CITY OF TUCSON

The Business Case for Low Impact Development

ASU SCHOOL of SUSTAINABILITY

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Abstract:
Low impact development (LID) has become a promising paradigm for the environmental, social, and economic externalities of conventional stormwater management, which include pollution, high cost, and unsightly infrastructure. Those externalities, however, are not always accounted for in comparisons and the benefits of LID are likewise sometimes difficult to monetize and make tangible for decision makers. As arid cities like Tucson embrace LID, they are finding that a strong business case is sometimes hard to make. The feeling of many is that this is not due to the actual economics, which are often favorable, but because of lack of evidence for arid climates and other barriers and the simple need for a new accounting paradigm that includes all potential benefits beyond initial project construction. This case study analyzes the economic situation and available tools, one in particular called the Business Case Evaluator, to frame and give voice to the Tucson contingent of LID advocates that want to advance the city's standing for progressive infrastructure. Two projects in particular give a focus.

Keywords: Low impact development, LID, green infrastructure, GI, Tucson, sustainability, business case, arid

Introduction

Water is the enemy!

This seems like a strange sentiment in an arid climate. But there is a long tradition of viewing water as a burden and the desert dwellers of the Southwest are no exception. Derived from English common law, the *Common Enemy Doctrine* holds that surface water is a "common enemy" to all landowners, and thus each property owner can alter the drainage of water at will. Obviously, in a modern city many regulations govern the flow of water, but the precious resource itself is often taken for granted.

Arizona is a paradox concerning water. Impressive feats of water engineering and massive federal spending allows the state to support millions of urban inhabitants but municipal infrastructure evolved with a hands off ethic: "out of sight, out of mind". The infrequent but often intense rainfall of the desert is whisked away as rapidly as possible in grand plumbing systems that eventually empty into natural outlets.

Conventional infrastructure has contributed to stormwater pollution, urban heat island effects, air quality issues, and unsightly streetscapes. With shrinking budgets and reduced personnel, cities like Tucson are under increasing pressure to creatively manage the externalities of urban living and one of the solutions showing great potential is low impact development (LID), also known as green infrastructure (GI).[1]

But LID originated in wet and humid climates and solutions are highly contextual. Decision makers in arid climates desire more data, more pilot projects, and generally more evidence proving that LID provides viable alternatives. One of the formidable barriers to adoption is creating a convincing business case that accounts for the wide range of potential benefits. To that end, through personal interviews and analysis and a LID literature synthesis, we weave together a short narrative of Tucson's experience and vision concerning LID, highlighting an economic tool called the Business Case Evaluator (BCE) and two specific projects: A streetscape revitalization on Scott Avenue in downtown Tucson and the Blue Moon Community Garden.

The Lowdown on LID in Tucson

> **"LID should strive to have a positive impact, not just a *low* impact."**
>
> **~ Catlow Shipek, Watershed Management** Group

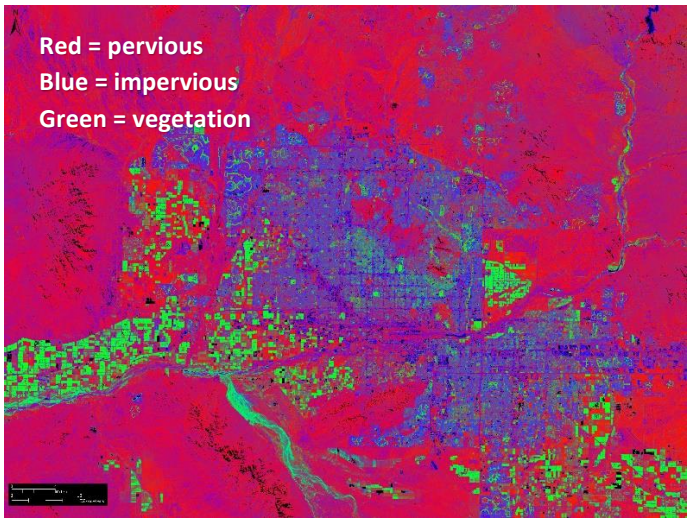
The term *low impact development* is a direct response to the negative consequences of conventional urban development. Cities have huge areas of impervious surfaces (*Figures 1,3*) – roofs, streets, sidewalks, and parking lots - that prevent natural infiltration, resulting in large volumes of water that have to be managed through expensive infrastructure. Along these directed routes, stormwater picks up trash, biological contagions, heavy metals, and a host of other contaminants on its way to final drainages. In 2008, the Environmental Protection Agency (EPA) noted 136 incidents where Arizona waters were severely impaired by pollution (*Figure 2*); one of the leading causes was urban runoff or nonpoint source pollution.

