Next Generation Stormwater Master Planning to Address Evolving Needs

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Highlights

- Dashboards can drastically increase flexibility of stormwater master planning
- Visualizations that can engage the public to absorb the effects of stormwater scenarios are highly valuable

Introduction

Recent history has demonstrated how rapidly and unexpectedly watershed conditions and priorities can change, which can quickly diminish the value of a conventional stormwater master plan. New and increasingly accessible approaches including 2D modeling, dynamic dashboards, and interactive visualizations provide increased utility and longevity of master planning efforts, better addressing stormwater challenges, and communicating those solutions to key stakeholders. This presentation will provide examples of the range of tools and approaches available to municipalities to support next generation stormwater master planning efforts, while discerning the benefits and limitations of these tools.

Background

Hazen worked for Gwinnett County, GA, a 440 square mile, urbanized county near Atlanta. The County's Department of Water Resources provides water and wastewater services to over 240,000 customers, and maintains the stormwater utility. From 2000 to today, the County has assessed the watershed, planned for improvements, began implementing plans, and has recently entered an "adaptive management" phase, in which leveraging the existing geospatial data sources they have collected would allow a county-wide, dynamic characterization of which projects or locations to prioritize.

Boston Water and Sewer became a case study in interactive visualizations for a different reason—it wanted to identify where flooding occurs, how long, and who or what is impacted. This involved understanding flooding in a changing climate—how do storm intensities and sizes and sea level rise impact the severity of flooding in ultra-urban areas, and, equally importantly, how can municipalities best communicate the results to stakeholders, rate payers, and the affected public.

Key Findings

Dashboards and Weighting

In one example, a dashboard allows a user to dynamically adjust the weight of priorities like feasibility, cost, and co-benefits to rank proposed stormwater solutions based on how well they address those objectives. Not only does this approach provide long-term utility as objectives may change based on a variety of factors, including feedback from implementation efforts, but also allows stormwater planners to better understand and communicate alignment with different stakeholder priorities.

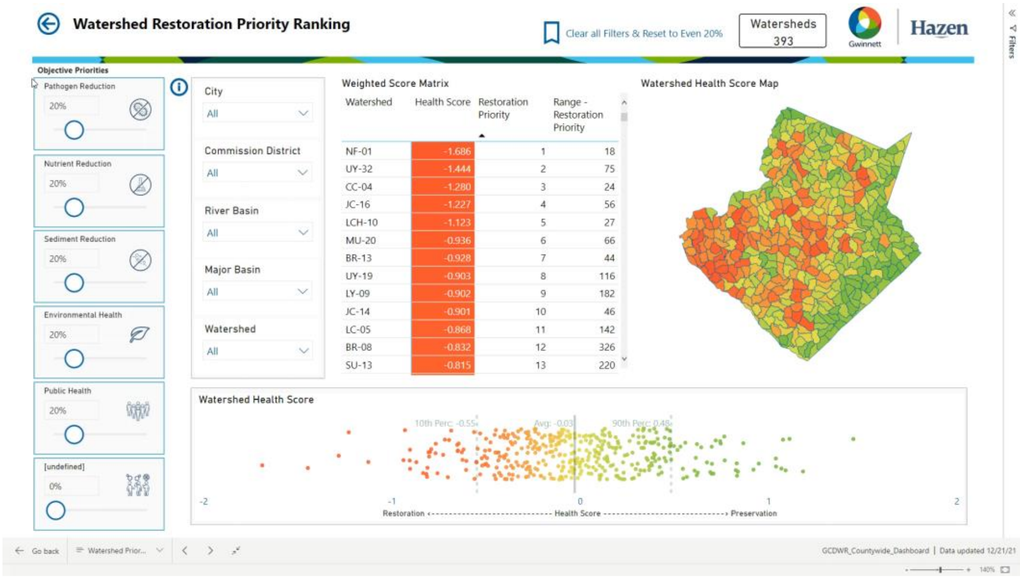

Figure 1. Watershed prioritization dashboard showing 1 mi^2 subwatershed prioritization for restoration. The dashboard includes client-controlled objective priority sliders (left), whose combination results in highlighting different subsets of priority subwatersheds.

2-D Inundation Visualizations

In another example, interactive 360° renderings of projected flooding from 2D model results allows the general public to understand complex modeling results in a meaningful way. Understanding tools that are available, how they might be applied, and key considerations in their development and implementation can equip stormwater managers to effectively build the future of stormwater management efforts.

