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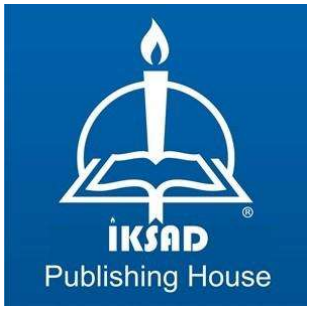

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DIGITAL APPROACH TO DOCUMENTING CULTURAL HERITAGE DYNAMICS IN HASANKEYF

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ABSTRACT

The history of humanity has a rich and diverse history with numerous civilizations and cultures. Cultural heritage sites preserve this heritage as an urban memory that can be passed on to future generations. However, rapidly increasing urban development, unpredictable natural disasters and complex socio-political dynamics are serious risks that threaten the sustainability of these heritage assets. Hasankeyf, with its thousands of years of history and hundreds of archaeological sites, has been one of the cultural treasures under risk. The major change in the city due to the Ilısu Dam project has aroused widespread repercussions at the international level and it has reminded that the preservation of cultural assets should include not only tangible assets, but also historical memory and knowledge. Therefore, documenting and archiving historical and cultural assets in detail is crucial before their permanent transformations. In this study, photogrammetric models of Hasankeyf were created with Metashape software using old drone images. Then, a photogrammetric model of the area was created using the latest drone images in order to make a process evaluation. Then, the transformation of Hasankeyf was examined through the models obtained and the transformation was visualized. The interaction between cultural heritage and technology has gained great importance in preservation studies in the digital age of rapidly developing technology. This study highlights the possibilities that digital technologies can present in the preservation of cultural heritage and demonstrates the increasing necessity of documenting historical values. It also provides a framework for documentation of similar historical heritages.

Keywords: Cultural Heritage, Digital Tools, Photogrammetry, Hasankeyf, Türkiye.

1. INTRODUCTION

Cultural heritage is the totality of tangible and intangible elements that reflect the identity, history and cultural values of a community, people or nation. Tangible and intangible cultural heritage includes aesthetic-artistic, historical-documentary, symbolic, socio-economic, religious and spiritual, and even political values. In addition, cultural heritage is the manifestation and proof of the existence, characteristics and cultural continuity of human beings, societies and cultural groups that make up society (Halaç & Öğülmüş, 2021). The conservation of cultural heritage is critical for passing on the history, identity and cultural values of societies to future generations. However, numerous factors such as globalization,

rapid urbanization, environmental degradation and economic pressures make cultural heritage conservation challenging and complex. In these challenging circumstances, digitalization is often proposed as a solution. With the rise of digital technologies, there is a growing interest in the idea that cultural artifacts and structures can be preserved digitally, creating a wider accessibility and even a more active role for society in this process. In addition, digital data play an important role in the preservation and sustainability of cultural heritage, as they serve as documents. The opportunities offered by digitalization are not only in document creation. Digitalization also includes features such as documentation and research, digital archiving and cataloging, global outreach and education, virtual tourism and observation, digital restoration and simulation, community engagement and crowdsourcing, benchmarking and tracking, digital exhibitions and museums, and many other interactive experiences that help carry cultural heritage to future generations.

Developments in the technologies used in the documentation and representation of cultural heritage have forced experts working in this field to think about the effects of technology, its benefits and the resulting possibilities. The digital documentation obtained with this technology allows the production of a simplified model of the object that allows the transfer of the necessary information and contains sufficient information, instead of the model produced by traditional methods, which consists of drawings that define the geometry of the object and pass through reference sections that divide the space horizontally and vertically. Such representation methods not only allow the direct extraction of metric information, but also facilitate our understanding of the object while forcing us to select the most important parts to simplify the object (Korumaz et al., 2011). In this context, two-dimensional and three-dimensional digitization of heritage data in today's studies is becoming a common practice in cultural heritage areas. This process, which can be explained by the term "digital heritage", is used intensively by international institutions such as UNESCO, which have studies in the field of cultural heritage, and it is intended to reveal the cultural values of societies together with the principle of digitization and to be presented to us as digital information (Töre, 2018).

