A Case Study:

Using Geographic Information Systems to investigate an incident from the Vietnam Conflict

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Abstract

The United States military has made a solemn commitment to ensure that no one is left behind on the battlefield. Despite the dedicated efforts of the Defense Prisoner of War/Missing Personnel Office (DPMO), the Joint Prisoner of War/Missing in Action Accounting Command (JPAC), the Life Sciences Equipment Laboratory (LSEL), and the Defense POW/MIA Accounting Agency (DPAA), not all investigation and recovery missions have been successful. Geographic Information Systems (GIS) can help researchers and historians understand both historical and contemporary spatial relationships about these cases. Using a spatial approach by integrating spatial data from initial loss documents, previous recovery efforts, and historical imagery into GIS, we may gain valuable new insights for these investigations.

This case study involves mapping historical location information from past accounting efforts and comparing imagery from 1968 to the present where HMC John H. Garner of the 1st Battalion, 1st Marines, 1st Division was reported killed in action (KIA) on May 29, 1967 (DPAA, 2019). By comparing imagery and mapping the shoreline changes over time, I aim to illustrate the geomorphologic evolution of a section of the Thu Bồn riverbank near Hoi An, Vietnam to validate a witness statement of the burial location of a United States Marine after an enemy ambush during the time of HMC Garner's disappearance.

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Introduction

The Secretary of Defense is responsible for providing a system of accounting for all military personnel in the Department of Defense. This accounting effort involves military personnel missing in action (MIA) from past conflicts (OLRC, 2021). In 2017, by order of the Inspector General's office, the Secretary of Defense designated the Defense POW/MIA Accounting Agency (DPAA) the responsibility to provide the fullest possible accounting of missing military personnel from past conflicts (DoDD 5110.10, 2017). Before this time, there were three organizations responsible for accounting for missing personnel, the Defense Prisoner of War/Missing Personnel Office (DPMO), the Joint Prisoner of War/Missing in Action Accounting Command (JPAC), and the Life Sciences Equipment Laboratory (LSE). The merger and reorganization of these three agencies is an effort to make the process of recovering missing in-action military personnel more efficient (Moorfield, 2018).

Using GIS to map battle rhythms, flight plans, and other chronology reports of wartime incidents can provide valuable insights about possible locations of missing in action (MIA) personnel for the DPAA. In a book written by Alexander von Lünen and Charles Travis (2013), *History and GIS,* they describe how a spatial narrative can move the historical narrative beyond the written linear constraints. A GIS narrative can complement a historical narrative by giving the researcher a geographic perspective of the event.

> "What must be added is a spatial narrative that acknowledges how engaged human agents build spatially framed identities and aspiration out of imagination and memory that complement the verbal narrative traditionally employed by humanists" (von Lünen, & Travis, 2013).

For research analysts and historians, this means that including spatial analysis as part of the historical research process of a wartime incident can provide an additional narrative that can be valuable to an investigation. Mapping location information from command chronology reports, wartime flight plans, search and recovery reports, incident reports, past recovery efforts, and investigations can be brought together to tell the story of the progression of an incident's case. Wartime aerial imagery, surveillance satellite imagery, and modern imagery can illustrate how the environment has changed over time by natural and human processes surrounding an incident's location. This project aims to demonstrate the benefits of GIS for a research investigation to provide accountability for HM3 John H. Garner, who was reported as killed in action on May 29, 1967.

Petty Officer Garner was part of a Marine unit crossing the Thu Bồn River by boat when they came under heavy small arms and automatic weapons fire from an unknown number of

enemy forces as reported in the Intelligence Summary after the incident. (Texas Tech, 2013). The Marine's boat overturned, and Petty Officer Garner was swept away by the river's swift current. The intense enemy fire and strong current thwarted recovery attempts (DPAA, 2019).

This case study requires examining a series of imagery from 1968 to 2024 to reveal the geomorphologic changes of a section of the Thu Bồn riverbank in the Duy Vinh Village, Vietnam to validate the alleged burial location of a U.S. Marine provided by a local witness to the incident.

JPAC has conducted several investigations into this incident. In 2006, the investigation team interviewed a witness to the event. This witness was a former member of the Duy Vinh Village Militia who provided information about a 1967 ambush of a U.S. military unit crossing the Thu Bồn River and the subsequent discovery and burial of a Black American serviceman's body as recorded in the 85th JFA 06-3VM investigation report. The location he identified was partially underwater and on an exposed sandbar of the Thu Bồn riverbed located at Military Grid Reference System (MGRS) 49PBT 14012 53447 World Geodetic System 1984 (WGS-84). There was a disagreement between him and the investigation team interviewer concerning the movement of the riverbank and the sandbar over the past 40 years.

