Use of high-resolution images to reveal the changing of Tigris river morphology by anthropogenic effect between Al-Muthanna and Sarafiya bridges – Baghdad

Key words
High-resolution images, Tigris River morphology, anthropogenic effect.

Asst. Prof. Halah Mohammed. S. Majeed (Ph.D.)
University of Diyala, College of Education for Humanities
iraqprof@yahoo.com

Abstract

In this study a high-resolution image used to detect the geomorphic and hydraulic response of a fluvial system to human-induced environmental change in reach. Many dramatic changes observed on both riparian included land use, channel morphology and sedimentation, based on a spatial analysis of space images (2008-2020). Analysis of 12 selected channel cross-section with 3d images and photographs unveiled a major change in morphology and sedimentation of the reach During the period of the study : the magnitude of change difference for each selected cross section between (2008-2020) was (161.81 to -82.43) m reflected the human-induced environmental change in reach , Sinuosity index varied between (1.005-2.01m) so the reach contained one straight and tow meanders . The spatial pattern of land cover within the reach also changed considerably: highly degraded orchards and green cover land on each riparian was removed and some of islands was cultivate, others used for fish breeding while others used for tourism and recreation. a large and fast changes in the spatial context of land use within the reach during 12 years. This suggests that the response of the reach to land-use change not only depends on discharges and other hydrological properties, but also on the spatial pattern of LULC change within the reach. This research highlighting on changes of not only of LULC on banks only but also concentrated on channel morphology, meandering processes and channel adjustment in a fine-grained alluvial setting, finally this study demonstrates the processes of channel morphology change due to human disturbances.

Introduction:

When Tigris river penetrate Baghdad, metropolis face a spectacular rapid change induced by anthropogenic activity which appear clearly on river banks and channel, thus an important change reflecting on river morphology itself, to reveal this change in this study was using a high-resolution space image. Especially that coincidence with the decrease in the discharge of the Tigris River in the area and the low levels of discharge, Intense Human land-use activities have fundamentally changed the hydrogeomorphic of rivers. This anthropogenic changes to alluvial system, contributes significantly variations in channel morphology , During the last 12 years, the reach had undergone some large-scale human activities(such as tourism and recreation building on both banks

and islands, excavation and modification banks and islands, channel regulation ,agricultural us for some islands , levee construction, water extraction, infrastructure construction. , bridges and modification works) which changed the morphology of the river bed and its banks ,and resulted in the hydrodynamic characteristics different as an intensification of lateral migrations of sediments . the channel morphology in the reach changed severely as a result. So, this study looks into the role of human disturbance on channel evolution by exploring the chronological change in channel morphology due to human influences in the studied reach.

Location of the study area:

The reach lies in North of the capital Baghdad city between Almuthana bridge and Aladimya bridge, length of the reach covered in this study is 14.037 km with coordinates (33°25´38″-33°21´41″N) (44°20´35″-44°22´31″E) (Figure 1).

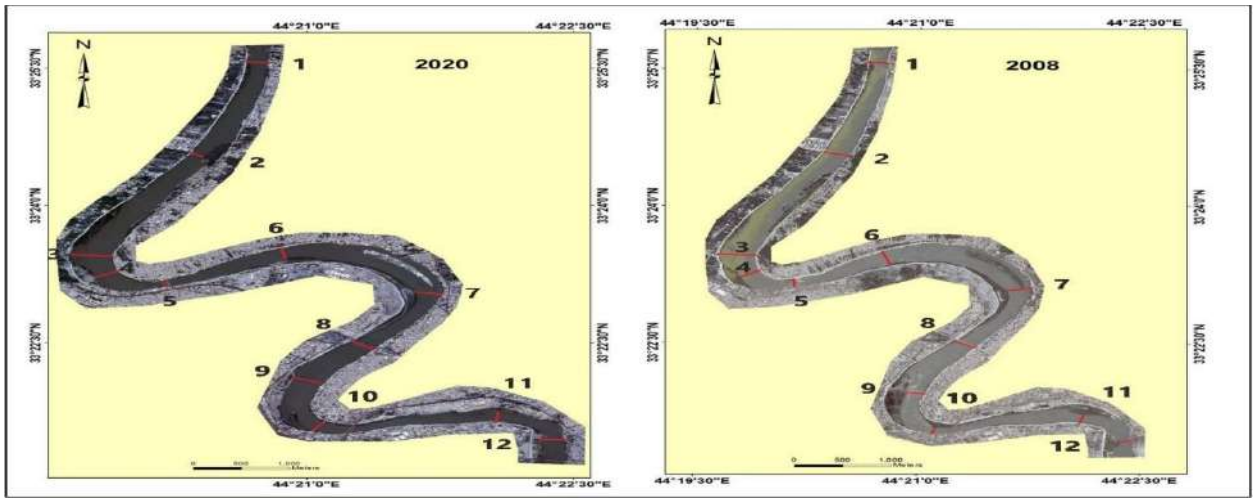


Fig 1: Location of the study area for (2020-2008)

Human activity in the region has increased with a decline in river discharge levels in recent years fig (2).at Baghdad the mean annual discharge is 1140m^3/sec, while the maximum and minimum discharges are 7,640m^3/s, on 12/2/1941,and 163m^3/s, on October, 1955, respectively 7,640m^3/s,12/2/1941, and 163m^3/s, October, 1955, respectively. The slope of the channel is6.9cm/ km (Nadhir Al-Ansari et al,2010,11) fig (3).

