, and trails throughout under-served communities in California's Los Angeles Basin. As of 2023, the organization has completed over 110 multi-benefit natural infrastructure projects across Los Angeles County, supported by millions of dollars in competitive grants. These projects have engaged over 45,000 volunteers and mentored over 260 young professionals to become environmental leaders. Amigos de los Rios' community-based design process empowers students and families that have been disadvantaged by poverty and pollution to be part of a movement to transform blighted river, park, and school spaces into meaningful multi-benefit places.

Earth Economics partnered with Amigos de los Rios to measure the impact of the Watershed Discovery Campus of Mary W. Jackson Elementary (Jackson Elementary) in Altadena, a green schoolyard project that is part of the larger Emerald Necklace vision. Results from the economic valuation analysis show the value of benefits associated with the Watershed Discovery Campus can be substantial for the students, the school, and surrounding area. Earth Economics analysis of quantifiable benefits suggests that the restored playground provides nearly $400,000 (USD 2022) in annual benefits and supports the equivalent of roughly three part-time, year-round jobs. Of the annual benefits measured, community investment benefits make up most of the estimated value (55 percent), followed by environmental benefits (37 percent), and social benefits (7 percent). A benefit-cost analysis suggests that every dollar invested in the greening of Mary W. Jackson Elementary's playground brought at least $3.60 in measured social, environmental, and economic benefits.

The analysis shows that greening the Jackson Elementary schoolyard produces benefits for students and teachers, the school administration, and the broader community. Some accrue primarily to students and teachers, who share benefits of $128,404 each year, mostly from the ability of the new green features (e.g., newly planted trees) to mitigate higher temperatures during heat waves (reducing associated health impacts), but also through improved compliance with ADA regulations and the food provided by the garden. Other benefits are more broadly shared—students and teachers, the school administration, and the broader community receive $271,364 in annual benefits, most of which come from the Community Investment Benefits associated with project spending. Stormwater management is also important, as are the aesthetic beauty of the newly green playground and improvements to improve drainage and water quality. Other public benefits include water capture, improved air quality, and energy savings from lower temperatures during heat waves.

[1] Read more about local climate change impacts from Los Angles County Public Health http://www.publichealth.lacounty.gov/eh/climatechange/index.htm

[2] https://cal-adapt.org

Figure 1. The Benefits of Schoolyard Greening: Earth Economics' Areas of Analysis

Earth Economics also explored the potential benefits to the community from opening the playground to the public during non-school hours. If an additional 556 community members were to exercise one day per year at the school, the benefits of that increased physical activity would be equal to the annual cost to operate and maintain the playground. In other words, the annual cost of maintaining the playground would be justified even if the park was open to the public only one day per month—as long as at least 46 visitors used the park that day to engage in moderate to vigorous physical activity.

It is important to understand that this analysis was unable to quantify important benefits, including: the quality of educational and recreational experiences, improved mental health for children and staff, and ecological benefits such as improved soil quality and bird habitat. The literature also suggests there are additional social and environmental benefits of greening schoolyards that are beyond the scope of this study. As such, the total benefits associated with the project likely exceed the estimates shared here.

This report is organized into four sections. The first section introduces the Watershed Discovery Campus project and its green features. The second section details the approach used to calculate the benefits associated with the greening project. The results of that analysis are presented in the third section. The report concludes with a short discussion of the implications for community organizations and public agencies interested in implementing green schoolyards.

Mary W. Jackson STEAM Multilingual Magnet Elementary

Watershed Discovery Campus Project

In 2021, Amigos de Los Rios began working on the Watershed Discovery Campus project, an effort to transform the Mary W. Jackson Elementary schoolyard (Jackson Elementary) to integrate nature-based solutions for stormwater management, redesigning its playground areas to create a more harmonious environment for students and teachers while bolstering the school's climate resilience. The project 1) replaced impervious surfaces, 2) integrated natural features into playground equipment, 3) added bioretention areas and tree wells, 4) rendered an existing edible garden accessible to all students, and 5) re-landscaped the playground to a more sustainable design. Specifically, the project:

- Replaced 22,000 sq ft of asphalt and 30 percent of the impervious surfaces with permeable pavement, native landscape grasses and shrubs, tree wells, or other natural features
- Redesigned 15 percent of the schoolyard to include bioretention areas and natural landscape features
- Planted 84 trees, the canopy of which will cover 70 percent of the schoolyard at maturity
- Removed impervious and grassy surfaces to create habitats native to the San Gabriel Mountains
- Worked with the Science Teacher, parents, and high school students through the Emerald Necklace Stewardship Program to create a stormwater garden and worked with the Mary W. Jackson Elementary's Garden Foundation to improve an existing edible garden to provide space for hands-on learning about botany and nutrition
- Leveraged funding from multiple sources from Water Alliance, Lowes, California ReLeaf, Disney Foundation, California Natural Resources Agency, One Tree Planted, and Cal-fire over six years[3].

Amigos de los Rios, Jackson Elementary, and community partners worked together to transform a barren hardscape into a beautiful and stimulating outdoor education space. The project captures stormwater and allows it to infiltrate to recharge the groundwater, creates native habitat, and provides outdoor seating to form a dynamic space where students can learn the value of water conservation and stormwater capture.

