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Green Roofs for a Green Town: Possibilities of Green Roof Implementation in the Town of Normal

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Abstract: Green roofs have been growing in popularity throughout the world. Scientists have been studying them since the 1980's. This research project reviews the literature regarding both the benefits and barriers to green roof construction and management. Policies around the nation are then examined and analyzed. Suggestions are made regarding possible additions to the local Stormwater Management Policy that would emphasize the importance of sustainable building techniques such as green roofs, and hopefully offer incentive to their implementation.

Introduction

The town of Normal, Illinois has faced environmental problems head-on through many new innovative programs and policies. It is home to a pilot LEED certified neighborhood development project, and has worked to include sustainability into many new endeavors, including the Main Street Redevelopment Plan (Mercy Davison presentation, IWU, Sept. 3, 2008). The town has even gone so far as to initiate an Environmental Stewardship Policy which states, "The Town is committed to reducing its use of natural resources, to investing in green buildings, vehicles and materials, to saving taxpayer dollars through wise energy use and resource conservation, and to improving the

overall quality of life in the Town." This policy includes sustainable building, water efficiency, indoor and outdoor environmental quality, design innovation, and energy and natural resource conservation (Town of Normal Website, 2008). With such a notable record of accomplishments, the town could become a much-needed leader within the Midwest, tackling environmental problems in a timely and productive manner.

To further solidify Normal's status as an environmentally conscious community, the building of green rooftops should be considered. Green roofs, or roofing systems that include water retention and drainage layers along with plant life, provide many benefits to both the owner and surrounding community. They lead to lower energy bills, and provide a carbon sink in urban areas, along with many other diverse ecological advantages. Cities around the world such as Chicago and London have taken the initiative and made green rooftops a common sight. Sustainable technologies such as green roofs are sometimes overlooked when new construction or renovation is taking place, however, due to issues surrounding economic or political barriers like zoning laws. If green roofs were formally recognized by the town of Normal as a positive and feasible way of enhancing sustainability, the community could take another step towards a cleaner town, and therefore a greener Earth.

Green roofs are increasing in popularity throughout the United States because of the economic and ecological benefits that they offer (Kennedy, 2008; Markham, 2008; Muroff, 2007; Richman, 2008). While upfront cost remains an issue, an increasing number of builders are beginning to recognize the long-term advantages of having a green roof (Kennedy, 2008). With global climate change and other environmental problems on the rise, green roofs act to combat many of the harmful consequences of our changing world (Bass et al., 2003). Research suggests that green rooftops retain stormwater, improve energy efficiency, decrease the heat island effect in cities, and promote urban biodiversity in addition to sequestering carbon dioxide and preventing it from entering the atmosphere (Mather, 2006, Oberndorfer, 2007). Many builders today, however, are still hesitant when it comes to building a green roof, as the logistics, including maintenance, seem daunting (Orbendorfer, 2007).

In this research project, I investigate the literature on the benefits of green roofs as proposed by scientists. Using interviews with experienced green roof architects and supporters as a guide, I then consider potential barriers to green roof implementation. These interviews allowed me to explore the topic of green rooftops in a very relaxed setting. Instead of simply relying on articles in which only specific information can be obtained, or in surveys, which follow a strict path, interviews allow the expert to focus on what topics they find most interesting and most important. This explorative method allows for a varied research experience, as the conversation can follow any line of possible topics. As there was not much literature regarding the barriers to green roof implementation, the thoughts of experts are critical to an analysis of this issue. Having determined the barriers to green roof implementation, I then ascertain possible ways of removing them by analyzing different approaches taken by other cities around the United States. I then examine policies in Normal to determine where changes could be made that would bring attention to green roofs and their benefits.

What is a Green Roof?

A green roof is essentially a roof outfitted with vegetation and growing media, or some type of soil. Layers are built upon the actual rooftop to provide necessary irrigation, drainage, and soil needed to sustain plant life. All green roofs consist of seven layers: a substrate, a filter fabric, a drainage layer, a protection layer, a waterproofing layer, a moisture barrier, insulation, and a separation layer (See Figure 1 below). All of these layers lie on top of the actual roof. (EPA website, 2008). The most common plants used on green rooftops are grasses in the Sedum family. They are tolerant of extreme temperature, winds, sun, and drought – conditions that are quite common to rooftops (Muroff, 2007). There are two major types of green roofs – intensive, and extensive.