Low Impact Development

An innovative stormwater management approach modeled after nature: infiltrate, filter, store, evaporate, and detain runoff close to its source. Treat water as a resource, not waste. Space should be multifunctional. Strategies can be simple, effective, economical, flexible, and balanced.
(LID-stormwater.net, 2007)

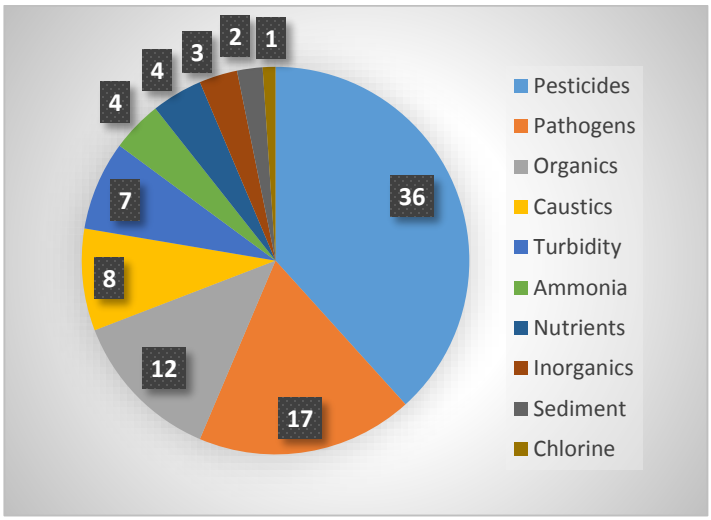
[1] Many sources distinguish between LID and GI. For the purposes of this case study, the terms are used interchangeably.

Figure 1–Satellite Map Land Cover Phoenix 2010



Adapted from NASA Johnson Space Center 2010: http://www.nasa.gov/centers/johnson/home/phoenix_heatwaves_feature.html.

Figure 2– Incidents of Arizona Impaired Waters 2008



Adapted from EPA 2014: http://iaspub.epa.gov/tmdl_waters10/attains_state.control?p_state=AZ&p_cycle=2008.

Figure 3– Increase in Impervious Urban Surfaces in Tucson

Adapted from NASA Earth Observatory 2012: http://earthobservatory.nasa.gov/IOTD/view.php?id=78613.

Adapted from NASA Earth Observatory 2012: http://earthobservatory.nasa.gov/IOTD/view.php?id=78613.

LID attempts to replace or supplement the need for large conveyance piping and other infrastructure with a multitude of techniques and features. Those identified as appropriate for Tucson are listed on the right (City of Tucson & Pima County, 2014). We found that water management professionals do not expect LID to fully replace conventional means but most believe it can substantially reduce requirements and eliminate costly upgrades and expansions, especially as cities brace for the impacts of climate change.

LID is not just about water. In fact, the multifunctional nature of LID was frequently mentioned by interviewees as its greatest strength, the essence of its common sense quality. Besides conserving energy, facilitating ecosystem restoration, aiding flood control, and improving groundwater recharge, LID is a constructive method of revitalizing streetscapes and beautifying neighborhoods (EPA, 2012).

Pima County LID Features

- Harvesting Basins
- Vegetated or Rock Swales
- Bioretention Basins
- Infiltration Trenches
- Cisterns
- Pervious Pavements
- Curb Cuts
- Pretreatment Filters
- Disconnected Downspouts
- Berms with Spillways

Larger scales can also be addressed by a LID philosophy. Watershed Management Group (WMG), a local Tucson nonprofit established in 2006, advances LID through simple, site level projects with tangible benefits but also thinks holistically by analyzing the watershed level and envisioning the bigger picture. In their opinion, LID can be a potent strategy in the search for more sustainable ways of life.

