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The Ancient Abu Al-Khaseeb River, Origin and Extinction - By Geophysical Investigations

Walaa M. Al-Mosawi *; Zainab. A. Al-Muturi and Dawood S. Al-Mayahi
Marine Science Center, University of Basrah, Basrah-Iraq
Corresponding Author: e-mail: walaa.khudher@uobasrah.edu.iq*

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Abstract - In Basrah Governorate, south of Iraq, there are many ancient river course sites. This issue is related to the nature of the region that represents the lower part of the Mesopotamian basin. One of these courses is the ancient Abu Al-Khaseeb River course; many queries have been raised about its existence, location, origin, and extinction, which is the subject of the current study. The current study uses Ground Penetration Radar and Sub Bottom profiler surveys to determine the trace of a river course named (the old Abu Al-Khaseeb River) extending from the main road that links the center of Basrah city with Al-Faw city and extends for 31.65 km towards the west at one of the dendrite branches of Khor Al-Zubair channel. The average width of this stream is about 40 m, and its depth does not exceed 2 m. The straightness of this course and its extension from east to west, unlike the river courses in the region (from north to south), the extent of ancient irrigation systems on both sides of this captured course, and the flatness of the land along it, all these features are evidence that this river course was the artificial origin for irrigation or drainage purposes for the area which was agriculturally active in the Abbasid period, according to historical sources.

نهر أبو الخصيب القديم، نشأته واندثاره بالتحريات الجيوفيزيائية

ولاء مجيد الموسوي و زينب عادل المطوري و داود سلمان المياحي
مركز علوم البحار، جامعة البصرة ، البصرة-العراق

المستخلص – يتميز الجزء السفلي من حوض الرافدين بالخصوص جنوب العراق بتواجد العديد من مواقع مجاري الأنهار الحالية والمندثرة، وتنتشر مجاري الانهار المندثرة بكثرة في المنطقة واشارت اليها العديد من الدراسات لكن معظم هذه المجاري المشار اليها لم تحدد تفاصيلها بدقة لأن معظم الدراسات التي أجريت عليها أعتمدت بالدرجة الاساس على الصور الفضائية دون التحري عنها في أرض الواقع. أحد هذه المجاري هو نهر أبي الخصيب القديم والذي أثيرت حوله العديد من الاستفسارات حول وجوده من عدمه وموقعه وأصله واندثاره وهو موضوع الدراسة الحالية. استخدمت الدراسة الحالية مسوحات رادار الاختراق الأرضي ومسوحات المقاطع العرضية للقيعان للتحري عن هذا المجرى على أرض الواقع فضلاً عن امتداده التخميني باتجاه قناة خور الزبير.

أثبتت الدراسة الحالية عن وجود هذا المجرى (نهر أبو الخصيب القديم) والذي يمتد من الطريق الرئيسي الذي يربط مركز مدينة البصرة بمدينة الفاو بمسافة 31.65 كم باتجاه الغرب عند أحد الفروع الشجيرية لقناة خور الزبير. يبلغ متوسط عرض هذا المجرى حوالي 40 مترا وعمقه لا يتجاوز 2 متر. من المرجح ان هذا المجرى أنشأ بفعل بشري قبل 1250 عام في العصر العباسي ولا يوجد دليل منطقي يشير إلى وجود صدع تسبب في حدوث هذا المجرى، وحفر هذا المجرى كان لغرض تصريف مياه الأنشطة الزراعية وادامة الاراضي الزراعية وصيانتها والتخلص من الملوحة باتجاه قناة خور الزبير. أما سبب اندثار هذا المجرى فقد كان بفعل بشري أيضا حيث أصبح هذا المجرى سبباً لاقتحام المياه البحرية من قناة خور الزبير باتجاه الاراضي الزراعية ولذلك أصبح وجود هذا المجرى غير مجدي وضار.

كلمات مفتاحية: نهر ابو الخصيب القديم; قناة خور الزبير; تقنية الرادار الارضي; تقنية المقاطع العرضية للقيعان.

