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Spatiotemporal Analysis on Shipwrecks in Shatt Al-Arab River and Iraqi Marine Waters Northwest Arabian Gulf

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Abstract: The shipwrecks generate different impacts mostly represented by geomorphological changes of the waterways, source of potential pollutants, impeding navigation and fishing activities. A total of 141 locations of shipwrecks were identified in the inland and marine Iraqi territorial waters. The study area is categorized into four sites including Shatt Al-Arab River, Shatt Al-Arab Estuary, Khor Abdulla and Khor Al-Zubair. The shipwrecks data analysis was investigated on spatial and temporal approach based on salvage state, type and size of sinking vessels in these sites. The shipwrecks are of different types classified according to the size into three categories. Only 43 of these shipwrecks were salvaged mostly in Khor Al-Zubair, however, no attempt has been carried out to salvage any of the shipwrecks in the most important fishing ground located within Shatt Al-Arab Estuary. On temporal basis, most of the shipwrecks are resulted due to the wars. The majority of the sunken shipwrecks are of small size indicated by 94 (67%), however many are still not identified by type and size particularly those located in the Shatt Al-Arab Estuary. The impacts of the shipwrecks were investigated following to findings of previous related studies and feedback of questionnaire circulated to specialists in relevant authorities. Moreover, the findings of relevant published data in relation to hydrological features, water quality, fishing and biodiversity aspects have considered particularly in the shared zone among Iraq, Kuwait and Iran. The paper recommended the great importance to initiate a regional survey to assess the levels and types of pollutants in this area and to take a cooperation action on removing the sunken vessels.

Keywords: Shipwrecks, Iraqi Ports, Shatt Al-Arab, Khor Abdullah, Khor Al-Zubair, Fishing, Iraq.

Introduction

The term ship represents whatever type of vessel operating in inland waters and high seas. However, the definition of wrecks was adopted by Nairobi International Convention on the Removal of Wrecks 2007 as: a sunken or stranded ship; or any part of a sunken or stranded ship, including any object that is or has been on board such a ship; or any object that is lost from a ship and that is stranded, sunken or adrift at sea; or a ship that is about, or may reasonably be expected, to sink or to strand, where effective measures to assist the ship or any property in danger are not already being taken. The wreck may also covers the remains of transport vehicles of conspicuous dimension, which is submerged either partially or totally. The most common sources of shipwrecks are attributed to shipping accidental collisions, war and deliberate sinking to create artificial reefs.

There are over three million shipwrecks scattered on the ocean floor around the world (UNESCO, 2008), where 8 – 9 thousands of wrecks on global scale are considered as potential sources of pollution, where approximately 2.5 – 20.4 million tons of oil residual inside the wrecks (Michel *et al*., 2005). The navigational and environmental risks posed by shipwrecks present big challenges to maritime industry along several decades ago (Whittington *et al*., 2017).

The ship accidents is the most source of shipwrecks throughout the world. Oliviera-Goumas & El Houdagui (2000) categorized the ship accidents into seven types (sinking, grounding, collision, capsizing/listing, fire/explosion, engine failure, leaking and accidents linked to bad weather). About 4% of the world's sunken vessels are located in the Mediterranean where 75% date back to the II World War (Parliamentary Assembly of the Council of Europe, 2012). Therefore, shipwrecks are among the biggest sources of marine pollution in the Mediterranean (Consoli *et al*., 2015). These shipwrecks are a cryptic source of pollution, since the uncontrolled leakage of toxic material and organic/inorganic pollutants potentially affect marine ecosystems (Sprovieri *et al*., 2013). Similar findings were reported by Ceyhun (2014) on the effects of shipping accidents on marine environment in Turkish Seas based on the statistics of shipping accidents recorded. Moreover, the shipwrecks largely affect the fishing sector due to the tangling of gill nets and trawls by these debris. In the Baltic Sea, assessments of the measure of lost gillnets were made in regard to the Swedish fleet working in open waters, both in the coastal areas just as in more inaccessible fishing grounds (WWF, 2015).

The most positive impact of shipwrecks is represented by providing non-natural bed of complexity habitat act as an artificial reef that play important role providing a structure to marine sessile organisms, supporting species diversity and enhancing broad-scale of fishery resources. On the other hand, these sites may generate downsides as a result of toxic materials such as heavy metals (copper, aluminum, lead and steel), petroleum hydrocarbons and other potential pollutants, which can be subject to corrosion, and affecting marine biota. On global scale, many attempts have been conducted by sinking old vehicles and ships at certain sites. Bianchini & Ragonese (2011) examined different

opportunities dealing with natural and deliberately scuttled shipwrecks in the marine waters of Sicily focusing on the positive and negative impacts.