This witness was interviewed five times between 2006 and 2013 providing the same information and burial location. The archeologist assigned to investigate this site in 2006 suspects the 1967 shoreline accreted from where the witness states he remembers it to be as documented in the DPAA Case Summary, 2022. The witness is adamant that the body was buried on the sandbar at 49P BT 14008 53460 (WGS-84) in Figure 1 taken by the lead investigator in 2013.

Figure 1: Photo provided by Buddy Newell, JPAC lead investigator, taken during an interview with the witness on August 28, 2013.

Hypotheses

I hypothesize that a sandbar was formed by flood events over the years. Sediment is transported downstream when the river's velocity is high, such as during heavy rain events that cause flooding. As the flow velocity decreases, the river's capacity to carry sediments diminishes, causing the sediment to settle. The sediment in the inside curve of the river settles and forms a sandbar because the velocity of the water is much slower than that on the outer curve of the bank. Also, manmade structures slow down the water and sediment can settle downstream creating a ridge of sand that is separated from the main body of land. Built structures to accommodate a sustainable community have emerged over the years that have affected the sinuosity of the river system (Ribbe, 2017). It may appear to the witness that the riverbank had been washing away when in fact the beach in 1967 remains and residential

structures have been constructed on it (Figure 2). Sediment transported down the river has settled on the inside curve of this section of the river and created a new sandbar.

Figure 2: Image of the location identified by the witness in the red triangle on WV03 imagery dated October 14, 2007.

Study Area

The study area is in the Quang Nam Province, specifically in the Duy Vinh Village, Vietnam, which lies 29 km southeast of Da Nang within the Thu Bồn Estuary. The estuary covers approximately 2,594 square kilometers and flows into the South China Sea (Thong et al.). The topography of this project's area of interest has lower elevations in the coastal plain and dunes area (Wang, 2022). The region experiences two distinct seasons: the rainy season, from September to December, and the dry season, from January to August. It is prone to heavy

monsoonal rains, extreme flooding, and economic devastation during the rainy season of September through December (Nguyen et al, 2024). (Figure 3).

Figure 3: The project Location on the Thu Bồn river in south central Vietnam near Da Nang, Vietnam.

Methodology

Area of Loss reporting documents:

Marines often used pre-planned grid references from standard military maps such as those from the series L7014 maps. These references were communicated in coded formats to prevent enemy interception and understanding. Radio was the primary communication method. Each unit was equipped with field radios which allowed them to communicate with command posts and other units. Radio operators during the Vietnam conflict would relay their location in the MGRS coordinate system from military maps (Army, 2006) using the Indian 1960

reference datum. Based on the intelligence summary in the command chronology report, the command group from the 1st Battalion, 1st Marines, 1st Division, was moving by boat to an assembly area for withdrawal from the operation when they came under heavy weapons fire. The coordinates were relayed (Figure 4).

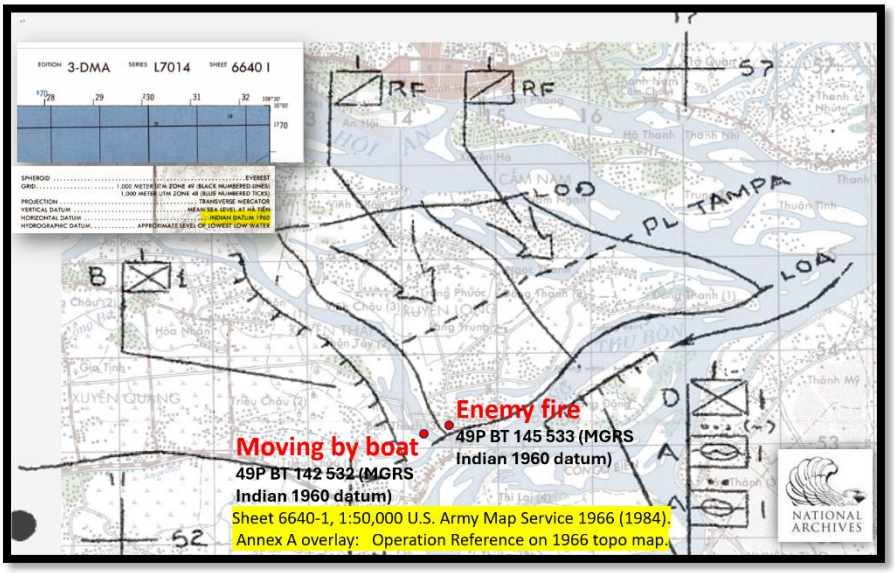

Figure 4: Map overlay, Annex A, was obtained from the command chronology and incident report on May 1967 and overlaid on the 1966 L7014 topo map.

