Using GIS to Calculate Change in Surface Area of Lake Mead from March 2000 to April 2015

Nathan Corder
June 23, 2016
When John Wesley Powell explored the Colorado River in 1869, the Colorado River ran from the Rocky Mountains in Colorado to the Gulf of California where it emptied into the Pacific.
The 1921 Colorado River Compact allocated the water rights of the Colorado River to Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada, and California. Mexico by treaty also has water rights. Some Native American Indian tribes also have senior Colorado River rights (Reisner 1993).
Lake Mead is part of the Colorado River System. It was created by the building of Hoover Dam, completed in 1935.

Lake Mead is a major source of water for the cities of Las Vegas, Los Angeles, and cities in Arizona. The lake also supports agriculture in Arizona, Southern California, and Nevada (Reisner 1993).
First Look Methods

Used Google Earth for a first look:

The boat ramp is 797 meters long.

Determined the shoreline has receded 400 meters at the boat ramp between 2002 and 2015.
Lake Mead Marina, November 18, 2002, push pins mark the shoreline. Image from Google Earth.
Lake Mead Marina, March 19, 2015, push pins mark the shoreline location in 2002. Image from Google Earth.
Landsat 8 USGS
Maps

Using Arc Map 10.3 software:

Created maps Lake Mead from the 2000 and 2015 Landsat 7 and Landsat 8 images.

Overlaid the 2000 map over the 2015 map and set the transparency of the 2000 map to 40 %
Dark Gray Shadow is the 2000 Lake Shoreline
Lake Mead 2000 image overlaid on 2015 image, near the marina. (USGS Earth)
Digitizing and Calculations

Using Arc Map 10.3 software:

Digitized the lake surface of the 2000 and 2015 images and overlaid both images on the 2015 image used as a base layer.

Software calculated the lake surface area for both images.
Lake Mead Digitized Polygons

Lake Mead 2015 Base Image

Legend
- 2015 Digitized Lake Polygon
- 2000 Digitized Lake Polygon

Created by Nathan Corder April 23, 2015
Image Credits USGS Earth Explorer
Lake Surface Area

Digitized 2000 polygon is ~550 Km$^2$ (~212 mi$^2$)

Digitized 2015 polygon is ~309 Km$^2$ (~119 mi$^2$)

Lake area has diminished ~241Km$^2$ (~93 mi$^2$) in 15 years (~44%).
Bureau of Reclamation Statistics

Lake levels: Max elevation is 1229 ft.
March 16, 2000: ~1213 ft above sea level surface area of 153,700 acres = 622 Km\(^2\) (240 mi\(^2\)).

April 25, 2015: ~1080 ft above sea level surface area of 82,900 acres = 335Km\(^2\) (129 mi\(^2\)).

Lake area has diminished ~286Km\(^2\) (~93 mi\(^2\)) in 15 years (~46%).

Tighi, S and R. Callejo (2009)
US Bureau of Reclamation
GIS Calculations
Lake area has diminished ~241Km² (~93 mi²) in 15 years (~44%).

Bureau of Reclamation
Lake area has diminished ~286Km² (~93 mi²) in 15 years (~46%).
DAILY RIVER REPORT FOR 6-11-2016

PAGE 1

(Releases are averages over the hour.)
(Elevation and storage values are end-of-period readings.)

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Conclusion

The software calculated lake area within 2% of Bureau of Reclamation statistics.

The results of this project shows that GIS software and remote sensing technology can easily and inexpensively be used to monitor levels of remote water bodies where infrastructure and monitoring equipment are not readily available.
References

ArcGIS Online:

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Colorado River Basins: luv2map, USGS, NHD, and USDA.
Colorado River Basin Canals: luv2map, Central Arizona Project, Bureau of Reclamation, and BING Aerials.
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United States Bureau of Reclamation, Lake Mead elevation levels http://www.usbr.gov/lc/region/g4000/hourly/mead-elv.html

Lake Mead 2003 Image Parallelepiped Classification