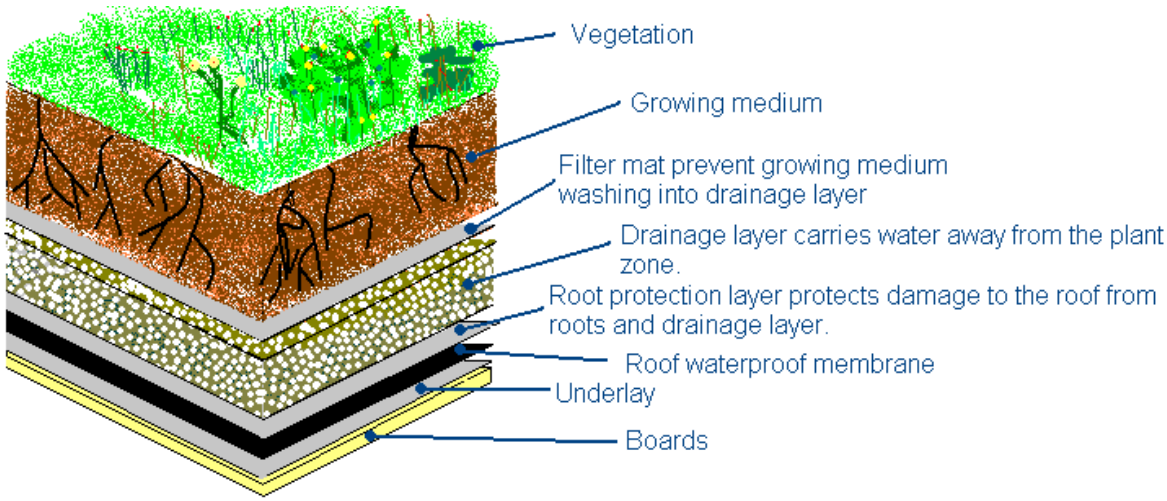

Figure 1

According to the Environmental Protection Agency, *intensive* green roofs require a minimum growing media depth of one foot and can accommodate trees, gardens, and larger, more demanding plant life. They add approximately 80-150 pounds per square foot to the weight of the building structure itself, and allow for human access. They require regular maintenance, partially due to their irrigation and drainage systems that regulate the flow of water to and from the roof. *Extensive* green roofs require much less maintenance. They usually limit soil depth to one to five inches, and are therefore only capable of sustaining smaller plants such as grasses. They typically do not allow for access, and add 12-50 pounds per square foot of weight onto the building. The irrigation and drainage systems they use are much less complex than those in an intensive green roof system.

While it is typically more widely accepted to create new built-in-place green roofs using either intensive or extensive systems, existing roofs can also be outfitted to support vegetation. To do this, a modular system must be used, as opposed to a layered structure that is physically built into the roof construction. This modular system requires pre-planted plastic modules that are placed on top of the existing roof (See Figure 2 below). Even when wet, this system results in much less strain on the existing building than both extensive and intensive green roof projects, adding only fifteen to eighteen

pounds per square foot of weight for a module with four inches of growing media. These types of green roofs are much easier to install and maintain, but do not offer the same beneficial scope as the built-in-place roofing systems. Because the plants are placed in modules that hold a limited volume of water as opposed to layers of drainage and retention materials, stormwater retention is much lower (Markham, 2008).

Figure 2

Just as the types of roofing system vary greatly, so do their installation and maintenance costs. The US EPA attests that an extensive green roof costs approximately eight dollars per square foot, whereas a traditional roof with no modifications or plant life would only cost one dollar per square foot. This discrepancy is due to initial maintenance and labor costs. However, studies have shown that green roofs are cheaper over their lifecycle than traditional roofs. In Singapore, a team of scientists and economists formulated an experiment to test this idea and found that "…life cycle costs of extensive green roofs with or without consideration for energy costs, are lower than that of exposed flat roofs, despite its [sic] higher initial costs" (Wong, 2003). Similar results have been shown for intensive green roofs, as the benefits accrued from this more complex system are greater due to more roof layers and an increased soil depth. Studies by the EPA have shown that the lifetime of green roofs are on average twenty years longer than those of traditional roofs (EPA website, 2008). This notably longer lifespan is due to the face that less sunlight contacts the actual rooftop, limiting ultraviolet exposure as well as providing fairly constant temperatures. These two factors prevent the freezing and thawing of the roof during the winter, virtually eliminating the contraction and expansion of the roof that severely weakens most traditional roofing materials (EPA website, 2008).