The Watershed Discovery Campus project replaced a majority of the schoolyard's impervious surfaces with permeable surfaces such as bark mulch, pervious concrete, planters and tree wells, and rain gardens, which have helped to reduce heat impacts. To support stormwater management, infiltration areas were retrofitted to include low-impact drainage features that slow and store stormwater while also addressing water quality issues.

Before the project, Jackson Elementary resembled many other schools across L.A. County, dominated by impervious asphalt, with a small grass field that required significant water and fertilizer. The extensive paved surfaces preventing rain from infiltrating into the groundwater, while collected contaminants that were often transported to surface waters, leading to water quality issues. Where stormwater tended to pool, it enabled mold growth and vector-borne diseases (e.g., West Nile virus), both significant public health concerns.

[3] Funders are listed sequentially

Methods to Value Social, Environmental, and Economic Benefits

Earth Economics was able to quantify select social, environmental, and economic[4] benefits associated with the features of the Watershed Discovery Campus greening project at Jackson Elementary. These were then reformulated in monetary terms using common valuation methods. Two types of economic valuation methods were used:

- The economic or community investment benefits associated with the project were projected based on project spending levels. An *economic contribution analysis* was performed to estimate these benefits as the effects on the local economy, including additional employment.
- The social and environmental benefits associated with the project were estimated through an *ecosystem service valuation* within the Millennium Ecosystem Assessment framework.

Economic Contribution Analysis

Spending related to the planning, construction, operation, and maintenance of the Watershed Discovery Campus generates local and regional economic activity in terms of economic output and new jobs.[5] At each phase of the project, Amigos de los Rios must purchase inputs, hire labor, and rent equipment. All of this investment directly supports local and regional companies.

That initial spending leads to additional economic activity. Firms that supply the initial inputs, labor, and equipment must in turn hire and pay employees, and purchase goods and services to re-stock their inventories and maintain their own businesses. In turn, these employees purchase food, rent, and pay other expenses, rippling through the local economy. The cumulative impact of all this spending is known as the *multiplier effect*—the additional economic activity spurred by initial spending—which varies by project type and the affected sectors. In this report, economic contributions are also referred to as community investment benefits.

In this study, Earth Economics applied multiplier estimates associated with construction and operations and maintenance (O&M) spending for 24 stormwater projects across L.A. County—including one at a Magnet Elementary School. These estimates were taken from an economic contribution analysis of stormwater projects completed by the Economic Roundtable in 2011 (Burns and Flaming, 2011).

The total economic contribution of project spending can be separated into output and employment effects, often reported as the change in economic output and employment for every $1 million in spending. Tables 1 and 2 show the multipliers used in this study to estimate the effects of the Watershed Discovery Campus greening project on local economic output and employment.

Table 1. Economic output multipliers: Effect per $1 million in spending

	Direct	*Secondary*	*Total Effect*
Construction	$1,000,000	$992,674	$1,992,674
O&M	$1,000,000	$689,259	$1,989,059

[4] In this report, the terms economic benefits and community investments are used interchangeably.

[5] Economic output refers to production by industries directly and indirectly supported by project spending. Project spending also supports local employment as construction companies and retailers (among others) must expand their full- and part-time positions to meet new demand for their services generated by the project.

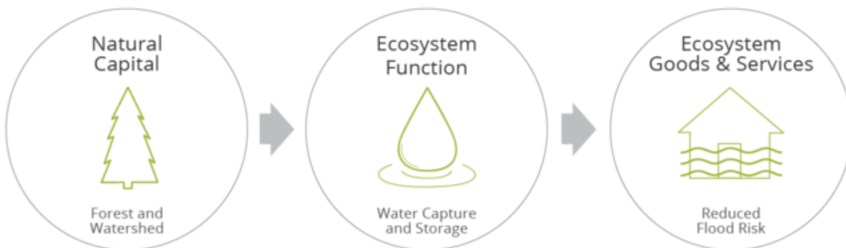
Table 2. Job multipliers: Effect per $1 million in spending

	Direct	Secondary	Total effect
Construction	6.6	6.4	13.1
O&M	7.4	6.4	13.8

Ecosystem Services Valuation

Ecosystem services are the benefits humans derive from nature, including air and water filtration, regulation of stormwater runoff, or the provision of recreational experiences. As the natural features of a landscape (e.g., soils, microorganisms, plants) interact with larger hydrological and atmospheric systems, they give rise to ecosystem functions (e.g., nutrient exchange, primary productivity), most of which directly or indirectly support human wellbeing (Figure 2).

Figure 2. Capital Functions



While there are multiple frameworks to organize ecosystem services, one of the earliest and most straightforward approaches is the Millennium Ecosystem Assessment framework (MEA, 2003), which organizes 21 ecosystem services into four categories: provisioning, regulating, supporting, and information services (see Table 3).