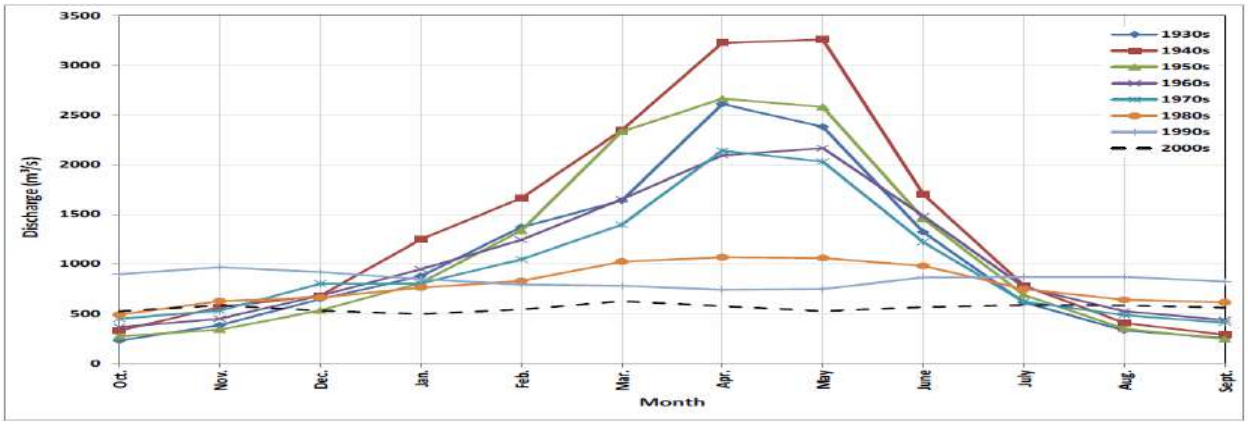


Fig 2: Decadal hydrographs of the Tigris River at Sarai Baghdad for the period 1930-2013 (Nadhir Al-Ansari, et.al,2018,32).

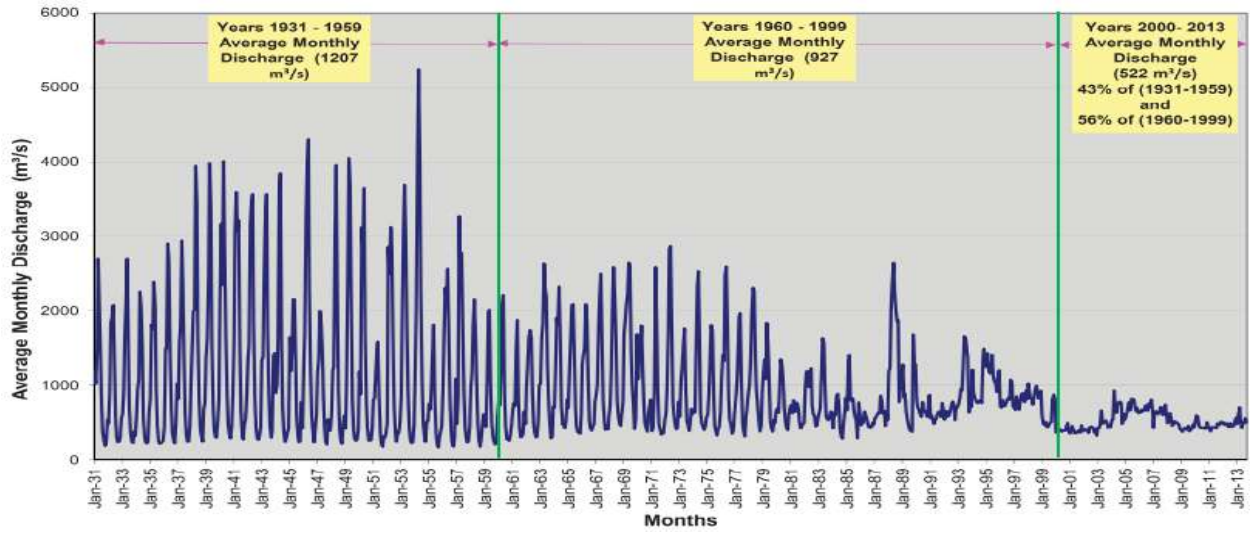


Fig 3 Figure 4. Mean monthly flow of the River Tigris at Sarai Baghdad for the period 1931–2013 (Ammar A. Ali, et.al,2019,367).

