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Water Squares

Building Sustainability

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Contents

Abstract

With the growing threat of climate change essential resources may be harder to maintain for growing urban populations. The Dutch have tackled sustainability and water management in the face of climate change through infrastructure. Water Squares is one Dutch solution that can be applied to meet the goals drafted by the 2021 Spokane Sustainability Action Plan. This paper explains how building social, environmental, and economic sustainability can be applied to a city through design and involvement of the people.

Part I: Building Sustainability

The earth provides plentiful resources (energy, materials, food, water, and more) that are consumed thoughtlessly by humans on a daily basis. The use of these resources has limitations. Sustainability is a practice that ensures these resources for present day and future generations. With the rise in the globalization of industries many cities have gained access to resources from around the world, many citizens that are economically well-off are rarely faced with resource scarcity. Globalization allows for resources around the world to be acquired on a seemingly endless basis, often leading to over exploitation of resources. Data from 2013 suggested, almost half of the world's population lives in cities and most live in "unsustainable conditions" (Brazil

et al., 2013). While urban environments make up less than 2% of the planet's area, they amass almost 80% of the world's resources (Yunos, 2001). As cities continue to grow, these unsustainable practices will lead to a further decline in available resources and even greater crises. Each city/region has its own unique social, environmental, and economic background, as well as available resources which require localized solutions. Civil engineering has the potential to impact the practices and culture of cities through design and infrastructure. Careful, localized planning by Civil Engineers and other professionals can reshape cities through sustainable ideas that safeguard resources and end excessive exploitation for generations to come.

Implementing true sustainability requires an understanding of cultural, environmental, and economic impacts. Our modern understanding of sustainability was established by the Brundtland Report of 1987. It introduced the idea that true sustainability includes social, environmental, and economic aspects (Keeble, 1988). Kyle Whyte's paper "Our Ancestor's Dystopia" includes these three principles are in the restoration of Manoomin (wild rice) by the Anishinaabe people in the Great Lakes. The harvesting of the wild rice is culturally integrated into the Anishinaabe people's way of life (Whyte, 2016). Upon the arrival of white settlers, the native species were threatened (Whyte, 2016). However, conservationist efforts by the Anishinaabe have led to its survival. A symposium is held every year where the deep historical meaning behind Manoomin is celebrated and the wild rice is sold (Whyte, 2016). The economic benefit was a byproduct of the environmental and cultural conservation of Manoomin. Social, environmental, and economic factors create a deep motivation for sustainability among communities.

Localized solutions in the pursuit of sustainability will lead to satisfactory, culturally significant, and successful transformations in resource management. In modern day industrial culture many cities have lost touch with the unique and valuable role resources play in their lives. Wendell Berry, an environmental activist, connects this separation between people and commodities to general dissatisfaction and the abuse of resources, in his essay "The Whole Horse" (Berry, 2002). He claims that globalization has left no accountability for the abuse of resources (Berry, 2002). He argues goods that were once locally cultivated and sold created a greater sense of satisfaction because the history of the items were intertwined with the people and their land

(Berry, 2002). He suggests that the solution to protection of land and its resources is agrarianism (living off the land) (Berry, 2002). The transition from our current industrialist lifestyle to one based around farmers would be challenging. However, Berry makes a good case for the essential connection between land, its people, and the sustainability of its resources. Every city has its own social, economic, and environmental fabric that requires a localized solution when addressing sustainability. Herbert Giradet, an urban sustainability expert based in Amsterdam, explains that we "have to look at cities as living organisms and find ways for them to adapt to their surroundings" (Yunos, 2001). Local sources of energy, materials, food, and water will be different for each existing community depending on their culture and landscape. A globalized solution to sustainable practices would ignore the intricacies of each city and echo Berry's concerns about the devaluation of land and its resources. Integrating localized solutions for the demand of goods would not only create accountability for a city's use of resources but build a satisfying relationship between people and the goods they consume. For true success the implementation of sustainability must be on a city-by-city basis.

