Civil Engineering

Title: Real time Levee Monitoring using LiDAR : Detecting Seepage and Boils

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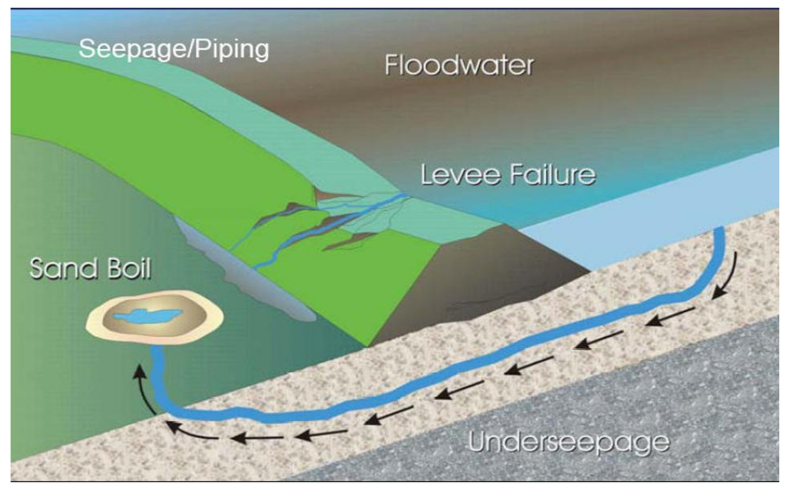
Abstract

One of the main mechanisms of failures of levees is the phenomenon called piping. Piping can be found on the leeward side of the levee by what is called a boil. A boil is the result of head pressure forcing its way through sand. Early detection of a boil will result in piping not causing levee failure. Failure to locate a boil that is indicating a threat to the levee system will result in levee failure causing many millions of dollars in damages as well as loss of lives.

Introduction

This project was engendered by the April 2006 high water event around the city of Fireball and the Chowchilla bypass. Outdated maps led to incorrect information which might lead to correct incorrect decisions. The use of LiDAR to not only detect boils but also see the contours of the terrain will help Emergency Responders. Boils are the result of piping and seeping probably caused by sand crab or other creatures. Levee failure can be detected in its earliest stage by a sand boils. Using LiDAR it is possible to realize a boil in a timely manner. This method will prevent failures of the levee system as seen by the Jonestrack breech.



Objective

The purpose of this project is to show that LiDAR will assist the Division of Emergency Flood Management in the early detection of boils. Early detection of boils is essential to maintaining the structural integrity of the levee system. Using LiDAR will not only present to Emergency Responders digital elevation contours of boils but assist in the reduction of required Emergency Responder Technicians to survey the levees.

Methodology

- Building 4 x 4 box able to sustain a steady state of water pressure.
- Obtain dirt to fill the box from the Chowchilla bypass.
- Use traditional plumbing to supply a steady state of water pressure.
- To imitate piping using sand and cause a boil to develop in a controlled environment.
- Use LiDAR to detect and the results from the LiDAR to develop algorithms for comparison of future boils.

Result

The results we obtained showed many variances in the life of a boil. The first boil was obtained at the velocity calculated at 21 ft./s. The resulting sand boil was one of the sand spreading which would signify little if any hazard to the levee. Subsequent boils resulted in sand and levee dirt combining to a foam, bubbling the water and developing a noticeable sand boil. The calculated velocity for these trials was 3 ft./s. The final boil from which we took the LiDAR scans showed a sand ring of 1 inch at the highest peaks which would allow contours to calculate subsequent algorithms.