Documentation in cultural heritage should be based on the current state and historical past of the building, its structural layout and deterioration rates, as well as material analysis, and should also include the features that determine the morphology of the building and its current state and the interventions it has undergone over time (Tucci, 2009). In recent years, developing documentation techniques offer fast, reliable and cost-effective solutions in many different fields. When the studies in the literature are examined, it is seen that photogrammetry, which is one of the most important methods of digital documentation techniques and used in this study, can be used for determining coastal areas (Gonçalves & Henriques, 2015), monitoring land use change, determining urban areas, monitoring forest destruction, green area detection, flood analysis, volume calculations (Ulvi, 2018; Kaya, et al, 2019; Minařík & Langhammer, 2016), modeling of historical monuments (Şasi & Yakar, 2018; Galantucci & Fatiguso, 2019; Yılmaz, et al., 2008), cultural heritage sites (Yastıklı, 2007; Hassani, 2015; Dostal & Yamafune, 2018), structural analysis of historical buildings (Kutlu, et al., 2023; Barille et al., 2016).

With its history, Hasankeyf has the characteristics of a museum city with its immovable cultural heritage, multi-layered historical structure, topographical features and the current conditions it has reached today. In this study, it is aimed to reveal the possibilities provided by digital tools in protecting cultural heritage and documenting and analyzing the change of cultural heritage on an urban scale through Hasankeyf.

In this context, photogrammetric models of Hasankeyf were created with Metashape software using old drone images. Subsequently, a photogrammetric model of the flooded old settlement area was created using the most recent drone images in order to make a process evaluation. Hasankeyf's transformation was analyzed through the models obtained. The fact that the models provide an opportunity to address the city in a holistic manner has allowed to clearly see the transformation of the historical area of Hasankeyf and the transformation of the city in the process has been revealed on an urban scale.

2. MATERIALS and METHODS

2.1. General information about Hasankeyf

Hasankeyf, formerly known as Hısn-ı Keyfa, is located in the province of Batman in the Southeastern Anatolia Region of Turkey. "Hısn-ı" The Arabic "Keyfa" is Syriac and both mean "rock". Hısn-ı Keyfa also means "Yalçın Rock Peak" (Umar, 1993). The history of the district dates back to approximately 12,000 years ago. Hasankeyf, which has been home to many civilizations in history, contains rich cultural heritage structures. According to records dated 1530, Hasankeyf, which was under Ottoman rule, had 4 mosques, 11 zawiyas, 30 masjids, 2 caravansary and 4 baths (Baluken, 2016: 310-335). Hasankeyf was declared a natural protected area by the Ministry of Culture and Tourism in 1981 (Çoban, et al. 2017; Yeşil and İnal, 2019; Öncül and Alpaslan, 2014; Öztürk, et al., 2021). The city is accessible to Batman and Mardin from the west and Midyat and Gercüş from the south (Figure 1). Hasankeyf, which is an important tourism center with its historical and natural beauties, is visited by many local and foreign tourists.

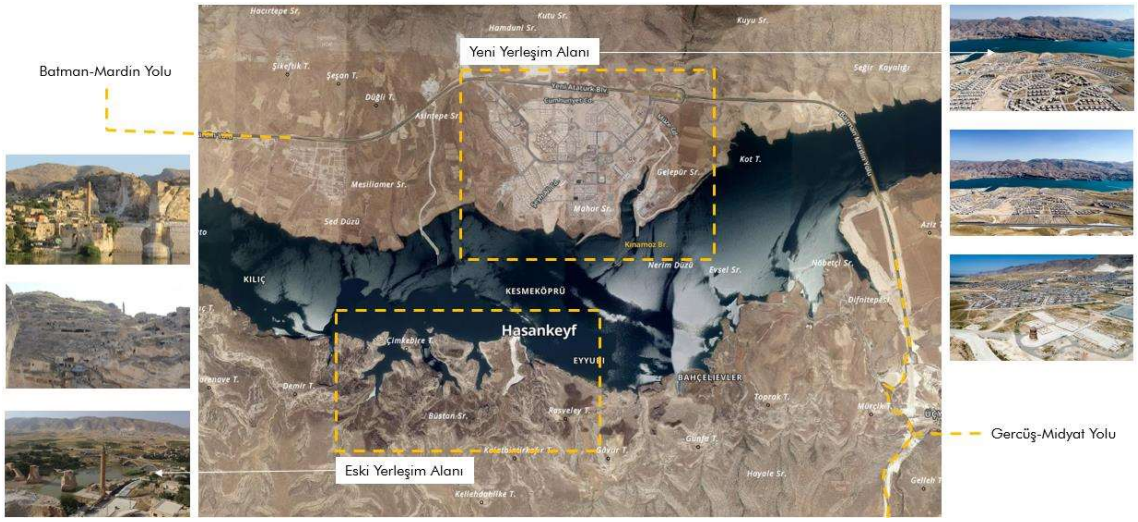

Figure 1. Hasankeyf city boundaries and views (Edited from General Directorate of Mapping)

