Research Article

Paleoflood Analyses in Southeastern Turkey: Batman Case

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Abstract

In this study, paleoflood analyses were performed in order to determine the frequency of flood and overflow incidents which have caused loss of life and property in Batman in recent years. Batman, founded as Iluh village in Southeastern Turkey, is now a city thanks to developments in oil industry in migration from rural areas within 50 years. The number and frequency of floods are increasing as city center expanded to the river bed. Sediment log wells are opened to determine paleoflood features. Thermoluminescence and radiocarbon analyses are applied to the samples collected from log wells near Iluh riverbed where river fan widens. The sedimentological data revealed that 3 catastrophic flood occurred at present location of the city center. Radiocarbon analyses (\(^{14}\)C) dated the first flood 1420±21 years BP, the third was dated back to 220±25 years BP. According to historical data, the period of the second flood between the first and third one dates back to 800 years BP. Thermoluminescence analyses showed a decrease in flood energy from past to present. Other than these analyses, regional scaled geoarchaeological and historical data and studies on the climate changes were compared and the accuracy of the discovered dates was tested.

Keywords: Paleofloods; Batman; Iluh creek; Thermoluminescence (TL); Radiocarbon dating

Introduction

The number and frequency of floods in Turkey increased during 1990-2012. Some of the flood events were devastating, caused loss of life and property throughout the country. Contemporary floods are studied by researchers particularly geographers [1-8]. Unfortunately studies on plaeofloods have never been outlined in Turkey. Thus, our study is first of its kind in Turkey that documented characteristics of plaeofloods. However, several paleoflood studies have been throughout the world that gave clues for possible future flood events, e.g., [9-26].

Batman city was founded in the area of Iluh Creek which was once not linked to Batman Stream. The city developed rapidly and became a medium-sized industrial city after 1970 (Figure 1). From then onwards, an increase was observed in the incidence rate and frequency of flood and torrent events causing great loss of life and property. The flood and torrent events occurred almost every year in the city after intense precipitations were observed in Iluh Creek and its branches. The last flood that occurred on October 31 to November 1, 2006 resulted in 10 deaths and a material damage on loss of 20 million dollars (Figure 2).

Iluh Creek is a seasonal stream which drains the waters of an area located between Mountain Kira and Raman in the Southeastern Anatolia Region. This creek is linked to Batman Stream in the west of Batman city. With its pyramidal shape, it collects the waters of an area of 316 km\(^2\) (Figure 3). The wide basin area and seasonal characteristic of the creek is of utmost importance with regard to the occurrence of flood and torrent events following downpours.
samples were collected from the fan for analyses. A total of four log
of the sediment is repeatedly deposited in the alluvial fan, and so
log wells. Since Iluh stream has seasonal flow (Figure 3a), majority
field surveys, on sedimentology and geomorphology, and sediment
performed by utilizing satellite images, 1/25.000 topographic maps,
data processing [32]. The paleoflood analyses of Batman city were
sedimentology, hydrology, hydrologic modeling and statistical
to shed a light on the flood periods in Late Holocene.
paleoflood periods in Batman were determined. Also it was seen that,
evaluations, the findings of 4 different methods were compared and
forward the climate changes were evaluated (4). As a result of these
researches on the sedimentologic and pollen analyses which put
studies of the region were reviewed (3). With all these studies, the
test the accuracy of the age data, historical and geoarchaeological
data of dating the findings resulting from these analyses (2). In order to
determine the frequency of the floods which took place
in Batman. Different methods which are used very often in the
paleoflood analyses were applied as there were no hydraulic data of
the stream in which the flood was seen. The first method is composed
of sedimentological analysis (1), and the second one is composed
of dating the findings resulting from these analyses (2). In order to
test the accuracy of the age data, historical and geoarchaeological
studies of the region were reviewed (3). With all these studies, the
researches on the sedimentologic and pollen analyses which put
forward the climate changes were evaluated (4). As a result of these
evaluations, the findings of 4 different methods were compared and
paleoflood periods in Batman were determined. Also it was seen that,
geoarchaeologic, sedimentologic and pollen analyses were qualified
to shed a light on the flood periods in Late Holocene.