Introduction

Rivers are not just waterways that flow from one place into another place, but metaphorically, they are actually life arteries, and they would look like the arteries of the planet if viewed from space. On the banks of rivers, the oldest civilizations arose, not only because they provided drinking water, irrigation, and urbanization but also because the investigation of their existence and development provided effective tools to know the development of civilizations. It provides keys to understanding the geographical and geological evolution of the areas in which they existed during the time, as rivers represent one of the most important morphological forms sensitive to geological and tectonic changes, which in turn affect the shape of the earth. The area south of Basrah, south of Iraq, is located in the lower part of the Mesopotamian basin; it is characterized by the abundance of river courses that continue to flow to the present time, and many ancient river courses have become extinct, but their traces remain on the land.

The study of the lower part of the Mesopotamian basin and its development during geological history has been the focus of attention of many researchers because it represents the part overlooking the Arabian-Persian Gulf, which has been subjected to geological changes over time, where many studies such as (De Morgan, 1900; Lees and Falcon, 1952; Kassler, 1973; Larsen, 1975; Hansman, 1978; Purser *et al.*, 1982; Karim, 1988; Al-Mussawy, 1993; Aqrawi, 1995; Pournelle, 2003; Vanessa, 2007) have been completed, which an argument has arisen among them about understanding the times and locations of the head of the Gulf and its development during the history and the issue has remained controversial to the present. However, the study presented by (Al-Mosawi and Al-Manssory, 2019) discussed most of the opinions of the two different teams about the stability or change of the gulf head during history. It indicated that there is no long-term change at the head of the gulf. Still, there is a fluctuation in sea level and a short-term change that affected the head of the gulf, accompanied by the climate changes that followed the last glacial period (which occurred from the end of the Last Interglacial to the beginning of the Holocene). This does not contradict the conclusions of the two different teams about the stability or change of the gulf head.

One of the most important issues that can overcome this argument and bring views closer is the study of ancient river courses and their development during the history of the region. Hence, the region has many of the courses of these rivers, this issue has been of interest to many researchers, one of these rivers is the ancient Abu Al-Khaseeb River. This course has been marginally mentioned in many studies (Hansman, 1978; Al-Mussawy, 1993; Al-Mutori *et al.*,2021), even its name is taken from the city (Abu al-Khaseeb) in which it is located, and Lees and Falcon (1952) is the first study referred to it using an aerial image. It should be noted that at present, there is a small river branched from the Shatt Al-Arab River that has the same name, but it is located north of this course. The course of this likely river is located in Abu Al-Khaseeb city south of Basrah Governorate. It is one of the extinct rivers in the region (lower part of Mesopotamian basin), and its trace appears in satellite images as a stream extending from the dendritic branches of the Khor Al-Zubair channel from the west and extending to the end of the highway that connects the Basrah city center with Al-Faw city (figure 1).

Due to the large thickness of the sedimentary column in the area and its exposure to many periods of morphological changes caused by river flooding as well as human influences, the course of the river cannot be traced using just one technique. Still, the integration of information that can be obtained from many technologies is more important and gives more detailed results when determining this course. So, the present study intends to discover the origin, nature, and extinction of the river by redrawing the ancient course of this river with a new vision using the

recent satellite images and confirming it by geophysical information using Sub Bottom Profilers technique (SBP) and Ground Penetration Radar (GPR) as well as historical sights.