Table 3. The MEA Framework for Ecosystem Service Valuation

Service	Economic Benefit to People
Provisioning	
Energy and Raw Materials	Fuel, fiber, fertilizer, minerals, and energy
Food	Food crops, fish, game, and fruits
Medicinal Resources	Traditional medicines, pharmaceuticals, and assay organisms
Ornamental Resources	Materials for clothing, jewelry, handicraft, worship, and decoration
Water Storage	Long-term reserves of usable water stored in surface waters, aquifers, and soil moisture
Regulating	
Air Quality	Providing clean, breathable air
Biological Control	Providing pest, weed, and disease control
Climate Stability	Stabilizing climate at local and global levels through evapotranspiration, shading, carbon sequestration and storage, and other processes
Disaster Risk Reduction	Mitigating impacts from natural hazards such as floods, hurricanes, fires, and droughts
Pollination and Seed Dispersal	Pollinating wild and domestic plant species via wind, insects, birds, or other animals
Soil Formation	Building soils through decomposition or sediment deposition
Soil Quality	Maintaining soil fertility and the capacity to process organic inputs
Soil Retention	Retaining arable land, slope stability, and coastal integrity
Water Quality	Removing pollutants via soil filtration and metabolization by microbial and vegetative communities
Water Capture, Conveyance, and Supply	Intercepted precipitation, and resulting surface and subsurface water flows
Navigation	Maintaining adequate depth in surface waters to support recreational and commercial vessel traffic
Supporting	
Habitat	Providing diverse shelter and refugia to maintain biological diversity
Information	
Aesthetic Information	Compelling natural views, sounds, and smells
Cultural Value	Meaningful spiritual and historic engagement with nature; sense of place
Science and Education	Natural systems as a focus for the creation and transfer of knowledge
Recreation and Tourism	Enjoying the natural world and outdoor activities

Adapted from Daly and Farley 2004, de Groot 2002, and Boehnke-Henrichs et al. 2013.

Valuation and the Benefit Transfer Method

While some ecosystem benefits are traded in markets (e.g., food, fiber), many are "non-market benefits," the value of which is not fully reflected in market transactions. However, over the past several decades, a range of econometric tools have been developed to estimate that value in monetary terms. For example, urban forests are known to moderate flooding following heavy rains by absorbing and storing water. Because this decreases runoff and reduces flood risk in downstream communities, that value may be quantified by estimating the avoided costs of flood damage or public health impacts expected to have taken place if the trees were not there (see table 4).

Most valuation methods fall into one of three categories: direct market valuation, stated preference, and revealed preference. Direct market valuation can be applied where markets exist for the good or service being analyzed (e.g., carbon market prices to assess the value of carbon sequestration). Stated preference methods rely on surveys to ask how much individuals are willing to pay for a given benefit. Revealed preference methods are based on the costs actually incurred to experience a particular feature or benefit, often understood as the minimum that person will pay for such experiences (see Table 4).

Table 4. Economic Benefit Valuation Methods

Method	Description	Example
Direct Market Valuation		
Market price	Valuations are directly obtained from the prices paid for the good or service in markets	The price of energy sold on open markets
Replacement cost	Cost of replacing a given benefit provided by functioning green infrastructure with a built solution	The cost of replacing a raingarden's natural filtration capacity with a water filtration plant
Avoided cost	Economic losses that would be incurred if a particular form of green infrastructure were removed or its function significantly impaired	Costs related to flooding (e.g., life losses, building and road damages, missed workdays, etc.) that would be mitigated by GI that reduces flood extents
Revealed Preference Approaches		
Travel cost	Costs incurred in the traveling required to consume or enjoy a benefit provided by green infrastructure	People who travel to visit an urban park must value that experience at least as much as the cost of traveling there
Hedonic pricing	Benefits (or costs) of green infrastructure manifested through the impact of different factors on observed market prices	Property values near lakes and parks tend to exceed similar properties without such nearby amenities, all else being equal
Stated Preference Approaches		
Contingent valuation	Value elicited from survey instruments that pose hypothetical continuous valuation scenarios	What people are willing to pay to protect water quality
Discrete choice	Value elicited from survey instruments that present a series of discrete hypothetical alternatives	Whether people prefer to pay a larger fee to restore environmental quality or a smaller fee to limit pollution

The Benefit Transfer Method

These innovations have led to a large and growing literature focused on ecosystem services valuation, and complimentary methods that allow estimates from the primary literature to be applied to similar sites that have yet to be carefully studied, known as *Benefit Transfer Methods* (BTM). This is the most common approach to valuation of ecosystem services, as it is often the most practical option available to produce reasonable estimates quickly and for relatively low cost. In this study, Earth Economics researchers used BTM to estimate the value of community benefits associated with the Watershed Discovery Campus.

In practice, BTM begins by identifying valuation studies of ecosystem services produced by features or landcover types with similar characteristics and contexts as those found in the new research site (e.g., climate, land use, location relative to urban centers). After standardizing the original estimates to ensure “apples-to-apples” comparison, those values are reformulated as unitized monetary values (dollars per year per square feet). These are then scaled by the extent of each feature or landcover type present in the study area.

When selecting appropriate studies, researchers follow best practices to ensure that the ecosystems and services in the literature closely match the new study site, and that the initial research was methodology was sound. The studies are also restricted by geographical area to ensure that beneficiaries share similar characteristics. Studies considered to have incompatible assumptions or landcover types are excluded from further analysis. Where more than one study or value has been determined to be appropriate, researchers include all such estimates to reflect the potential variability of ecosystem service benefits. Here, these have been presented as average values. Table 5 shows the ecosystem services valued in this study, the corresponding valuation method, and the data or literature sources used in valuation.