Ecological Benefits of Green Roofs

Stormwater Management

In addition to the long term cost savings of green roofs, there are several environmental benefits. One very important advantage of having a green roof is its ability to retain stormwater runoff. Stormwater management in cities can be a very complicated problem. Green roofs can help combat some of the negative effects of stormwater, mainly runoff. The issue of stormwater runoff has plagued urban areas for years. It spreads pollutants throughout urban areas, leading to wide scale environmental degradation. This runoff has proved to be dangerous not only inside cities, but in surrounding areas as well. The US EPA shows that runoff from cities is filled with contaminants like pesticides and metals (EPA website, 2008). Mason et al. (1999) studied roof runoff more closely and found that the stormwater contained higher amounts of heavy metal elements than normal stormwater. They go so far as to suggest that runoff from these areas is "the leading source of water quality impairments to surveyed estuaries and the largest source of impairments to surveyed lakes". They attribute this to the fact that roof runoff collects particulate pollutants as it falls off the roof. They found that with the help of green roof vegetation, however, some of these pollutants can be effectively broken down. (Mason et al., 2004; VanWoert, 2005).

One of the most well-known benefits of a green roof is stormwater retention. Large amounts of stormwater can lead to extensive soil erosion. The massive influx of rainwater after a storm carries soil with it, as it makes its path towards level ground, resulting in building instability and other major costs to cities. Sewer system floods have also caused damage to many American cities. The US EPA (2008), however, believes that if green roofs were built on just twenty percent of buildings within the same 10,000 square foot radius, they would provide over 23 million gallons of water storage for the area, as well as reduce the outflow of nearby sewer systems by 300 million gallons per year. This would drastically decrease erosion in urban areas, as well as quell the spread of pollutants found in stormwater. Because of the importance of stormwater management in cities, scientists have studied the effects of green roofs on stormwater retention in depth. VanWoert (2005) found that vegetated roofs retained approximately 82.8% of rainwater, while gravel roofs only retained 48.7%. He also found that runoff from green roofs was significantly delayed and spread out over time, allowing the ecological system more time to handle the amount of water. He identified many factors that affect the rate of water runoff and retention, including the depth of the growing media, the slope of the roof, the species of plants, and rainfall patterns. (VanWoert, 2005; Dunnett and Kingsbury, 2004). Other studies have had similar results to VanWoert's. (Moran, 2005; Beattie et al. 2003). As a general guideline, it has been shown that the shallower the substrate and the steeper the roof slope, the greater the overall runoff (Mentens et al. 2005).

Energy Efficiency

Another benefit of green rooftops is improved energy efficiency (EPA website, 2008; Kennedy, 2008; Orbendorfer, 2007, Bass et al., 2003; Richman, 2008). Buildings with green roofs use much less energy during the summer because the green roof acts as a

shield from heat that would otherwise have come through the roof. Liu (2004) found that on an average summer day, the energy that came through the roof in the form of heat was reduced by 75%. Liu recorded that a traditional roof heated up to approximately 158° F, while the green roof's temperature was a much cooler 86°F (Liu, 2004). Another study seeking to prove the energy efficiency of a green roof showed that during the warmest seasons of the year, the average daily energy demand for air conditioning was 6.0-7.5kWh for a traditional reference roof, whereas the green roof only used 1.5kWh (Bass et al., 2003).