I created a file geodatabase in ArcGIS Pro 3.2 and named it Capstone.gdb where all spatial data will be stored for this project. The datum and projection for all data in this project will be WGS 1984 UTM Z49N. Standardizing datums and coordinates is essential for achieving precise measurements. Using multiple datums without standardization is similar to taking some measurements in Imperial units and others in metric and expecting accurate results without converting them to a common unit. The incident and investigation coordinates from the intelligence summary are plotted in ArcGIS using the Military Grid Reference System (MGRS) in

the Indian 1960 datum. These coordinates were then transformed to WGS 1984 UTM Zone 49N in decimal degrees to modernize and standardize the location reference (Table 1).

Incident Report statement	**MGRS Indian 1960**	**WGS 1984 UTM Z49N**
Command Group moving by boat	49P BT 142 532	108.3316847°E 15.8413128°N
Enemy fire	49P BT 145 533	108.3297480°E 15.8452322°N

Table 1: Incident coordinates derived from the intelligence summary report May 29-30, 1967.

The witness burial location is documented in the JPAC and DPAA investigation reports from 2006 to 2019. Over the years the witness stands by his statement of the burial location somewhere within the area he had marked using three sticks during the 28 August 2013 interview from the JPAC Joint Field Activity (JFA) 13-4VM. The coordinates provided are in MGRS WGS-84 and are again converted to decimal degrees to standardize location naming conventions (Table 2).

Witness burial location triangle	**MGRS WGS-84**	**Decimal Degrees WGS-84**
Stick 1	49P BT 14008 53460	108.3298626°E 15.8436387°N
Stick 2	49P BT 14026 53447	108.3300321°E 15.8435234°N
Stick 3	49P BT 14005 53436	108.3298375°E 15.8434217°N

Table 2: Witness alleged burial location.

The witness also mentioned in the interview that the cove directly across from the north shore of the river was there in 1967 (108.3279542°E, 15.8423700°N, WGS 1984) and made a statement that the channel north of the river on the other side of the sandbar did not exist during the war. He said that after flooding in 1989, a small back channel was created. He

mentioned that the concrete bridge to the west of the witness burial location did not exist during the war but there was a small wooden footbridge, and He also stated that the river was previously much narrower. The most recent imagery available for this location is from the Google Earth imagery service in AGOL. (Figure 5).

Figure 5: This image is dated March 4, 2024. There is sediment visible under the water near the burial location identified by the witness.

I now have five statements from the witness to verify from the JPAC 85th Joint Field Activity investigation report on July 27, 2006.

1. Was the cove across the river in 1967, and was it at an azimuth 235 of degrees and a distance of 250 meters?
2. Was the river narrower in 1967?
3. When did the sandbar appear? Was it present in 1967? Witness states that the channel behind the sandbar appeared after flooding in 1989.
4. When was the concrete bridge constructed?

5. The witness states he buried the body 15 meters from the shoreline, approximately 80 centimeters (2.62 feet) deep, perpendicular to the shore.

Imagery Collection and Comparison:

This study involves comparing the imagery collected from the National Archives and Records Administration (NARA), the USGS Earth Explorer, Esri Wayback, and Google imagery to examine the shoreline from 1967 to 2024 of the project's area of interest on Thu Bồn river. Imagery is only a snapshot in time and the compilation will provide a general representation of the changes along the Thu Bồn river. These images will be used to create a temporal visualization of the geomorphology of the project location on Thu Bồn river over the past 57 years and the changes in the shoreline by human interaction.

The image used to verify the shoreline of the beach on March 7, 1968 is high resolution arial imagery taken during the Giant Dragon T972 reconnaissance mission (NARA, 2020). A key challenge in this project is georeferencing oblique aerial imagery. As Bulman (2008) demonstrated, ortho-rectification of frame camera aerial photography is a complex process. The use of off-nadir imagery introduces distortions during rectification. Additionally, locating ground control points (GCPs) is challenging since each image captures a snapshot of the area at a specific time, making it difficult to match historic and modern features. I used ArcGIS Pro 3.3 to georeference the wartime imagery and maps selected for this project to identify changes in the morphology of the river and assess the built environment of the riverbank from 1968 to 2024. After the 1968 imagery was georeferenced, I digitized the shoreline and used the copy parallel tool located in the Edit tab in ArcGIS Pro to create an off-set line 15meters from the 1968 shoreline inland to help define a new search location. This is to serve as a guide of where the witness may have buried the body on the beach when overlaid the modern imagery (Figure

6). Also verified in this image is the cove located across from the alleged burial location. The shoreline along the outer bend of the river is noticeably further north in this historic image. The point indicates where the mouth of the cove was in 2024.