Method and Data

Paleoflood studies require inputs of geomorphology, sedimentology, hydrology, hydrologic modeling and statistical
data processing [32]. The paleoflood analyses of Batman city were
performed by utilizing satellite images, 1/25.000 topographic maps,
field surveys, on sedimentology and geomorphology, and sediment
log wells. Since Iluh stream has seasonal flow (Figure 3a), majority
of the sediment is repeatedly deposited in the alluvial fan, and so
samples were collected from the fan for analyses. A total of four log
well were dug and cleared for sediment designation at river terraces
of Iluh Creek (Figure 3b).

In the field observations, the places in which sedimentologic
observatory wells would be opened were determined. As Iluh Creek
has seasonal flow, it was determined that the most suitable areas were
the ones in which the fan formed by this creek started to widen. In
accordance with this decision, 4 observation wells were opened in Çay
District Iluh Creek Bed and its periphery with a simple construction
vehicle. In the observation wells which were opened later, cleanings
were carried out in the parts from which the profiles would be taken.

Transported pottery shards were found in log wells within
gravel layers. Moreover, bone fragments weighing less than 50g
were detected as well. Samples were stored in black plastic bags for
avoiding exposure of samples to direct sunlight since exposure might
cause anomalies during Thermoluminescence (TL) and radiocarbon
analyses.

The samples taken from various depths (section number 2 170-
190, 200-215 and 260-290 cm, Figure 6, 8) in the study area for
the thermoluminescence analyses were put into black plastic bags in
order for them not to be affected by the sun rays [33]. Electrons of
the sun rays which are trapped to directly come to the samples especially
affected them after 40°C and they formed negative results in TL
readings [34]. Due to lack of measuring annual doses, TL analyses
were undertaken by comparing relative weathering levels of shards
[35]. The TL sample preparation was based on fine grain method [36].
The surface layer of shards was first removed from the surface. The
remaining sample was crushed and powdered in an agate pestle and
mortal. The grains sized from 4 to 11 µm (fine grains) were treated
with HCl to neutralize carbonate, and washed with diluted water.
Unirradiated samples were taken to obtain the natural TL signal and
the remaining samples were irradiated for 5 minutes for artificial
doses.

The bone fragments thought to be of human and animal origin
were dated by ¹⁴C. Radiocarbon measurement is required for
precise dating in paleohydrology studies [37,38]. Historical and
goarchaeological findings and sedimentologic and pollen analyses
were compared in order to ensure that bone fragments which were
found as a result of the sedimentologic analyses reflected the flood
periods. As a consequence of the comparison, radiocarbon age results
and other analyses results were found to be consistent.

Findings

Detailed geomorphologic observations, sedimentologic and
thermoluminescence analyses and radiocarbon dating were made
in order to reveal the paleofloods that occurred in Batman and its
vicinity. The findings acquired were compared with the historical and
goarchaeological data and the following results were obtained.

Geomorphological and sedimentological findings

Batman city was founded on the old meander terraces and the
new alluvial fans of Batman Stream. These terraces are split by Iluh
Creek in the area where the city was founded (Figure 4). The valleys
of creeks affecting the area where Batman city was founded are quite
apparent and have a deep structure in the upper basins. The stream
beds in the foundation area of the city were destroyed due to low
inclination as a result of urbanization.
In geomorphological observations along the valleys of Tigris River and Batman Stream, flood materials were found in the terrace deposits located 25-45 m (T3) and 10-15 m (T4) above the valley bottom. This situation is the indicator of the fact that the floods frequently occurred also in the past.

Figure 4: Geomorphological map of Batman city [28].

The presence of coarse cobbles in alluvial fan detected at log wells supported the paleoflood occurrences and a total of three flood events were observed in well logs (Figure 5, 6). Low silt containing soil layer at 250-260cm from surface was determined at Well-1 followed by 60-thick red colored well-packaged fine sand and gravel layer. This layer is equivalent to bar gravels which are determined at other wells that showed flood events. Paleofloods were best seen at Well-2 opened at Iluh creek bank (Figure 7). Current 30 cm thick surface layer contained flood material, a mixture of anthropogenic material and soil that were deposited in 1990 and followed by 20cm thick fine laminated loamy layer. These layers are succeeded by gravelly, clayey loam bar with 110cm thickness. Three gravel bars varying from 10-50cm to 290cm were determined under the recently deposited surface materials (Figure 5, 6, 7).

The size of gravels, sand and loam particles increased with depth. This is most probably due to decrease of flood energy in time. Moreover, the presence of shards and bones suggest effect of recent floods on rural settlements. Sediment features in Well 3 opened on the west of Well-2 was quite different because the creek bed of Iluh was changed by humans. Thus, deposits at 160-290cm in Well-2 were not determined in Well-3 (Figure 7).