The geological structure of Hasankeyf consists of cave dwellings created by natural and man-made processes due to its limestone structure that can be easily carved. The appearance of its rocky terrain with valleys and hills formed by natural factors over thousands of years is one of its most important features (Arık, 2003: 13). While excavations were continuing in Hasankeyf, located on the banks of the Tigris River, the construction of the Ilısu Dam Project began. In May 2020, as a result of the dam built on the Tigris River, the historical settlement of Hasankeyf

was flooded. For this reason, rescue excavations and works for the transportation of historical artifacts were carried out in Hasankeyf before it was submerged under the waters of the Ilısu Dam. Protection and transportation works were carried out in cooperation with the General Directorate of State Hydraulic Works and the General Directorate of Cultural Heritage and Museums (Sevgi & Yılmaz, 2020). The historical buildings moved to the archaeopark area organized in the new Hasankeyf settlement area were prevented from being flooded.

2.2. Data Collection

Data collection method is the research technique used to obtain data that will bring the research subject to the conclusion. Depending on the research topic, data collection can be done in various ways such as document analysis, questionnaire, interview, observation, experiment (Symon & Cassell, 1998: Yıldırım, 1999).

Due to the relocation of historical buildings to the new settlement area in Hasankeyf district, data collection studies on the old city views were carried out first. Extensive online publications and research on image acquisition were conducted. Following the acquisition of data on the old city, data research on the new city views was carried out. Especially the existing images obtained from unmanned aerial vehicles (drones) provide important data for the city as a whole. The data obtained was used as a base in the study in order to reveal the old and new urban texture of the region.

2.3. Digital approach to documenting cultural heritage

Two stages are very important in the cultural heritage process. The first one is data collection and the other is the decision-making process. The data collection phase is a process that also affects the decision-making process and should be followed carefully. According to Boehler and Heinz (1999), the decision-making process in the study of cultural heritage involves first deciding what to document and then selecting the appropriate methodology in consultation with experts from other disciplines.

With the developing technology, the methods used in documenting historical values are also changing and developing. The use of modern techniques in historical buildings and cultural heritage studies has provided great convenience over time compared to traditional methods (Balcı, 2022). Although these methods have diversified over time, the margins of error have gradually decreased, time savings have increased, manpower burden has decreased, and it has progressed digitally to 3D documentation (Masciotta et al., 2021; Reunanen et al., 2015; Korumaz et al., 2011). It is easier, faster and more precise to take detailed measurements, make drawings, take photos and videos, and obtain 3D data from drawings. In addition to all these, modern techniques provide the opportunity to store the obtained precise and visually rich data in a digital environment for a long time.

In this study, photogrammetry, one of the 3D modeling techniques enabled by today's technology, was used. Photogrammetry means measuring with the use of photos and enables the creation of a 3D model from photographs (Gienko & Terry, 2014; Yılmaz, et al., 2007; Şenol, et al., 2021). In general, photogrammetry is a science in which reliable information about objects and the environment is obtained as a result of the recording, measurement and interpretation of photographic images shaped by the rays emitted from the objects and the environment they form, and the electromagnetic energy they emit (Figure 2). There are different photogrammetric classifications such as terrestrial photogrammetry and aerial photogrammetry

according to the technique of obtaining images. In this study, aerial photogrammetric technique was used. Aerial photogrammetry is a technique used to create maps, models, and measurements from aerial photographs. It involves capturing overlapping aerial images and using them to extract 3D information about the terrain or objects of interest.

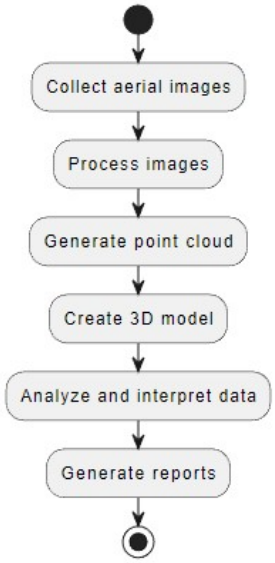

Figure 2. Process flow chart of 3D photogrammetric model production with aerial images used in the study

3. FINDINGS

In this study, Hasankeyf data were analyzed in two different periods, before and after 2019, with reference to the water filling of the Ilısu Dam and the hydroelectric power plant in August 2019. Photogrammetric models were created for both periods in order to ensure an effective and holistic analysis of the periods. The cultural heritage data were analyzed through the digital three-dimensional models created in the study. These models were created with real measurements using the program's depth detection algorithm.

