Critical Flood Risk Assessment, Priority Classification and Vulnerability Assessment Guidelines for PR Wastewater Treatment Plants

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Abstract

Floods occurs in almost every part of the world because of extreme rainfall events. Around 7,000 people lose their lives and nearly 100 million people worldwide are adversely affected by floods each year. Flooding also cost billions of dollars each year in damages and repairments. Puerto Rico is not exempt to this problem. In this project, a risk assessment priority matrix was created to classify each wastewater treatment plants in Puerto Rico. The classification and prioritization of the plants will allow the owner to identify those with highest risks and perform specific vulnerability assessment. General guidelines for the specific vulnerability assessment were provided.

Introduction

Flooding is a problem that affects many areas in Puerto Rico. These critical events have caused serious damages to private and public property, as well as agriculture and infrastructure, in addition to causing loss of life. This project presents a risk assessment using a matrix with the purpose of establishing a critical floods priority value and risk classification to each WWTP. The elements used in the risk matrix were the Federal Emergency Management Agency (FEMA) flood zones, the discharge facility classification, and the categorization of the receiving waterbody according to the designated uses to be protected.

Background

A risk is a random event that may possibly occur and, if it did occur, would have a negative impact. The risk analyzed in this project is the flood. A flood occurs when water inundates land that's normally dry, which can happen in a multitude of ways. Climate change is increasing the risk of floods worldwide, particularly in coastal and low-lying areas, because of its role in extreme weather events and rising seas.

FEMA Flood Zones in San Germán WWTP

Problem

WWTP's are one of many critical facilities in Puerto Rico. Many of these facilities are located near water bodies, either rivers or coasts, since must discharge their effluents to these bodies. The location of WWTPs creates a challenge to PRASA since makes them susceptible to flooding and storm surge events. This issue become more relevant due to climate change.

Flooding of San Sebastián WWTP during Hurricane María

Methodology

A risk assessment priority matrix (RAPM) was created with WWTP's relevant information. The RAPM consists of an arrangement of rows and columns, which allow the weighting of selected key elements. The key elements used in the matrix columns were the FEMA flood zones with their percentage coverage and the impact of the floodway on the property. The elements used in the rows of the matrix were the classification of the facility (major or minor) in combination with the categorization of the receiving waterbody (SA, SB, SC, or SD). This matrix was organized in such a way that the upper left corner is the area with the highest risk, while the bottom right corner is the area with the lowest risk. In other words, the lower the priority value is the higher the risk; in the other hand, the higher priority value, is the lower risk.

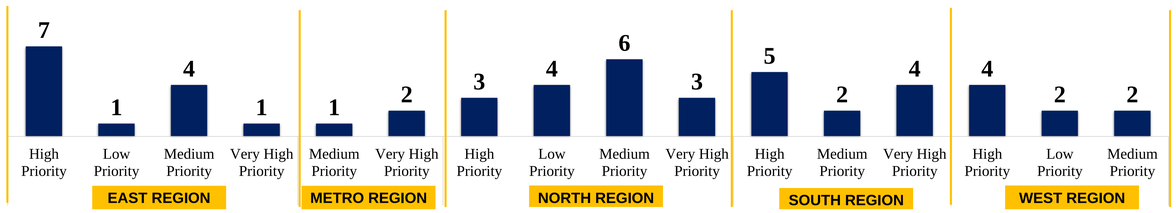
RISK ASSESSMENTY PRIORITY MATRIX

RISK FACTOR			1	2	3	4	8	12	13	16	20	40	60	70	100	200	210	215
Category		FEMA Flood Zone	A - AE (50% - 100%)		A - AE (>0% - 50%)		VE (50% - 100%)		VE (>0% - 50%)		X 0.2 ACF (50%-		X 0.2 ACF (>0%-50%)		X (50% - 100%)		X (>0% - 50%)	
		Floodway	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
SEVERITY FACTOR Facility Classification / Water Classification	1	Major / SA	1	2	3	4	8	12	13	16	20	40	60	70	100	200	210	215
	1	Major / SB	1	2	3	4	8	12	13	16	20	40	60	70	100	200	210	215
	2	Major / SC	2	4	6	8	16	24	26	32	40	80	120	140	200	400	420	430
	3	Major / SD	3	6	9	12	24	36	39	48	60	120	180	210	300	600	630	645
	4	Minor / SA	4	8	12	16	32	48	52	64	80	160	240	280	400	800	840	860
	5	Minor / SB	5	10	15	20	40	60	65	80	100	200	300	350	500	1000	1050	1075
	6	Minor / SC	6	12	18	24	48	72	78	96	120	240	360	420	600	1200	1260	1290
	6	Minor / SD	6	12	18	24	48	72	78	96	120	240	360	420	600	1200	1260	1290

Legend: Very High · High · Medium · Low · Very Low

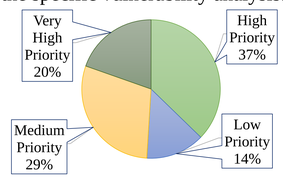
Results and Discussion

The objective of this project was to perform a risk analysis using a matrix to establish priority values and risk classification for each WWTP in Puerto Rico. 29 of the 51 active WWTP, or 57%, are at high risk of flood damage. The priority values ranged from 2 and 112. Priority values equal to 1 or greater than 112 were not obtained. This is because there was no combination of flood zones, facility classification, and receiving water-body classification that produced these values. The results of this project validated the assumption of the vulnerability to critical floods due to their proximity to water bodies.



Conclusions

This project applied a risk analysis technique using a matrix to create a priority value and a risk classification for each WWTP in Puerto Rico. The most susceptible WWTP's were identified and general guidelines for specific vulnerability assessments were recommended. The results indicated that 57% of the wastewater treatment plants are classified as high risk of critical floods damages. The calculated priority values allow to establish the order to perform the specific vulnerability analysis.



Recommendations & Future Work

To better understand the implications of these results, it is recommended to start the specific vulnerability analysis of the WWTP's with very high-risk classification. This project was performed using wastewater facilities, but this analysis can be modified and applied to other types of infrastructure such as drinking water supply facilities or pump stations within PRASA. Likewise, it can be applied to critical infrastructure in the island such as hospitals, schools, police, and firefighters' stations, among others. Further research is needed to include other factors such as coastal erosion and sea level rise for those plants located on the coasts.

Approach to Specific Vulnerability Assessment

Step 1 Plant Description and Flood Description → **Step 2** Identification of Vulnerable Assets and Determine Consequences → **Step 3** Identify and Evaluate Resilient Countermeasures → **Step 4** Implementation of Resilient Countermeasures

Acknowledgements

First, I want to dedicate this success to my wife and children. Without his understanding and patience, it would not have been possible. I would like to express my special thanks and gratitude to my advisor Dr. Christian Villalta for his closely support along my journey in my graduate studies. My thanks to Dr. Auristela Mueses for her teachings. Finally, thanks to my classmates Kettsy García and Orlando Colón for his joining me in the race and the teamwork.

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