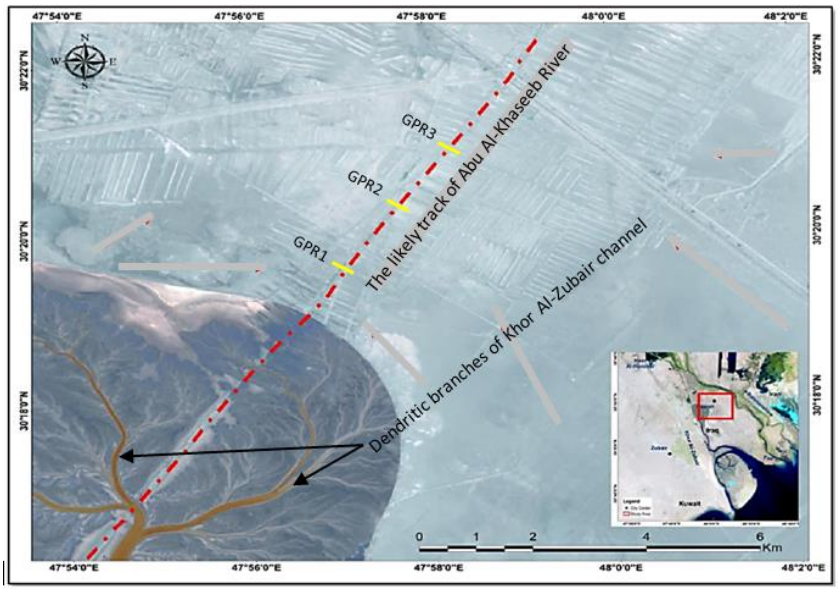

Figure 1. Satellite images show the likely track of the Abu Al-Khaseeb River.

Materials and Methods:

Ground-penetrating radar (GPR):

GPR is a geophysical survey that uses radar pulses to image underground targets. It is a non-intrusive method of surveying the sub-surface to investigate underground utilities such as concrete, asphalt, metals, pipes, cables, or masonry. The nondestructive method uses electromagnetic radiation in the microwave band of the radio spectrum and detects the reflected signals from subsurface features. GPR is used in many sub-surface media, such as soil, rock, ice, pavements, and structures, as well as can be used to detect subsurface targets, changes in material properties (electrical properties change), cracks, and voids(Srivastav *et al.,* 2020; Daniels,2004) GPR uses high-frequency radio waves, usually in the range of 10 MHz to 2.6 GHz. A GPR transmitter and antenna emits electromagnetic energy into the ground. When the energy encounters a buried object or a boundary between materials having different permittivities, it may be reflected, refracted, or scattered back to the surface. The survey was carried out using the GPR Mala system with 250 KHz, and the Rad Explorer software version possessed the field data. 1.4. In the present study, three GPR profilers were completed (GPR1, GPR2, and GPR3) with a distance of 200m for each profiler. These profilers were completed with a direction of NW-SE and perpendicular to the trace believed to be the course of the ancient Abu Al-Khaseeb River (figure 1).

Sub Bottom Profiling:

Due to the depositional nature of the study area and its surroundings, in addition to its exposure to flood tides, agricultural activities, and the remnants of military operations from the First Gulf War in the past, the subsurface survey method using the GPR technique alone may not give us highly reliable results, so it was necessary to use another survey method to investigate of the ancient river course, the present study preferred to use a marine survey method for this

purpose on one of the water branches (tree creek or dendritic branches) bottom of the current Khor Al-Zubair channel.

The Sub Bottom Profiler technique (SBP) is an acoustic examination that maps the sub-bottom of rivers and sea floors by detecting the sediments, beds, and strata under the bottom. This is made by attaching the probe transducer to a boat and towing it through the water too. The generated acoustic pulses are described as a single beam, and these pulses or waves transmit through the water column at a rate that is determined by water temperature, suspended material concentration, and salinity and penetrate the river bottom or seafloor. The reflection of acoustic energy takes place at sub-bottom boundaries, and the reflection strength depends on the rate of impedance contrast. Technically, a portion of the incident energy is reflected in the sediment-water interface. At the same time, the rest of the energy will be transmitted deeper through the substrate (McQuillan *et al.*, 1984; Davies *et al.*, 2002).

Although river courses are affected and their features change by human influence on the land, the features under the bottom may not change much due to the burial effect, so it is noted that there is a trace of the ancient river heading towards one of the branches of the current Khor Al-Zubair channel and crossing it perpendicularly. So, the current study used the SBP survey for the efficiency of the method to investigate the characteristics of the sub-bottom, where the SBP profiler performed with 1.25 km length was completed in perpendicular direction to the trace of the ancient river course (figure 2).