DATA AND METHODS:

Data sources mainly include two parts: one is from high-resolution remote sensing images downloaded from SASPlanet, Terra Incognita programs, the resolution of these images range between (0.60cm-1.5m) the second is from photograph and field study data. Analysis of reach morphological changes was performed with ArcGIS10.7.1 and 3d images with Arc scene 10.7.1 , with using three methods: First, space images between (2008-2020), Second width of channel for (2008-2020) to comparing and calculate the magnitude of change variations , third use of Sinuosity index to know changing and river channel morphology .

Results and discussion:

There are an dramatic and rapidly changes occurred in river reach within studied period result from anthropogenic influence , the impact of human activities in dam building, bank lining and dumping of debris within the channel at Baghdad

has led to changes in the geometry of the river and its ability to carry flood waters (Ammar A. Ali, et.al,2012, 3785). ,this included both riparian with land use changing and river channel morphology, Human intervention will inevitably affect the river processes of erosion and sedimentation like islands during the last 20 years, growing islands became noticeable phenomena in the channel of Tigris River within Baghdad City and numbers of islands are increasing with time (Ammar A. Ali, et.al,2012a, 2). and for each morphological part of the river section, so the reach consists of three morphological parts: Alkhidmya (straight)Alkreaat Aladhamiya are both (meanders) Table (1)

Part name	Length of stream channel(m)	Length of straight line(m)	Sinuosity index(m)	Description
Alkhidmya	4676.8	4632.4	1.005	straight
Alkreaat	5054.7	2286.95	2.2	meandering
Aladhamiya	5309.4	2636.55	2.01	meandering

Table (1): Sinuosity index for reach parts

Channel change of Tigris River within studied area:

Satellite images saved a lot of time, effort and cost in studying and following up the environmental impact assessment of the change in the morphology of the river and with results of high reliability, ease of access and rapidly, The river reach was divided into 12 secondary segments and a comparison was made between two satellite images (2008-2020) for each segment Table (2), to show the features of the change clearly, and the result of the change appeared as follows:

Profile Num.	Channel width (m) in 2008	Channel width (m) in 2020	change difference(m)
1	140.24	136.54	3.7
2	285.67	123.86	161.81
3	382.16	362.49	19.67
4	224.26	219.9	4.36
5	151.97	101.48	50.49
6	278.9	193.56	85.34
7	181.68	155.5	26.18
8	235.5	221.88	13.62
9	233.6	275.6	-42
10	112.8	194.25	-81.45
11	248.1	252.22	-4.12
12	117.97	200.4	-82.43

Table (2): change difference(m) for selected cross-section

1- This segment represent the North border of studied area which began with an anthropogenic structure called Almuthana bridge which its piles disturbing river flow with its contents from sediments so this sediments tends to sedimentation at

right bank fig (4-A) , fig 3d (5-A) tracking inclination of this side so an longitudinal coalescence island forming at and growing taking advantage of its planting a grape and fixing an fish breeding cages photo (1-A). The proportion of change difference was (3.7m) this cause the existence of this island which mentioned above in this section, on banks of this segment observed that land use growth, agricultural use shrinks confront an active urban growth, both banks witness a riparian vegetation increasing.

2- In this segment of the river It is noted in that there is a development in the land use and a contraction in the orchards and is evident on the left side of the river constitutes an island bound to that bank fig (4-B) and also in 2020 it is clear that these island plants were removed preparing for the initiation of their use, as the amount of change difference in this section amounted to (161.81m) and this apparent change and narrowing of the channel as a result of human intervention in the expansion of that island for use.

3- In this section there is a clear development in the land use , shrinking of orchards and there is a development in morphology and the expansion of the conjunctivitis island in the right bank of the river fig 3d (B) as the island was divided into multiple sections and cultivated fig (4-C) ,amount of change difference was (19.67 m) and this change and narrowing in the channel is due to the growth of the island and its use for agricultural purposes.

4- One of the most prominent characteristics of this section is the shrinking of orchards to be replaced by urban growth, but in the right bank of the river shows the large size of the island fig (4-D) in that bank and its expansion and the emergence of many uses of land in it fig 3d (5-B) , the amount of change difference for this part is (4.36 m) due to the island located on the right bank of this section.

5- In addition to reducing the area of green cover on the banks and replacing it with extensive urban use, the most prominent characteristic of this sector of the river is the formation and rapid formation of the conjunctivitis islands for the two banks due to the construction of the floating bridge in this area fig (4-E) fig 3d (5-B) , the amount of change difference in this section was (50.40 m).

6- There is an active and dense urban expansion that has replaced the green cover with an island conjoined on the left side of the riverbank, and in 2020 the land uses on this island varied fig (4-E) fig 3d (5-C), the amount of change was (85.34 m).