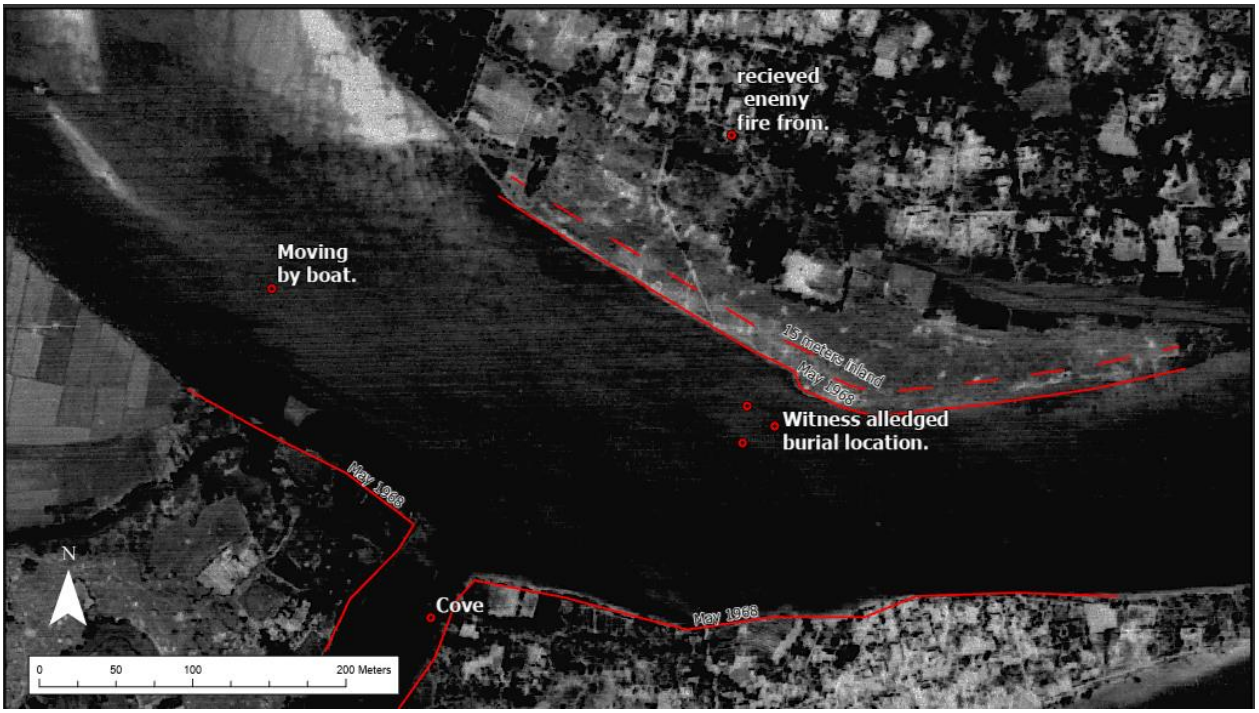

Figure 6: Giant Dragon T972 Imagery from March 7, 1968. The shoreline is digitized, and reporting coordinates are plotted for reference. The dashed line is the 15-meter offset from the shoreline.

I used the Distance and Direction tool in ArcGIS Pro 3.2 to measure the distance and direction from the shoreline to the cove across the beach near where the witness indicates the alleged burial location in the 1968 arial imagery (Figure 7). The cove is 250 meters from the 1968 shoreline at an angle of 235 degrees. This will provide a clue as to where the new research area could be by using the 235-degree bearing of the line as indicated in the investigation report from 2006.