Civil engineers and other professionals can shape the landscape and culture of a city through its design. Creating plans that integrate sustainability into the fabric of the city's design will help insure the welfare of the people and the landscape. One example of this is the bicycle inclusive transportation networks throughout the Netherlands. In 2014, "every Dutch citizen travelled an average of 1,000 kilometers (around 621 miles) by bicycles" ("Dutch Travelled Average of 621 Miles by Bike in 2014: Netherlands Bicycles," 2015). With the proper infrastructure bicycling has become an everyday part of Dutch culture. The increase in cycling helps cut greenhouse gases emitted by cars and provide daily exercise for citizens which translates to health benefits (Goddard, 2020). On top of the environmental and social benefits of cycling transportation systems, the economic impact of bicycles surged with 1.5 million bicycles purchased in 2014 ("Dutch Travelled Average of 621 Miles by Bike in 2014: Netherlands Bicycles," 2015). The cycling systems serve as a perfect example of integrating social, environmental, and economic sustainability through design. There are other burgeoning sustainability frameworks looking to make an impact. One of these movements are green walls and green roofs, where vegetation covers the roof or wall(s) of buildings. These designs bring aesthetic value, decrease stormwater runoff, increase oxygen production, create new wildlife habitats, and offer the economic benefits

of decreased heating and cooling bills (Smith & Roebber, 2011). These strategies are benefiting society while cultivating sustainability. Design can initiate movements towards sustainability by creating systems and infrastructure that weave conservation into the fabric of cities.

Civil Engineers have a responsibility to create localized systems and infrastructure that will support the three main ideals of sustainability. Considering centuries of exploitation and the devaluation of available resources, work must be done to create a satisfying and sustainable relationship between humans and nature. To motivate change, societies must look beyond economic ambitions and cultivate a space inclusive of the social and environmental aspects of sustainability. This wider definition of sustainability requires societies to be reframed to value their local resources and respect their limitations. The designs of Civil Engineers can impact the daily lives of the people that interact with them and redefine the fabric of a city. Engineers and other experts can create infrastructure and systems that value the whole picture of sustainability and rebuild the relationship between humans and nature. It is now more important than ever to learn, research, and implement sustainable living in a way that respects each city's social, environmental, and economic needs. While most cities can currently enjoy an endless stream of goods, if the unstainable methods of consumption don't shift, there will come a time where the limitations of nature will be realized by all.

The City of Spokane's Sustainability Action Plan recognizes the value in social, economic, and environmental sustainability. The Goals set forth in their plan seek to maintain and protect Spokane's wildlife and resources all while bettering life for its residents. Infrastructure created by Civil Engineering has the potential to help Spokane weave sustainability into the fabric of the city. The Sustainability action plan set forth seven different areas for sustainability improvement. This paper will be focus on how water resources engineering can help Spokane meet the social, environmental, and economic goals in its plan.

Part II: Water Resources

Water is an essential ingredient in sustaining life, and thus a vital resource for cities. Regardless of a city's geographical location or cultural background, water is a need that is shared around the world. The discipline of water resources manages both natural and manmade systems that

encompass a given area. Natural systems include wetlands, tributaries, lakes, streams, rivers, and ground water (City of Spokane's Sustainability Action Committee, 2021). Manmade Features include water delivery and wastewater/ stormwater discharge. (City of Spokane's Sustainability Action Committee, 2021). The natural and designed systems are integrated into a bigger picture that form an area's overall water quality and availability. With the effects of global warming and pollution growth water management has become a central focus of many communities. Integrated solutions for a region's water supply and discharge improves the health and wellbeing of residents and encourages environmental and economic sustainability.

To understand the scope of water-related issues the next few sections analyze similar challenges Spokane and the Netherlands face in providing clean water for growing populations.

Spatial Adaptation

The people of the Netherlands live in a notoriously wet climate (Klijn et al., 2011). Lately, Dutch people's relationship with water has grown more complex. The Netherlands is currently experiencing high demands for water with a growing population and a decrease in rainfall in a historically wet region (Nwanazia, 2022). In 2018, the Delta Programme introduced the first Plan on Spatial Adaptation (The Delta Programme 2021, 2020). Spatial Adaptation formulates projects to use land in cities and surrounding areas to create resilience in the face of excessive heat, drought, waterlogging (soil saturated with water), and flooding due to climate change (The Delta Programme 2021, 2020). One example of spatial adaptations includes adding more vegetation and making more space for water retention as seen in Figure 1 (The Delta Programme 2021, 2020). The smart use of existing spaces provides citizens a safer more reliable access to the necessity of water. Spatial Adaptation can also grow local biodiversity with increased surface water and greenery while increasing the values of nearby real estate (The Delta Programme 2021, 2020).

Figure 1. Waterspoorpark in Voorburg, Netherlands. Park crafted for water retention (own photos).