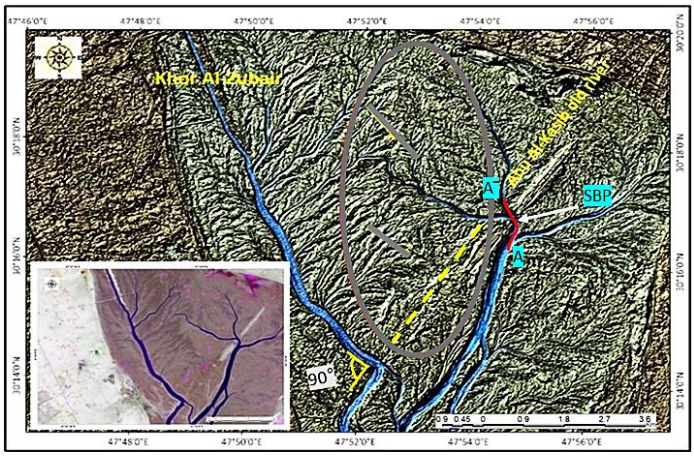

Figure 2. Satellite images show the completed SBP survey line (A-A¯) perpendicular to the ancient river course

Results and Discussion;

The GPR sections revealed the presence of a trace of a buried channel with a width rate of 40 m and a depth of up to 2 m (figure 3). Although the existence of this channel was detected, it was not distinctively prominent. This may be due to many reasons, the first of which is the absence of significant differences between the sediments that fill this channel and the surrounding sediments. The second reason is that the area was affected by the flood tide process, which changed the features of the land. The area was affected by the shallowness of groundwater, which in turn affected the penetration and the accuracy of radio waves. The third reason is the impact of the human aspect that affected the area, whether in the past or at present, which was represented

by the abandonment of agricultural land and the burial of most of the rivers in the area, and the subsequent conflicts and wars that affected the southern regions of Iraq.

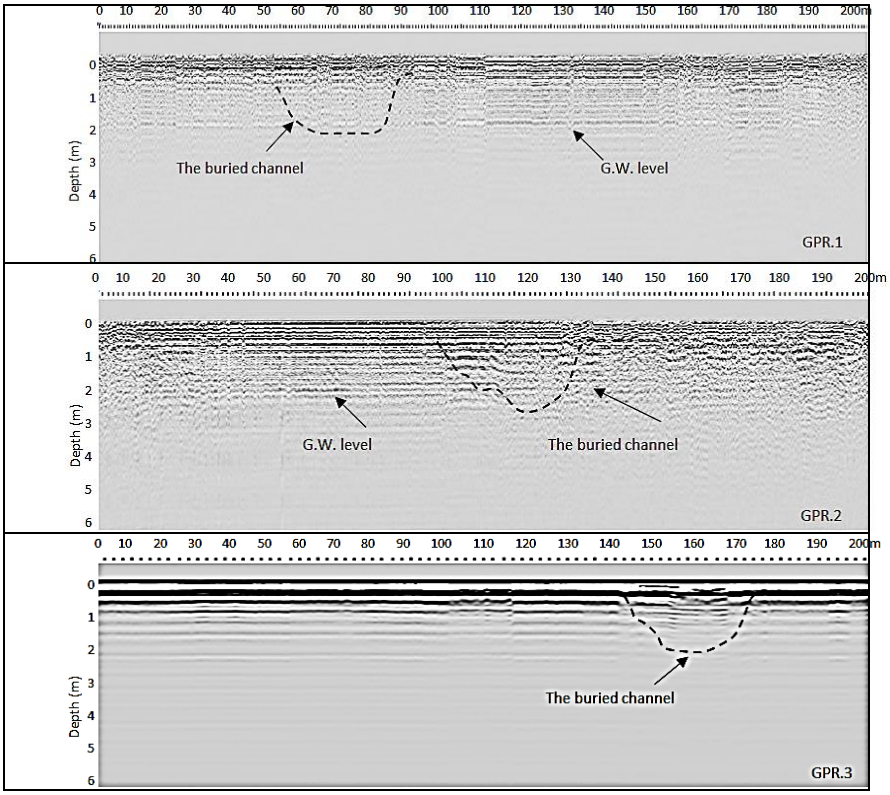

Figure 3. The GPR sections show the presence of a buried channel with a width rate of 40 m and a depth not exceeding 2 m; the low depth (2 m) may not indicate the real depth of the channel due to the absence of penetration of the radio waves to more depths due to the shallowness of groundwater.