Gravelly transition and relatively low gravel containing brown soil layer observed at 175-185cm was equal to gravel bar of Well-2 at 260-290cm.

Figure 5: Well-2 opened on Iluh creek bed. Numbers 1, 2 and 3 shows different flood events.

Figure 6: In the log well-2, it is possible to see layers together comprising of gravels, silt and fine sand which reflect different flood periods. The gravel sizes decreasing from down to top indicate that the energy of floods has reduced from past to present.

Figure 7: The stratigraphy of log wells (with scale). Layers associated with paleofloods were also observed in four log wells opened at different points of the bed of Iluh Creek. Of them, the most ideal section reflecting the floods which occurred in the last 1500 years was observed in the log well-2.
Well-4 was opened at northwest of Well-2 in cultivated field which represent similar features such as flood deposits to Well-2 (Figure 7). Deposits at 110-135cm and 250-260 revealed the last and first flood events in the past.

Shards collected from Well-2 were analyzed by thermoluminescence and $^{14}$C in University of Çukurova, Department of Archaeometry, Adana Turkey and Germany respectively.

**Thermoluminescence (TL) analyses**

Shards collected from Well-2 at 170-190, 200-215 and 260-290cm depths were analyzed for their exposure to sunlight since no dosimeter was installed at site. Pottery is produced more than 800°C which empties trapped electrons from the minerals and following firing traps are again filled with environmental radiation [33]. Thus, exposure to sunlight or heat from a fire at a site of human occupation empties many of the traps in minerals of the shards. This well-known phenomenon is used for comparing shards exposure to sunlight to determine exposure period after flood event which also reveals frequency of floods [35,39,40]. Thus, low TL peaks showed longer exposure since sun light empties electrons from mineral traps [33].

The TL glow of 290-260cm shards with porous, unglazed with nonuniform firing pattern, suggests a relatively low period of exposure (Figure 8). Coarse gravel bars and rock fragments revealed high transportation energy [41]. The exposure of 200-215cm shard samples with fine slip relatively higher than 260-290cm samples however 170-190cm sample documented the highest exposure period (Figure 8, 9, 10, 11).

The medium to fine gravels of the section suggests a moderate transportation energy (grading and sorting) (Figure 7) [42]. Thus, shards at 215-200cm were most probably transported with moderate energy and exposed to sun light longer than 290cm samples. Samples of 190-170 cm glazed with uniform firing pattern have the highest glow (Figure 9, 10, 11). Moreover, grading and sorting of the materials in the layer finer than former two layers revealed low energy of the creek transportation (Figure 7).

**$^{14}$C Analyses**

Dating error may vary from 4 to 160 years in radiocarbon analyses [43]. However, dating error in this study was 25 years and it is within the 25 to 50 years of acceptable error range which was suggested by Benitto and Thorndycraft (2005) [32] for the last millennium flood deposits. $^{14}$C analyses were performed in Heidelberger Academy of Science (Germany) only at Well-2 samples of human and animal bones that are suitable for $^{14}$C analyses (Table 1).

$^{14}$C dating revealed severe flood events 1420±21 years before present in Batman. Fine sand and loamy bar deposited on gravelly layer manifested a more humid and high rainfall period. Last severe flood occurred 220±25 years before present. Latter flood deposited relatively finer material than the first flood which most probably...
showed low transportation energy. Another flood event was observed between these two events however, due to lack of available sample for \(^{14} \text{C} \) analyses dating was not employed for this layer. However, it was stated in the study of Öğün Bezer (2001) [44] that there had been a big flood around Batman in 19 May 1165, which was mentioned in historical sources. When radiocarbon age data and this date are compared, it is found that the second flood occurred 800 years ago. Therefore, it has become possible to determine accurately the floods which occurred in the past 1500 years around Batman.

### Historical and geoarchaeological findings

It is of utmost importance to know the characteristics of flood and torrent events experienced in the past to forecast the behaviors of probable floods and torrents in the future. In this respect, in flood and torrent studies, it is necessary to review the floods in paleo or historical periods. Historical records on floods are not available in Batman due to its recent approval as a city in 1940. However, damages seen in rural settlements on Batman riverbanks suggest frequent flood occurrence in the past. The largest flood known to have occurred in Batman and its vicinity dates back to May 19, 1165. 160 people died in this disaster [44]. The second largest hazardous flood recorded occurred in El Medina located on flood plain of Batman river in 1926 [45] and repeated floods wiped out the town (Figure 12).