In order to present the change of the region with digital tools, the change of the old and new settlement areas of Hasankeyf over time was mapped on 2D Google Maps. Prior to 2019, a 3D photogrammetric model of the area was created in addition to the 2D map. The model indicates the locations of the cultural heritage structures in the area at that time. In the period after 2019, an updated photogrammetric model was created to show the condition of the flooded old settlement area. In the study, a model was also created for the new settlement area in the city, where a process of cultural heritage relocation was managed, and the new locations of the relocated cultural heritage were also indicated.

3.1. Hasankeyf – Before 2019

In the study, existing drone images were used to create a model of the Old Hasankeyf settlement area. The photogrammetric software program Metashape (developed by Agisoft) was used to obtain the images. The program has algorithmic features that can detect depth from the acquired

images. In order to create a photogrammetric model of the Old City of Hasankeyf, 174 photographs were added to the program.

In order to perceive depth from photographs, they must be overlapped and taken from different angles. Otherwise, the program cannot identify and align the images. The program aligned 138 out of 174 images obtained for Old Hasankeyf. After the alignment process, a model is formed from the point cloud. Upon completion of the alignment process, build dense cloud is created. The build dense cloud allows to create a denser point cloud than the base points that can be aligned from the photographs. With the creation of the dense point cloud, the "built mesh" process of converting the points into meshes was realized. The textures of the defined photographs were transferred to the model consisting of networks by "build texture" and "build tiled model" operations. Thus, the Old Hasankeyf model creation process was completed (Figure 3).

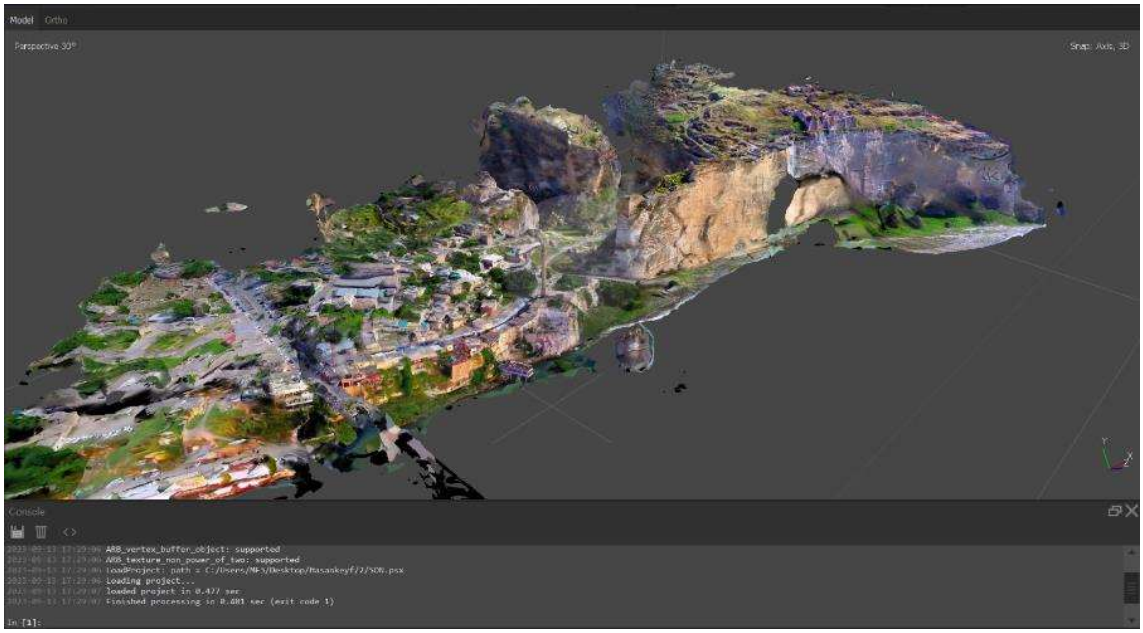

Figure 3. Photogrammetric model produced within the scope of the study for Hasankeyf old settlement area

At the beginning of the 21st century, the Ilısu Dam Project created the need for a new settlement area for Hasankeyf. This area was evaluated as the foothills of the mountain in the northern direction of the old settlement area and across the river. The new settlement area, which has a flatter terrain compared to the old settlement area, started to be built quickly after the decision was made (Figure 4).