The SBP section revealed that the shape of the bottom is irregular, and the sub-bottom layers are characterized by non-continuity and non-horizontal, indicating the presence of a rocky bottom (figure 4). This feature is common in more than one location in the Khor Al-Zubair channel and its dendritic branches. From field observations, parts of rock masses appear on the banks of these branches. As for the depths, they are variable and range from 3 to 6 m. The SBP section revealed the presence of a partially buried channel at a depth of 1 m under the bottom. Also, the SBP section revealed a process of scoring of the bottom that took place on the left side of the buried channel; this is also due to the presence of another stream that flows into the main channel.

The irregularity of the bottom and scoring process is caused by the exposure of the area to complex depositional conditions represented by the effectiveness of tidal operations that occur twice per day and with a large change in the water level between the highest and lowest tides, sometimes up to 4 m, and this is a distinct case of Khor Al-Zubair channel.

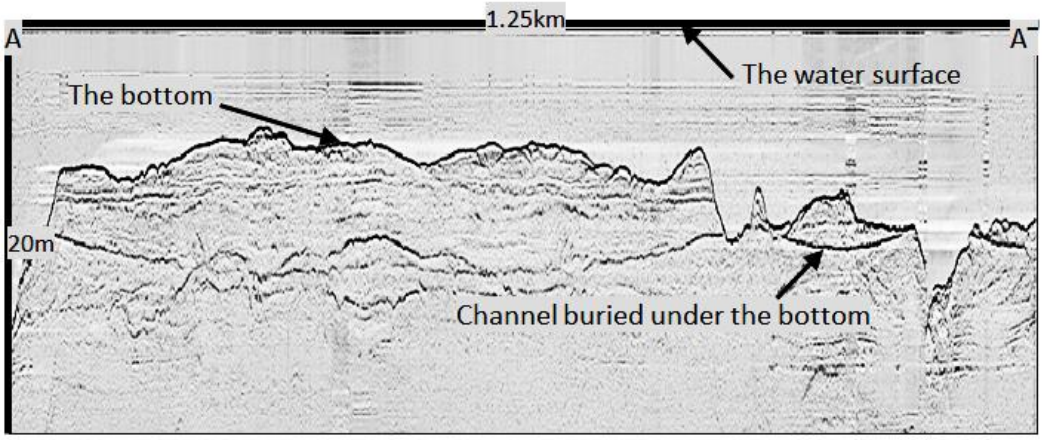

Figure 4. The SBP section shows the presence of a buried channel under the bottom; the scoring process of the bottom on both sides of the buried channel occurred due to the tidal process of one of the small dendritic streams.

The current study showed beyond doubt the existence of a course of an ancient river extending from the highway that is connecting the Basrah city center with Al-Faw city, towards the one of the dendritic branches of Khor Al-Zubair channel. The current study does not claim to be the first to discover this ancient course, but there are studies that indicated the existence of it, but these studies did not rely on actual site investigations as well as the lack of use of modern techniques available at the present time. Also, these studies did not indicate the origin and form of this river and what time it appeared, what time it disappeared, for example, Hansman (1978) pointed to the existence of this stream by relying on satellite images, Al- Mussawy (1993) referred to this river which relied on the satellite image documented in Hansman's study, and the study of (Al-Mutori *et al.*, 2021) documented the existence of many ancient river courses in most of south of Iraq regions, including the course of the ancient Abu Al-Khaseeb River.

Al-Mussawy (1993) pointed out that this river course is formed due to a fault as a result of the region being affected by tectonic activity. Still, this opinion has not been realistically confirmed either by the use of deep investigations (such as seismic or gravity investigations) or shallow investigation methods. In this case, the current study points out there is no negate exposure of the region to tectonic activities that have affected the ancient river courses, which led to changing or cutting the courses of some ancient rivers, as has been documented by many studies (Al- Sakini, 1986; Al-Sakini, 1993; Jassim and Goff, 2006; Al-Mayahi, 2011 Al-Mulla, and Albadran, 2011; Al-Kubaisi and Hussein, 2014; Sissakian *et al.*, 2018; Al-Mutori *et al.*, 2021). The sudden change with a right angle at one of the dendritic branches of Khor Al-Zubair channel at the end of this ancient course under study that revealed in figure (2) could indicate this issue.