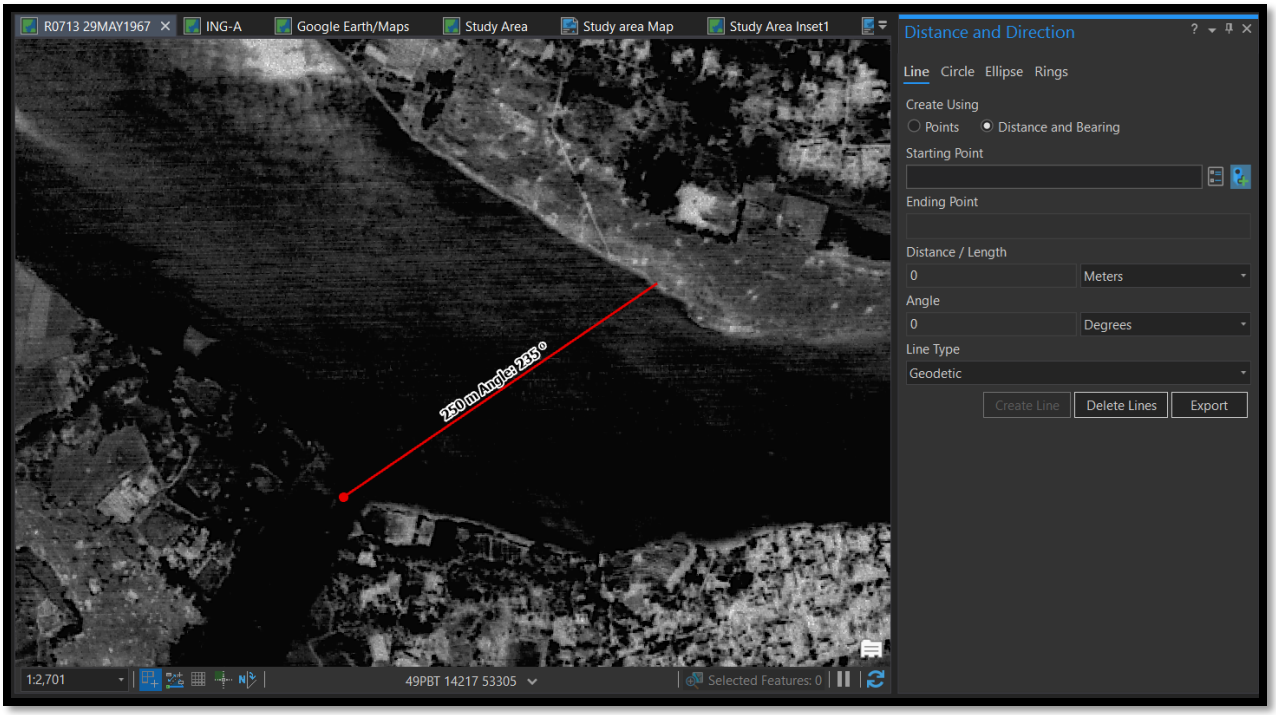

Figure 7: Distance and Direction tool measuring a line of sight from the shore to the cove.

Imagery collected from the USGS Earth Explorer was discovered and downloaded for the years 1977, 1988, and 1995 and used to show the sediment transport downstream along the inside bend of the river (Table 3).

Imagery source	Type	Date	GSD
Keyhole 9, image DZB1213-500102L001001_1_b.tif	Reconnaissance Satellite Imagery	15 October 1977	3.93-meter
Satellite pour l'Observation de la Terre (SPOT), image n16e108.tif	Earth Observation	07 January1988	10-meter
Landsat-5, image LT05_L1TP_124049_19950619_20200912_02_T1_refl.tif	Earth Observation	19 June 1995	30-meter

Table 3: Earth Explorer imagery collection.

The 1977 Keyhole 9 and SPOT imagery were georeferenced and provided good insight into the morphology of the river prior to the bridge construction. The ground sample distance (GSD) for Landsat-5 imagery of 30-meters did not reveal any large-scale clues as the pixel value was too large for the scale of this study. This imagery shows the movement of sediment down the river forming what is now the sandbar where the witness indicates he buried the body (Figure 8).