The Importance of Community

> "Tucson has a community atmosphere – city employees, partnerships, nonprofits, community gardens, are all a part of it."
>
> ~ Jason Kuklinski, Norris Design

> "Everyone in Tucson knows that water scarcity is a long term problem."
>
> ~ Evan Canfield, Pima County Chief Hydrologist

Over the last few years, a coordinated, regional effort has advanced the discussion and implementation of LID. A LID working group consisting of a wide range of stakeholders now guides policy direction and a strong sense of cooperation, optimism, and opportunity has emerged. Tucson and Pima County have produced a wealth of LID materials and research including a comprehensive LID manual, wastewater sustainability action plan, rain harvesting guide, LID case study compilation, and a detailed cost-benefit analysis (based on a beta run of the successor to the BCE). At the nearby University of Arizona Biosphere II, Dr. Mitchell Pavao-Zuckerman is performing important research on human ecosystem interactions, including the performance of LID.

This very dedicated core group of people is working to increase the number of completed projects and make LID the new normal for stormwater management for decision makers, professionals, and the public. As one participant stated, for LID to thrive "we need more of the community on board". Public engagement through volunteer opportunities on residential properties and low traffic residential streets has bolstered community understanding and advocacy for green infrastructure projects. With assistance from WMG, Tucson unanimously passed the Green Streets Policy in May 2013 that requires stormwater harvesting features to be integrated into all publicly-funded roadway development. A next logical step is to further evaluate the quantitative aspects of these LID projects including the financial, environmental, and social benefits.

The Economics of LID

> "Implementing GI and LID are good for the community but do not necessarily benefit its creators."
>
> ~ Evan Canfield, Pima County Chief Hydrologist

There is preliminary evidence that LID has advantages over conventional grey infrastructure both in terms of capital costs and long-term operations and maintenance. But there is a need to build and analyze the economic database related to LID, especially for arid environments. As James De Roussel, program manager at WMG, stated: "We are starting to see a turnaround, the case is becoming very strong for what we are advocating with LID". As communities work toward defining a triple bottom line approach that accounts for environmental, social and economic benefits, tools such as the BCE become critical to explaining impacts to human health and recreational value that traditionally have been available only through expensive consultant engagements.

Most economic evaluations of LID reported in the literature are based on a straight cost analysis, meaning they do not include operations and maintenance or potential future benefits. A small percentage use a more comprehensive benefit-cost approach that includes long term costs and benefits and can better compare projects to determine sound investment options. Non-market valuations that capture the benefits of

environmental goods and services such as clean air and water and other quality of life measures are rarely integrated into LID assessment (MacMullan & Reich, 2007).

The Economics of Asphalt and Water

Traditional grey infrastructure is expensive and costs are increasing as further urban development increases the volume of stormwater runoff. This is good news for LID. Arizona will need billions of dollars in road and water infrastructure repairs and upgrades in the next two decades (ASCE, 2014); Tucson alone has identified $850 million in backlogged street repair (Pima County, 2013). Pima County acknowledges that LID can reduce stress on existing infrastructure (2014), but LID also specifically seeks to minimize impervious surfaces, which means less asphalt and concrete to repair. Arizona is still overbuilding its roads due to lagging demand forecasts (Arizona PIRG, 2014) so there may be opportunity to replace excess infrastructure with LID retrofits that reduce overall impervious surface area. Now is the opportunity for LID to be integrated into standard stormwater practices.

Business Case Evaluator

> **"This is the most practitioner-focused, customized, and well researched tool I've seen for the Southwest."**
>
> **~ Kieran Sikdar, Watershed Management**

According to the EPA, "LID works everywhere" and is highly adaptable (2014), but the story of LID in Arizona is one that began cautiously. Much of the economic research and evidence for LID originally centered on wet and humid climates or regions that have combined sewer systems.

The Pima County Regional Flood Control District (RFCD) and the Pima Association of Governments (PAG) contracted with Impact Infrastructure LLC, a group of engineers and economists who developed the BCE, and Stantec to evaluate LID features specific to the desert Southwest.