7- This section shows a conjoined island on the left side, and in 2020 there is a clear modification and modification of this island to prepare it for using its land, but the left side of the riverbank shows the dense urbanization on it and the

movement of this expansion to the opposite island and near this bank and the investment of the island as recreation areas and restaurants as this island in the left Bank fig (4-G) fig 3d (5-D) photo (1-B,C) , was linked to the construction of a road with long 132 meters , the amount of change difference is (26.18 m)

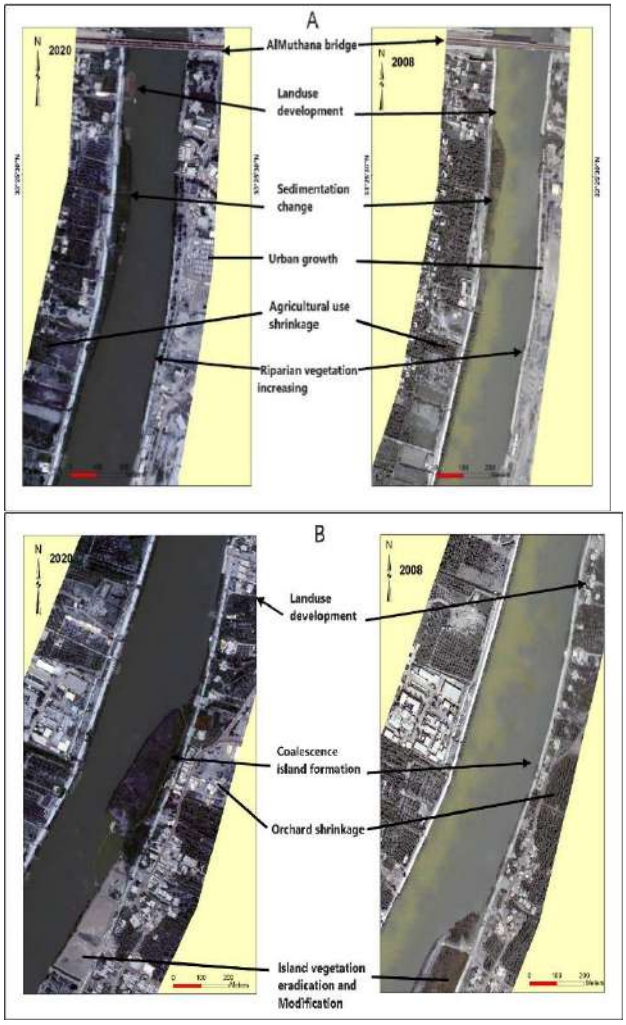
8- The most prominent feature of this section is the presence of the Imams Bridge as well as the replacement of the green cover with residential use and the presence of a strip of conjunctivitis deposits in the right Bank in this area fig (4-H) fig 3d (5-D), the amount of change difference for this section was (13.62 m)

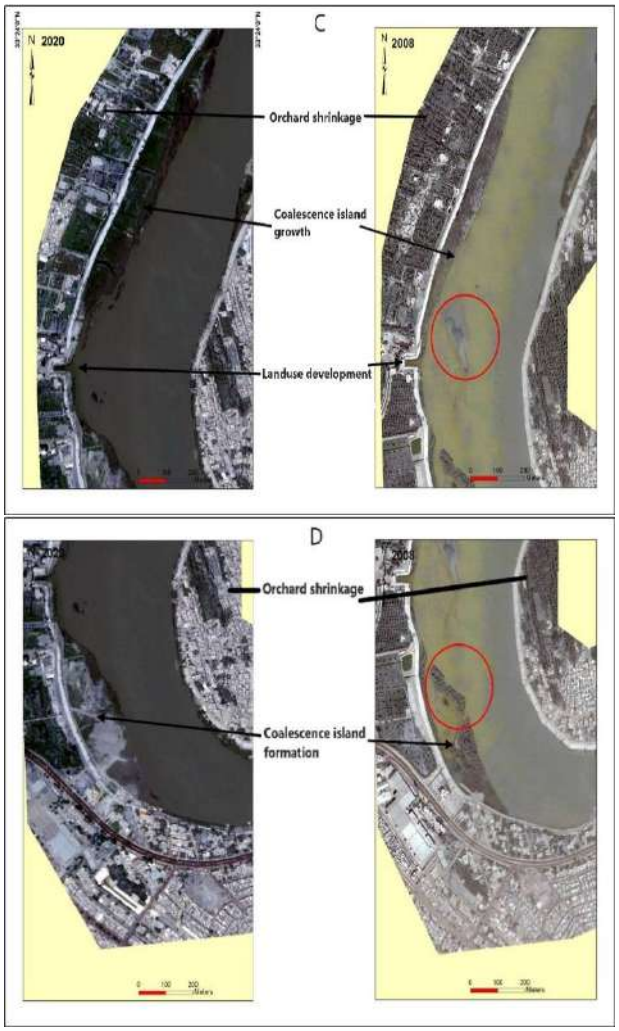
9- In this section there is a clear deposition of sediments on the right bank, and the islands are formed and developed on this side fig (4-I) fig 3d (5-D), with a change variation of (-42 m) for human modifications on the island for exploitation.