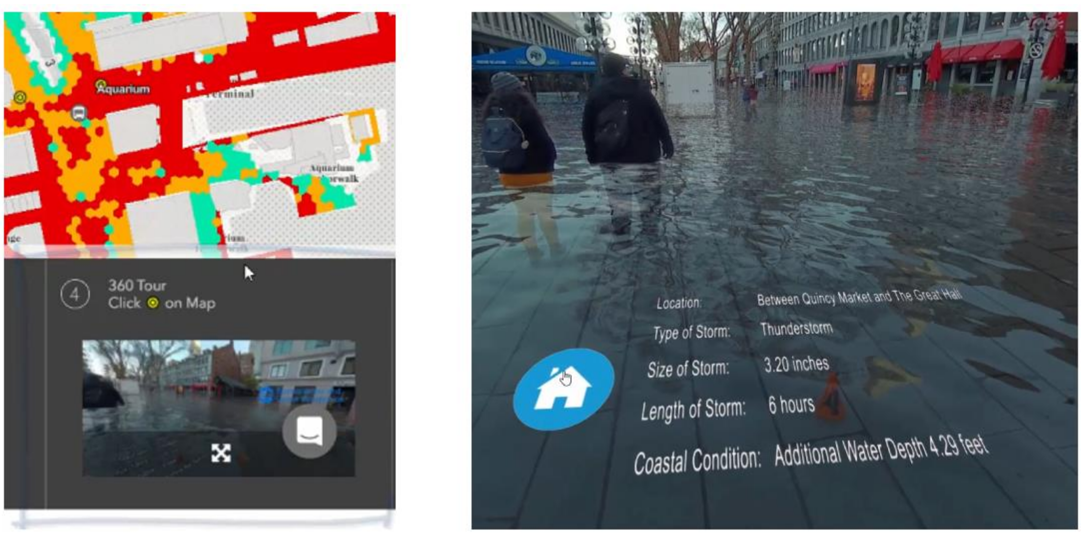

Figure 2. Results of a 2-D SWMM model, packaged in an inundation model viewer, which allows the user to select storm types, storm sizes, and future sea level rise scenarios, and drop into locations to visualize the flooding results.

Conclusion

Understanding tools that are available, how they might be applied, and key considerations in their development and implementation can equip stormwater managers to effectively build the future of stormwater management efforts.

Stormwater Management and Engineering Solutions in Refugee Camps at the US/Mexico border

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Highlights

- Over 7,000 refugees reside in Reynosa, Mexico at any time, living in tent encampments and shelters.
- Inadequate levels of humanitarian aid have been provided to the displaced population due to lack of funds.

Introduction

Reynosa, Mexico (a border town to McAllen, Texas) is currently home to an estimated population of more than 7,000 asylum seekers and refugees living on the streets, in makeshift tarp and tent encampments, and overcrowded shelters. Solidarity Engineering (SE) is a women-founded, women-led, non-profit that aims to reduce human suffering by applying community- driven engineering solutions in places of crisis. Their humanitarian response has been focused within the state of Tamaulipas, Mexico for the past 2 years in both Matamoros and Reynosa, Mexico. The aim of this presentation is to highlight the engineering and stormwater management solutions that SE has implemented in these areas as well as highlight the inadequate level of humanitarian aid provided to displaced populations in Reynosa due to lack of funding and resources.

Methodology or Background

Solidarity Engineering has been instrumental in the design, construction, and oversight of stormwater management practices and water, sanitation, and hygiene (WASH) infrastructure in various tent encampments and shelters in Reynosa, Mexico. The planning phase of these projects requires assessments regarding population, availability of current resources, land status, and more. SE utilizes UNHCR recognized Sphere Standards as denoted by the "Humanitarian Charter and Minimum Standards in Humanitarian Response" (Sphere Association 2018) to plan for the ideal services that are needed to adequately meet the population's needs in a humanitarian response setting. However, due to various constraints (resource and personnel availability, regional politics etc) these needs are rarely met. The project locations this presentation will focus on are the "Rio Camp" tent encampment, and a shelter called Senda de Vida (Path of Life) 2. The Rio Camp has an estimated 400 people living in a 1,400 m^2 area. The tent shelter Senda de Vida 2 is home to around 3,000 people in an 11,000 m^2 area. Both camps house asylum seekers in tents and makeshift housing out of tarps and blankets. Additionally, they are both located within a floodplain, with the Rio Camp directly on the bank of the Rio Grande River.

The importance of stormwater management in camps cannot be overstated as it prevents against illness, disease and sometimes even death. These interventions can help avoid; breeding grounds for mosquitoes, damage to tents and belongings, illnesses from intense periods of cold and wetness, major displacement of communities, and flash flooding. SE has executed both small- and large-scale stormwater management interventions at various camps. Specifically, the use of gravel, drainage ditches, and overhead protection will be discussed. Stormwater management, however, is often times not seen as a priority as other needs take precedence in humanitarian emergency situations such as food, shelter, and bathrooms. When it *is* considered, systems and infrastructure have been difficult to implement due to political and social tensions, limited funds and resources, time constraints, a transient population, and the overall prioritization of other camp management needs.