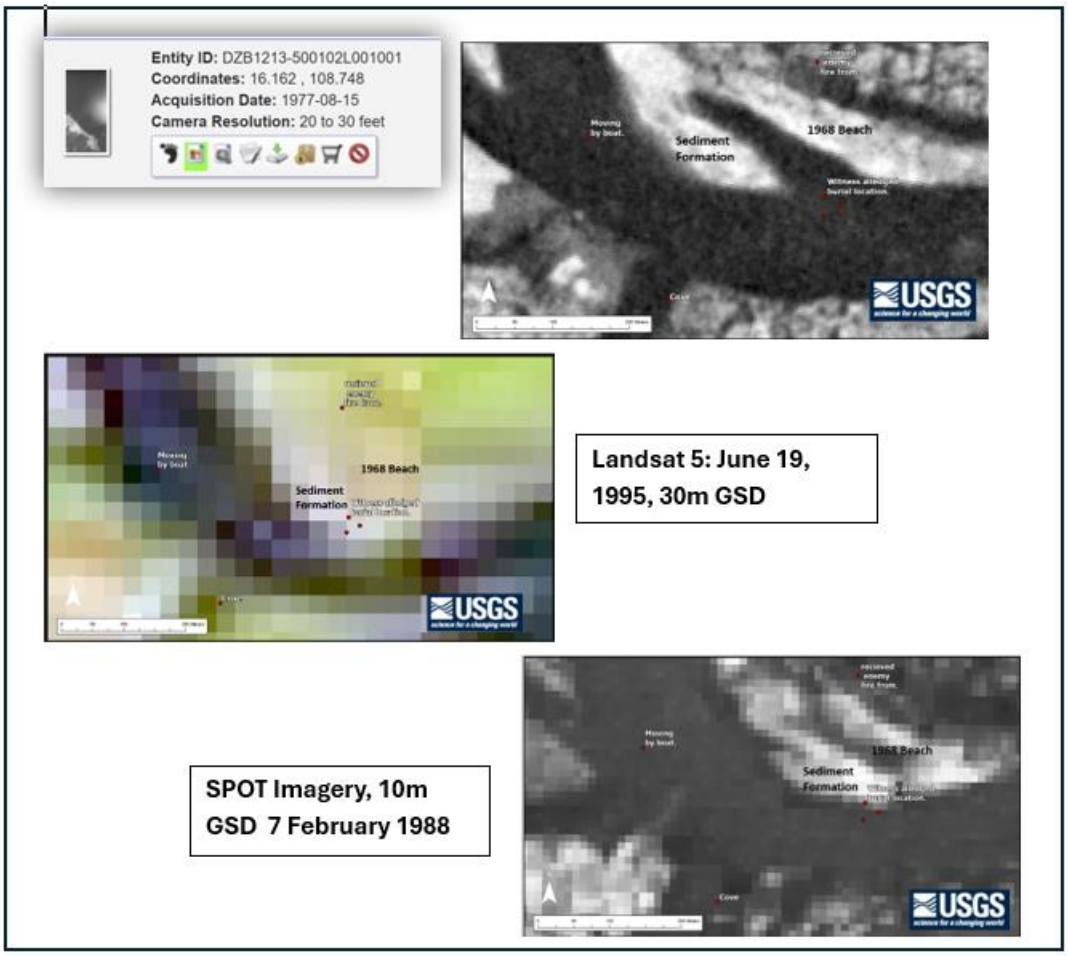

Figure 8: Imagery collected from the USGS Earth Explorer used to show the sediment transportation from 1977 to 1988.

Sediment on the inside curve of the river can settle and form a sandbar because the water's velocity is much slower than on the outer curve. As seen in this SPOT image on 07

February 1988, the polygons of the sediment transportation have been illustrated from 1967 to 2010 (Figure 9). Additionally, bridge pilings slow down the water, allowing sediment to settle downstream of the bridge. (Figure 10).

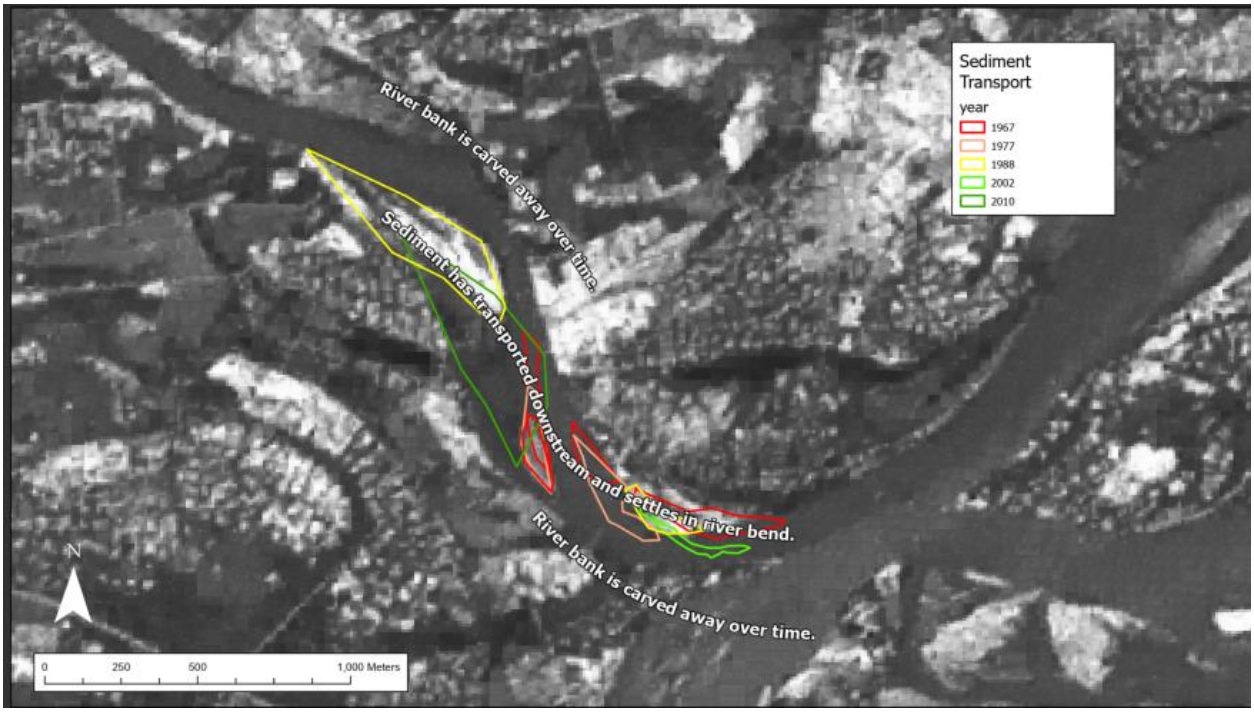

Figure 9: SPOT imagery with digitized sediment movement from 1967 to 2010 overlaid.