Historically, the first accident of sunken vessels in the Shatt Al-Arab River was in the third century AH, where maritime battle took place during the "Zinj Revolution" in Basrah at that time, during which several ships of the Abbasid fleet were sunk.

On local basis, a two years survey was initiated in June 2010 to identify the shipwrecks in Shatt Al-Arab River. The shipwreck sites were positioned regardless to the number of sunken vessels at each site as in some sites more than one submerged shipwrecks have been observed (Marine Science Centre, 2012). Recently, one small island is created in the Shatt Al-Arab River by a sunken ship (Fig. 1). Khaleefa (2014) investigated the origin of islands in the Shatt Al-Arab River to understand the subsurface geological factors and the natural, sedimentary and anthropogenic factors affecting the formation of the islands. The most recent study carried out by Al-Musawi (2020) detected 17 distinct locations characterized by a numerous objects of sunken shipwrecks and debris on the Shatt Al-Arab River bottom for the area between Al-Ashar Creek in Basrah city center to Al-Seebah south of Basrah city using side scan sonar and sub-bottom profiler techniques.

Fig. (1): New Island created on sunken vessel in the Shatt Al-Arab River.

The present paper aims to analyse the shipwrecks in the Shatt Al-Arab River and Iraqi marine waters on spatial and temporal basis and to determine the potential geological, physical, chemical and biological impacts.

Materials & Methods

Study Area

The surveyed study area in the present work is categorized into four sites:

Shatt Al-Arab River

The Shatt Al-Arab River is resulting from the confluence of the Tigris and Euphrates rivers in the city of Qurna at a distance of 375 km south of Baghdad. The length of the river is approximately 190 km, about 84 km is shared as a border between Iraq and Iran. The width of the river fluctuates according to the areas it passes through with a range of (120-2250 m). The deeper sections of the river at Seehan area

south of Basrah is of 21 m, the river flows into the Arabian Gulf at the city of Al-Fao representing the basic freshwater resource in Basrah and most important economic artery for water transport in Iraq (Fig. 2). There are some of tributaries that flow into the Shatt Al-Arab River, including the Al-Suwaib and Qarma rivers from Iraqi side and Karkheh from Iranian side by which waters flow from the marshland. Shatt Al-Arab River is characterized by several creeks on the west bank of the river.

Shatt Al-Arab estuary

Shatt Al-Arab Estuary receives freshwater from two main tributaries (Shatt Al-Arab River and Karun River) as presented in fig. (1). The estuary is characterized by successive tide cycle two times per day with a difference in water levels by approximately 1 m during low tide cycle to 3 m during high tide cycle. As a result of the bottom slop toward the Arabian Gulf, the water column being very turbid during the low tide where the bottom surface noticeably disturbed due to high velocity of low tide currents and the turbidity gradually decrease during the high tide cycle. Shatt Al-Arab Estuary comprises important part of the Iraqi marine waters with a depth range 6-10m.

Topographically, this region is slopping gently from the Iraqi coastal mudflats for 30-40 km southward, then a sudden drop in depth occurs due to multi "Khors" such as Khor Al-Amaya, Khor Al-Khafja to the south, Khor Al-Adied and Khor Musa to the east and Khor Al-Qaid to the west with depths of l0-20 m. The intertidal and tidal flat areas on the sides of the estuary are locally known "Maraqat", represented by Maraqat Abdullah to the west and Maraqat Abadan to the east.

Biologically, Shatt Al-Arab Estuary is characterized by high primary productivity as a result of the freshwater influx through Shatt Al-Arab River. This area plays an important biological role as feeding, nursery and spawning ground for different marine and estuarine fishery species, which together constitute the shared stock among Iraq, Kuwait and Iran.

Consequently many fishermen of these countries exert fishing throughout this part of the Arabian Gulf by different types of fishing vessels mostly using trawling and gill nets.

Khor Abdullah

Khor Abdullah is an open coastal lagoon of funnel shape water intake south of Iraq lies between Shatt Al-Arab estuary and Bubiyn Island (Fig. 2). On the other hand, Khor Abdullah represents another linkage between the Mesopotamian basin and the Arabian Gulf through connecting discharge by Shatt Al-Basrah canal across Khor Al-Zubair. The Khor is located within an intertidal flat subjected to a continuous deposition and erosion processes (Albadran & Albadran, 1993). Khor Abdullah extending for ~60 km with l-14 km in width separating the mudflats of southern Iraq from Warbah and Bubiyan Islands. The water is very turbid due to strong tidal currents, which lift up silty sediments besides the continuous dredging of the navigational channel (Hussain *et al*., 1999).