Table 5. Summary of research categories by benefits, valuation methodology, and related notes

Category	*Benefit*	*Description*	*Method*	*Data/ Literature Source*
Social	Aesthetic Information	Enjoyment and appreciation of the beautified scenery, including sounds, and smells of nature	BTM; Hedonic Price Method	Mcpherson et al. (various)
	Cultural value	Improved sense of belonging and identity	BTM; Compensatory value	Nowak et al. (2002)
	ADA Compliance	Child safety and protection of children with disabilities	Avoided cost	Earth Economics calculations; L.A. Controller (2021); L.A. Mayor's Office (2015)
	Food	Value of produced crops and fruits	Market price, BTM	Algert et al. (2014)
	Science and Education*	Value of using established natural systems for education and science research	N/A	N/A
	Recreation*	Experiencing the natural world and enjoying outdoor activities	N/A	N/A
	Civic engagement and social cohesion*	Participating in social activities that promote community development	N/A	N/A
	Workforce development*	Providing opportunities for job training and education	N/A	N/A
Environmental	Heat reduction	Mitigation of Urban Heat Island effect	Avoided cost	Earth Economics' Urban Heat Mitigation Mapping tool; Hcupnet (2022); CDC (2022); DAYMET (2022); EPA (2022)
	Stormwater retention	Runoff control	BTM	Earth Economics' Stormwater tool
	Water Quality	Removal of water pollutants (zinc)	BTM; Alternative cost	ARLA's SCWP Benefit- Cost Analysis Tool
	Water Supply	Groundwater recharge	BTM; Avoided cost	Porse et al. (2017)
	Air quality	Removal of air pollutants	BTM; Avoided cost	Bakshi et al. (2018)
	Climate Stability	Carbon sequestration	BTM	Mcpherson et al. (various)
	Climate Stability	Avoided CO2 emissions	BTM	Earth Economics' Stormwater tool
	Temperature Regulation	Energy cost savings	BTM	Mcpherson et al. (various)
	Soil Quality	Maintaining soil fertility	N/A	N/A
	Habitat	Providing shelter that supports biological diversity	N/A	N/A
	Biological Control	Providing pest, weed, and disease control	N/A	N/A
Economic	Community Investment Benefits	Economic Impact	Economic Contribution Analysis	Burns and Flaming (2011)

* Assessed but not included due to data limitations and study assumptions. See "Other Benefits" in the Results section for a detailed discussion.

Many of these values were informed by a previous project in which Earth Economics developed a benefit-cost analysis tool to inform the Safe Clean Water Program Working Group of Accelerate Resilience L.A. (ARLA). Earth Economics researchers were able to provide an estimate of this benefit thanks to an optimized a water engineering model developed by Craftwater Engineering to minimize the cost of alternative multi-benefit projects that address zinc pollution in the Alhambra Wash watershed (Earth Economics 2022)[6].

Results

This study examined selected benefits associated with the Watershed Discovery Campus. The monetary value of the benefits associated with a greener playground can be substantial for students, schools, and the broader public. **This analysis suggests that the Watershed Discovery Campus project provides $399,770 (USD 2022) in measured annual benefits and supports the equivalent to roughly 3-part time year-round O&M jobs. Given these expected annual benefits this suggests net annual benefits of $288,920, or a benefit-cost ratio of 3.60 to 1.**

In summary, Earth Economics analysis found that,

1. Community investment benefits—the local and regional economic output and employment spurred by project spending or economic contribution —are the largest source of project benefits, accounting for about half of all the quantified project benefits.
2. The ability of green features to mitigate urban heat is the second largest area of value, providing 30 percent of all benefits, and 80 percent of the environmental benefits. This is consistent with the literature which has largely attributed changes in student behavior to the cooling effect of greenspaces (Raney et al., 2023; Daniel and Jack, 2023).
3. Stormwater retention or runoff regulation is the third-largest important source of environmental benefits (4 percent of overall value), followed by removal of water contaminants, groundwater recharge, and various other benefits related to air quality and climate stability such as air pollutant removal, carbon sequestration, reduced energy costs, and reduced CO_2 emissions.

Tables 6 through 8 summarize the monetary value of benefits by feature and by ecosystem service. Note that these values are annual and based on the benefits projected when the schoolyard trees have reached full maturity.

[6] Learn more at https://acceleratela.org/scwp/

Table 6. Summary of monetary value by ecosystem service

Benefit category	Specific benefits	Annual value (USD 2022)	% of total
Community Investment	Additional economic activity, jobs	$220,658	55%
Environmental	Heat reduction	$119,809	30%
Environmental	Stormwater retention	$14,099	4%
Social	Aesthetic Value	$11,422	3%
Social	Existence value	$9,672	2%
Environmental	Water quality	$8,792	2%
Social	ADA compliance	$6,618	2%
Environmental	Water supply	$3,914	1%
Social	Food provision	$1,977	0%
Environmental	Air quality	$1,334	0%
Environmental	Temperature Regulation	$1,145	0%
Environmental	Climate stability	$327	0%