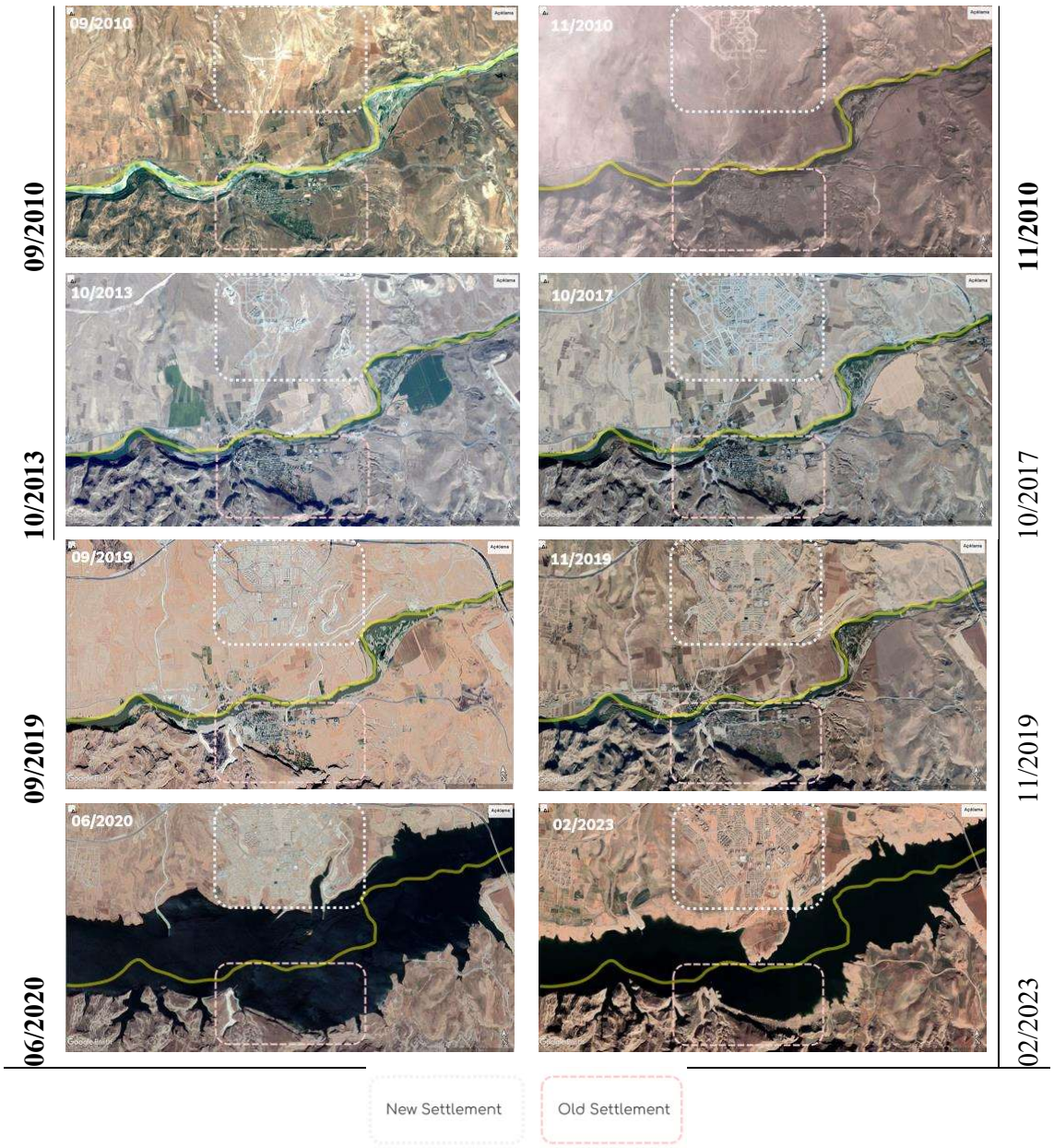

Figure 4. Historical development of Hasankeyf settlement area

3.2. Hasankeyf – After 2019

In order to make a comprehensive assessment of the old and new settlement areas, models were created for both the current situation of the old settlement area and the new settlement area of Hasankeyf after 2019.

The flooded model of the old settlement area was created with data from 2021. 133 photographs of the settlement area were added to the program and the program recognized and aligned all

these photographs. After the alignment process, the dense point cloud generation was performed and the process was completed by generating a model consisting of meshes (Figure 5).