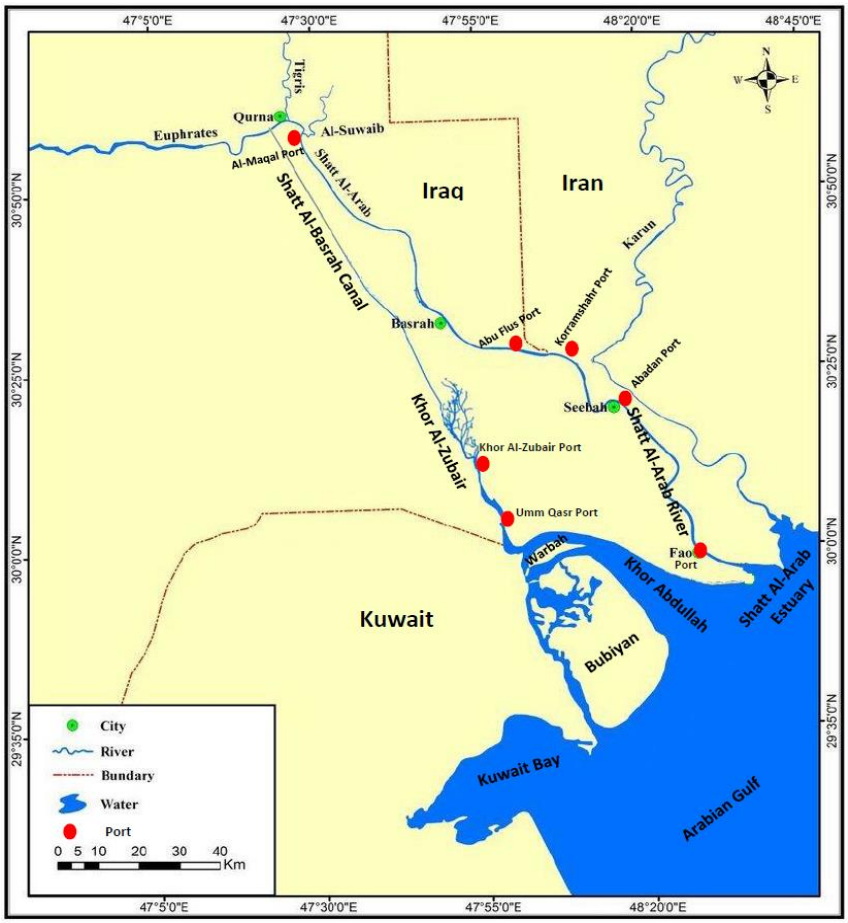

Fig. (2): Location map of the study area

The average tidal range of spring and neap tides is 4.6 m and 3.5 m, respectively (Darmbian & Lindquist, 1988; Mahdi, 1990). Umm Qasr Port is the biggest and premier maritime gateway to Iraq founded in early 1960s located at the connection between Khor Abdullah and Khor Al-Zubair. This port serves as deep water port of multi-purpose capability, handling different types of cargo, including liquid and dry bulk, general cargo and container cargo. The port reduces the dependence on the Shatt Al-Arab waterway where it is composed of 21 berths and a total berth length of 5,000 m.

Khor Al-Zubair

Khor Al-Zubair is a longitudinal extension of the northwest Arabian Gulf waters toward lower Mesopotamia across Khor Abdullah (Fig. 1). The length of the khor is approximately 46 km with an average width of 1 km and depth range of 15-20 m. The northern part of the khor is characterized by a huge number of tidal branches at which the depth < 4 m. In 1983, Khor Al-Zubair has been connected to the marshland by Shatt Al-Basrah Canal to discharge water to the khor through a regulator gate. Such connection changed the khor from a high saline to a moderately saline one. Khor Al-Zubair Port is situated at the extreme northwest

of the khor at a distance of 16.3 km northwest of Umm Qasr Port consisted of 11 berths with various drafts. Further industrial areas are located nearby Khor Al-Zubair including petrochemical, Fertilizer and Iron and Steel Plants. These activities provide the opportunity for commercial vessels shipping toward the port. The branches on the east side at the most north of the khor represent fishing grounds for many local fishermen using fixed and drift gillnets.

Iraqi ports

There are three commercial ports located along the Shatt Al-Arab River. These are represented by Al-Maqal Port in the north and Al-Fao Port in the South, which were established in 1916. The third is a small port known Abu Flus located in the Abu Al-Khaseeb region (Fig. 1). Another two commercial ports are constructed in the Khor Al-Zubair lagoon. The first is Umm Qasr Port at the entrance of Khor Al-Zubair established in the early 1960s and the second is Khor Al-Zubair Port established in 1974. Moreover, there are two further oil terminals in the Iraqi territorial marine waters; Khor Al-Amaya established in 1950s and Al-Basrah established in the 1970s. On the Iranian side, there are two main ports on Shatt Al-Arab River; Khorramshahr and Abadan. These ports play an important role in the navigational movement for different types of vessels and oil tankers across the Shatt Al-Arab River and Iraqi marine waters.

