Introduction

On January 2, 2017, Dexter Filkins published a piece in The New Yorker detailing the deteriorating conditions of the Mosul Dam and the destruction that would occur should the dam fail. According to his research, the dam’s structure is precarious at best, as it was built in 1985 on a bed of soluble rock. Over the years, maintaining the dam’s stability has required the continuous injection of a cement mixture (“grout”) into the bedrock to replace any dissolving areas. Experts posit that without regular grout injections, dissolved pockets of the foundation will grow and lead to the collapse of the bedrock and eventual failure of the dam.

One of the greatest threats to the dam’s maintenance and structural integrity has been continuous conflict in the region. Most recently, concerns stem from the region’s instability and the near-constant threat of ISIS. The organization has already caused challenges in the dam’s operation; ISIS took Mosul Dam in August 2014 and even though it was recaptured by American and Iraqi forces within two weeks, upon inspection of the dam it became clear that it had not been properly maintained for some time (though estimates vary among different organizations). Despite the lack of clarity surrounding the dam’s structural health, experts agree that should the dam collapse, the damage would be devastating: in his article, Filkins cites estimates of 1.5 million people dead and 4 million displaced as a result of the wave.

This project is a vulnerability and risk assessment that determines which areas within Iraq are most at-risk and vulnerable to destruction if the Mosul Dam collapses and how many people are estimated to reside in those areas. It seeks to answer three primary questions: (1) Which areas in Iraq are most at-risk and vulnerable should the dam collapse? (2) How many people are at-risk and vulnerable if the Mosul Dam collapses? (3) Under whose control are these most vulnerable areas? The results of this analysis have practical applications for humanitarian actors who, in the event of the dam collapse, would be working to provide aid to those most affected.

Methodology

As this study was meant to determine which areas were most at-risk and vulnerable to destruction if the Mosul Dam were to collapse, the analysis was started by sorting the risk and vulnerability factors into three categories: (1) environmental; (2) socioeconomic; and (3) security.

Environmental risk was determined as the flood inundation zone. It was calculated using the least-cost path method, which accounts for how far the lake’s water would logically move upon release. It also used a 500km radius in order to include Baghdad, as other scholarly models show that if the dam break occurs when the lake is at full capacity (11 km2), the resulting wave is likely to reach beyond Baghdad. After the inundation zone was calculated, it was reclassified into four zones—severe, major, moderate, and minor—to remain consistent with other scholarly flood model classifications.

Socioeconomic vulnerability was based on the distribution of Iraq’s poor by district. The motivation to pursue this factor was based on the assumption that those with fewer resources to receive timely information about the disaster, seek shelter away from the flood path, or otherwise, would be more vulnerable to flood damage. This measure was calculated using World Bank Group poverty headcount data from 2012/2013.

Security risk was based on recent ISIS control and support zones from the Institute for the Study of War (ISW). According to ISW, “Control zones...are areas in which ISW has assessed ISIS to have a larger degree of defensible control...in which a counter-ISIS force would be faced with serious ISIS resistance.” Support zones, on the other hand, “are areas in which ISIS enjoys freedom of movement and from which...attacks are often staged...[and] in which ISW forces can travel and operate with relatively low risk.” Given this information, it is assumed that those living in ISIS control and support zones have fewer resources available that would be helpful in the wake of the dam breaching and are movement-constrained. This combination would make the populations in ISIS control and support zones at greater risk in the wake of a dam breach than those in areas controlled by other groups (i.e. the Iraqi Government or Kurdistan Forces).

After analyzing the risk and vulnerability categories, the population was calculated for each inundation zone. This was done by running zonal statistics on the extracted population data by zone and the ISIS control and support zone map.

Results

Upon constructing the inundation zones and calculating the population of each, it was found that approximately 1.8 million people reside in the severe flood inundation zone. Of those, nearly 400,000 are in ISIS support zones and nearly 1.3 million are in ISIS control zones. In addition, the highest poverty count districts are those that overlap with the severe inundation zone. This confluence of factors indicates that should the dam collapse, the severe inundation zone is both at greatest risk and has the highest vulnerability. Among the other three zones, socioeconomic vulnerability remains relatively constant with little variation among the district-level poverty rates. However, there are interesting trends among the risk factors. Working from major to minor, the total population of each zone rises, as does the number of people in ISIS support zones. However, the population in ISIS control zones decreases as you move from the major inundation zone to the minor. When considering these factors, we can posit that the inundation zones offer a priority ranking of sorts for humanitarian assistance—the most dire needs will be in the severe inundation zone, followed by the major, moderate, and minor inundation zones.

Risk and Vulnerability Analysis

Despite these results, though, it is important to consider the unique challenges those in the minor inundation zone face, particularly in Baghdad. If this model holds and the wave reaches Baghdad—the capital city with a population of more than 6 million—it would not only threaten the most vulnerable of the city’s population, but shut down government operations and close the Baghdad International Airport. This would make it nearly impossible for humanitarian actors to access the area and provide much-needed assistance for those in all inundation zones left devastated by the wave.

Limitations

The greatest limitation to this study was in finding accurate, timely data. Iraq is in a state of constant conflict where some data is updated regularly (i.e. ISIS control data), other data are out-of-date (i.e. population and socioeconomic data). As an example, the available population data do not account for the necessary day-to-day movement of people that the country has experienced as a result of the continued conflict. More specific socioeconomic data would have been helpful to disaggregate which populations within the inundation zone were, in fact, most vulnerable.

Additionally, the model allowed for constructing the inundation zone. First, while the inundation zone shows severity of the flooding, it does not indicate how quickly the water reaches each area and produce a lower estimate of people at-risk or vulnerable to the dam breach effects.

Conclusion

As previously noted, this study was influenced by Dexter Filkins’ article, “A Bigger Problem than ISIS?”, that detailed the Mosul Dam as “the most dangerous dam in the world.” Mosul Dam is in an area of imminent failure and the results would be devastating. Filkins estimates that a dam breach could result in as many as 1.5 million dead and 4 million displaced. After modeling the risk and vulnerability factors, we conclude that Filkins estimates are very much feasible, if even conservative when compared against a model of the worst-case scenario.

While this study offers insight into the populations at-risk and vulnerable if the Mosul Dam collapses, there are other important areas for study. For example, in the event of a Mosul Dam collapse, it would have great implications for the country’s infrastructure, development, and already destroyed much of its infrastructure. A Mosul Dam collapse would wash away any progress that has been made and set the country back even further in its development goals. Additionally, in considering the country’s tenuous relationship with the West, including the United States, and the sustained internal conflict with ISIS, Filkins and others argue that a dam collapse would only serve to exacerbate current tensions. American officials have detailed the dam’s precarious state but many Iraqi officials will not publicly admit to the problem. A dam collapse would likely lead to a blame war and a breakdown in the country’s already weak-structured, Iraqi-American relationship. Within the country, the dam collapse could lend more legitimacy to anti-government sentiments and draw out the current conflict even longer.

Given these challenges, this study offers a starting point for the consideration of the ramifications of a Mosul Dam breach. It is clear that a breach would be immediately devastating in lives lost and people displaced, but the aftermath would extend for years to come.

Information and References

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