SE also prioritizes community input and community created solutions. The importance of including community members in discussions regarding camp management, infrastructure and system implementation, and all aspects of the humanitarian response efforts is crucial in creating solutions that address the most important needs and aspects of the community. SE includes asylum seekers in the discussions regarding response efforts, as only the community knows best what it needs. This builds community trust and ensures that SE's solutions address the problems holistically and consider all aspects of asylum seekers lives that practices may affect. Various methods of inclusion include working with local partners, contractors and asylum seeker team leaders and their teams, discussing needs with community members candidly, and gaining community trust and conversation opportunities through community projects.

Implementation

SE and the refugee community implemented various stormwater management practices and WASH solutions at the project locations previously mentioned. The location and ownership of the land, funds and resources available and population transiency largely impact which stormwater management interventions can be carried out.

Gravel

Placing gravel in camps allows for a larger volume of rainwater to collect, move, and compound. The dirt ground beneath is also protected and kept from immediately becoming saturated and muddy. This practice decreases localized pooling during and after storms and thus decreases breeding grounds for insects and disease. It also protects communities from mud and rushing water both of which are safety, and sanitation hazards when living in a tent.

Drainage

Drainage systems permit for larger volumes of water to be collected and diverted out of crucial camp regions such as living areas and hygiene and sanitation facilities. Drainage systems vary from shallow, small canals (<6 in.) that direct rainwater out of immediate areas, to deep, large and more involved canals (<6 ft.) that direct drainage off-site. These canals respond to the need for diversion of rainwater during intense storm periods and protect camps from intense flooding that could lead to displacement of people from camps due to the flooding of their tents. This intense flooding can cause damage to tents, and thus all belongings for families and individuals, and illnesses such as pneumonia due to all they own, including themselves) being wet and cold.

The importance of gravel in preventing long term localized pooling after rainstorms is displayed in this photo as the ground in Senda de Vida 2 where gravel coverage is missing is over saturated with water.

Key Findings

Stormwater management is crucial in reducing flooding in camps and thus reducing risk to disease and infection. It is not always prioritized by other humanitarian aid actors and it is important that humanitarian aid engineers have a seat at the table to ensure that stormwater management solutions are implemented in refugee camps as a preventative measure. Political, social, technical, economic and environmental factors all play a crucial part in the success, and sometimes failures, of engineering solutions in these environments. Additionally, due to a lack of resources and funding, there is an inadequate level of aid provided to displaced refugees in Reynosa, Mexico and thus working within these constraints presents a challenge when creating stormwater management solutions. While additional stormwater management techniques and infrastructure need to be prioritized and built, the current techniques are effective in preventing small scale flooding in these camps and protects asylum seekers and their belongings. Lastly, it is also crucial that the asylum-seeking community themselves be consulted before decisions are made and solutions implemented and when possible lead and upkeep projects themselves.

Recommendations

It is recommended that more research and field project experiences be published and discussed regarding low cost engineering and stormwater management practices in refugee camps. Key points to note include the inadequate level of aid provided to such a vulnerable population, as well as the low resource solutions implemented as a result.

- Engineering solutions can still be implemented even when funding is lacking
- Easy to maintain and limited technical solutions are ideal due to the displaced population being transient

References

Sphere Association. The Sphere Handbook: Humanitarian Charter and Minimum Standards in Humanitarian Response, fourth addition, Geneva, Switzerland 2018, www.spherestandards.org/handbook

Finding Green and Gray Infrastructure Opportunities in Chicago, IL: A Masterplan Study of Social Equity and Building Resilient Community Infrastructure

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Highlights

- Innovative scoring and ranking tool created to prioritize GSI projects for maximum investment
- Stormwater master plan for three underserved communities on Chicago's west side
- Bundled recommendations of green and gray infrastructure opportunities

Introduction

The Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) has been pursuing stormwater master planning efforts with their municipal partners to withstand climate change and help communities become more resilient. This project, the Chicago West Study Area, was completed in conjunction with the City of Chicago (City) and encompassed three community areas: Austin, Humboldt Park, and West Garfield Park. This 7,710-acre combined sewer study area was selected due to frequent basement backups and street flooding, and to assure the equitable investment of essential infrastructure within disenfranchised communities throughout Cook County.

The vision of this master plan was to guide stormwater investments for a variety of stakeholders, including the City of Chicago. This plan consisted of both gray and green stormwater infrastructure (GSI) projects to complement the City's current Capital Improvement Program. The plan focused on hyper-local neighborhood drainage issues and prioritized outcomes that provided co-benefits, such as increased tree canopy and reducing urban heat island effects, to ensure the greatest contribution to the community.

Projects were developed with a two-pronged approach: utilization of the City's Integrated Catchment Model (ICM) to identify and target areas of localized flooding, and performance of a Geographic Information Systems (GIS) desktop study to optimize the placement of proposed GSI systems. GSI projects were ranked and then "bundled" with conveyance recommendations to provide a list of projects for MWRDGC.