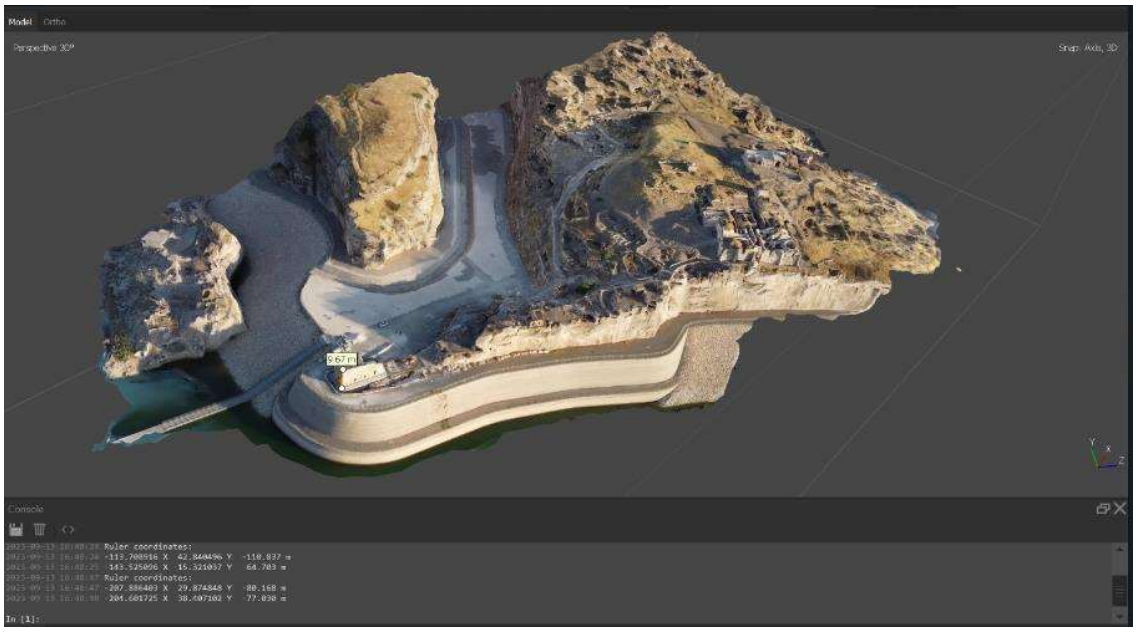

Figure 5. Hasankeyf eski yerleşim alanının su altında kalan durumunu gösteren fotogrametrik model

With the flooding of the Hasankeyf settlement area, the issue of relocation of both civilian life and cultural heritage has arisen. Immovable cultural heritage sites known as Zeynel Bey Tomb, Artuklu Bath, Imam Abdullah Zawiyah, Kızlar Mosque, Middle Gate, Süleyman Han Mosque and Er Rızk Mosque were moved to the Archaeopark Cultural Area due to the risk of being submerged under the Ilısu Dam and Hydroelectric Project (HES). This new settlement area is located approximately 2 km north of the old settlement area from a bird's eye view. As part of the study, a photogrammetric model of the area was created in order to see the legibility of this area and the new locations of the historical buildings on an urban scale. To create the model, 283 photographs were used and the program created a photogrammetric model of the area by identifying 271 of these photographs (Figure 6).

Figure 6. Photogrammetric model of Hasankeyf new settlement area and Arekopark area

4. Evaluations and Discussion

The tools used in the conservation and documentation of cultural heritage are changing and evolving with the development of technology. The method of photogrammetry used in this study has spread rapidly with the development of photographic techniques and computer software in the mid-20th century. Considering the identification process of the photographs used in photogrammetric model making, the process may not be a single step, and the program may not be able to align all the photographs taken. Therefore, it may be necessary to take new photos in the field. Photographs that cannot be identified by the program are detected by the program interface. New images should be taken from the same or similar angle using the "overlap" technique, paying attention to the previously identified image.

The new images can be aligned with the previously taken images by adding them back into the program. The problem with unidentified photos is usually that the images are not of similar daylight, size, and resolution quality. The visibility of the surfaces in the camera angle is one of the most important factors of the model quality. It is recommended that images be taken before hours of intense shade or intense sunlight. The 3D model obtained by photogrammetry is dimensional. However, it is recommended to check the dimensions of the models against an object whose real dimensions are known and to rescale them if necessary. One of the most important advantages of a scaled model is that important data measurements for surveys required for conservation and documentation studies can be obtained from 3D models.

When Hasankeyf is considered through the models created within the scope of the study, the transformation of Hasankeyf can be clearly seen. When this transformation process is evaluated within the scope of the models created;

- Examining Figure 7, it can be seen that old Hasankeyf, where the historical urban fabric is integrated with socio-cultural life, is completely submerged, while a part of Hasankeyf Castle is still above the water, can still be visited, and contains important cultural structures.

- Examining Figure 8, it can be seen that the original stairs that provided access to the castle and the area where the caves were located, which were among the first settlement areas, were covered with fill material in order to control the water from the dam.

