RECLAMATION
Managing Water in the West

U.S. Department of the Interior
Bureau of Reclamation

Research Update

Fall 2016
Bulletin 2016-23

Using Airborne Red, Near-IR, and Thermal-IR Imagery to Detect Leaks

Airborne remote sensing using the red, near-infrared, and thermal-infrared bands can narrow down the geophysical survey areas along canals to save time and money

Bottom Line

Anomalously green and wet areas, which may indicate leaks, can be detected using relatively simple image processing techniques on the red, near-infrared, and thermal-infrared bands.

Better, Faster, Cheaper

Save time and money by narrowing down areas along a canal embankment that may be leaking and avoid conducting more intensive surveys on areas that are not leaking.

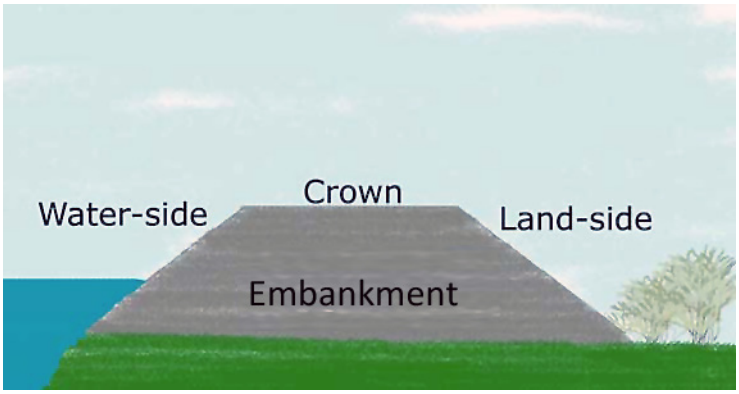
Principal Investigator

Audrey Rager, Ph.D.
Geologist
Concrete, Geotechnical, and Structural Laboratory
Technical Service Center
303-445-2377
arager@usbr.gov

Research Office Contact

John Whitler
Science and Technology Program Manager
303-445-2241
jwhitler@usbr.gov

Problem



Raised embankments help prevent rivers or canals from overflowing. Embankments are some of the most critical infrastructure and key resource sectors (e.g., assets, systems, and networks so vital to the United States that their incapacitation or destruction would have a debilitating effect on security, national economic security, public health, or safety). Over 100,000 miles of embankments are on the national inventory list, and many of these structures are nearing or have exceeded their design life.

As canals age, they tend to develop problems, which can lead to seepage and leaks. While these leaks can be confirmed with in-person inspections, soil resistivity surveys, and other on-the-ground methods, these surveys are expensive, time-consuming, and require intensive data analysis. Remote sensing may provide a relatively easy, economical way to narrow down which areas along a canal embankment may be leaking. This could save time and money by focusing intensive surveys on areas that show signs of leaking—rather than requiring these surveys over a wide area.

To detect canal leaks, remote sensing imagery must have a high spatial resolution (no more than a few meters) and particular wavelengths of light. However, global satellite systems have low spatial resolutions (larger than 30 meters) and can only be used for regional-scale studies. Regional remote sensing systems, on the other hand, can provide high resolution within a few meters. However, they may not cover the geographical areas or the wavelengths that Reclamation needs to analyze levees and canals for possible leaks. No cost-effective high spatial resolution remote sensing data suitable for searching for levee and canal problems are currently available.

Solution

This Reclamation Science and Technology Program research project performed a literature review to determine effective ways to use remote sensing technology to create the data needed for analyzing canals to detect leaks.

— continued

— *continued*

Previous studies, such as those conducted by the U.S. Department of Agriculture's Agricultural Research Service and Texas universities (e.g., Huang et al., 2005 and 2010) have used aerial surveys of irrigation canals in the Lower Rio Grande Valley, Texas. They investigated three different types of multispectral imaging systems for airborne remote sensing to support management in agricultural application and production. They concluded that airborne multispectral imaging might help evaluate canal conditions and leak detection in irrigation distribution networks.

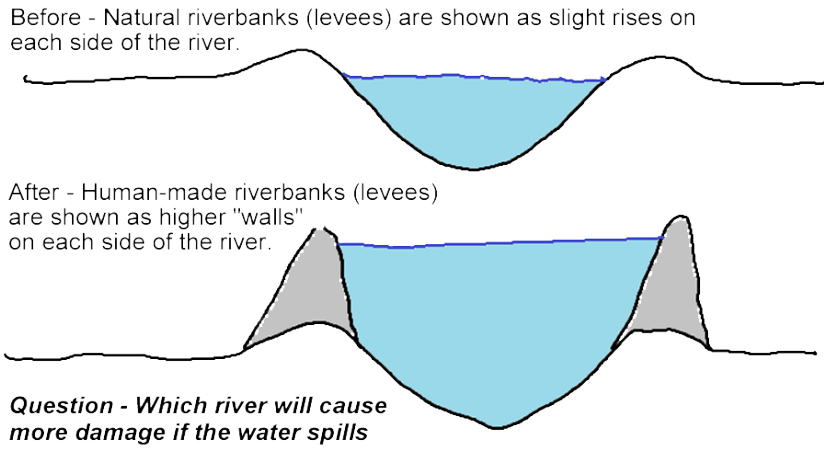
They also found that systems might have tradeoffs; for example, low cost systems can sacrifice performance, while higher cost systems may be heavier and not suitable for some airborne systems. Based on this literature search, this research project recommends a general approach to using aerial remote sensing to effectively evaluate Reclamation's canals and levees:

- Prioritize canals for analysis, by using Reclamation's existing geographic information system (GIS) maps, risk analysis, and other data
- Develop any supplemental data needed for this prioritization
- Use airborne systems to acquire aerial remote sensing data
- Analyze the remote sensing data to determine suspicious leak points and potential seepage areas, using methods outlined in the literature
- Use these results to pinpoint areas for effective on-the-ground surveys followup

Future Plans

Reclamation's canal inspection program used a process similar to this under the American Reform and Recovery Act to find areas along canal embankments and levees that may be leaking. Further research is needed to find technologies that will help effectively identify water movement and internal erosion in embankments before these leaks can be identified visually or via remote sensing data.

By doing this Reclamation can narrow down areas where on-the-ground surveys could be best used to detect leaks, thus saving time and money.



Question - Which river will cause more damage if the water spills over its sides?

"In arid and semiarid areas, leaking areas along canals and levees are more wet and cool and have healthier, green vegetation than surrounding areas. If we can narrow down the areas of potential leaks by using remote sensing, we can reduce the time, effort, and money spent using on-the-ground methods along the entire canal to detect leaks."

Audrey Rager
Geologist
Reclamation's Technical Service Center

More Information

www.usbr.gov/research/projects/detail.cfm?id=5326

Huang, Y., S.J. Thomson, Y. Lan, and S.J. Maas. 2010. "Multispectral imaging systems for airborne remote sensing to support agricultural production management." ***International Journal of Agricultural and Biological Engineering*****, 2010; 3(1): 50-62.**

Huang, Y., G. Fipps, J.S. Maas, and S.R. Fletcher. 2010. "Airborne remote sensing for detection of irrigation canal leakage." ***Irrigation and Drainage*****, 59524553, 20th Biennial Workshop on Aerial Photography, Videography, and High Resolution Digital Imagery for Resource Assessment, October 4-6, 2005, Weslaco, Texas.**

For printable version see: www.usbr.gov/research/docs/updates/2016-23-ir-imagery.pdf