Collection of data

Statistics of shipwrecks

The data of shipwrecks was collected from two major components. The first is based on data recorded at the Inspection Directorate in the State Company of Iraqi Ports. The locations are identified in these records by date of sinking, type and size of vessel, owner and salvage date for those have been removed in the four sites of the study area. The second is based on survey conducted during 2018-2019 within the fishing ground mostly in the Shatt Al-Arab Estuary. The locations identified in the survey were positioned by an assistance of many fishermen companied the survey at different periods following to the sites at which their nets have tangled and lost due to submerged shipwrecks. All the shipwrecks within this site have not been salvaged yet and were labeled as unknown by date of sinking and type of vessel as no data provided on shipwrecks specifications.

Questionnaire and interviews

A questionnaire has been prepared including both closed and open-ended questions. The questionnaire format was circulated for the following stakeholders:

Fisheries Department, General Directorate of Agriculture in Basrah Directorate.

Al-Nasr Cooperation Fishing Society in Al-Fao.

State Company of Iraqi Ports.

General Directorate of Environment in Basrah Governorate.

Fishermen using trawling and gillnets in Shatt Al-Arab and Iraqi marine waters.

Moreover, several interviews were organized with persons in charge at the directorates above on the impacts of the shipwrecks and the policy to manage the problem to support the findings of the questionnaire feedback.

Mapping

The locations of the shipwrecks identified by the survey of the General State of Iraqi Ports in

the four sections and the survey conducted during 2018-2019 in site 3 were positioned using GPS. The (x, y) co-ordinates for each location were saved as tabular data in Excel sheet format. The coordinates were imported in a GIS database and were converted to point layer in Arc GIS Software.

Results & Discussion

Statistics of shipwrecks

The sunken shipwrecks throughout the study area are categorized on spatial basis into four sites:

1-Shatt Al-Arab River (from connection of Tigris and Euphrates rivers to the connection with the Arabian Gulf at Al-Fao City).

2-Shatt Al-Arab Estuary (from the connection with the Arabian Gulf to Khor Al-Amaya).

3-Khor Abdullah (Khor Al-Amaya to Umm Qasr Canal).

4-Khor Al-Zubair (from Umm Qasr Port to Khor Al-Zubair Port).

A total of 141 shipwrecks have been identified within the four sections as illustrated in fig. (3). The number of shipwreck locations were distributed by 34 (24%), 57 (40%), 24 (17%) and 26 (19%) in sites 1, 2, 3 and 4, respectively. Forty three (30%) of these shipwrecks were salvaged mostly in Khor Al-Zubair, where 20 shipwrecks were removed contributing 46% of the total number of salvaged shipwrecks in the study area followed by 12 (28%) and 11 (26%) in sites 1 and 3, respectively (Fig. 4). However, no attempt has been carried out to salvage any of the 57 shipwrecks in site 2.

During the two years survey on shipwrecks in the Shatt Al-Arab River, the results revealed that most shipwrecks were identified in the area between Sindbad in the north and Abu Fluse in the middle (Marine Science Centre, 2012). The report emphasized on the necessity to commence a further survey to cover the remaining parts of the Shatt Al-Arab River and Iraqi marine waters. On temporal basis, the results revealed that 22 of the shipwrecks were sunk during 1980s mostly due to the Iraq-Iran war. During the 1990s, the record indicates 15 shipwrecks were added to the study area generally as a result of the Gulf war 1991 (Fig. 5). For 2000-2010 period, 54 vessels were sunk, whereas 35 were resulted from the Gulf war during the Iraq invasion in 2003. However, the other 50 shipwrecks have not been identified by year of sinking mostly located in the Shatt Al-Arab Estuary site. Most of the shipwrecks of 1980s are found in sites 1 and 2.

On the other hand the shipwrecks of 1990s are mostly associated with sites 3 and 4 and the majority of those recorded after 2000 are positioned in sites 1 and 4.

The sunken vessels are of different size following to the type of the vessel (Fig. 6). The lengths are ranged between 24 m for small boat up to few hundred meters of oil tankers. The sunken vessels are classified into three groups; small vessels (< 50m), medium vessels (50-100 m) and large vessels (> 100 m).

The small shipwrecks covered fuel barge, navy boat, military boat, tug boat and dhow. In general, the medium shipwrecks represent oil tanker, yacht, military vessel and bunker, however the large shipwrecks are cargo, oil tanker, dredger and big barge.