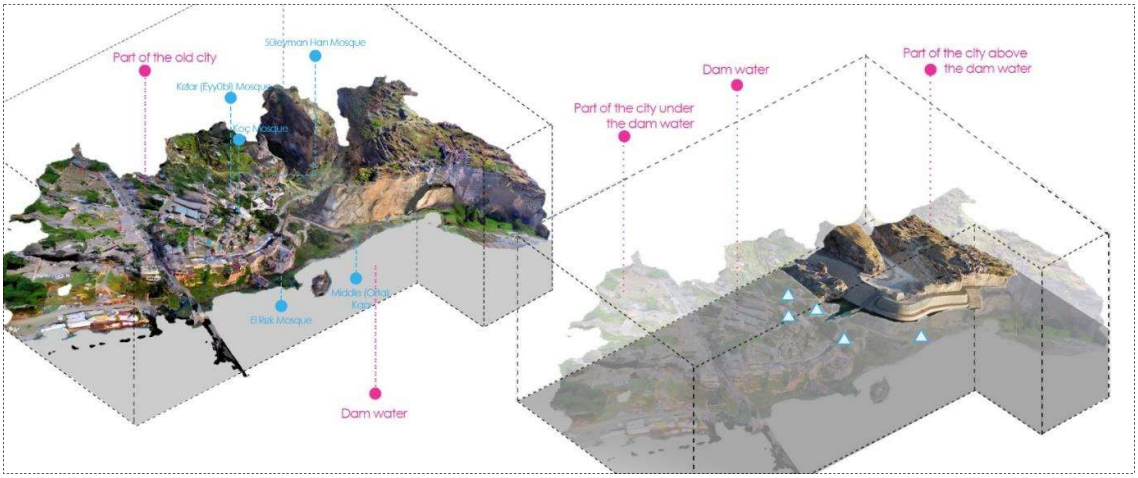

Figure 7. Historical Hasankeyf settlement and flooded areas

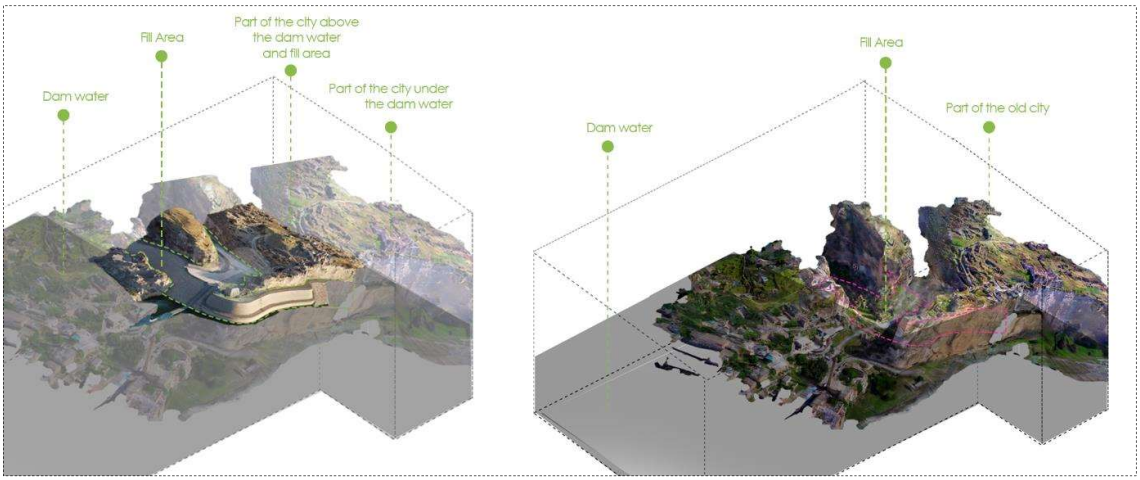

Figure 8. Regional locations of the embankment operations for the dam

- Examining Figure 9, the Archaeopark Cultural Area can be seen where the historical buildings that will be flooded by the Ilısu Dam have been relocated. The urban life and cultural heritage areas, which form an integrity with the civilian life of Hasankeyf, are located together in the new settlement area. The Archaeopark area has become an area that ensures the protection of individual structures.