The association of the existence of this course with a fault action is unsubstantiated, and there is evidence that contradicts this opinion. First, if these faults are found in the region, are deep, they may not have this significant impact, and not cause the occurrence of a river as a straight shape where the thickness of the sedimentary cover in the region is more than 10 km. The second, exposure the region to flood tidal processes, which effectively affected the region and hid all the

evidence of faults (if it is founded). The third, exposure the region to tectonic subsidence, which is mentioned in many studies (Less and Falcon,1952; Hansman, 1978; Kareem, 1988, Almosawi and Al-Manssori, 2019) and this subsidence hidden the features of the faults in this region.

The results of the current study and the extension of this river trace as a straight track contradict the emergence of this river by a natural action such as tectonic activity. Still, the evidence indicates that the emergence of this river occurred by human action (artificial). To ensure the reliability of this opinion, historical sources reviewed the origin, emergence, and naming of this river, which was named after the current city (Abu Al-Khaseeb). The prevalent belief that the name of Abu Al-Khaseeb, which this area was named, is due to the fertility of its soil and tree density, but through reviewing historical sources, it is found that the fact of this name belongs to the commander (Abu Al-Khaseeb Marzouk), who was sent by the Abbasid Khalifa (Abu Jaafar Al-Mansoor) in 140 H at the head of an army to this city in order to protect it from the invasions of the enemies and to rebuild and develop it, and when he settled in the city, he rebuilt and developed the city, where he excavated a river in it to transport water to other areas to develop agricultural activity then this river was named after him (Abu Al-Khaseeb River) (Al-Katib, 1971; Abood, 2017)

The mentioned river is not necessarily the same river under the current study, but this gives us a vision and perception that the area west of Abu Al-Khaseeb city (the current study area) was characterized in the past by the construction and digging of riverbeds, whether for irrigation or drainage purposes, so most of the canals and stream were produced by human action including the ancient course under the current study. The other evidence that confirms that this course was established by human and abnormal action is the direction of the river extension from the northeast (the direction of the Shatt Al-Arab River) to the southwest (the direction of the Khor Al-Zubair channel) against the direction of the rivers in the southern region of Iraq, from areas with the highest level to the areas with the lowest level. It is known that the ground levels that pass through this stream are almost very close. Still, the ground levels near the Khor Al-Zubair channel, which represents the estuary or mouth of this stream, are one meter higher than Shatt Al-Arab River level, which represents the source of this stream. It is uncommon for rivers to flow from areas with a lower level to areas with a higher level.

Regarding the date of the establishment of this stream, the course cannot have existed before 140 H (1250 years ago) for two reasons. First, if the river existed before that, the features of the agricultural systems in the region, which are still visible to the present time (figure 5), disappeared due to the exposure of the region to maritime tyranny for the period from 7000 years to 3750 years and the level water reached about 2-3 m higher than its current level (Evan *et al.*, 1969) and the subsequent impact of flood tide processes that affected the region as well as the amount of sediment carried from the Tigris and Euphrates rivers, which caused the extinction of most of the surface features in the region. The second reason is the absence of any archaeological evidence on the banks of this stream, and historical information indicates that previous civilizations in Mesopotamia were mostly founded near rivers, and if the course is traced from beginning to end, there is no archaeological evidence, the area is barren, and most of it represents Sabakha lands.