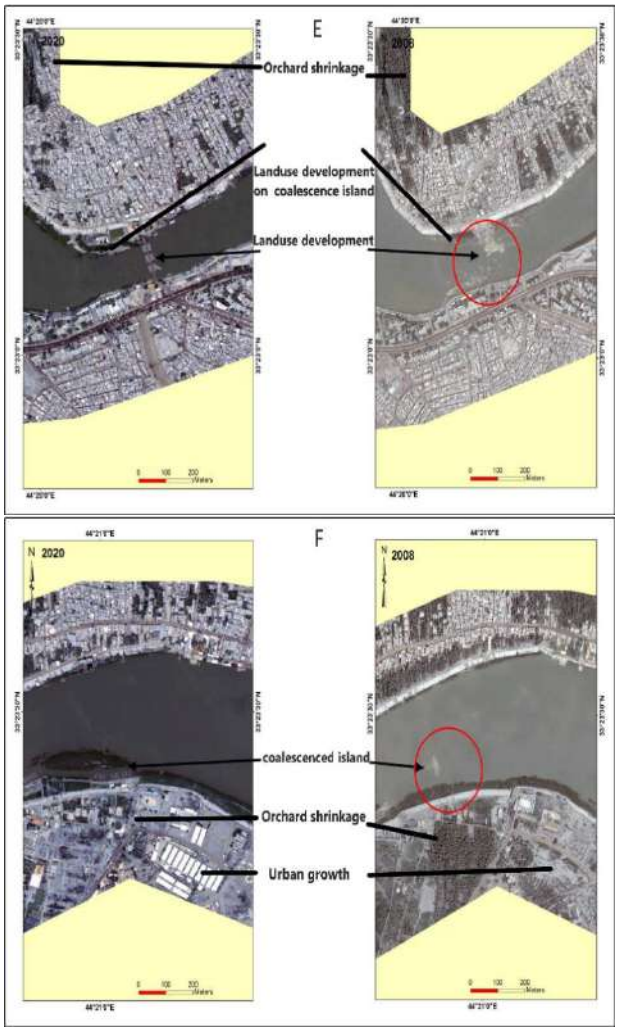
10- This section shows a shrinking vegetation cover for general , A multi-function working boat working on left bank so a anew sedimentation islands appear on two banks fig (4-J) fig 3d (5-D) photo (1-D) , the magnitude of change variation in this part of the river is (-81.45) due to river training works in right bank.

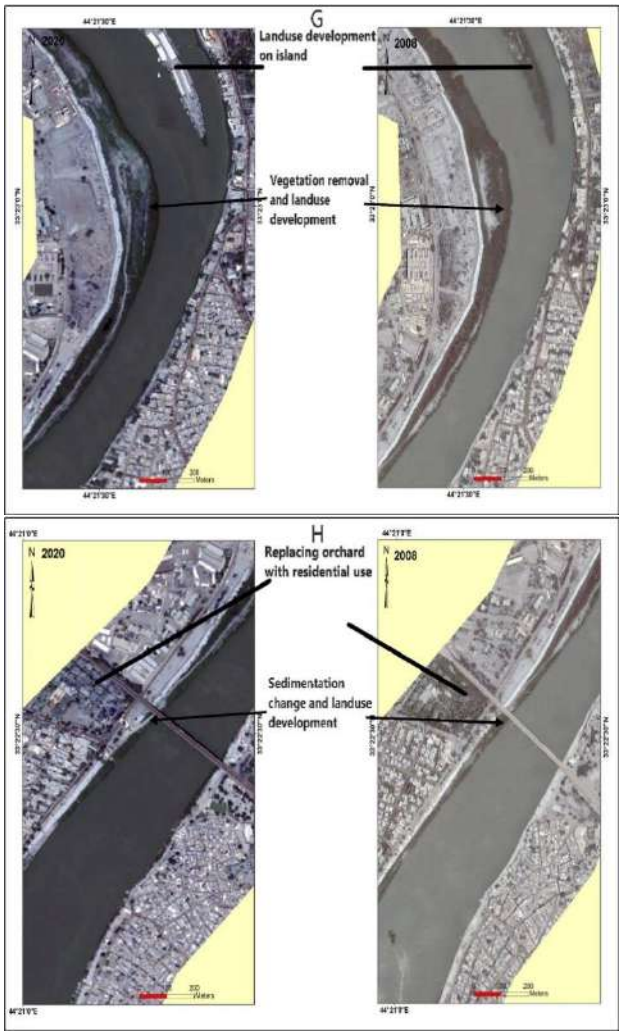
11- Here Formed in the left Bank island and grown with dense plants and then a large part of this island was removed due to this bank used for entertainment and recreation and existence of ferry port fig (4-K), the percentage of difference change was (-4.12 m).