Sustainable Return on Investment (S-ROI)

Financial evaluation methodology that assigns monetary values to all costs and benefits of a project or investment including economic, social, and environmental. Helps communicate benefits and account for externalities that are not part of traditional economic assessments (HDR).

The BCE is an extension of the Envision Rating System framework promoted by the American Society of Civil Engineers and Harvard's Zofnass program to evaluate the sustainability features of public infrastructure. The BCE, free to the general public, is a sophisticated Excel spreadsheet that incorporates economic modeling, in depth LID research, and Monte Carlo statistical simulations to produce potential values for a project. Based on sustainable net present value (S-NPV) and sustainable return on investment (S-ROI), the BCE produces time discounted benefits related to resource use and waste, recreational benefits, air and water quality, and flood risk.

This report covers the evaluation of two LID projects in the Tucson area utilizing the BCE to develop economic data on LID.

Scott Avenue Streetscape

> "The goal for Scott Avenue was to create a safer, more pedestrian-friendly and inviting, day and night "strolling street." ~ Wheat Scharf Associates

Like many American cities, Tucson's was struggling to attract activity back into the downtown area. Urban sprawl, the rise of the suburbs, decline of public transportation, and other historical development patterns led to the decline of the once vibrant urban core. Revitalization efforts, however, are reinvigorating the area. For example, anticipation and launch of Tucson's first modern streetcar line in July, 2014 ferried 60,000 people in its first three days of operation and helped spark hundreds of millions of dollars in public and private investment (Downtown Tucson Partnership, 2014).

Though troubled by setbacks and controversy, the Rio Nuevo taxing district approved by voters in 1999 was able to fund a roadway improvement project in a historic stretch of downtown. Scott Avenue was part of the Phase I redevelopment plan that kicked off in August of 2008 and was completed in May of 2009.

Figure 4 – Scott Avenue Site: Before and After

Photo by Wheat Scharf Associates

Photo by authors

Unfortunately, access to financial information related to the project was limited but standardized costing, one of the advantages of the BCE, helped fill the gaps and complete a financial scenario for Scott Avenue. The results are based on assumptions about typical costs rather than actual costs, which limits the accuracy of the final results, but the BCE did show how Scott Avenue could obtain a positive S-NPV through reduction of impervious surface area and other benefits.

The majority of the benefits derived were the result of the large number of trees included in the project that obtain some of their water needs from stormwater harvest basins and curb cuts. Square footage estimations were done via Google maps, an onsite visit, and landscape architecture plans. Similar to other studies done by Impact Infrastructure, reduction in heat stress mortality represented a large percentage of the overall benefit calculation.

Figure 4 – Benefits for Scott Avenue

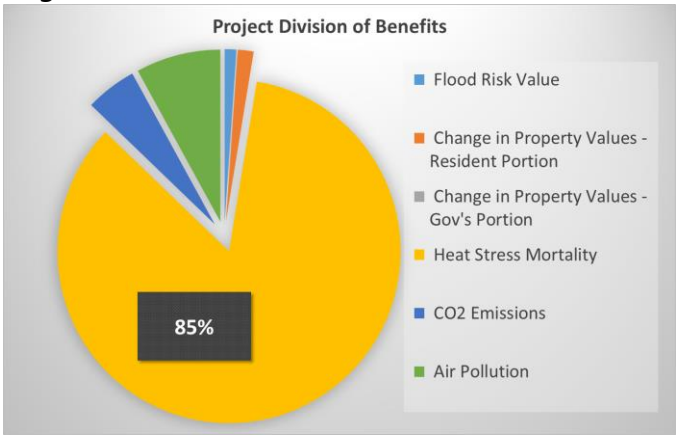
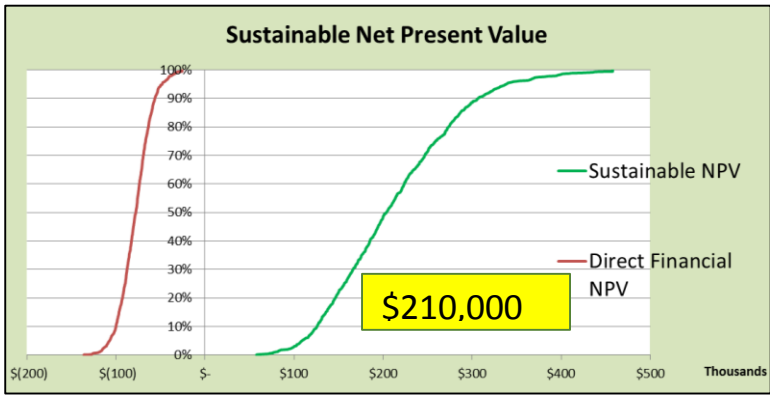