The foundation date of El Medina is not exactly known; however, as recorded in 1899 yearbook, it is a settlement comprising of 128 houses within the administrative organization of Diyarbakır Province [46]. The fact that the last important flood occurred 220±25 years ago according to radiocarbon dating indicates that El Medina was founded in the early 1800s after this flood.

It is very difficult to obtain historical documents related to previous floods in the areas other than large centers of Turkey. Nevertheless, in the studies carried out along the valleys of the Euphrates and Tigris rivers, significant findings were obtained in relation to floods that occurred in historical periods in the Southern Anatolia Region [47-50] (Figure 13). Undoubtedly, it is considered that the floods in the upper basins of the Euphrates and Tigris rivers also had an effect in the lower basins. Archeological excavations carried out in the mounds along the valleys of the Euphrates and Tigris Rivers provide reliable data about the floods occurred within the years 4000-5000 years, 1500 years before today (Table 2).

In the archaeological excavations on the historical settlements which were submerged under the waters of the dam constructed on Euphrates and Tigris rivers, important flood data of historical periods were reached. Most of the archaeological excavations in Tigris River Valley were done in the mounds very near to Batman (Figure 13). So, geoarchaeological data provide considerably tangible results about the paleoflood in the territory.

Batman became a province through development as a result of rapid urbanization movements in the last 50 years. There was once a small village settlement in the foundation area of the city. In addition, Körtik Tepe located on the junction of Tigris river and Batman Stream in the southeastern part of Batman city was founded in the Aceramic Neolithic (10500?BC) period [51]. The existence of dense historical settlements in the valley of Tigris River and Batman Stream indicates that the district has been an area of settlement since the early periods of history.

In archeological excavations carried out in Tigris Valley between Bismil (Diyarbakır) and Batman, significant changes were obvious in the natural environment conditions of the district in the Holocene Period [49,50]. According to geoarchaeological data obtained through studies conducted in historical settlements located on the terraces of Tigris River between Bismil and Batman, this site has been an area of settlement since the Neolithic period. The settlements founded on the terraces of Tigris River were affected by floods in certain periods (Table 3). Accumulation occurred during the periods of large floods and incision occurred in the interim periods.

### Table 1: \(^{14} \text{C} \) Analyses of Well-2 samples (09.04.09) (09.04.09).

<table>
<thead>
<tr>
<th>Lab. No</th>
<th>Sample Label and dept</th>
<th>Mean date (^{14} \text{C} ) BP</th>
<th>( \delta^{13} \text{C} )</th>
<th>Calibrated age 1 ( \sigma )</th>
<th>Calibrated age 2 ( \sigma )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hd-27943</td>
<td>II-1. 170-190 cm</td>
<td>220±25</td>
<td>-29.4</td>
<td>cal AD 1650-1950</td>
<td>cal AD 1644-1951</td>
</tr>
<tr>
<td>Hd-27944</td>
<td>II-4. 260-290 cm</td>
<td>1420±21</td>
<td>-18.8</td>
<td>cal AD 618-649</td>
<td>cal AD 600-656</td>
</tr>
</tbody>
</table>

Note: Calibrated with INTCAL04 and CALIB5 [55].

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**Figure 12:** The site of El Medina settlement, founded in flood plain of Batman river, and wiped off in 1926 flood.

**Figure 13:** Historical settlements located in the upper and lower basins of the Euphrates and Tigris rivers and affected by the flood.
The classification of Doğan [50] covering the periods up to Iron Age was used for the separating of accumulation and incision periods and these periods from that time to present were determined in accordance with sedimentological analyses which we performed on the fan formed by İluh Creek. Flood data within the archaeological excavations generally belong to the period 1500-2000 years before today. Flood periods in the last 1500 years period which was missing within the last 1500 years period were determined (Table 1, 3).

Table 3: Accumulation and Incision Periods around Tigris River and Batman Stream between Bismil and Batman According to Archeological and Radiocarbon Dating Data.