The majority of the sunken shipwrecks are small vessels represented by 94 vessels equivalent 67%, while the medium found to be

22 (16%) and the large vessels are 24 (17%) as presented in fig. (7). Only one shipwreck nearby Buoy 11 is unknown for type and size as well.

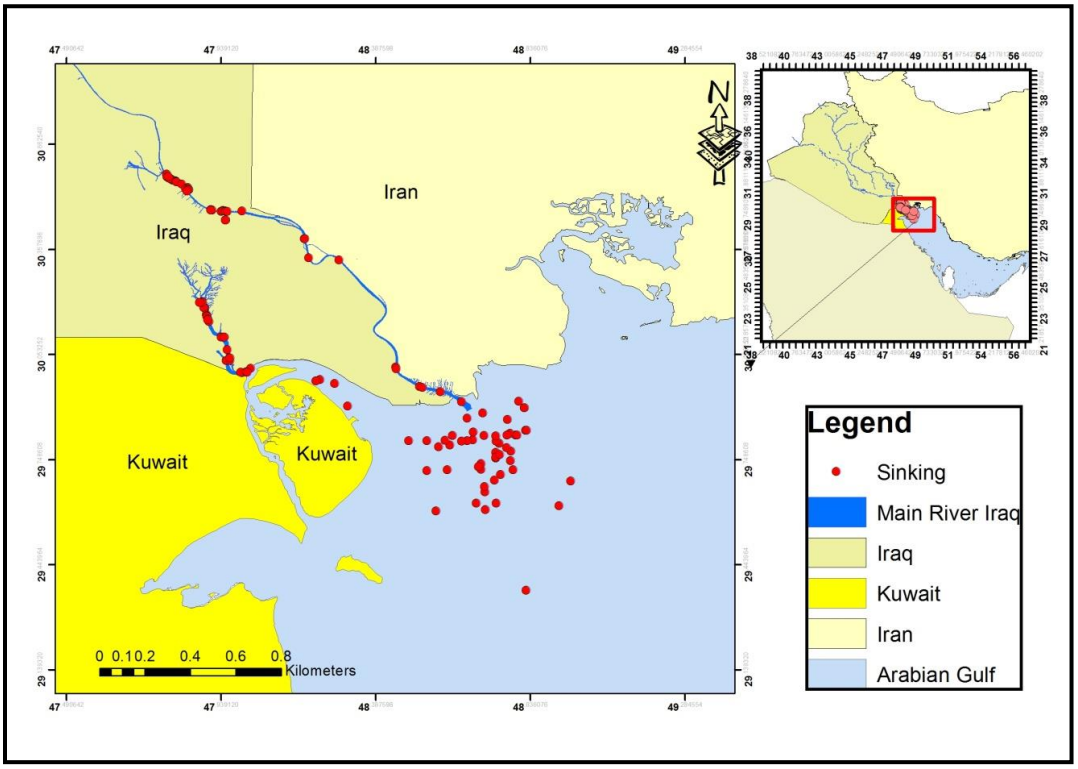

Fig. (3): Location map indicating shipwrecks in the inland and territorial Iraqi marine waters

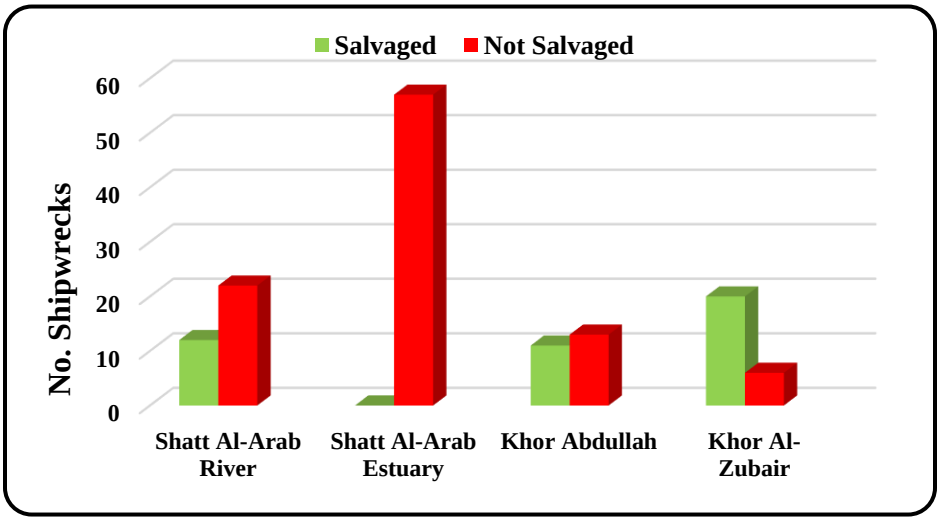

Fig. (4): Salvaged and non-salvaged shipwrecks in Shatt Al-Arab and marine waters