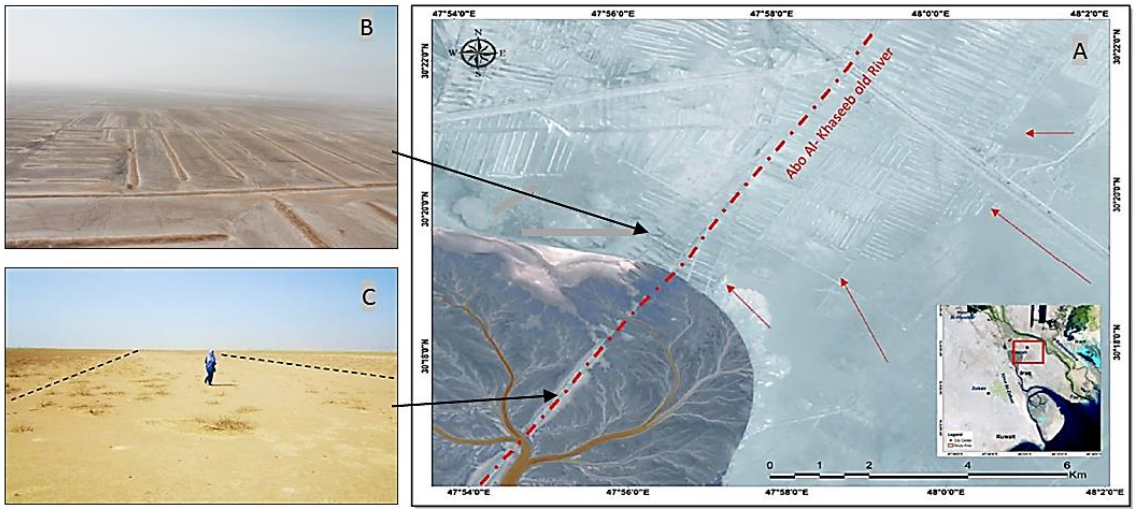

Figure 5. A- Map shows the course of the ancient Abu Al-Khaseeb River and its surroundings of the ancient irrigation systems, B- aerial photo of the ancient irrigation systems, C- A photo of the ancient course.

Regarding the reason for the extinction of this stream, it is not possible to attribute its extinction to the tectonic effect caused by the Siba formation, as indicated by Al-Mussawy (1993), because the river, as mentioned above, has an artificial origin. It was created about 1250 years ago, and there is no subsurface evidence indicating that the effect of Siba formation has reached the ground surface. There is no surface evidence, such as the significant change in ground levels, to prove this opinion. So, there are two views for the extinction of this stream related to the purpose of digging this river. The purpose of digging the river was to irrigate agricultural land. Still, it was found that digging this stream was useless due to the salinization of most of the land on both sides of the river, in addition to the intrusion of marine water coming from the Khor Al-Zubair channel through this stream. Thus, the existence of this stream became useless and landfilled.

The second view is that the purpose of digging this stream is not to irrigate agricultural land. Still, on the contrary, the digging of this stream was to drain the drainage water towards the Khor Al-Zubair channel and not to salinize the land as a result of agricultural activities that reduce the efficiency of the soil without the process of treatment and reclamation of these lands. The soils of the study area (clay - silt soils) suffer from this problem particularly and the regions of south of Iraq generally to the present time (where at present, many drainage canals have been established for drainage water such as the Main Outfall Drainage in southern Iraq). After that, this stream was buried because it became useless as a result of the intrusion of marine waters coming from the Khor Al-Zubair channel. The opinion that adopts the idea that this river was dug for the purposes of draining the drainage water can be confirmed by, firstly, the lack of evidence, whether from satellite images or history, which indicates that this stream was connected to Shatt Al-Arab River for the purpose of benefiting from it to irrigate agricultural lands, and secondly, the historical studies indicated that the Abbasian state used the Negroes which are coming from

East Africa to work in inhumane conditions in scraping the sabakh and reclamation of Basrah wastelands (which includes the current study area) before 1250 years ago.

Conclusion

The current study proved the existence of a river course called as (the ancient Abu Al-Khaseeb River) extending from the main road linking the of Basrah city center with Al-Faw city and extending for 31.65 km towards the west at one of the dendritic branches of Khor Al-Zubair channel. The average width of this stream is about 40 m and a depth does not exceed 2 meters. The creation of this stream was by human action before 1250 years ago in the Abbasid period and there is no logical evidence indicating the existence of a fault caused the occurrence of this stream, and most likely that the stream has been dug for the purpose of draining the water of the agricultural activities towards Khor Al-Zubair channel. As for the reason for the extinction of this stream, it may be due to human action also, it has become an inlet for the marine water intrusion from Khor Al-Zubair channel, and therefore the existence of this stream had become useless and harmful.

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