*Table 7: Annual monetary value by project feature**

Feature	Specific Benefit	Annual value (USD 2022)
Pervious surfaces**	**Total**	**$26,895.10**
	Stormwater retention	$14,099.45
	Water quality	$8,791.55
	Water supply	$3,913.61
	Climate Stability	$86.49
New Trees	**Total**	**$143,632.32**
	Heat reduction	$119,809.46
	Aesthetic value	$11,422.31
	Existence value	$9,672.43
	Air quality	$1,334.01
	Temperature regulation	$1,144.65
	Climate stability	$240.66
Safer playground	**Total**	**$6,618.03**
	ADA compliance	$6,618.03
Edible garden	**Total**	
	Food provision	$1,976.85
TOTAL		$179,109.52

* Does not include community investment benefits
** Pervious surfaces include pervious pavement, landscape surfaces, wood fiber

Figure 3. Summary of benefits generated from landcover changes

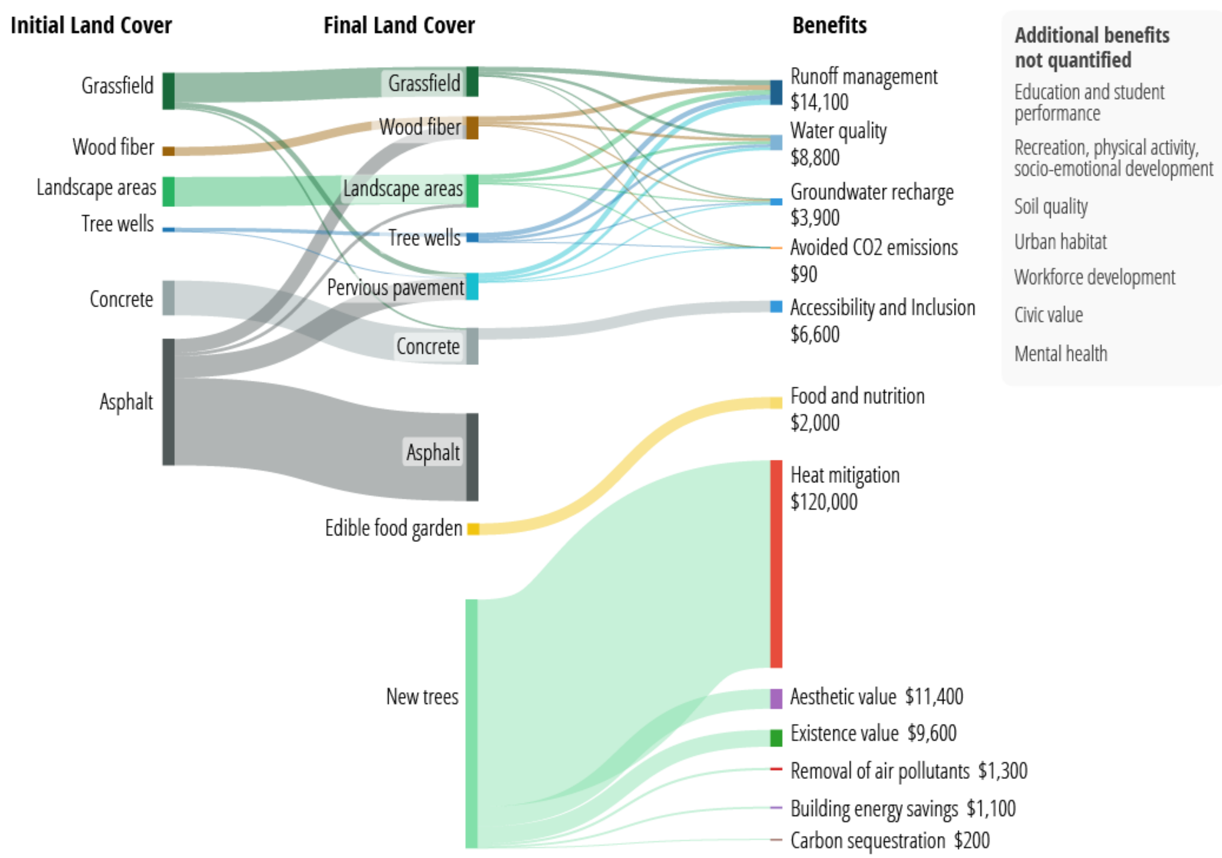


Table 8: Summary of annual monetary value by beneficiary and service category

Service category	Annual value (USD 2022)	Beneficiaries		
		Students and Teachers	*School administration*	*Public*
Community Investment Benefits	$220,658	●	●	●
Heat reduction	$119,809	●		
ADA compliance	$14,099	●		
Food provision	$11,422	●		
Aesthetic value	$9,672	●	●	●
Temperature regulation	$8,792	●	●	●
Stormwater retention	$6,618	●	●	●
Existence value	$3,914	●	●	●
Water quality	$1,977	●	●	●
Water supply	$1,334	●	●	●
Air quality	$1,145	●	●	●
Climate stability	$327	●	●	●

Benefit-Cost Analysis

Earth Economics then combined these benefits with the annualized costs of implementing, operating, and maintaining the newly greened schoolyard (over a 20-year period) to develop a simplified Benefit-

Cost Analysis of the project. The capital cost of the project is $963,900, or just under $48,200 per year over two decades. In addition, Earth Economics assumed annual O&M costs equivalent to 6.5 percent of construction costs, based on feedback from Amigos de los Rios and the LA County Department of Public Works (Zerolnick et al., 2018). Based on information from Amigos de los Rios, Earth Economics assumed that roughly 77 percent of O&M costs would go to labor, with the remaining for supplies and equipment rentals. Accordingly, the annual O&M cost for the playground was estimated to be roughly $62,650. The combined O&M and annualized construction costs summed to roughly $110,850 per year, over 20 years.