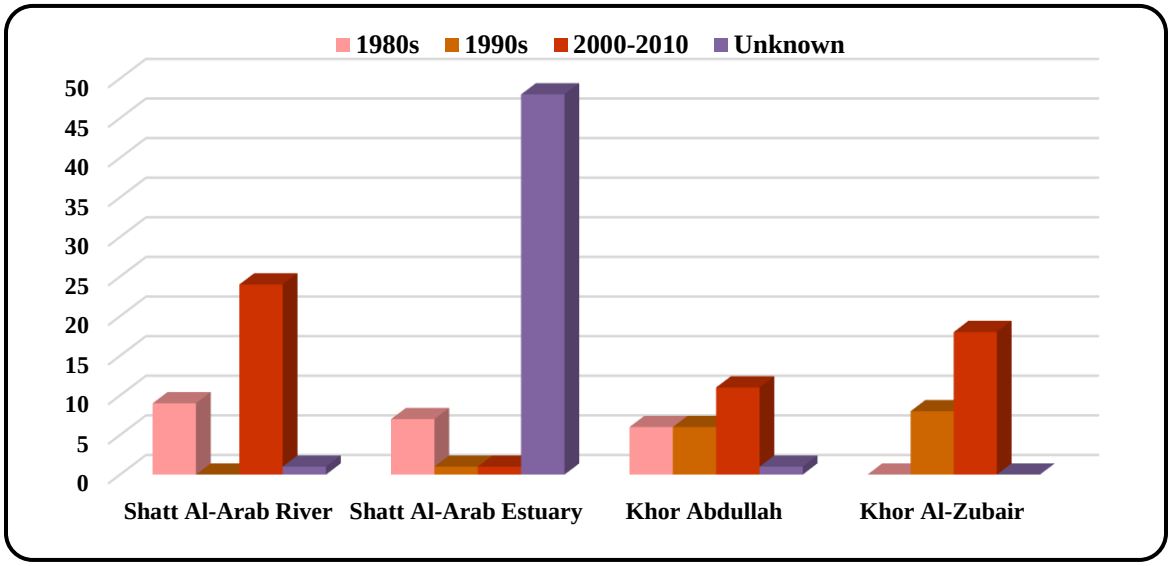

Fig. (5): Shipwrecks records based on temporal basis in Shatt Al-Arab and marine waters

Fig. (6): Examples of sunken vessels throughout the study area

The salvage process is the most challenge for shipwrecks in the Shatt Al-Arab River and marine waters as well. This is well considered on global scale, whereas challenging salvage conditions have led to significant increases in operational costs, although the number of cases for which services were provided by the salvage industry remained relatively stable during the last 15 years, the gross revenue generated from wreck removal activities have increased drastically (ISU, 2016). The key factors contributing to the rising costs have been analysed in a recent report by Lloyds, and the analysis of the most expensive cases has found that the role of relevant authorities to be one of the key drivers of increasing costs (Herbert, 2013). As in many other countries, marine accident data should be recorded in a database format at the regulator authority (General State of Iraqi Ports) to be easily identified by date, location, type of vessel, distance from coast, owner, and reason of sunken, killed and injured persons. Moreover, these locations to be marked by visible signs during night and to be labeled on maps and update regularly.

