Uzbekistan's Sardoba Dam Failure: Georeferencing and Disaster Relief Report

Abstract

This report analyzes the Sardoba Dam failure in Uzbekistan on May 1, 2020, using GIS-based methods including georeferencing, digitization, and spatial analysis. Satellite imagery from April 22 and May 8, 2020, was used to delineate the original reservoir, the flood path, and the inundated regions. A total of eight settlements were found to be affected by the floodwaters. The total inundated area was 170.80 km², while the flood path extended over 468.09 km². The study demonstrates how spatial analysis can support rapid response and recovery efforts during emergencies.

Introduction

On May 1, 2020, the western wall of Uzbekistan's Sardoba Reservoir partially collapsed, releasing an estimated 922 million cubic meters of water and causing severe flooding across the Sirdaryo region and parts of southern Kazakhstan. The flooding event inundated agricultural lands, villages, and transport routes. According to news sources, more than 70,000 people were evacuated from affected areas (Al Jazeera, 2020). This disaster emphasized the urgent need for spatial data and rapid analysis tools to assess damage and guide emergency response.

The goal of this exercise is to utilize GIS techniques to determine the total flood-affected area, identify impacted villages, and visualize the extent of flooding. Additionally, this study aims to demonstrate how geospatial tools can improve disaster response efficiency.

Methods

The workflow involved georeferencing satellite imagery, creating new feature classes for hydrological features, and digitizing the flood-affected regions. Data sources included DIVA-GIS for administrative boundaries and settlements (DIVA-GIS, 2020), and Landsat 8 imagery retrieved from the USGS Earth Explorer platform for April 22, 2020 (pre-flood) and May 8, 2020 (post-flood) (U.S. Geological Survey, 2020). The datasets were organized within a geodatabase (*Uzbekistan.gdb*) structured into feature datasets such as *Admin*, *Hydrology*, and *Transportation*.

The georeferencing process used 10 well-distributed control points to ensure spatial accuracy. The transformation applied was a *first-order polynomial (affine) transformation* under the WGS 1984 UTM Zone 42N coordinate system. Three polygons were digitized: *Sardoba_rsv* (original reservoir), *Sardoba_floodpath_rsv* (flow path), and *Sardoba_inundate_rsv* (ponded area). Polygon areas were computed in square kilometers using the Field Calculator. For comparison of spatial extents, the following formula was used to calculate the ratio between the flood path and the ponded area:

$$\text{Flood Ratio} = \frac{\text{FloodPath\_Area}}{\text{Ponded\_Area}}$$

A spatial overlay was performed to identify settlements (*UZB_Places_pt*) intersecting the inundated and flood path polygons, representing the number of impacted villages.

Results

The total area of the flooded (ponded) region outside the original dammed area was measured as 170.80 km². The flood path extending northward from the reservoir covered an area of approximately 468.09 km², indicating that the flood path was about 2.74 times larger than the ponded region. Within Uzbekistan, eight settlements were directly impacted by floodwaters. From Map 1, we can see the location of the reservoir as well as the eight affected settlements (marked in red).

The total flooded (ponded) area within Uzbekistan was determined to be 73.22 km², representing 42.87% of the total inundated area, while Kazakhstan accounted for 57.13%. From Map 2, we can see the safe and shortest route to be taken from Guliston to reach these affected areas (marked in deep green). The map also shows the affected water lines and roads damaged due to the flooding. These findings highlight the transboundary nature of the disaster and the importance of international cooperation in flood management and response.

Conclusion

This GIS-based analysis provided a spatial understanding of the Sardoba Dam failure and its impacts on Uzbekistan's Sirdaryo region. The integration of remote sensing and spatial analysis enabled accurate delineation of flood-affected areas and identification of at-risk settlements. This type of geospatial workflow is useful for real-time disaster management, especially in regions with limited spatial data infrastructure.

References

Al Jazeera. (2020, September 23). Uzbeks search for answers and stability after deadly dam collapse. *Al Jazeera*. https://www.aljazeera.com/features/2020/9/23/uzbek-dam-collapse

DIVA-GIS. (2020). *Global administrative boundaries and settlement data for Uzbekistan [Shapefile]* [Dataset]. http://www.diva-gis.org/gData

U.S. Geological Survey. (2020). *Landsat 8 (OLI/TIRS) Level-1 imagery for April 22 and May 8, 2020 [Data set]* [Dataset]. Earth Explorer. https://doi.org/10.5066/P9OGBGM6