Given the $399,770 in expected annual benefits (see Results), this suggests net annual benefits of $288,920, or a benefit-cost ratio of 3.60 to 1. In other words, every dollar invested in the greening of the Jackson Elementary playground is expected to generate $3.60 in measured *monetizable* social, environmental, and economic benefits. This is exclusive of other, less-easily quantified benefits to the students and teachers, the school, and the surrounding community.

Scenario Analysis - Recreation Benefits

Recreation and health

Inactivity is known to lead to negative health outcomes which incur real costs, averaging $113 per person, per year (Carlson et al., 2015). Expanded options for play-time activities have been linked to higher rates of physical activity observed amongst children or at the very least diminish the rate of sedentary activity (Bates et al., 2018; Flax et al., 2020; Van Dijk-Wesselius et al., 2022; Bikomeye et al., 2020; Raney et al., 2023; Ward et al., 2016).

As of 2023, the Jackson Elementary school grounds are not open to the public. According to the *Park Needs Assessment* developed by the LA County Department of Parks and Recreation, 32 percent of the population in Altadena lives within a half mile of a park (i.e., a 10-minute). However, this means that more than 29,000 residents do not live near parks (LA County Department of Parks & Recreation, 2022). Opening Jackson Elementary's schoolyard to the public could address park access issues and lead to increased physical activity in neighborhoods near schools.

Using the same assumptions about annual O&M costs detailed in the previous section (i.e., 6.5 percent of construction costs), Earth Economics found the benefits from increased physical activity would be greater than annual O&M costs if community members were able to engage in moderate to vigorous exercise on the playground at least 556 total person-days, roughly 10 persons per weekend, or 46 persons per month. This suggests that the annual cost to maintain the playground would be justified even if the park was open to the public only one day each month—provided at least 46 people exercised in the park on those open days.

Additional Benefits

Earth Economics and Amigos de los Rios identified additional benefits that could not be captured in this analysis, due to a lack of data and gaps in the research literature. Although these could not be quantified given these limitations, supporting research was available for several benefits. Should additional data become available in the future, it may be possible to add these benefits to our overall understanding of the effectiveness (and cost-effectiveness) of schoolyard greening projects.

Expanding access and improving recreational experiences

Although the value of recreation provided by the playground were not included in this study, expanding accessibility and improving the quality of recreational experience are likely to offer substantial benefits.

Before the project, a strip of uneven, patchy grasses known locally as the “ankle twister” limited activities in that area. By replacing it with safer, sturdier surfaces, the playground was made more accessible for children with disabilities and injuries. The literature also suggests that additional greenspace may encourage more girls to use playgrounds (Raney et al., 2023; Bikomeye et al., 2020; Flax et al., 2020).

Recent evidence on physical activity and social behaviors of elementary school children in green playgrounds of Los Angeles, CA finds that exposure to nature changes children’s playground behavior during recess. Notably, students that are traditionally at higher risk of not meeting physical activity guidelines, girls, and older students, benefited the most from green space exposure. Researchers conclude that behavioral changes observed in the study may be the result of greater and more enjoyable opportunities for creative free play, more age-appropriate options, and an increase in intrinsic motivation (Raney et al., 2023; Raney, Hendry, and Yee, 2019).

By adding new recreational features and making the playground more accessible to all children, the project has improved the quality of recreational experiences and expanding opportunities for play-time activities, physical skill development, and pro-social behaviors.

Student performance

The Watershed Discovery Campus provides access to safe and stimulating outdoor classrooms—both significant, quantifiable educational benefits. The restored playground and its natural features offer students with new forms of learning by offering a unique opportunity for students and teachers to engage in didactic environmental science learning or take brief field trips to learn more about natural science and ecosystems (Flax et al., 2020). Studies looking at the relationship between youth exposure to green areas and cognitive development find that activities supported by natural features are linked to increasing cognitive development and motor skills/control in preschool children (Zeng et al., 2017). Student performance research finds that academic outcomes and green spaces are positively correlated (Bikomeye et al., 2020; Browning; Kuo et al., 2021; Ohly et al., 2016; Kuo et al., 2021).

Environmental science, nutrition, and health learning opportunities

The new garden in the Watershed Discovery Campus includes a shaded area with tables and signage for perennial plants and herbs. A new mural is planned to honor Dolores Huerta. In this study, food production has been valued as the potential revenue the garden produce could generate, based on studies of urban community gardens in California. However, this does not reflect other benefits to students gained by having access to the garden.

In 2022, students and staff grew over 30 different plant species on campus, including seasonal fruits and vegetables, herbs, flowers, trees, and vines (see Appendix B). These are used to support weekly on-site cooking classes for children at the school. These classes offer a unique space for children to learn about nutritious, healthy foods, as well as learn new skills that can have an important influence in their personal formation and growth.

Volunteers and youth participation

Volunteering is a common form of civic participation that can yield many health benefits. The civic participation literature finds that in addition to the direct benefits that volunteering provides to the community, it also produces health benefits for participants. A recent summary of the literature finds that civic participation improves health by building social capital. Specifically, belonging to civic groups expands participants’ social networks, which makes them more aware of opportunities to be physically active in the community (Marquez et al., 2016). Also, engaging in meaningful civic activities can help individuals develop a sense of purpose, which may promote continued civic participation (Barber et al., 2013).