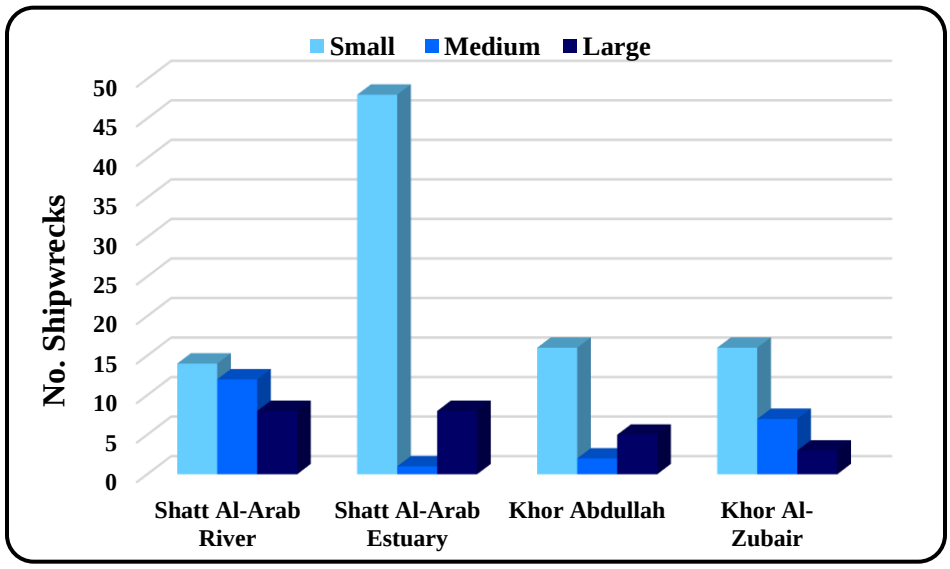

Fig. (7): Size of shipwrecks in Shatt Al-Arab and marine waters

Impacts of shipwrecks on hydrological features

A huge quantity of suspended matter is loaded across Tigris and Euphrates to Shatt Al-Arab River. Thus, regular dredging operations are required to secure the depth for navigation toward Iraqi ports particularly at the entrance of the Shatt Al-Arab River in the south and also in Khor Abdullah. These operations have been ceased along the 1980s due to the Iraq-Iran war (1980-1988) and in the 1990s and years after as a result of lack of technical capabilities due to sanction against Iraq. Many vessels were attacked along Shatt Al-Arab River and the Iraqi marine waters during the Iraq-Iran war (1980-1988) and the Gulf Wars 1991 and 2003. By the time, these shipwrecks became traps for the sedimentation drifted across Shatt Al-Arab River, therefore several small islands and semi islands have been created over these shipwrecks at several locations along the river. On the other hand, the river course is heavily affected by some dams and bridges constructed for military operations where several morphological changes have been resulted on the river waterway. Khaleefa (2014) found that anthropogenic activities (construction of roads, bridges and embankments across the waterways, as well as water transport and the sinking of ships) determine the geomorphological features of the river. Similar findings were concluded by (Hamdan, 2015) indicating that shipwrecks heavily affected the geomorphological aspects of the Shatt Al-Arab River on the Iraqi bank as a result of their cross section on the bottom that provide an opportunity for erosion. Consequently, these shipwrecks being barriers against tidal currents at which huge drift sediments are accumulated, which generated alterations in the river course mostly in the part at which the river represents shared border with Iran where the land is reducing on the Iraqi side and increasing on the Iranian side. Similar conclusion has been pointed out by (Al-Wahaily, 2009) indicating that shipwrecks might have a serious risk represented by slowly changing of marine borderline between Iraq and Iran, causing shoreline erosion and forming new islands. The new islands created impede navigation activity due to the geomorphologic change, where the width of Shatt al-Arab River has decreased by as much as 300 meters in some areas in addition of narrowing the shipping channel.

According to the records of the State Company of Iraqi Ports in 2005, a total of 15 new small islands are indicated on the shipwrecks with an area of ~ 1250 hectare and the area potentially increased due to continuous accumulation of river sedimentation. Two of these islands are located near Shaheeniya Island in the southern part of the river, and the two islands are created on the wreckage of two ships, one of which is Iranian and the other is Indian, which are currently inhabited by some families.

Impacts of shipwrecks on water quality

Consoli *et al*. (2015) reported that oil pollution is commonly resulted due to maritime accidents that significantly impacting marine environment and often portrayed by the media as environmental disasters with dire consequences predicted for the survival of marine flora and fauna, which therefore, mandatory for appropriate remediation and/or mitigation of the potential negative effects. In view of the potential hazards from wrecks and historical wrecks, many countries have recently developed comprehensive risk assessment systems to

examine the wrecks impacts in their national waters (Whittington *et al*., 2017).

In the northwest Arabian Gulf, the shipwrecks are of a growing impact on the environment, which can be considered as one of the common sources of environmental pollution due to the oil spilled mostly from oil tankers and also the Tributyltin (TBT) leached from the paints of hull shipwrecks due to long time of sunken (Alkandari *et al*., 2018), however further potential risk could be sourced by military waste and unexploded ordnance. Kamm (2014) pointed out that the conventions, which are relevant to pollution from shipwrecks context contain similar definitions for ships as those identified by the International Convention for the Prevention of Pollution from Ships 1973/1978 (MARPOL 73/78). The potential risk to the marine environment of oil release from potentially polluting wrecks is increasingly being acknowledged, and in some instances remediation actions have been required, however removing oil from wrecks is not always cost effective, so a proactive approach is recommended to identify potential polluting wrecks that pose the greatest risk to sensitive marine ecosystems and local economies and communities (Goodsira *et al*., 2019).