Figure 5 – S-NPV Calculation for Scott Avenue



The heat stress mortality calculation is based on the marginal reduction in urban temperatures and the value of a statistical life used by the U.S. Department of Transportation. While all of the BCE algorithms are well researched and based on accepted economic analysis, the heat stress mortality calculation is still somewhat controversial but critical for hot climates.

The BCE is not for the uninitiated. As a free tool offering, it has limited error correction, can be somewhat temperamental, and contains a high level of detail. Comprehensive information is not required for analysis, but it is difficult to determine degrees of importance for the various inputs without running multiple simulations. AutoCase, an online commercial version of the BCE, includes a number of automated features, making the benefit-cost analysis much easier to develop.

Blue Moon Community Garden

"It is important to have a project champion - you must overcome many barriers."

~ Gina Chorover, Blue Moon project initiator

"Gardening is the highest art; it uses all five senses."

~ Dixie Langdon, Tucson House resident

The Blue Moon Community Garden is a remarkable project that was made possible only by dedicated individuals and collaboration between multiple parties. After an economic revitalization report identified the Tucson House, a public assistance high rise with over 600 low-income and elderly residents, as an area in need of green space and access to fresh food, Housing and Community Development staff and the Community Gardens of Tucson group sprang into action.

One acre of an under-utilized parking lot was reclaimed and transformed into an award winning, ADA accessible public space. The site boasts several impressive LID features including cisterns that harvest water from the roof of The Tucson House and high tech water monitoring systems. Unlike Scott Avenue, there is not a conventional

project cost framework with which to compare the project. Despite high construction costs, federal funding and donations allowed Blue Moon to show a positive return on investment for the community.

Figure 6 – Blue Moon Site: Before and After

Photo by Tucson LID Working Group

Photo by Tucson LID Working Group

Figure 7 – Benefits for Blue Moon

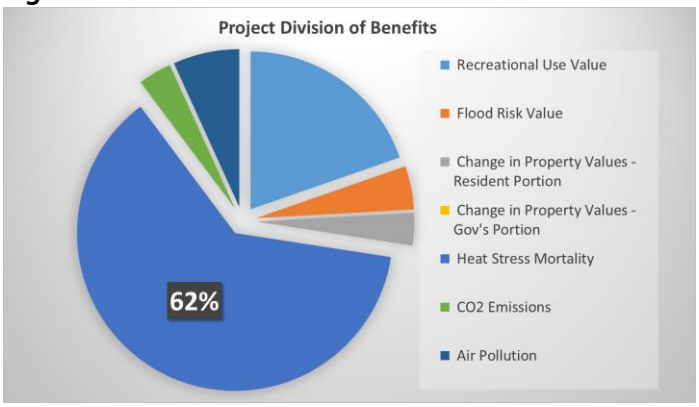
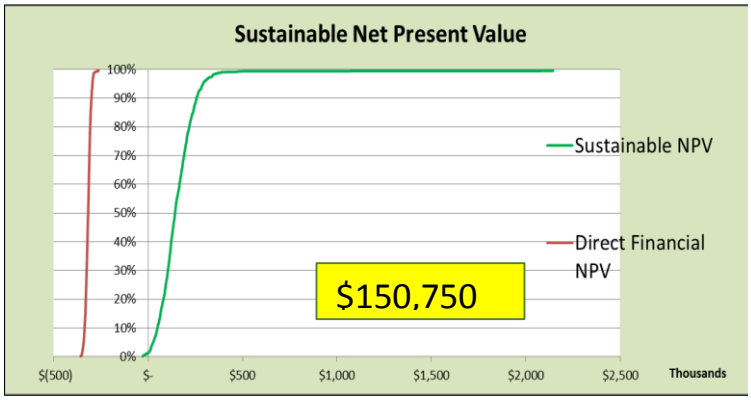