Urban Heat Island

Although stormwater retention and energy efficiency are both very important to urban areas, the problem of urban heat islands may prove to be even more relevant to these more densely populated environments. With the effects of global warming becoming more apparent, it has been suggested that urban areas may be particularly vulnerable, suffering from extreme temperatures because there is little vegetation to shade the ground and moderate temperature through evaporation and transpiration (Bass et al., 2003; Rosenzweig et al., 2006). Ground level ozone builds up in these areas because of the burning of fossil fuels and the large amounts of concrete, leading to high temperature and smog. For example, New York City's Central Park is currently 2.12-5.44° F warmer than many other locations radiating farther out from the center of the city and the average heat island temperature of the entire city ranges from 5.4° F in the winter to 7.2°F in the summer (Gedzelman et al., 2004). The Portland Bureau of Environmental Services believes that if all buildings were given green roofs, the urban heat island temperature could be lowered between fifty and ninety percent (Rosenzweig et al., 2006). To test the extent of urban heat reduction by green roofs, Bass et al. (2003) used irrigated green roofs and observed surrounding temperatures. They found that the immediate surrounding area cooled 2°C, and 1°C as you moved further away from the green roof. The authors noted some issues of oversimplification in their research, but point out that other studies have found the cooling effect of green roofs to be even higher than the results found in their own study (Bass et al., 2003).

Urban Biodiversity

In a more purely ecological vein, green roofs promote urban biodiversity. By offering green space in a mostly urban area, green roofs can provide a habitat for local species of insects and birds. The effects of both intensive and extensive roofs on urban biodiversity have been studied. One analysis in Switzerland found over 12,500 spiders on one green roof. Other roofs were home to 79 beetle species as well as 40 spider species. In London, green roofs were built for the express purpose of offering replacement habitats to species in need (Brenneisen, 2006). If applied in Illinois, green roof habitats could potentially house a multitude of native Illinois insect or plant species.

The urban biodiversity opportunities that green roofs offer are not just specific to animal life. Plant life on green rooftops can also vary depending on the type of roof. While Sedum grasses are the most commonly used plants, others can be used as well depending on the depth and type of substrate. Research has been conducted in order to

determine what substrate depths and plant species promote the greatest urban biodiversity. One study by Schaefer found that there was no significant difference in Sedum plant growth in five, ten, fifteen, and twenty centimeters of growing media (Schaefer, 2005), although other studies, such as that performed by VanWoert et al., (2005) had previously argued that the water retention provided by deeper substrates would lead to increased plant growth. But according to the slightly more recent data collected by Schaefer, cheaper, less intensive systems can still sustain adequate plant growth. However, the type of growing media used also affects urban biodiversity. In London, interestingly, media including crushed brick and concrete housed more species than a roof with a sedum mat on top of garden soil (Gedge and Kadas, 2004). Moreover, the practice of using brick and concrete within the growing media has a two fold environmental benefit- the ability to use recycled building materials, while also increasing urban biodiversity.

Challenges

Cost

The benefits of green roofs – stormwater management, energy efficiency, reduction in urban heat island effects, and an increase in urban biodiversity – are far reaching and backed by scientific studies. This being the case, it is worth noting why green roofs have not been implemented everywhere. Immediate costs do raise major concerns for some builders. Kurt Hovarth, President of Intrinsic Landscaping in Chicago, has vast experience promoting and building green roofs throughout the Chicago area. When asked about any potential drawbacks to green roofs, he responded that the while the EPA conjecture of cost was high (eight times the price of a traditional roof per square foot), he does believe that a green roof would cost approximately three times more than a traditional roof. In the Chicago area, however, this challenge is not as difficult to overcome as it is in other areas, because of Chicago's extensive Green Roof Grants Program, which will be discussed later (Hovarth Interview, 2008).

The other green roof expert I spoke with was Bob Royce, senior project architect for Walgreens. His current position in the corporate world has shown him some of the major barriers to sustainable design, the most important of which is cost. He said that the major problem he has encountered when trying to convince building owners to build green roofs is that there is "no real pay back in the short term". Green roofs are expensive, and Royce attests that few people are currently willing to make the investment.

Aesthetics

In a study based upon the limited usage of green roofs, Noel Kingsbury, a leader in green roof research, found that public opinion of green roofs is an impediment to major reform. He believes that in order to be accepted and respected, green roofs are going to have to appear as "pretty" as other urban environmental havens such as parks. To do so, substrate levels would need to be much deeper and the irrigation systems much more complex (Kingsbury, 2007).