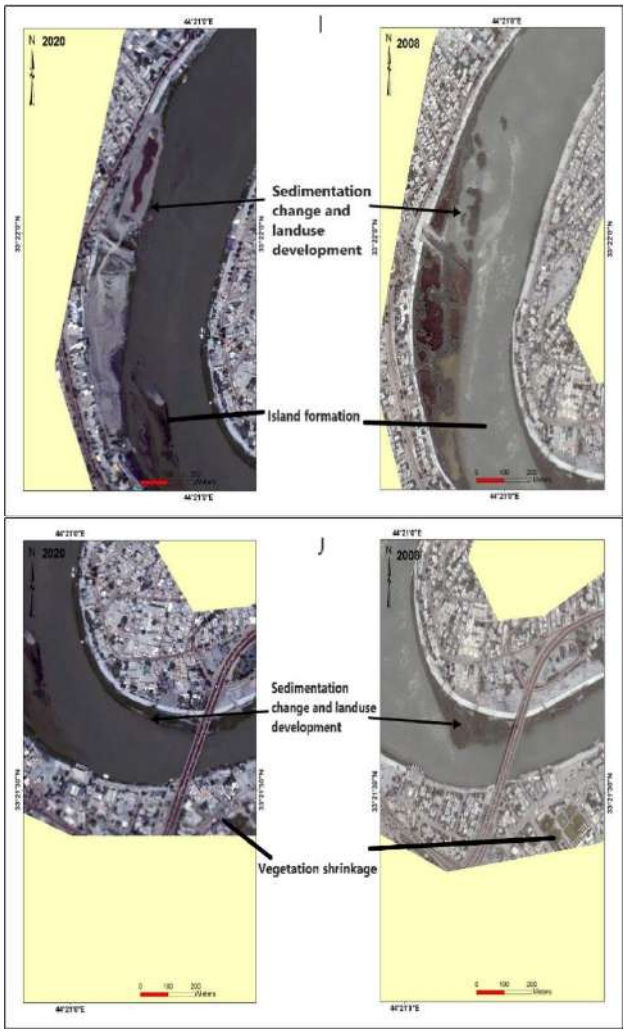
12- In the last section there is a clear formation of the island on the left bank of the river, but a large part of it has been removed and specific parts been kept to use as a restaurant and a boat moorage, fig (4-L) fig photo (1-E,F) the difference of change is (-82.43m).


A
N
2020
AlMuthana bridge
Landuse development
Sedimentation change
Urban growth
Agricultural use shrinkage
Riparian vegetation increasing
N
2008
B
N
2020
Landuse development
Coalescence island formation
Orchard shrinkage
Island vegetation eradication and Modification
N
2008


C
N 2020
N 2008
Orchard shrinkage
Coalescence island growth
Landuse development
D
Orchard shrinkage
Coalescence island formation


E
2020
2008
Orchard shrinkage
Landuse development on coalescence island
Landuse development
F
2020
2008
coalescenced island
Orchard shrinkage
Urban growth


G
Landuse development on island
Vegetation removal and landuse development
2020
2008
H
Replacing orchard with residential use
Sedimentation change and landuse development
2020
2008


I
N 2020
N 2008
Sedimentation change and landuse development
Island formation
J
N 2020
N 2008
Sedimentation change and landuse development
Vegetation shrinkage

