

Summary

A western section of the Sardoba dam in Uzbekistan broke on May 1, 2020 causing widespread flooding in roughly an area covering 1033 km². The flood waters spread north-east to neighboring country, Kazakhstan. Eighty-eight percent of the flood waters are in Uzbekistan and Kazakhstan sustaining the remaining twelve percent damage. The flood path area totalled 282.6 square kilometers and the ponded area roughly equivalent at 211.6 square kilometers. In addition to the environmental impact, eight Uzbek villages and one village bordering Kazakhstan with approximately 549 inhabitants were directly in the path of the flood. Twenty-eight primary and secondary road segments were in the inundated flood water area and likely impassible -- highlighted in red on Map 2. Fortunately, there are remaining available roads from for rescue efforts from Guliston to impacted villages.

Introduction

The Sardoba dam located in the Sirdaryo region of Uzbekistan completed construction in 2017 after seven years and designed to hold 922 cubic meters of water. Only three years after construction on May 1, 2020, a portion of a western wall of the Sardoba dam broke after heavy rains. The breach flooded the surrounding area creating an environmental and humanitarian crisis. In response to the crisis, the government of Uzbekistan lacking any prior geographical information requires creation of two new maps and a geodatabase.

Methodology

Government of Uzbekistan does not currently have geographical data infrastructure for the region of the Sardoba Reservoir. New data will have to be mined from two online sources:

- DIVA GIS
 - <http://www.diva-gis.org/gData>
- Two Earth Explorer Landsat 8 Aerial Imagery
 - The first georeferenced image is from April 22, 2020 before the dam broke
 - The second image is from May 8, 2020 and is not georeferenced

Definitions

Please note that the satellite image from May 8, 2020 had cloud coverage so some errors may have been introduced in the digitizing of the following flood areas.

1. *Inundated flood area*: land area covered with water after the dam failed encompassing the Sardoba reservoir, path flood waters, and ponded area. Represented on Maps 1 and 2 as a nearly transparent off-white polygon.
2. *Flood path*: path likely taken by the water after the breach using existing water lines and roadways as a guide in addition the Landsat 8 image from May 8, 2020. Shown on Maps 1 and 2 as dark blue finger like shaped polygon.
3. *Pooled area*: ponded water area / body of water where the flood waters settled. Displayed as two separate figures in periwinkle – one in the north on the administrative border of Uzbekistan and Kazakhstan and one directly south of the Sardoba dam.

The methods employed for creating the two maps:

1. Build an Uzbekistan geodatabase
2. Use Projection System WGS 1984 UTM Zone 41N for database and all features hereafter
3. Create a data layer from a longitude and latitude data from using gazetteer data from DIVA GIS. Use this as settlements layer.
4. Georeference the May 8, 2020 image to the already georeferenced landsat image from April 22, 2020
5. Sardoba_rsv: Create a feature called using heads-up digitizing to represent the Sardoba reservoir prior to the breach

6. Sardova_inundate_rsv: Create a feature using heads-up digitizing representing inundated area including remaining water left in the reservoir
7. Sardova_floodpath_rsv: Create a feature using heads-up digitizing showing the path the floodwater likely took post break
8. Sardova_pooled_area_rsv: Create a feature displaying the extent and area where the water has ponded
9. Determine value of one pixel and unit used

- Use the 5/8/22 landsat image's resolution properties and these formulas:

Data Source

Set Data Source...

| | |
|----------------|--|
| Data Type | File Geodatabase Raster |
| Database | S:\DATS_6450.80_Topics_in_Data_Science_202103\Teinfalt,Lydia-I |
| Name | LC08_L1TP_154032_20200508_20200526_01_T1 |
| Vertical Units | Meter |

Raster Information

| | |
|-----------------|------------------|
| Columns | 6788 |
| Rows | 8988 |
| Number of Bands | 4 |
| Cell Size X | 36.7558828152988 |
| Cell Size Y | 28.2053613775005 |

- Cell X = 36.755883 meters
- Cell Y = 28.205361 meters
- Area = X * Y
- Area of single pixel = Cell X * Cell Y = 36.755883 * 28.205361 = 1,036.71 m²
- Area of 25 pixels = 25 * Cell X * Cell Y = 25 * 36.755883 * 28.205361 = 25,917.82 m²

10. Impacted settlements: Determine villages impacted by the flood by using spatial join of the Sardoba inundated polygon with the settlement points from step #3.
11. Import Uzbekistan population data from DIVA GIS. Determine how many people were impacted by the flood. Use the extract multi values to points tool to join settlements points with the inundated polygon. This tool appends the population field to the settlement attributes table.
12. Determine the percent of the inundated area is in Uzbekistan vs Kazakhstan. First create a feature based on spatial join of Sardoba Inundated polygon and the administrative boundary of Uzbekistan and calculate based on the following formula:
 - Percent of flooded area in Uzbekistan = (Area of Uzbekistan / Total area of flooded region)
 - Percent of flooded area in Kazakhstan = (Area of Kazakhstan / Total area of flooded region)
13. Calculate many times larger is the flood path in comparison to the area where the water is ponded:
 - Area of flood path / Area of ponded water
14. Geodatabase location: S:\DATS_6450.80_Topics_in_Data_Science_202103\Teinfalt,Lydia-LTeinfalt\Lab 1\