Studies show that volunteers enjoy better psychological well-being and more positive emotional health (Jenkinson et al., 2013; Musick and Wilson, 2003). Studies of community gardens find that participants may form a sense of neighborhood pride (Alaimo et al, 2010), experience an increased appreciation for their neighborhood, and be more motivated to get involved in community life (Litt et al., 2015; Armstron, 2000). Moreover, by providing constructive endeavors to engage in, particularly in the summertime when many young adults have a lot of free time and few recreational opportunities, volunteering opportunities serve as deterrents of negative behavior (Cruz-Piedrahita et al., 2020).

Amigos de los Rios recruited 3,190 volunteer hours to complete the project. There were also in-kind donations for project development, including donated labor, equipment and supplies for asphalt removal, shrub planting, mulch spreading, and for civil engineering and construction oversight activities. The Mary W. Jackson Elementary Dad's Group also helped setting up the pergola that provides shade to the garden.

Workforce Development

In addition to creating opportunities for civic engagement, Amigos de los Rios provides volunteers with hands-on learning opportunities in conservation and preservation, including the restoration of natural habitats and ecosystems and learning how to protect and maintain more natural urban environments. Volunteers and workers that participated in the creation of the Watershed Discovery Campus gained or strengthened skills in native landscaping and stormwater management. This training and exposure can help fulfill jobs that require specialized skills for working with natural systems.

Other Considerations

Projects to green schoolyards are also likely to have other important environmental benefits that have the potential to be quantified, but which would require additional monitoring and site-level research. These include improvements to soil quality, effects on hydrological dynamics and other ecosystem functions, and improved habitat for birds, insects, and other urban wildlife. While many of these could potentially be valued (avoided or replacement costs, contingent valuation), site-level data would be necessary to inform subsequent analysis.

Looking beyond the economic value of greening schoolyards, topics for future research topics highlighted from this engagement include 1) the relationship public schoolyard greening and State and national biodiversity initiatives and 2) the relationship between schoolyard greening and vector control, particularly mosquitoes.

Conclusion

This report has demonstrated that the Watershed Discovery Campus of Jackson Elementary in Altadena is a cost-effective investment that can provide nearly $400,000 in annual benefits to students and teachers, the school administration, and the broader public. Most is provided by the broader economic effects of project spending (55 percent), although environmental benefits (37 percent), and social benefits (7 percent) are also important. Some benefits primarily affect students and teachers, such as the ability of trees to reduce temperatures during heat waves (and associated health impacts), compliance with ADA regulations, and the new garden. Other benefits affect the broader community, including the aforementioned economic and employment gains associated with project spending, but also improved stormwater management, improved water quality, the aesthetic appeal of a greener playground, improved air quality, and school and household energy savings from reductions to local temperatures during heat waves.

Overall, every dollar invested in the greening project is projected to provide at least $3.60 in measured social, environmental, and economic benefits. *These are conservative estimates which exclude multiple benefits that could not be quantified at this time.* The literature also suggests there are additional social and environmental benefits of greening schoolyards that are beyond the scope of this study, including: the quality of educational and recreational experiences, improved mental health for children and staff, and ecological benefits such as improved soil quality and bird habitat. As such, the total benefits associated with the project likely exceed the estimates shared here.

Moreover, this report has shown that allowing non-student visitation during off-hours can benefit the community by supporting improved physical activity, health, and quality of life. Earth Economics found that opening the playground to the public during non-school hours would be a cost-effective strategy to improve health outcomes in the community, supporting increased physical activity and other recreational and cultural values. This has important implications for public access rules, and how money is invested in green schoolyards. The benefits of increased physical activity are greater than these annual O&M costs after only an additional 556 persons have one day of access to recreational activities at the school. With support from programs like the *Safe Clean Water Program* for enhancing and maintaining green schools,[7] Los Angeles County could explore joint use agreements to open school playgrounds to the community after school hours and on weekends.

Next Steps

Moving forward, Earth Economics and Amigos de los Rios intend to refine and expand this analysis to include more of the benefits associated with the greening of Jackson Elementary and other schools in the basin. With assistance from Amigos de los Rios, Earth Economics will seek funding to engage parents, school staff, and students to better understand changes in multiple metrics of interest, including student performance, perceived mental and physical health changes among students and staff, quality and breath of the educative programs offered by the school, and parent perception of school quality.

In addition, Earth Economics will work with Amigos de los Rios to continue to refine these benefits to inform grant funded programs and policy initiatives including, Cal Fire Green Schoolyards Programs, SCWP, and related bond measures. For example, this work could inform general performance metrics to evaluate green schoolyard projects that can be used by the Safe Clean Water Program. Earth Economics can develop an accounting tool for tracking the economic benefits of green schoolyard projects.