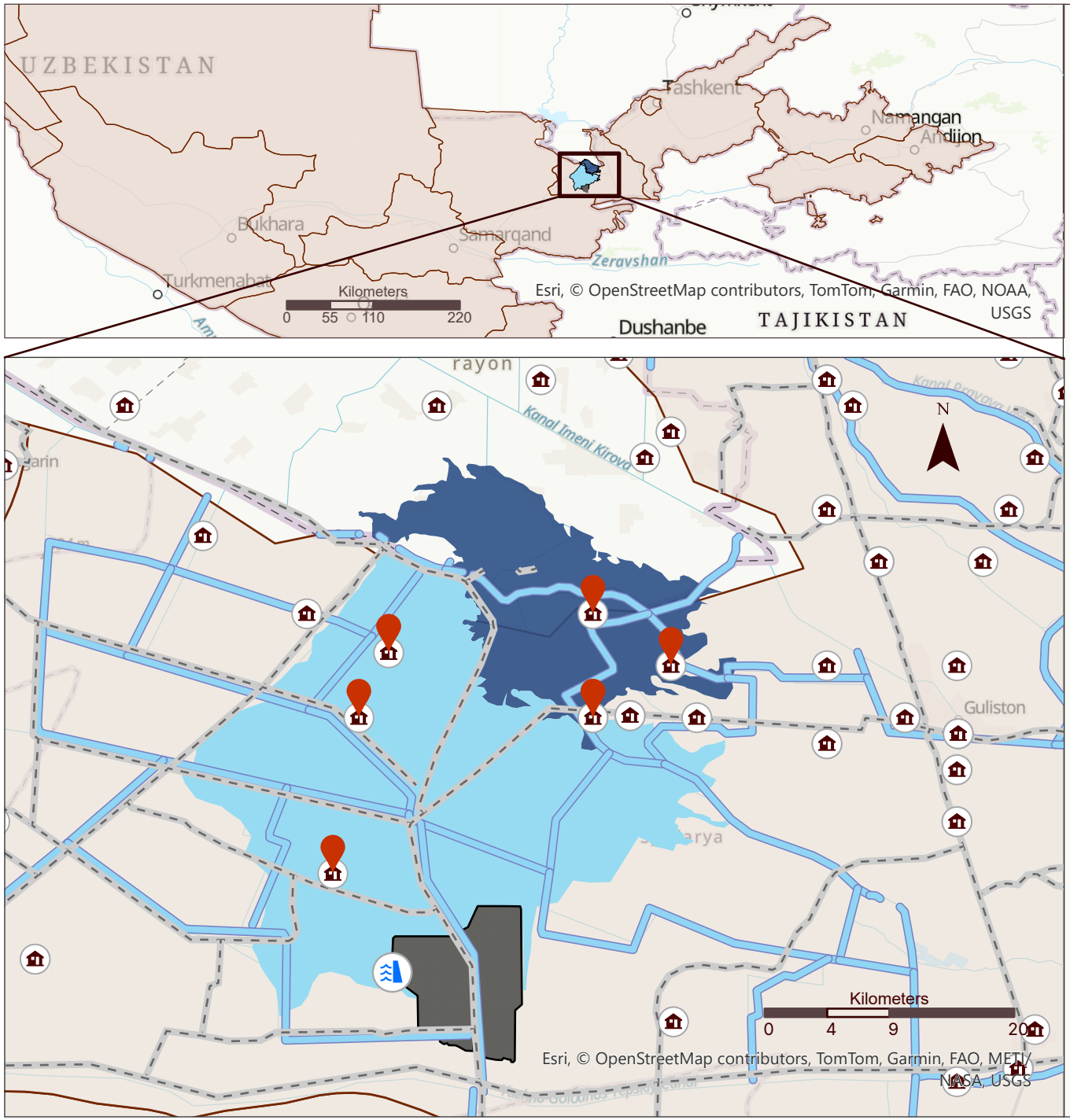
Appendix: Map Design Summary

Map 1: This map shows the full extent and impact of the Sardoba Reservoir dam failure. The design uses shades of blue to show water features clearly; dark grey for the reservoir, medium blue for inundated areas, and light cyan for the floodpath. Red icons mark the affected settlements. Administrative boundaries and roads help provide context for location. An inset map gives a national overview, and a short text box summarizes the flood's effects for quick understanding.

Map 2: This map focuses on the search and rescue response after the flood, showing routes and access conditions from Guliston to the affected zone. Consistent blue tones indicate water areas, while dark green lines show the safest routes. Damaged or impassable roads are highlighted in orange for quick visibility. Red settlement icons identify the flooded villages. A yellow star marks Guliston, the main staging area.

Both maps include a clear legend, scale bar, and north arrow and use the WGS 1984 UTM Zone 42N projection for spatial accuracy.