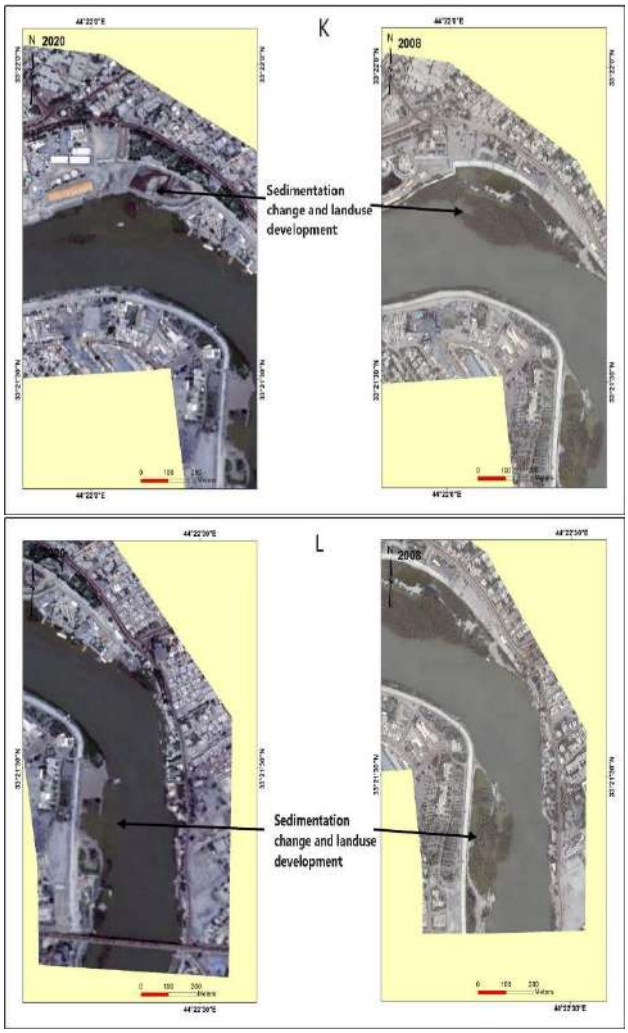


Fig (4): compression between (2008-2020) for selected 12 cross-sections in reach


A
B

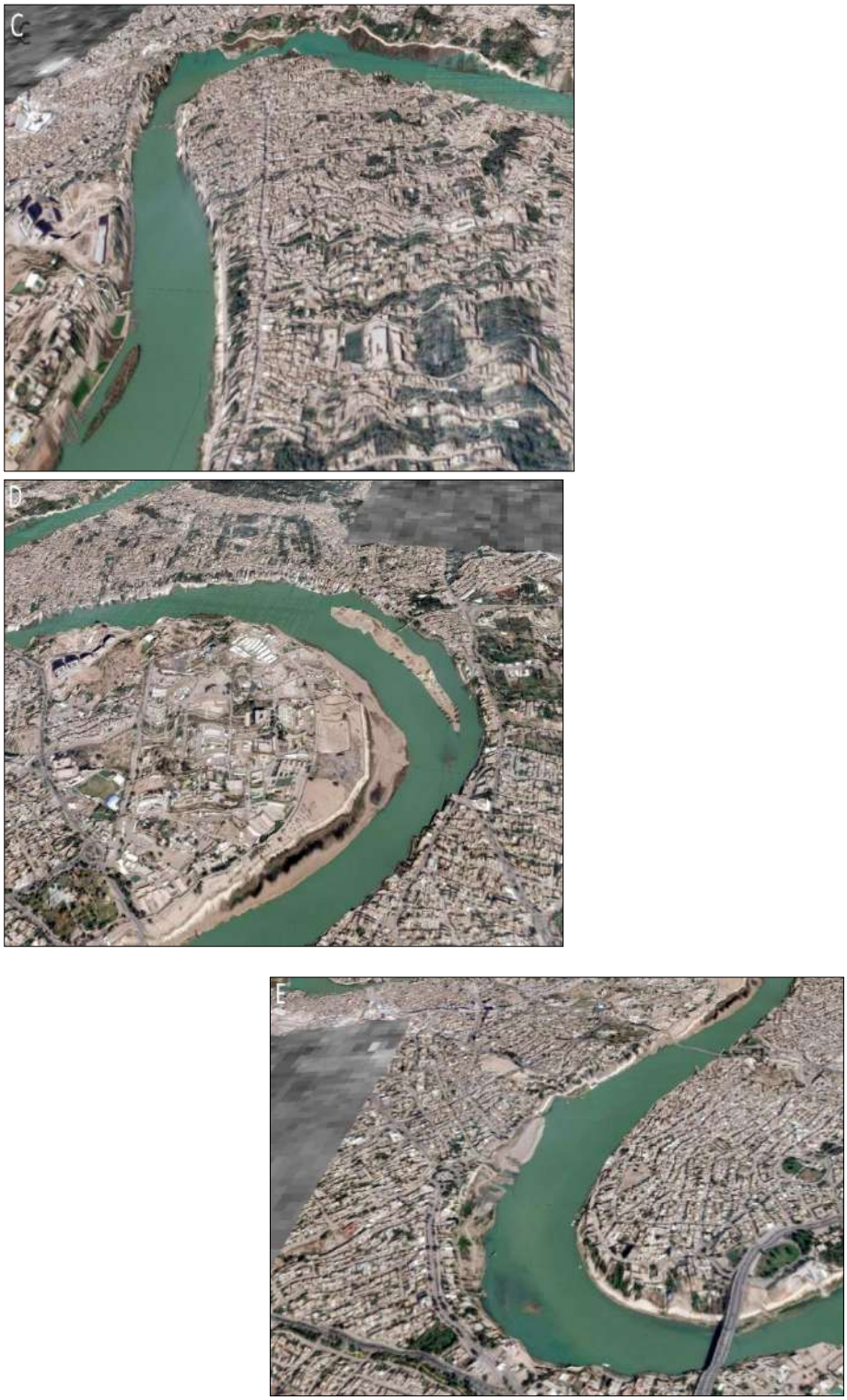


Fig (5): 3d image for selected scene in reach


A


B


C


D
Multi function working boat

Photo (1): photos depict many human activities in reach (15-18/9/2021)

Conclusion:

By tracking change in selected section in reach appear:

1- section 1 began with an Almuthana bridge so sediments tends to sedimentation at right bank than left bank, proportion of change difference was (3.7m) , both banks shown land use growth ,agricultural use shrink confront an active urban growth ,both banks witness an riparian vegetation increasing, in section 2 noted that there is a development in the land use and a contraction in the orchards and is evident on the left side of the river, amount of change

difference 161.81 m and this apparent change and narrowing of the channel in this segment as a result of human intervention.

2- section 3 showed a clear development land use, shrinking of orchards and there is a development in morphology and the expansion of the conjunctivitis island in the right bank of the river as the island was divided into multiple sections and cultivated, amount of change difference (19.67 M). while in section 4 suffered a shrinking of orchards to be replaced by urban growth, but in the right bank of the river shows the large size of the island its expansion amount of change difference is 4.36 m.