<table>
<thead>
<tr>
<th>Periods</th>
<th>Sediment Accumulation or Incision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early Neolithic (before 6000 BC)</td>
<td>Accumulation</td>
</tr>
<tr>
<td>Late Neolithic (6000-5500 BC)</td>
<td>Incision</td>
</tr>
<tr>
<td>Early Chalcolithic (5500-4000 BC)</td>
<td>Accumulation</td>
</tr>
<tr>
<td>Late Chalcolithic-Early Bronze Age (4000-2650 BC)</td>
<td>Incision</td>
</tr>
<tr>
<td>Early Bronze Age-Iron Age? (2650-1200 BC)</td>
<td>Accumulation</td>
</tr>
<tr>
<td>Iron Age - First and Middle Age (1200 BC-637 AC)</td>
<td>Incision</td>
</tr>
<tr>
<td>Middle Ages and Modern Age (637AC-1800 AC)</td>
<td>Accumulation</td>
</tr>
<tr>
<td>Modern Age (1800 AC after)</td>
<td>Incision</td>
</tr>
</tbody>
</table>

Only limited number of log wells could be opened as a major part of the fan formed by İluh Creek was occupied by the settlements. Nevertheless, reliable results were obtained from four log wells opened. Gravelly levels in the alluvial fans indicate high energy periods of streams. For seasonal streams with a wide basin like İluh Creek, gravelly levels also correspond to flood periods. The section no 2 in the log wells opened in the part of İluh Creek at the exit of Batman city has such a structure. At this section, gravelly layers as well as fine sand and silt layers exist.

As Batman city has an ancient history of settlement, many shards carried by floods were found in the log wells. It is not always possible to see such materials by the streams. As no measurement with dosimeter was possibly made in the terrain, the age of shards could not be determined. The material was analyzed using Thermoluminescence method in order to reveal the intensity of flood. Other than historical evidences, bone parts carried certainly by floods were subject to radiocarbon dating (14C) process. As radiocarbon dating is a standard process in paleofoold investigations, it was also employed in this study [37,38]. When these data and climate and vegetation records of the region covering a period of the last 1500 years were compared, the existing dating was proved to be true (Figure 14).

The results obtained by means of arboreal pollen analyses applied to the surroundings of Lake Van and geochemical analyses on the sediments of Lake Van may also possibly by used to explore the floods experienced in the valleys of the Euphrates and Tigris rivers. Even though Lake Van is remote to the Southern Anatolia Region and exhibits different climatic characteristics, it has similar features to the upper basins of the Euphrates and Tigris rivers. In this respect, pollen and paleoclimate data obtained for the surroundings of Lake Van [53,54] may be used as a reference for the parts of the Euphrates and Tigris rivers involved in the boundaries of Turkey. This reference is especially more suitable for flood studies. As a matter of fact, the occurrence of slack water deposits is a necessity in paleoflood studies. Paleoflood studies are generally carried out in a stream valley where frequent flood events occur. Our study was also conducted according to sedimentological data obtained from the area of İluh Creek Valley where flood events occur frequently (Figure 3). The existing findings were compared with geoarchaeological data and thus the floods occurred around Batman within the last 1500 years period were determined (Table 1, 3).

The results obtained by means of arboreal pollen analyses applied to the surroundings of Lake Van and geochemical analyses on the sediments of Lake Van may also possibly by used to explore the floods experienced in the valleys of the Euphrates and Tigris rivers. Even though Lake Van is remote to the Southern Anatolia Region and exhibits different climatic characteristics, it has similar features to the upper basins of the Euphrates and Tigris rivers. In this respect, pollen and paleoclimate data obtained for the surroundings of Lake Van [53,54] may be used as a reference for the parts of the Euphrates and Tigris rivers involved in the boundaries of Turkey. This reference is especially more suitable for flood studies. As a matter of fact, the

Table 2: Paleofloods and their occurrence periods according to archeological excavations carried out in the historical settlements located in the valleys of Upper Euphrates and Tigris rivers and Southern Mesopotamia.