Figure 8 – S-NPV Calculation for Blue Moon



The BCE did not capture all the social benefits of the site. The recreational aspect does show up in the calculations but the demographic makeup of the Tucson House is also particularly important. Its elderly residents have mobility limitations that can affect mental well-being and the nearest grocery store is miles away. According to one resident active in the community garden, the positive psychological impact of the garden is substantial. Nearby community members are also invited to take up a plot and the public is welcome to roam the garden as an amenity. In a neighborhood with a lack of natural open areas and other amenities, Blue Moon is a treasured space. The BCE did not capture the potential physical and mental health benefits of the project.

"The biggest asset is the sociability".
~ Dixie Langdon

The funding issue is interesting. Without federal assistance and donations, Blue Moon had a negative S-NPV of almost $300,000. Federal grant requirements made the project much more expensive but was perhaps the only way this project could show a positive return.

Conclusions & Recommendations

LID methodology is not yet the new normal for stormwater management, especially in places like the arid Southwest. The City of Tucson has emerged as one of the leaders exploring how green infrastructure can positively impact communities, which is one of the reasons Impact Infrastructure partnered with the City, Pima County, and PAG to test the beta version of AutoCase and introduce the BCE to regional stormwater engineers.

The Blue Moon and Scott Avenue LID analyses revealed issues and areas for future research. Stormwater projects involving housing or recreational improvements, for example, need to include mental and physical benefits to capture a more holistic understanding of the societal benefits of LID. Cities need a framework for accountability as community reponsibilities and costs affect public funding, policies, and incentives.

Residential and business properties adjacent to Scott Avenue have improved their lots, contributing to property value increases in the area. Understanding how LID affects property values is an important focus area. Intuitively, the transformation in the look and feel of a place that LID can provide seems like something that would be positively correlated to property values. The BCE includes property value calculations, but the underlying research requires further development.

Cost benefit analysis for low impact development is still in an embryonic stage as research continues to connect human health, urban form, and environmental quality. An example that is important for automobile centric communities is traffic calming, which has safety and health benefits. Motor vehicle crashes cost the state of Arizona $4 billion per year, almost $833 per person (Tripnet.org, 2014). The combination of road diets, narrowing of paved lanes, and LID techniques can reclaim public space and make public places safer and more pleasant.

It is important for Tucson to address information flow and accounting for LID if the data gap it to be closed. In order for economic analysis of LID to be a tool for decision-makers, financial data on projects need to be accessible. All projects involving city resources should have a standardized information set that is transparent, centralized, and comprehensive enough to allow LID vs. conventional comparisons.

A life-cycle-costing framework (Powell et al., 2005) combined with insights from Impact Infrastructure's ongoing work could be used to develop an innovative process that would put Tucson at the forefront of LID analysis. Existing calculators are very basic and in our opinion do not provide much value for complicated projects. Combining standardized (and hopefully online) data collection with a tool like AutoCase could be a powerful combination in the future.

Tucson has its handprints all over the arid climate LID literature and the city continues to implement progressive practices while LID advocates improve the tools required to help decision-makers understand the community benefits of green infrastructure. The future looks bright for the Old Pueblo as awareness of urban problems grows.

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Appendix A: Methodology

Construction of this case study was done through personal, semi-structured interviews with City of Tucson and Pima County employees in various fields, Tucson residents, researchers, and water management professionals. The limited number of interviews limits the generalizability of this research; it is not intended to be used for statistical considerations. Self-selection bias is also present as all of the participants were involved with LID in some manner and mostly held pro LID stances on various issues.

A LID literature review was also conducted to give context and meaning to the case study and help synthesize the financial aspects of LID for arid environments and beyond.

Appendix B: Other LID Resources

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