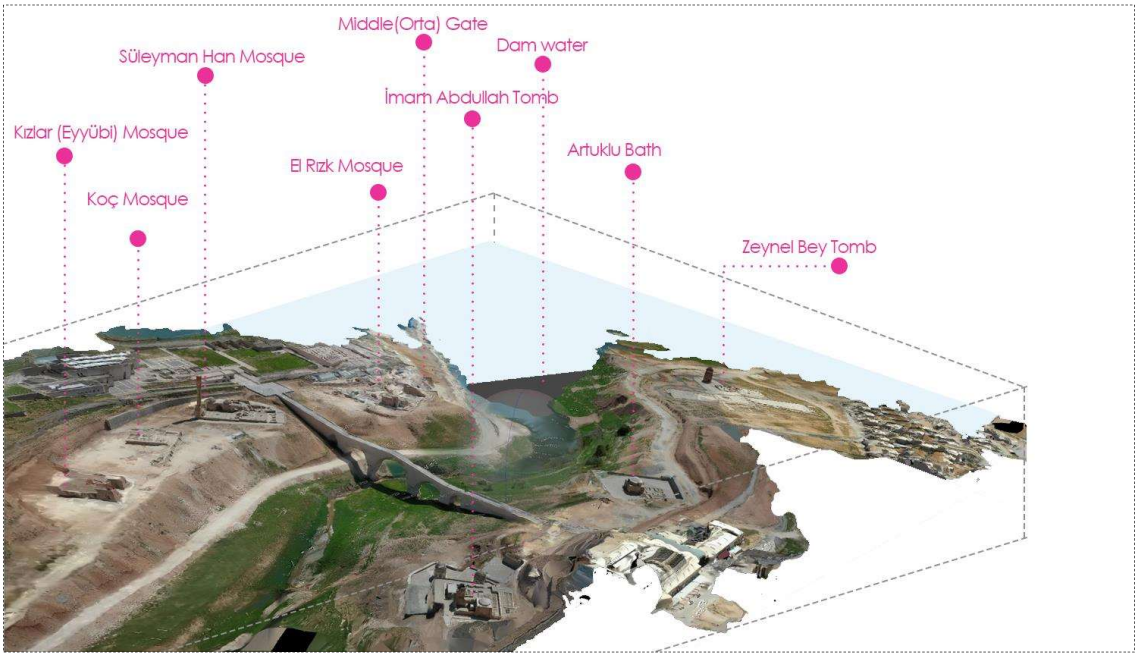

Figure 9. Photogrammetric model showing Hasankeyf new settlement area and Archaeopark Cultural area

Hasankeyf is a settlement with a rich historical and cultural background. It has historical buildings, caves and ancient ruins. For this reason, submerging under water also means losing the eye-catching effect of the cultural heritage. Although the tangible cultural heritage has been transferred to the new settlement area, the intangible cultural values have not been transferred. It can be said that in a region where abstract cultural values and feelings of belonging cannot be transferred, the original values of the region are also lost, and it will take many centuries to recreate these values in a new settlement area.

Although large-scale infrastructure projects such as the Ilısu Dam create a cycle in terms of resource production and consumption, their environmental impact is quite high. Such large-scale infrastructure projects can often cause conflicting emotions and different opinions. In this context, it is necessary to ensure the sustainability of all the physical, social and cultural values in the area without ignoring them when dealing with large-scale infrastructure projects, which are also a current topic of debate.

5. CONCLUSION

One of the primary rationales for integrating the concept of digitization with cultural heritage is the belief that sustainable documentation can be achieved by transferring heritage data requiring preservation to a digital medium. Consequently, this study has shed light on the significant role that digital methodologies can play in documenting the complex cultural heritage dynamics of Hasankeyf, a site of historical importance yet faced with various contemporary challenges.

Researchers are able to create a comprehensive digital archive that captures not only the physical elements of the heritage site but also its socio-cultural and historical dimensions through a multi-faceted approach incorporating digital mapping, 3D modeling, and interactive

databases. Digital tools discussed, ranging from GIS to drone-based photogrammetry, offer scalability in modeling and analysis, thus presenting a significant opportunity for the preservation or reconstruction efforts of Hasankeyf. These technologies also democratize the documentation process, allowing the community to actively participate in and contribute to the discourse surrounding their own cultural heritage.

While the digital approach offers numerous advantages, its limitations should not be overlooked. Technical constraints, resource limitations, and issues of digital preservation must be addressed to ensure that the generated data remain accessible and interpretable for future generations. Ethical concerns related to data ownership, representation, and inclusivity also necessitate further research. As we advance in the age of digital innovation, the need to leverage these technologies not merely as repositories of information but also as dynamic platforms for storytelling, dialogue, and mutual understanding becomes increasingly important. This study takes a significant step in preserving its rich history for future generations by documenting Hasankeyf's cultural heritage through a digital approach. At the same time, it lays the groundwork for data sets intended for future initiatives in heritage conservation, urban transformation and redevelopment.

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