Maintenance and Labor

Other scientists argue that more logistical problems are to blame for an overall lack of green rooftops within the United States, including the extreme weather conditions of a roof environment. Green roofs take time and care, especially in their initial stages (Dunnett and Kingsbury, 2004). Monterusso et al. (2005) found that many native plants cannot handle the intense conditions of a rooftop environment, as only four out of eighteen native prairie plants survived on a green roof in Michigan after three years. Other impediments to green roofs include weeding, which must be done by hand, and replanting (Markham, 2008).

Many individuals, upon learning about green roofs, wonder if traditional roofs can be converted easily into green roofs. At first examination, one would think that adding additional rooftop layers and vegetation would be more cost effective and less labor intensive than building an entirely new roof. Ken Hovarth said that this was untrue. Most roofs have to be completely retrofitted or remade to be able to hold the increased amounts of weight from the plant life and the different retention and drainage layers of the green roofing system. Because of these difficulties, Mr. Hovarth said that building a whole new roof is much simpler than trying to turn a traditional roof into a green roof. That way, the builders can be sure that the building can hold the new weight of layers, substrate, vegetation and any retained water.

Personal Challenges

In addition to these physical limitations, some of the barriers to green roof implementation are associated with the knowledge and opinions of individuals. Peck et al., (1999) suggested that there are four main barriers to widespread adoption of technologies such as green roofs – lack of knowledge and awareness, lack of incentives to implement, cost based barriers, and technical issues and risks associate with uncertainty. Most of the studies discussed in this review aim to educate the public, making them aware of the benefits of green roofs. The benefits themselves are incentives to promote action. This leaves the third of Peck's barriers to consider – cost. Other cities have overcome this problem, so it is certainly possible. Ultimately, it is the city planners and businesses that must decide how to promote green roofs by reducing the cost based barriers relying on different paths of incentive (Bass et al., 2003).

What Can We Learn From Other Cities?

Possible Paths

Although green roofs do present challenges, their benefits have outweighed the costs in many cities around the world. After researching how other cities have approached green roof implementation, three main methods appeared to be most widespread. This first, and most common, is to rely on building owners themselves. Towns like Normal without official green roof incentives fall into this category. While the people may understand green roofs, it is up to each individual to weigh the costs and

the benefits in order to determine if green roofs are a good choice for their building. This relaxed approach may be effective in certain areas where the citizens are very sustainable, but overall, the costs are high and business owners themselves cannot be relied upon.

The second approach is changing the buildings. Portland, Oregon currently has partial green roof requirements for all new public buildings (City of Portland website, 2008). The City of Chicago now requires new buildings to maintain a certain level of green technology, whether it is in building materials, heating systems, or roofing systems. Bob Royce approves of this approach, and believes that changing building codes is the only way green roofs will become common. During his many years in the industry, he has noticed the biggest influx in number of green roofs since the building codes were changed (Royce Interview, 2008). While this may be an incredibly effective approach, it will most likely be met with resistance, especially here in Normal where there are currently no grants for green roof building.

The third option is, in my opinion, the best approach for the town of Normal. By offering new incentives, building owners would still have the option of making an investment in green roofs. But because of the new incentives, they would more willing to make the financial commitment. There are many types of incentives, ranging from fee-based incentives, such as grants, to awards and recognitions, which are optimal for competitive industries in which having a sustainable image is very important.

Incentives Used in Other Cities

The nearby city of Chicago has used a mix of both building code changes and fee based incentives to promote green roofs. Chicago has been rated number one in number of green roof square footage for many years in a row. In order to entice business owners in the area, the City of Chicago Department of Environment offers grants for green roofs. Up to $5,000 can be given to a business to help install a more sustainable green roof. Green roofs have also been incorporated into stormwater management policies (City of Chicago website, 2008).

The City of Portland is a leader in green roof policy, and integrates both economic incentives along with buildling code changes in order to induce change. Green roofs, or ecoroofs as the called in Portland, have been added into their stormwater management policies as well as their sustainable development policies. In October of 2008, Portland initiated an Ecoroof Incentive Program that will grant green roof owners five dollars per square foot to aid them in the development of their roof. This greatly decreases the cost of a green roof to the roof owner. The city of Portland contends that green rooftops cost approximately five to twenty dollars per square foot, making it possible for the city of Portland to completely fund a private green roof (City of Portland Website, 2008).