Results

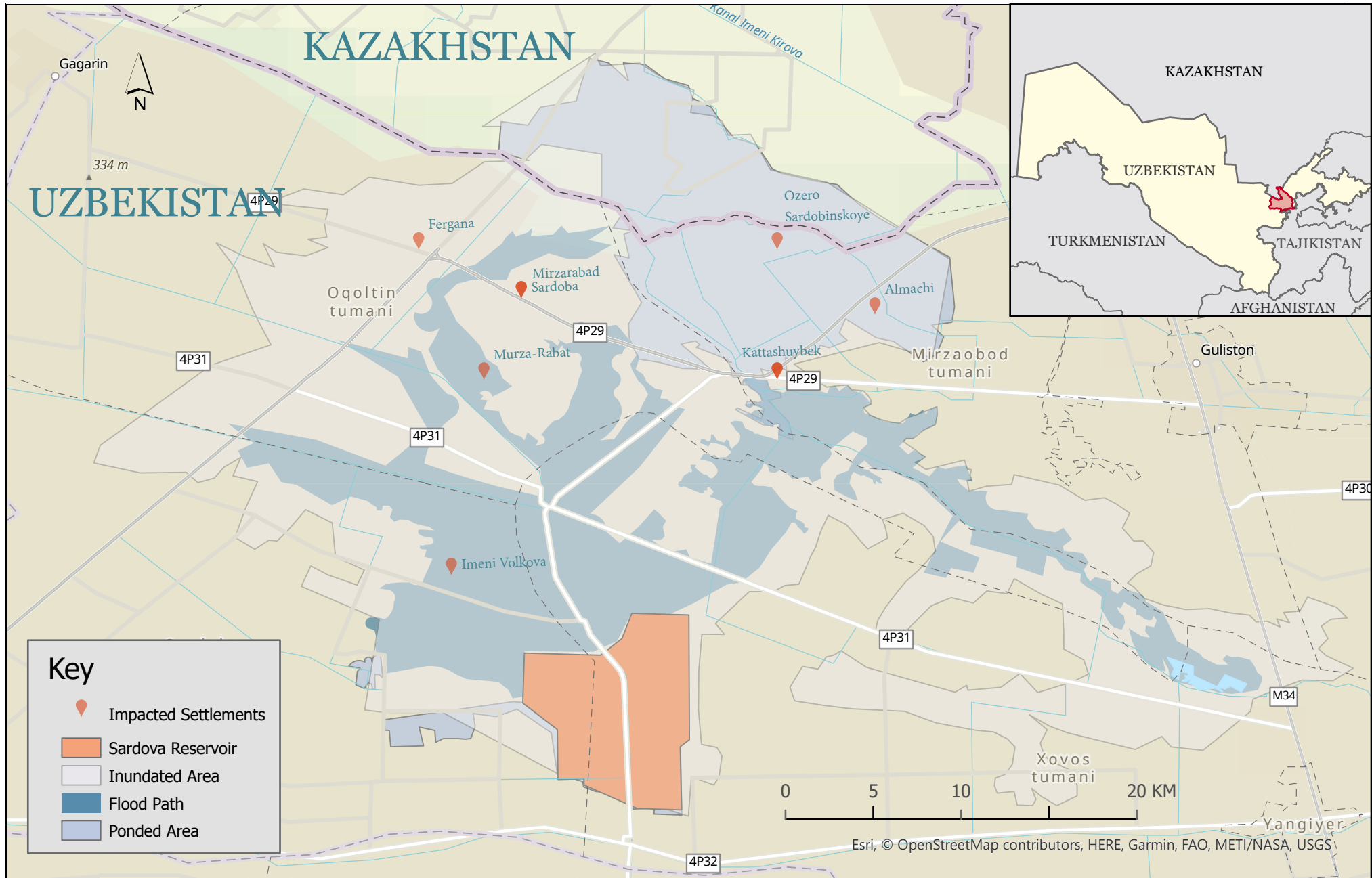
Map 1 shows an overview of the food after the Sardoba dam failed. The flood waters from Sardoba dam located in Uzbekistan pour out of the breach in the dam's western wall and flowed in a north – east direction. Map 1 gives a visualization the likely path the flood waters took with the periwinkle-colored shaded area. The flood waters path covered extensively the Sidaryo region of Uzbekistan and crossed over the boundary to Kazakhstan. The path along which the flood waters flowed from reservoir covered an area approximately 282.56 km². As a result, the flood waters path inundated an area covering 1032.88 km² in both Uzbekistan and Kazakhstan – 88% of the flooded area are in Uzbekistan versus 12% of the area located in Kazakhstan. The flood path area (282.56 km²) is roughly equivalent to the area where the water is ponded (211.60 km²).

Map 2 shows that there are eight villages directly in the inundated flood area in Uzbekistan and one village on the border with Kazakhstan. Two villages, Yangiaul Nawruz Yangi and Imeni Michurina, are not directly in the inundated flood area but are within proximity of floodwaters and should be checked by response personnel. There are approximately 549 villagers living in the impacted settlements. Rescue efforts will be hindered by roads damaged by the flood. Twenty-eight primary and secondary road segments are in the inundated flood water area and highlighted in red in Map 2. There are likely available roads from for rescue efforts from Guliston to impacted villages.

1. True or false, in practice when georeferencing an image there will always be some locational error? **True**
2. True or false, if your RMSE is zero then all locations on the image are registered to the correct location on the map? **False**
3. True or false, it is ok to keep control points with non-zero error if you believe they are meaningfully located? **True**
4. True or false, when digitizing a polygon, the first and last coordinates of a polygon *must* be the same? **True**
5. True or false, in practice when digitizing any new features you must assign them to a coordinate reference system? **True**

Sardoba Dam Breach: Environmental Impact

On May 1, 2020, a section of Sardoba dam in Uzbekistan broke creating widespread flooding



Sardoba Dam Breach: Humanitarian Impact