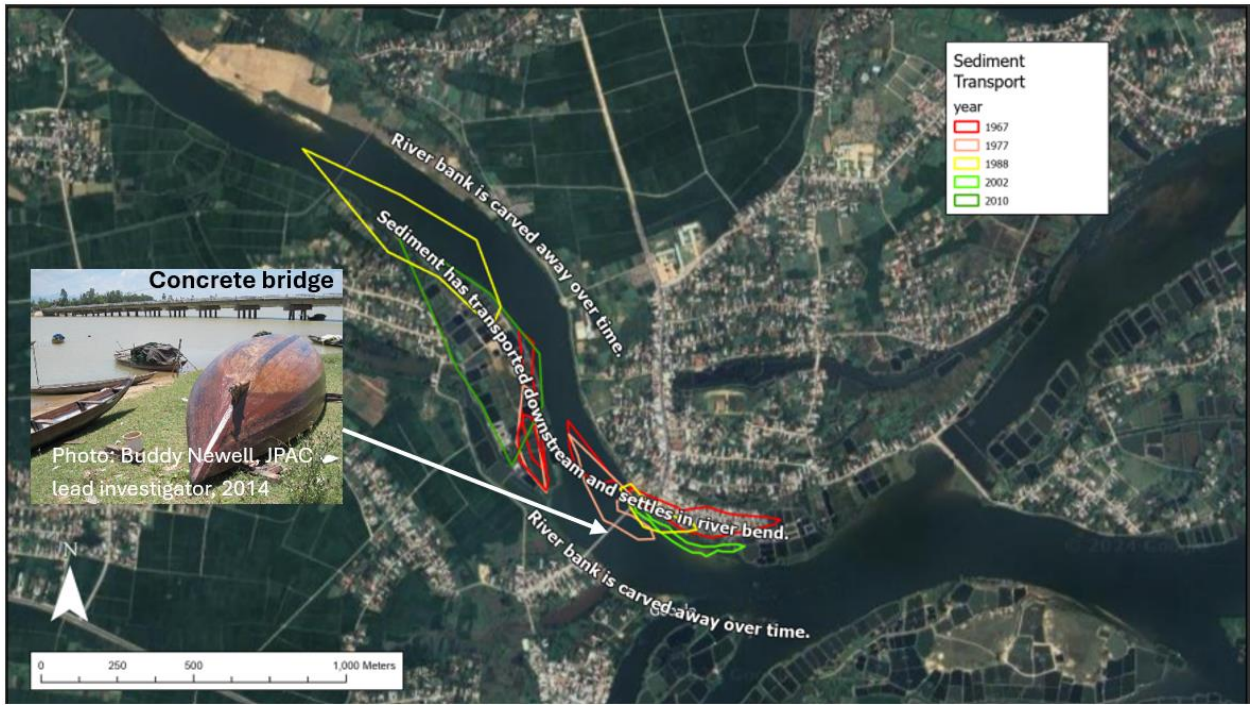

Figure 10: 04 March 2024 Google Earth Imagery service with digitized sediment movement from 1967 to 2010 overlaid.

Sometime after 1988, the concrete bridge was constructed. WV03 imagery collected on October 21, 2002, shows the new bridge and the subsequent formation of a sandbar (Figure 11).

Figure 11: WV03 Satellite image, October 21, 2002. A clear view of the concrete bridge and the sandbar that formed along the shoreline east of the north bridge piling where sediment settled.

The witness stated that the channel that separates the shoreline and the sandbar did not appear until after flooding in 1989. I suspect that the bridge was built in 1989, causing the sediment to deposit just east of the north piling where the current slows. I hypothesize that the sandbar was formed by flood events over the years, and the channel behind the sandbar was not carved from the existing 1967 beach, but rather created by the river's ebb and flow currents.

The witness stated that the river was narrower in 1967. I created a new feature class in the Capstone.gdb and selected the dimension Feature Class Type with the reference scale set to 1:5,000 to take measurements from the May 1968 shoreline to the 2010 shoreline to illustrate the change in width of this section of the river east of the concrete bridge. It appears that south of the sandbar along the outer edge of the river bank has been eroded and the inside channel has been built up with sediment (Figure 12).

Figure 12: Measurement of the channel downstream of the bridge in 1968 (red lines) and 2010 (imagery).