With 16.5 inches of annual rainfall, and 48 inches of snowfall on average, Spokane is already considered a climate with low precipitation (Spokane Geography and Climate, 2019). As climate change progresses, drought will likely become a more frequent concern to the city of Spokane, especially during the summer months. In an article by the Spokesman Review Jeff Marti, the region's Department of Ecologies Drought Coordinator explained the rising threat of drought in Eastern Washington by discussing capturing snowpack runoff (Tiernan, 2022). "If it isn't captured, it's not going to be around in the spring or summer," Marti said, "which is when we really need it" (Tiernan, 2022). Enacting Spatial Adaptation to expand water retention measures within Spokane will help meet the needs of the people, the ecosystems, and the businesses of Spokane year-round.

Proper water management is crucial to continue and improve the health and wellbeing of people both in the Netherlands and in Spokane. Often, designs that improve the health and welfare of a community also benefit the environment.

Water Supply

A city's water practices support the environmental health of the surrounding regions. In Spokane, these practices include preventing pollution from watershed. The Spokane Valley-Rathdrum Prairie spans from North Idaho to the City of Spokane (Figure 2). The aquifer is the top provider of drinking water to Spokane residents (City of Spokane's Sustainability Action Committee, 2021). To prevent pollution of the aquifer from stormwater runoff the city of Spokane has created storm water holdings that collect and divert storm water to treatment centers (City of Spokane's Sustainability Action Committee, 2021).

Figure 2. Spokane Valley-Rathdrum Prairie Aquifer. Graphic by Lisa Waananen (Inlander.com).

The Netherlands has faced similar problems with pollution concerning groundwater. In some locations much of their groundwater does not meet drinking safety requirements due to agricultural runoff, old contamination, and urbanization (National Water Plan 2016-2021, 2015). To counteract this the Netherlands is planning a rural development program to collect and treat agricultural runoff, implementing collection plants, all while monitoring the situations closely (*National Water Plan 2016-2021*, 2015).

These measures implemented by the City of Spokane and the Dutch not only serve to increase drinking water but create a healthier ecosystem by diverting and monitoring sources of manmade pollution. These preventative measures are examples of water management protecting water as a resource for future use both for humans and animals. This will contribute to a sustainable supply of water that can create an environment where healthy people and economies can thrive.

Flood Management

Spokane's low precipitation rate discussed earlier does not preclude the city from flooding. The first few weeks of June 2022 have shown Spokane how shifts in typical weather patterns can yield some unexpected consequences. Rainstorms brought light to significant flooding vulnerabilities as water flooded roads around the Spokane area (Gibson, 2022). The Washington Department of Transportation released traffic camera stills of standing water on I-90 near Freya (Figure 3) (Gibson, 2022). The interstate serves as a key mode of transportation for tourist into the city. Beyond the freeway locals found their neighborhood streets inundated with water as they commuted home from work (Gibson, 2022)

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Figure 3. Stills Released by the Department of Transportation. Figure 4. A screenshot of a video shot by Esther Bower of KXLY News from the corner of 5th and Lacey.

While heavy rainfall is responsible for the flooding seen in Spokane, our Dutch counterparts face similar issues with storms but on a grander scale. The Netherlands is built at a low elevation, putting over half of its population at threat of floods from the North Sea (Klijn et al., 2011). These large floods could level towns, take countless lives, and immediately devastate the economy of the Netherlands (National Water Plan 2016-2021, 2015). To prevent these floods the Netherlands has invested in dikes, barriers, and other water systems (Koohafkan, 2010). The lands protected and created by these dikes and barriers not only keep the Dutch safe but provide the economic benefit of fertile land for seed sewing and dairy farming on polders (areas of land drained of water) (Koohafkan, 2010).

Sustainability of the economy starts with taking care of the people and the environment. These measures not only impact the health and wellbeing and environments of the Spokane and the Netherlands, but they can help to sustain and create local economies.

Sustainability Through Collaboration

The Netherlands and Spokane, though thousands of miles away from each other, both face concerns in maintaining healthy and sustainable water management systems. The combination of global warming and increased urbanization has created an uncertain future for many cities when it comes to providing safe and clean water to support their residents, their local environments, and their economic endeavors. In this uncertainty it is important that different regions and cities work collaboratively on finding available solutions to combat rising threats. With a spirit of solidarity, the Netherlands is ready and enthusiastic to share their designs and values with other regions. My next section will discuss Water Squares which is one solution from the Netherlands that touches on drought prevention, protection from pollution, and circumvents urban flooding.