Result

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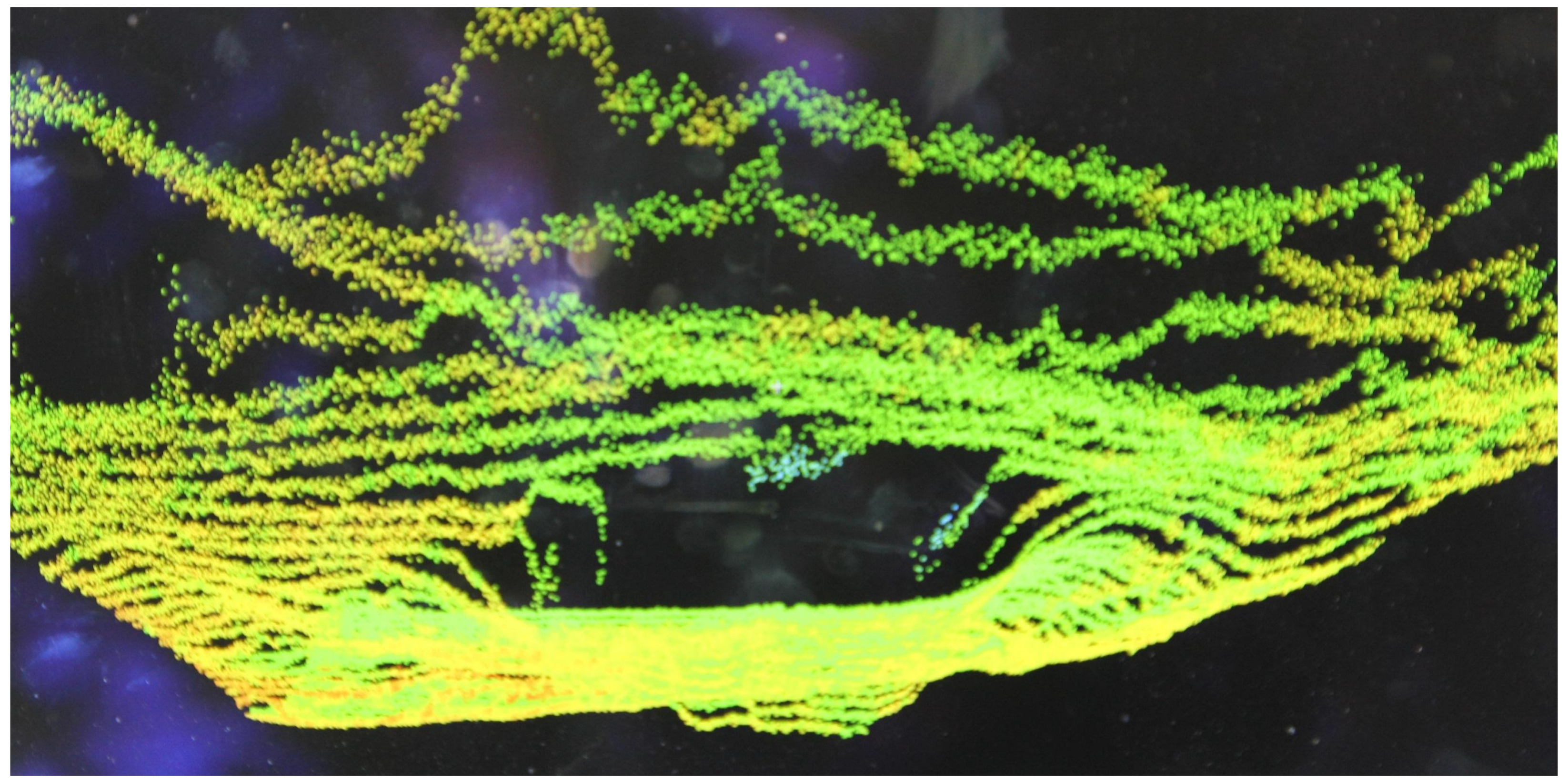

Conclusion and Discussion

1. This project showed many aspects of the life of a boil. The velocity of the water showed the relationship between a boil showing hazardous piping to the levee as well as one that is not. Using the soil from the Chowchilla bypass showed rings at a consistent size. It would be assumed that soil from different locations would demonstrate other ring sizes. It could be concluded that different numbers of rings would be found by different piping chambers connecting underground to the central piping chamber that is causing the boil.
2. Using the Lyica 3000 it was possible to see the contours of the boil. By using updated software and equipment it will be possible to develop algorithms of these boils to assist Emergency Engineers as well as detect boils in their infancy stage.

Sponsors, Acknowledgements and References

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