Results

The Thu Bồn estuary is a braided, meandering system. This study area has undergone many transformations from 1967 to the present due to fluvial geomorphological forces. Comparing imagery over time has produced promising results. There were five statements to verify from the witness interview. The first statement from the witness was that the cove across from the burial location was there in 1967. Imagery has proven this to be a true statement as illustrated in Figures 6 and 7. Figure 7 provides a bearing from the cove to the alleged burial site. The witness also stated that the river was narrower during 1967. The river has undergone many fluvial movements over the past 57 years. Fluvial forces have moved sediment down the river and have reshaped the river and riverbanks over the decades as shown in figures 9 and 10. Sediment has formed outside the 1967 shoreline creating a sandbar as illustrated in the images from 1977 and 1988. After February 1988, the concrete bridge was built, and the sediment buildup formed a sand ridge which resulted in the cove the witness identified as not existing in 1967 (Figure 11). Evidence of the new bridge appeared in the 2002 imagery. Imagery with a GSD of 10 meters or less was not available between 1988 and 2002. However, the witness did say a sandbar formed after flooding in 1989 which could mean that the bridge was built after February 1988 and before the flood event in 1989.

Finally, the witness stated that he buried the body 15 meters from the 1967 shoreline, approximately 80 centimeters deep, and perpendicular to the shore as recorded in the JPAC 06-3VM investigation. The compilation of all the facts from the 1967 investigation and command chronology reports, investigation reports from 2006 to 2019, and imagery comparison analysis reveals that the witness may not be aware that the shoreline has changed over time. He

remembers dragging the body approximately 15 meters up on a beach and burying him perpendicular to the shoreline. In 1967, the beach had no residential structures as verified in the 1968 reconnaissance ariel imagery. Today that beach has been built up with residential structures, new agricultural developments, and infrastructure.

Discussion

A new map and coordinates have been created to show a proposed research location (Figure 13), along with a table of coordinates that have been standardized to the WGS 1984 datum and written in the decimal degrees format (Table 4).

Figure 13: A Map showing a possible research location based on witness statements and imagery comparison analysis.

Location	LAT	LONG(WGS84)	
A	15.84364	108.329863	Witness alleged burial location.
B	15.84352	108.330032	Witness alleged burial location.
C	15.84342	108.329837	Witness alleged burial location.
D	15.84422	108.330213	Witness Point A relocated
E	15.84411	108.330383	Witness Point B relocated
F	15.844	108.330188	Witness Point C relocated
H	15.8438	108.330344	15 meters from 1968 Shoreline
I	15.84388	108.330101	15 meters from 1968 Shoreline

Table 4: Coordinates for map in Figure 13.

These coordinates can be used as a reference for future investigations on this case by the DPAA or as a record of accountability for the loss of Petty Officer John H. Garner who served his country as a medic charged with saving the lives of the 1st Battalion, 1st Marines, 1st Marine division he supported in combat.

Summary

The United States military has made a solemn commitment to ensure that no one is left behind on the battlefield. Geographic Information Systems (GIS) can help researchers and historians understand both historical and contemporary spatial relationships about these cases. A GIS narrative complements a historical narrative by providing a geographic perspective on events. Incorporating spatial analysis into the historical research of wartime incidents adds an additional layer of understanding that can be crucial to investigations.

This case study involves a May 1967 search and recovery mission for HM3 John H. Garner, who is reported as killed in action. The 1st Battalion, 1st Marines, 1st Marine Division was part of a reconnaissance mission. The unit was crossing the Thu Bồn River by boat when they

came under heavy weapons fire from enemy forces. The boat overturned and Petty Officer Garner was swept away by the strong currents of the river. In 2006, during an investigation mission by the Joint POW/MIA Accounting Command, a witness was located who was part of the ambush on the American Marines in 1967. He described the incident and the subsequent discovery of a black man dressed in U.S. Marine fatigues carrying no weapons. Corpsmen did not carry weapons as their primary function was to provide medical care. The witness describes where he retrieved the body from the shore of the Thu Bồn River near Duy Vinh Village, Vietnam. He described the distance he pulled the body up onto the beach, how deep the body was buried, and the direction the body buried in relation to the shoreline. He also described how the river appeared in 1967 and how the river has changed from 1967 to 2006.

Mapping location information from command chronology reports, intelligence summaries, search and recovery reports, and investigation reports weave together the story of an investigation's progression. Additionally, wartime aerial imagery, surveillance satellite imagery, and modern imagery illustrate how natural and human processes have transformed the environment surrounding an incident's location over time.

Examining a series of images from 1968 to 2024 has revealed significant geomorphologic changes in a section of the Thu Bồn River and its riverbank in Duy Vinh Village, Vietnam. This imagery confirmed the geomorphology of the Thu Bồn River in the study area and suggested a more plausible location for the alleged burial of HMS John H. Garner. The images have enriched the narrative by providing visual evidence that frames the witness statement within the context of the study area. While the witness's recollection of the alleged burial location is accurate in his mind, the gradual environmental changes over time may not have been evident to him.

This case study has established a practical framework for the further application of GIS in historical investigations. Integrating spatial analysis into the research process of historic wartime incidents offers an additional narrative that can significantly enhance the value of an investigation.

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