Sardoba Reservoir Dam Failure: Estimated Flood Extent and Impact



Flood Overview

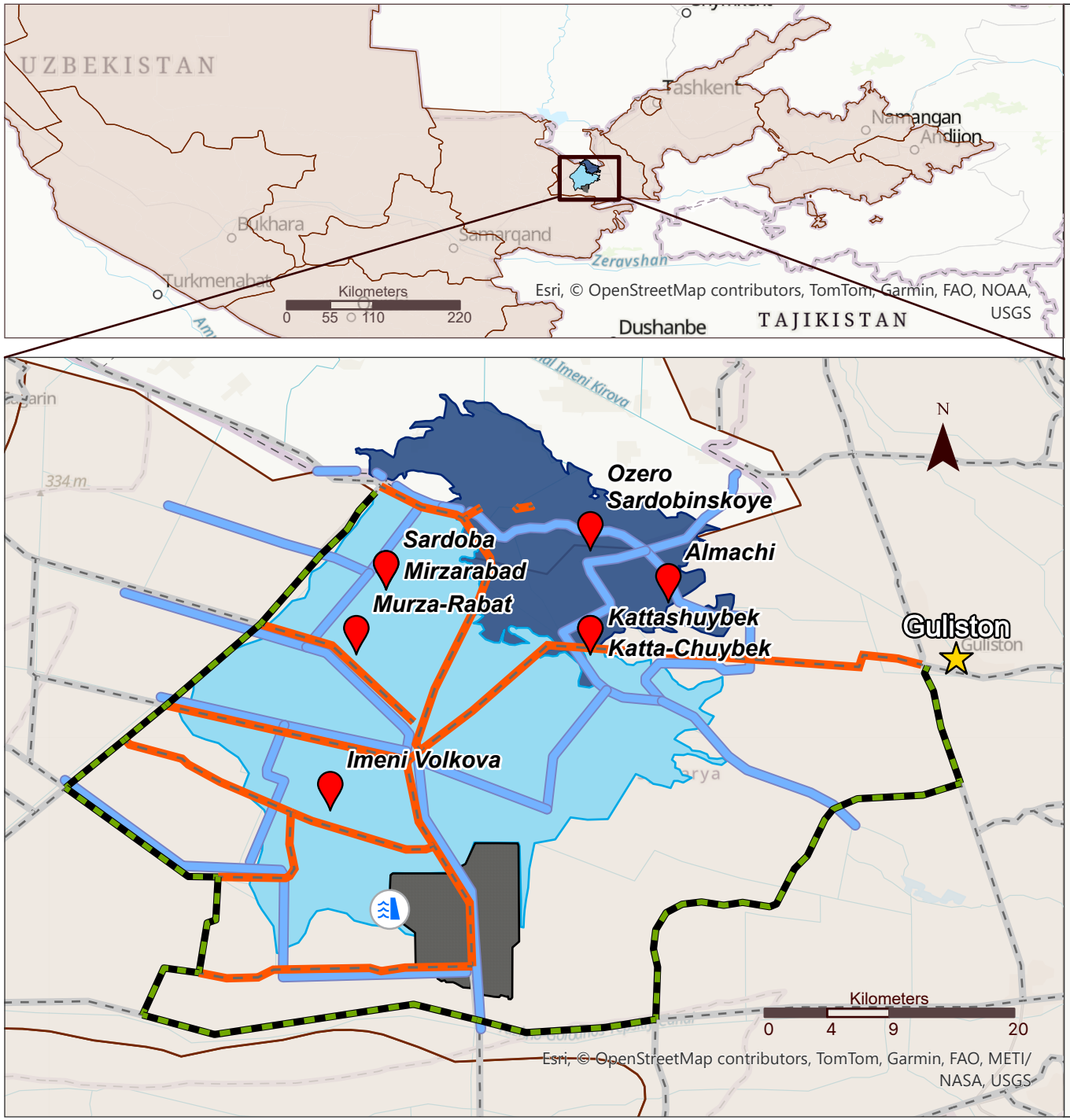
The catastrophic failure of the Sardoba Reservoir dam on May 1st, 2020, releasing an estimated 922 million cubic meters of water and causing severe flooding and creating an immediate humanitarian crisis and immense physical destruction. The disaster directly impacted tens of thousands of families and resulted in the immediate displacement of over 110,000 people from the Sirdaryo region in Uzbekistan and the neighboring Turkestan region of Kazakhstan. The total economic losses from the damage to homes, vital infrastructure, and farmlands were estimated to be approximately US $1 billion.

Affected Settlements		
	- Almachi	- Mirzarabad
	- Imeni Volkova	- Murza-Rabat
	- Katta-Chuybek	- Ozero Sardobinskoye
	- Kattashuybek	- Sardoba

- Affected Settlements
- Settlements
- Leakage point
- Roads
- Water lines
- Sardoba reservoir
- Floodpath area
- Innundated area
- Uzbekistan Boundary

Fyrooz Khan | 10/13/25 || WGS 1984 UTM Zone 42N || Source: DIVA GIS, USGS

Guliston to Sardoba Flood Zone Navigation and Search Area Map



Sardoba Flood Response

This map is for Search and Rescue teams navigating the flood zone from the primary staging area in Guliston. The objective is the rapid recovery of survivors in the eight villages/ settlements (marked in Red) directly impacted on the Uzbek side of the border. The primary operational route from Guliston is marked in Deep Green, and road segments marked in Orange are currently assessed as damaged or impassable due to residual standing water (dark blue ponding areas) and mudded area (light blue flood-path area).

- Affected Settlements
- Leakage point
- Guliston
- Affected roads
- Safest Route
- Roads
- Affected water lines
- Sardoba reservoir
- Floodpath area
- Innundated area
- Uzbekistan Boundary

Fyrooz Khan | 10/13/25 || WGS 1984 UTM Zone 42N || Source: DIVA GIS, USGS, OpenStreetMap/Esri