<table>
<thead>
<tr>
<th>Stream-Region</th>
<th>Location (Mound-Historical Settlement)</th>
<th>Period</th>
<th>Date</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tigris River</td>
<td>Körtük Tepe (Bismil/Diyarbakır)</td>
<td>Acemelik Neolith</td>
<td>Before 6000 BC</td>
<td>Doğan [50]</td>
</tr>
<tr>
<td></td>
<td>Kavuş Tepe (Bismil/Diyarbakır)</td>
<td>Late Chalcolithic-Early Bronze Age</td>
<td>3000-2000 BC</td>
<td>Doğan [50]</td>
</tr>
<tr>
<td></td>
<td>Aşağı Salat Tepe (Bismil/Diyarbakır)</td>
<td>Early Bronze Age I</td>
<td>2800-2650 BC</td>
<td>Doğan [50]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Early Bronze Age-Iron Age Middle and Today</td>
<td>2650-1200 BC</td>
<td>Doğan [50]</td>
</tr>
<tr>
<td>Euphrates River</td>
<td>Değirmantepe (Kale/Malatya)</td>
<td>Early Bronze Age I-Iron Age</td>
<td>3000-1000 BC</td>
<td>Esin [56]; Köroğlu [48]</td>
</tr>
<tr>
<td>Southern Mesopotamia</td>
<td>Köşkerbaba (Kale/Malatya)</td>
<td>Early Bronze Age-Iron Age</td>
<td>2650-1200</td>
<td>Bilgi [60]; Köroğlu [48]</td>
</tr>
<tr>
<td></td>
<td>İmkoğanı (Baskılı/Elazığ)</td>
<td>Late Bronze Age</td>
<td>2000-1500 BC</td>
<td>Sevin [59]; Köroğlu [48]</td>
</tr>
<tr>
<td></td>
<td>Kösehöyük (Malatya) and Kaleköy (Elazığ)</td>
<td>Early Bronze Age-Iron Age</td>
<td>2650-1200</td>
<td>Özdoğan [58]; Köroğlu [48]</td>
</tr>
<tr>
<td></td>
<td>Ur City</td>
<td>Late Chalcolithic-(Ubaid Period)</td>
<td>3500 BC</td>
<td>Wooley [57]; Köroğlu [48]</td>
</tr>
<tr>
<td></td>
<td>Kış Province</td>
<td>Early Bronze Age I (Early Dynasties I and II)</td>
<td>2700 BC</td>
<td>Köroğlu [48]</td>
</tr>
<tr>
<td></td>
<td>Tell ed-Der (South of Baghdad)</td>
<td>Late Bronze Age</td>
<td>1830-1770 BC</td>
<td>Köroğlu [48]; Doğan [50]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1770-1700 BC</td>
<td>2900 BC</td>
<td>Köroğlu [48]; Doğan [50]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1700-1650 BC</td>
<td>2600 BC</td>
<td>Köroğlu [48]; Doğan [50]</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1650-1500 BC</td>
<td>1900 BC</td>
<td>Köroğlu [48]; Doğan [50]</td>
</tr>
</tbody>
</table>
periods when arboreal pollens decrease correspond to arid and incision periods, while the periods when they increase correspond to humid and accumulation periods. This situation has been more clearly observed in the last 1500 years (Figure 14).

Figure 14: A comparison of accumulation and incision periods with arboreal pollen and atmospheric humidity in the Southern Anatolia Region. a) Arboreal pollen from Söğütlü, Lake Van (based on Bottema, 1995 [53]); b) Proxy humidity curve (from Lermicke and Sturm, 1997 [54]); c) Accumulation and incision periods seen within the last six-seven thousand years. In the flood periods, accumulation occurred, and in the following periods, incision events occurred. This event demonstrates the compatibility with the arid and humid periods above.

In the study on geochemistry of the sediments of Lake Van [54], a very close association was found between paleo-flood analyses for Iluh Creek and the periods of humidity and aridity in the last 1500 years. According to sedimentological analyses, 3 large flood events were recorded around Batman. According to 14C BP dating, the first flood dates back to 1420±21 years BP and the third one dates back to 220±25 years BP. The period of the second flood between these two flood periods was aged according to historical data and it was seen 800 years before today. According to historical data, the flood and torrent events experienced in Batman region on May 19, 1165 were recorded around Batman. According to 14C BP dating, the first flood dates back to 1420±21 years BP and the third one dates back to 220±25 years BP. The period of the second flood between these two flood periods was aged according to historical data and it was seen 800 years before today. According to historical data, the flood and torrent events experienced in Batman region on May 19, 1165 were recorded around Batman. All these data confirm the accuracy of pollen, sediment and 14C BP dating.

In conclusion, pollen and geochemical analyses applied around Lake Van, geoarchaeological studies conducted in the valleys of the Euphrates and Tigris Rivers, the historical data and our analyses indicate the existence of a period of 1000 to 1200 years between the accumulation and incision periods throughout the Holocene period around Batman and across the entire Southeastern Anatolia Region.

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