The Watershed Discovery Campus project provides a valuable case study for public entities and non-profit organizations. During project development, construction, and maintenance phases, Amigos de los Rios gained insights into fundraising, workforce recruitment, and education that could help others pursuing similar efforts. For example, Amigos de los Rios has found that this highly specialized line of work demands continuous engagement with each school community in addition to support from multiple and diverse funding sources and partners that sustain such projects and expand their potential. A flexible and diversified financial model can provide revenue during economic downturns. A sound financial model also

[7] The Safe Clean Water Program funds multi-beneficial stormwater capture and urban runoff projects that improve water quality, increase water supply and provide community benefits. Community benefits can include enhancing green spaces at schools, increasing tree cover, and creating new recreational spaces. Funding can be used for design, construction and/or operation & maintenance costs for projects across Los Angeles County. More information is available at safecleanwaterla.org.

leverages additional funding to minimize reliance on in-kind donations and personal relationships. These lessons can be of particular importance not only to those interested in schoolyard greening projects, but also to those interested in workforce development programs at the County level.

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Appendix A. Limitations

This analysis has been limited by the availability of data on educational outcomes (e.g. student performance, socio-emotional behavior, and recreational activities), as well as gaps in the literature on the marginal economic value of improvements to soil quality, habitat integrity and connectivity, and urban biodiversity, among others.

An especially important gap in the literature is that of the value of water quality improvements and urban runoff reduction. In this study, Earth Economics researchers were able to estimate the value of this benefit thanks to recent work by Craftwater Engineering, who developed a model to identify the most cost-effective means of addressing zinc pollution in the Alhambra Wash watershed. Zinc is a limiting factor for water treatment—meaning that when the objective is to remove zinc, the necessary processes also remove other contaminants. Accordingly, Earth Economics considers the cost to remove zinc to be an effective proxy for overall water quality improvement. It is important that such assumptions be reviewed and validated by researchers.

This analysis is further limited by the use of BTM, which transfers values estimated at primary research sites to secondary sites in similar contexts, with similar characteristics. To minimize error, Earth Economics follows best practices when selecting primary studies (see Methods), but it is not possible to quantify omissions from the dataset—ecosystem services produced by landcover types found in the study area that have not been the focus of valuation studies. The lack of valuation studies of the educational benefits of green schoolyards in California is a clear example. Future research into this topic could contribute significantly to the regional community of practice around green schools.

Appendix B. Additional Details on Greening Features

Newly planted trees

Amigos de los Rios and Jackson Elementary have been planting trees on the school campus since 2019. When Amigos began its work, there were 62 legacy trees on campus. Since 2019, 84 new trees have been planted (Table 14).

Table 14. Summary of new tree plantings at Jackson Elementary

Common name	Scientific name	Year planted			
		2019	2020	2022	Total
Western Redbud	*Cercis occidentalis*	9	2	5	**16**
Pink Trumpet Tree	*Handroanthus heptaphyllus*	4	3	6	**13**
California Lilac	*Ceanothus*		10		**10**
Desert willow	*Chilopsis linearis*			10	**10**
Chinese pistache	*Pistacia chinensis*	4		3	**7**
Bottle tree	*Brachychiton populneus*			6	**6**
Paloverde	*Parkinsonia Hybrid*		2	3	**5**
California sycamore	*Platanus racemosa*		2	2	**4**
Callery pear	*Pyrus calleryana*		3		**3**
Sycamore	*Platanus*			3	**3**
Coast live oak; California live oak	*Quercus agrifolia*		2		**2**
Fremont cottonwood	*Populus fremontii*		2		**2**
Engelmann oak	*Quercus engelmannii*			1	**1**
Illawarra Flame Tree	*Brachychiton acerifolius*			1	**1**
Pin Oak	*Quercus palustris*		1		**1**
Total		**17**	**27**	**40**	**84**

Edible Garden Details

Data provided by the Garden School Foundation, 2023

General features

Size of garden: 3450 ft^2 (30 ft x 115 ft)
Size of raise beds (10 raise beds total):

27” x 25” x 6” (1 ct)
60” x 77” x 97” x 9.5” (2 ct), triangular shape
71” x 37” x 12.5” (1 ct)
96” x 51” x 11” (1 ct)
98” x 48.5” x 17” (1 ct)
98” x 49.5” x 12” (1 ct)
98” x 49.5” x 16” (1 ct)
103” x 37” x 8” (1 ct)
120” x 37” x 7” (1 ct)

Vegetables and fruits grown in the garden

Warm/summer season crops 2022:

- Tomatoes
- Zucchini
- Cucumbers
- Beets
- Pumpkins
- Collard green

Cold/winter season crops 2022/2023:

- Snap peas
- Broccoli
- Rainbow Swiss chard
- Cilantro
- Butter lettuce
- Cabbage
- Fava beans
- Carrots
- Beets

Established Trees and Vines:

- Pomegranate
- Guava
- Fig
- Peach
- Lime
- Grapefruit
- Passion fruit
- Sugar cane

Flowers

- Roses
- Black eyed-susan
- Nasturtiums

Shade in the garden

Pergola: A covered archway built over two picnic tables (installed by Mary W. Jackson Elementary’s Dad’s Group).
Peach, Guava, Fig and Pomegranate trees: Large trees that provide shared areas throughout the garden.

Garden signage

- Signage/labels are displayed for perennial plants, mostly herbs.
- There is a sign that shares when milkweed blooms and the importance of attracting pollinators.
- A new mural is planned to be painted in the garden to honor Dolores Huerta.

Appendix C. Valuation Studies

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