Part III: Water Squares

With centuries of water management under their belts the Dutch are not afraid of new and innovative solutions (Koohafkan, 2010). One of these modern solutions is known as Water Squares, a form of Spatial Adaptation as seen in Figure 5. Water squares are made up of gutters, roof slants, chambers, pipes, and one or multiple catch basins that hold storm water for delayed drainage (Bravo, 2020).

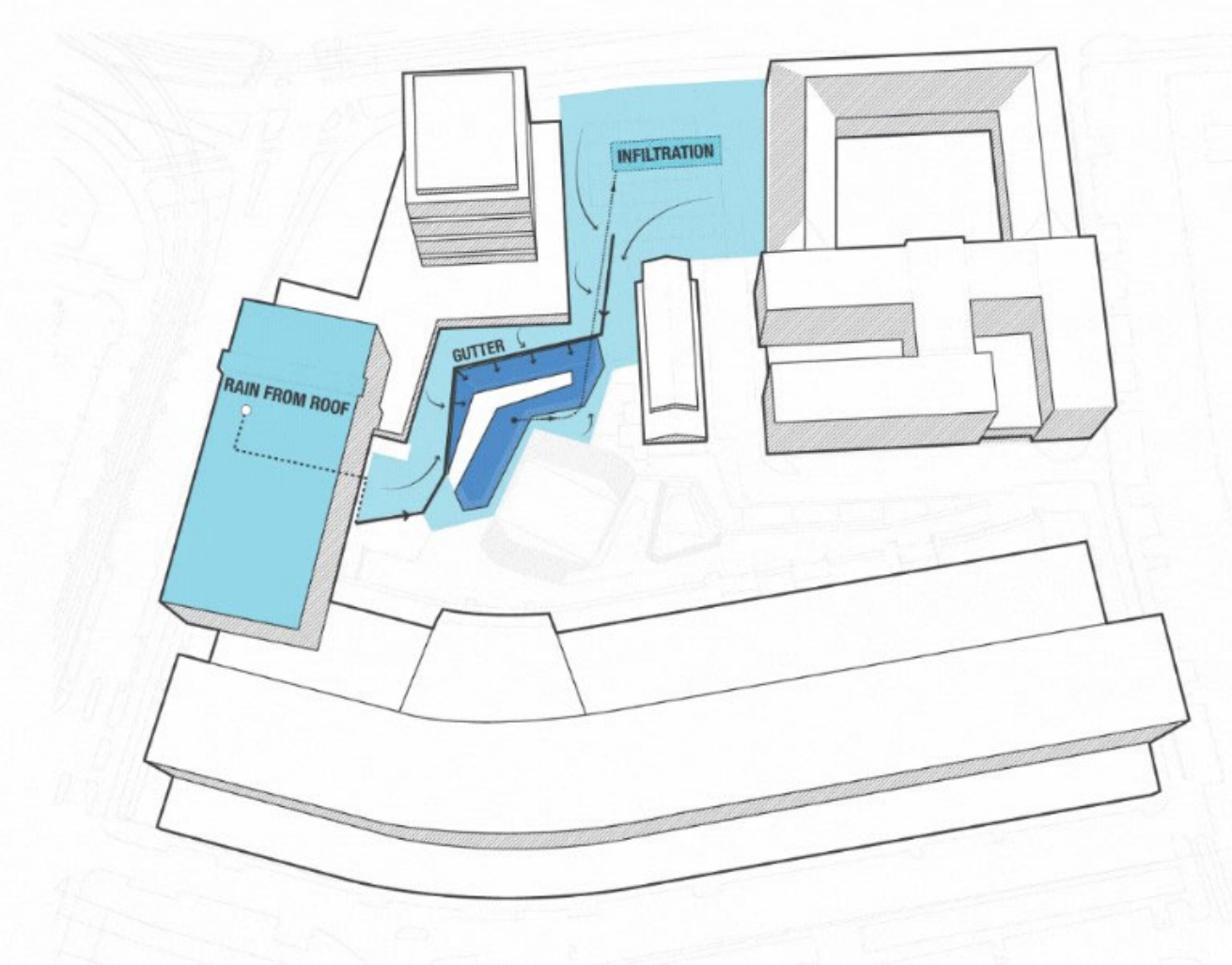

Figure 5. Benthemplein Water Square in Rotterdam, Netherlands. (https://www.urbanisten.nl/work/benthemplein).