Seattle, Washington has one of the most developed green roof policies in the United States. Like Chicago and Portland, Seattle has incorporated green roofs into their stormwater management policies. Green roofs qualify as an Impervious Surface Credit in Seattle. Impervious surface are defined by the city of Seattle as “any surface exposed to rainwater from which most water runs off including, but not limited to, paving, packed earth material, oiled macadam, or other treated surfaces, and roof surfaces, patios, and formal planters”. Properties in this city must minimize their impervious surfaces in order to comply with runoff requirements. By adding a green roof, building owners fulfill part

of this requirement, allowing them to build more impervious surfaces like parking lots. This is beneficial to building owners that desire impervious surfaces on their property (Flow Control Manual, 2000).

Smaller cities are also getting involved with green roofing policies. Cities like Royersford, PA, Amery, Wisconsin, and Germantown, Maryland have all been included in top ten lists for green roof square footage (Final Report, 2008). In a press release by Interior Design Industry News, I found that in Germantown, Maryland, the county paid developers $75,000 to build green roofs. Montgomery County, home of Germantown, has now instated a Green Building Law that requires all nonresidential buildings larger than 10,000 square feet to achieve a LEED silver rating- a program that promotes green roofs along with other sustainable development techniques (Carroll, 2007). The town of Normal can learn from these cities and others, and hopefully adopt some of their practices in order to make green roofs more common and therefore allow the town to reap the ecological benefits. The town's Environmental Stewardship Policy is certainly a step forward, but more work can be done to promote sustainability when building.

Current Policies in Normal

Environmental Stewardship Policy

Normal's Environmental Stewardship Policy has been mentioned multiple times throughout this examination of green rooftops. This policy makes the town of Normal responsible to the development of sustainable technologies. This mission of the Environmental Stewardship Policy is as follows:

> "The Town of Normal recognizes responsible environmental stewardship as part of its core mission in serving the citizens of this community. The Town's environmental policy is intended to create long-term environmental benefits and to conserve natural resources…" (Town of Normal website, 2008).

Due to this commitment to sustainability, the town of Normal has the duty to investigate the benefits of green roofs further. There is even an Innovation in Design article in the policy that states:

> "The Town realizes that as the community continues to grow, new innovations will be required to address the increasing environmental impacts of development. Thus, the Town is committed to supporting innovative designs that may result in positive environmental benefits whenever possible." (Normal website, 2008)

Green roofs are certainly a new innovation that address the impacts of development. Their benefits, such as stormwater management, would be an asset to the environment in the town of Normal.

Stormwater Management Program

After researching policies such as those in Chicago, Portland, and Seattle, I investigated local polices that might bear some similarity to those in larger cities. Normal does have a Stormwater Management Program that was written in an attempt to alleviate some of the problems associated with stormwater runoff. Citizens are required to pay a fee every month to account for the amount of runoff that they allow to flow over their property. The fee for larger buildings is determined by the amount of impervious surface the property has – a policy comparable to Seattle's Flow Control Policy. Normal has also established a stormwater credit system, in which property owners can avoid some of their stormwater user fees by taking steps that would either lessen the amount of stormwater runoff or improve the quality of the stormwater (Town of Normal Website, 2008).

Proposal

Using Seattle as an example, I propose that the town of Normal add green roofs to the list of acceptable technologies that would earn stormwater credit. By offering economic incentives, green roofs may become more feasible for building owners. While this is only a first step, by introducing green roofs to both the policy and citizens of Normal, perhaps more people will research their benefits and decide to implement them.

Conclusion

To encourage the city of Normal to promote green roofs, an explanation of the types of green roofs and the benefits they provide must be developed. Evidence suggests that the advantages to green roofs are extensive, and should be thoroughly examined before dismissing the idea of a green roof simply based on the perceived logistical and financial challenges. A review of the literature along with interviews from experts suggests that green roofs are most certainly worth review. This research can be used as a proposal to the town of Normal in order to gain green roofs recognition. With these new incentives, local building owners could make the choice to build green rooftops, making the town more sustainable.

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