3- section 5 the green cover on both banks replacing it with extensive urban use, and rapid formation of the conjunctivitis islands for the two banks due to the construction of the floating bridge in this area, the amount of change difference was 50.40 m.also section 6 have a dense urban expansion that has replaced the green cover, an island conjoined on the left side of the riverbank, the amount of change was 85.34 m

4- section 7 shows a conjoined island on the left side which exploit for many land uses, while left side shows the dense urbanization and the investment of the near island in this bank for recreation areas, the amount of change difference is 26.18 m. section 8 include Imams Bridge, green cover replacement with residential use and the presence of a strip of conjunctivitis deposits in the right Bank the amount of change difference was 13.62 m

5-section 9 a clear deposition of sediments on the right bank, , with a change variation of -42 m for human modifications on the island for exploitation. while section 10 show a shrinkage vegetation cover, A multi-function working boat working on left bank so a anew sedimentation islands appear on both banks, magnitude of change variation is 81.45-.

6- In section 11 left Bank island grown with dense plants and then a large part of this island was removed due to this bank used for entertainment and recreation and existence of ferry port, the percentage of difference change was -4.12 m.also in section 12 a clear formation of the island on the left bank of the river, but a large part of it has been removed and specific parts been kept to use as a restaurant and a boat moorage, the difference of change is 82.43-m.

استخدام صور عالية الدقة للكشف عن تغير شكل نهر دجلة بالتأثير البشري بين جسري المثنى والصرفية – بغداد

الكلمات المفتاحية: صور عالية الدقة ، مورفولوجيا نهر دجلة ، تأثير بشري

ا٠م٠د٠هالة محمد سعيد

جامعة ديالى/كلية التربية للعلوم الانسانية

الملخص

في هذه الدراسة، تم استخدام صور فضائية عالية الدقة لاكتشاف الاستجابة الجيومورفية والهيدروليكية في نظام نهري للتغير البيئي الذي يسببه الإنسان في هذا المقطع النهري المنتخب. العديد من التغييرات الدراماتيكية التي لوحظت في كل من ضفاف النهر تضمنت استخدام الأراضي، ومورفولوجيا القناة والترسيب، بناءً على التحليل المكاني للصور الفضائية (٢٠٠٨-٢٠٢٠). كشف تحليل ١٢ مقطعًا عرضيًا لقناة مختارة مع صور ثلاثية الأبعاد وصور فوتوغرافية عن تغيير كبير في مورفولوجيا وترسيب المقطع النهري خلال فترة الدراسة: كان فرق مقدار التغيير لكل مقطع عرضي محدد تراوح بين (٢٠٠٨-٢٠٢٠) (١٦١.٨١) إلى -٨٢.٤٣ م) يعكس التغير البيئي الذي يسببه الإنسان في المقطع النهري، وتراوح مؤشر التعرج بين (١.٠٠٥-٢.٠١ م) لذلك تضمن المقطع النهري على جزء مستقيم ومنعطفين. كما تغير النمط المكاني للغطاء الأرضي في المقطع النهري بشكل كبير: فتم إزالة البساتين والأراضي ذات الغطاء الأخضر وازالة بعض الجزر من على ضفتي النهر وزُرعت اخرى، فيما استخدم البعض لتربية الأسماك بينما استخدم البعض الآخر للترفيه. لذا ظهرت تغييرات كبيرة وسريعة في السياق المكاني لاستخدام الأراضي في المقطع النهري خلال ١٢ عامًا. يشير ذلك إلى استجابة المقطع النهري إلى تغيير استخدام الأراضي والتي لا تعتمد فقط على التصريف والخصائص الهيدرولوجية الأخرى، ولكن أيضًا على النمط المكاني لتغيير LULC في المقطع. لذا سلط هذا البحث الضوء على التغييرات ليس فقط ل LULC على الضفاف فحسب، بل ركز أيضًا على شكل القناة وعمليات التعرج وتعديل القناة في بيئة فيضية دقيقة، وأخيرًا توضح هذه الدراسة كذلك عمليات تغيير شكل القناة بسبب التدخل البشري.

References:

1- Ammar A. Ali, Nadhir A. Al-Ansari, Qusay Al-Suhail, Sven Knutsson,2019, Spatial total load rating curve for a large river: a case study of the Tigris River at Baghdad, Taylor & Francis, International Journal of River Basin Management, 18:3, 363-376.

2- Ammar A. Ali, Nadhir A. Al-Ansari, Sven Knutsson,2012a, Impact of Growing Islands on the Flood Capacity of Tigris River in Baghdad City, Conference: Sixth International Conference on Scour and Erosion At: Paris, France, August 27-31, 2012, ICSE6-170.

3- A. A. Ali, N. A. Al-Ansari, and S. Knutsson,2012, Morphology of Tigris River within Baghdad City, Hydro. Earth Syst. Sci., 16, 3783–3790.

4- Nadhir Al-Ansari, Nasrat Adamo,and Varoujan K. Sissakian,2019, Hydrological Characteristics of the Tigris and Euphrates Rivers, Scientific Press International, Journal of Earth Sciences and Geotechnical Engineering, Vol.9, No. 4, 2019, 1-26.

5- Nadhir Al-Ansari, Nasrat Adamo, Varoujan K. Sissakian, Sven Knutsson, Jan Laue,2018, Water Resources of the Tigris River Catchment, Science press, Journal of Earth Sciences and Geotechnical Engineering, vol. 8, no. 3, 2018, 21-42