Spatial Adaptation

A Water Square, nestled into the confines of an urban environment as seen in Figure 6, is Spatial Adaptation in action. Spatial Adaptation can meet the Goals of the Spokane Sustainability Action Plan by maintaining aquifer and river flow minimums despite increased periods of drought (City of Spokane's Sustainability Action Committee, 2021). The design of the Water Squares siphons water from the urban environment and captures it (Bravo, 2020). Spokane could potentially go a step further than Dutch Water Squares, by finding a way to filter and reuse collected water during dry periods.

Figure 6. Spatial adaptation in Rotterdam. Photo by Jurgen Bals (https://www.urbanisten.nl/work/benthemplein).

Water Supply

One of the Spokane Sustainability Action Plan's goals is to continue to invest in infrastructure that mitigates pollution by intercepting and treating storm water (City of Spokane's Sustainability Action Committee, 2021). The City if Rotterdam faced similar issues in reducing pollution from sewage systems overwhelmed with storm water (Bravo, 2020). With Water Squares, stormwater can be captured and treated before it reaches the river. Since its opening in 2013, the Water Square has not only circumvented this issue but has led to greater economic opportunities for the city of Rotterdam and its people. This includes a boost in tourism from dozens of visits from international delegations each year and new, international contracts with local companies to work on other water projects (First Full-Scale Water Square Opens in Rotterdam, 2014).

Flood Management

The idea for a Water Square was synthesized by the Rotterdam City Council in the Netherlands as a result of constant urban flooding. Extensive underground storage systems were originally used to store stormwater (Bravo, 2020). However, these storage systems designs were soon abandoned for above ground water storage systems because of the environmental benefits of

surface water and their open nature which makes them visible to taxpayers. Spokane's Sustainability Action Plan hopes to manage urban flooding in the city (City of Spokane's Sustainability Action Committee, 2021). Most of Spokane's stormwater management systems are underground (City of Spokane's Sustainability Action Committee, 2021). Water Squares would be a great way to directly involve taxpayers in water management.

Community Engagement

A once dull urban area in Rotterdam now features water basins that double as a court for basketball, volleyball, or football matches, a stage, and a skate park, (Figure 6) (Bravo, 2020). Community members from a surrounding school, theater, church, gym, and other neighbors were involved in designing a space where the community could come together (Figure 8) (Bravo, 2020). During heavy rainfall citizens can see water catchment in action (Figure 7). The Spokane Sustainability Plan recognizes that engaging the community is a key part in the success of potential projects (City of Spokane's Sustainability Action Committee, 2021).. Water Squares would be a great, visible way to cultivate community in an area while promoting sustainability and water management to the public.

Figure 7. Water flowing into a basin during heavy rain in Rotterdam. Photo by Jurgen Bals (https://www.urbanisten.nl/work/benthemplein).

Spokane's City Council could lead the way for Water Squares in the US and be the first in the world to have Water Squares aid in drought prevention. With their years of historic floods, the Dutch are quite flexible when it comes to enacting change that will positively impact the environment (Koohafkan, 2010). On the other hand, the Secretary of 350 Spokane explains in an article that there are already people/organizations "preparing to undermine" the city's confirmation of the Spokane Sustainability Action Plan (Miller, 2021). Like the Symposiums for wild rice near the Great Lakes, workshops could be held each year to educate the public on Water Squares. Education and involvement could turn uncertainty into understanding and acceptance, slowly weaving sustainability into our city's culture through crucial infrastructure.

Figure 8. Centerpiece of the community. Rotterdam. Photo by Jurgen Bals (https://www.urbanisten.nl/work/benthemplein).

Conclusion

The beginning of a sustainable city is implementing infrastructure that not only works but positively contributes to the social, environmental, and economic well-being of an area. With wise and collaborative planning Spokane City Council and local engineers have the time sensitive opportunity to shape Spokane into an efficient and reliable city in the face of a climate crisis. A Water Square would not only serve as drought prevention, pollution treatment, flood control, but could set the city apart and bring communities together. A Square would help connect residents to the value of water and create a satisfying relationship between the residents and conservation/ sustainability. Building a Water Square is a large undertaking to complete without guidance. The Netherlands' rich history in water management and their willingness to collaborate makes them a perfect partner in the pursuit of a Water Square and other water projects. Beyond the information and sources provided in this report, the Schieland and

Krimpenerwaard District Water Boar is partially responsible for the creation of the Water Square in Rotterdam and can be reached with further questions via email at info@hhsk.nl.

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