Methodology

Stakeholder Outreach

Throughout the project cycle, various meetings were held to engage with local stakeholders, such as City agencies, City Aldermen, and community leaders. A survey was posted to identify local issues, concerns, and priorities. Over 80% of respondents shared that future flooding in their neighborhood/property was an extremely concerning issue.

Conveyance Projects

The Chicago West Study Area conveyance modeling was completed using InfoWorks ICM. The Illinois State Water Survey (ISWS) Bulletin 75, 1-year storm was selected for identification of conveyance projects. The focus of the project was to identify block-level local projects that would still experience flooding after other regional projects were completed. To attain this level of focus, all major trunk sewers in the project area were assumed to have a free discharge condition to eliminate capacity restrictions that would be resolved by other larger-scale projects. The areas with remaining capacity restrictions were then scaled by analyzing the peak surcharge level relative to the ground surface, as these will have a higher likelihood for basement backups. Projects were identified to alleviate street flooding and potential for basement backup and included upsizing existing sewers and redirection of excess flows to other parts of the system. Boundaries were drawn to separate the conveyance projects into 21 areas. These study areas were the basis of the GSI analysis.

Green Infrastructure Projects

A desktop analysis utilized GIS to identify potential green infrastructure projects in the 21 study areas. Shapefiles were obtained for sewer main lines and laterals, catch basins, manholes, right-of-way boundaries, buildings, and parcel boundaries. Contours (1-foot resolution) of the area helped to determine flow paths and longitudinal slope of each street. Constraints were used to determine ideal GSI locations: within an area of localized flooding, as modeled through InfoWorks ICM, inside the right-of-way, and offset from water mains/laterals, building footprints, and parcel boundaries. These constraints were selected to best identify GSI projects that would be adequately sized and spaced for cost optimization and constructability and maintenance limitations.

GSI Project Ranking and Prioritization

GSI projects were prioritized based on a ranking system (values of 0-3) developed with MWRDGC. Table 1 shows the ranking criteria used to identify the top projects for recommendation in the master plan including the loading ratio (ratio of drainage area to system footprint), alignment with sewer improvements, and cost per acre. Initially, over 500 GSI footprints and drainage areas were identified across the 21 study areas. These were refined through the project ranking task to a total of 125 GSI projects. GSI and conveyance projects were then “bundled” to create a prioritized list of recommendations to MWRDGC and the City. The ranking parameters were adjusted to ensure equitable placement of projects throughout the community areas and wards. The flexible nature of the ranking system allowed for efficient modifications of project recommendations as dictated by MWRDGC needs. A summary of the projects is included in Table 2.

MWRDGC will issue a final report to the City with the goal of reviewing and coordinating on project recommendations. Within the next two years, MWRDGC and City agencies will finalize planning of the prioritized projects and secure potential funding opportunities. Design and construction will take place over the next three to four years.

Table 1. Scoring criteria and weights for project ranking.

Description	Scoring Weight	Priority Value = 0		Priority Value = 1			Priority Value = 2			Priority Value = 3	
		Not Recommended		Lowest Priority			Medium Priority			Highest Priority	
Drainage Area (SF)	20%	Less than	6,500	6,500	to	15,000	15,000	to	20,000	Greater than	20,000
Loading Ratio (Tree Trench)	5%	Greater than	35	20	to	35	15	to	20	Less than	15
Loading Ratio (Rain Garden, Planter Box, Bumpout)		Greater than	50	35	to	50	25	to	35	Less than	25
Sidewalk and/or Parking Lane Width (feet)	5%	Less than	5	5	to	8	9	to	12	Greater than	12
Volume Treated (Gallons)	25%	Less than	5,000	5,000	to	7,500	7,500	to	12,000	Greater than	12,000
Alignment with Sewer Improvements	35%	N/A		No			N/A			Yes	
Cost Per Drainage Area (Dollars/Acre)	10%	Greater than	300,000	250,000	to	300,000	200,000	to	250,000	Less than	200,000

Table 2. Summary of GSI and conveyance projects per neighborhood.

Neighborhood	Bundled Projects (#)	GSI Components (#)	Conveyance Component (ft)
Austin	10	51	27,310
Humboldt Park	9	65	31,580
West Garfield Park	2	9	4,080
-	21	**125**	**62,970**

Key Findings and Recommendations

- This is an urban area with full buildout, and at times it was difficult to find room for a new sewer main.
- ICM was cut from a region-wide model; team created a fit-for-purpose model to best serve project needs.
- Flat longitudinal slopes and closely located catch basins created a challenge when identifying GSI locations.
- GIS and Excel were used in tandem to efficiently identify, score, and recommend GSI projects.