The new sedimentations occurred around the shipwrecks noticeably affect the current velocity and the mixing during the ebb and tide cycle by reducing the depth at many parts of the Shatt Al-Arab River and the also the Shatt Al-Arab estuary. Both petroleum hydrocarbons and antifouling compounds are the major pollutants posed by shipwrecks (UNEP, 2003; Valerie, 2005). Alkandari *et al*. (2018) investigated the impact of the shipwrecks in the northwest Arabian Gulf as a potential source of TBT leakage from the hull paints. For instance, the location of Al-Rumaila oil tanker sunken in Khor Abdullah since 1991 is considered in the survey. The tanker is settled horizontally forming a barrier against the currents movement where huge sedimentation is accumulated around the tanker and the oil is still continuously spilling. The results revealed that the TBT level at the tanker location was extremely higher than the standard limit. Moreover, the study reported that further 34 shipwrecks are located within the Kuwaiti waters. These shipwrecks in addition to many others probably located on the Iranian side may potentially complicate the pollution impacts throughout the northwest Arabian Gulf.

Impacts of shipwrecks on fishing sector

The most impact of shipwrecks on fishing is reflected on socioeconomic aspects. For instance, the results of lost fishing gears in the Baltic Sea revealed that until 1998, the amount of nets lost by the Swedish fleet was estimated at 2750 – 3000, which corresponds to approximately 156 – 165 km and the annual amount of cod nets lost in the Baltic sea by the EU vessels were ranged from 5,500 to 10,000 pieces in 2005 – 2008. Moreover, the estimated amount of nets deployed on shipwrecks located in the Polish marine areas was ranged between 150 to 450 tones (WWF, 2015). Bianchini & Ragonese (2011) concluded that a precise knowledge of how many grasping sites exist in the fishing bottoms and of what kind, and where they are, especially when exploring new fishing grounds is of primary importance for Strait of Sicily, which is considered as home of the largest trawl fishing fleet of the Mediterranean and losing a gear is a very serious economical accident.

One of the most common fishing methods used in the Iraqi marine waters and adjacent

waters in Iran and Kuwait is the trawl nets, followed by drift gillnet. The first targets shrimp primarily and their associated bycatch, and the second is considered as selective gears mostly used for migratory species; hilsa shad, *Tenualosa ilisha* (locally known Sboor) and silver pomfret, *Pampus argenteus* (locally known Zubaidi). Many accidents of net tangling by submerged shipwrecks were taken place causing lost or damage to the fishing nets. Consequently, the fishermen practicing in the marine waters and in the Shatt Al-Arab River have positioned the sites of shipwrecks in their logbook whether those submerged or the ones where parts of the shipwrecks are visible to avoid passing over or nearby these locations. Therefore, the fishing ground has been reduced and the fishing vessels are crowded within a limited allowable area for trawling and gillnets as well. The decline in fishing ground minimizing the fish catch ability for most of the fishermen. As a result, an obvious elevation in price is observed for most of the commercial catch particularly Sboor and Zubaidi.

Impacts of Shipwrecks on Marine Biodiversity.

NOAA report on marine debris program (NOAA, 2015) indicated that lost or discarded fishing gear particularly gillnets, is known as Derelict Fishing Gear (DFG), act as a trap for fish, crustaceans, marine mammals, sea turtles, and seabirds and also causing damage to underwater habitats such as coral reefs and benthic fauna. The environmental impact of lost nets remain on the sea bottom is exerted mainly by long term, useless and uncontrolled catches of economically important species indicating that these nets particularly in shallow depths constitute a lethal danger for many species of diving seabirds in addition to documented cases of the death of marine mammals (WWF, 2015).

In spite of the potential hazards, sunken vessels are commonly deployed as artificial reefs (Arena *et al*., 2007), because they help to enrich and diversify the local fish community. The study undertaken by Vander Stoep *et al*. (2002) pointed out the necessity for managing Michigan shipwrecks using a variety of partnership strategies that recognize multiple values indicated that salvagers, historians, archaeologists, dive businesses, recreational divers, and tourists all have different opinions about how these resources should be used and managed.

Consoli *et al*. (2015) indicated higher levels of species richness and abundance of fish communities near shipwrecks in comparison with sites at a short distance selected as controls in the northern coast of Sicily, indicating that these sunken vessels, because of their higher environment unpredictability, act as artificial reefs, attracting aggregations of fish species and leading to a greater diversification of the local fish assemblage.

Bianchini & Ragonese (2011) focused on the importance of the shipwreck sites as fishery reserves or No Take Zones (NTZs), which are usually distinguished from Marine Protected Areas (MPAs) where the latter should be more oriented towards enhancement of marine environment and conservation of biodiversity (Anonymous, 1999), whereas the former are generally designed within fishery scenarios (Horwood, 2000). These NTZs are created by shipwrecks or other steel debris by preventing trawling, i.e., protecting the bottom structures providing nests for different broad-scale fishery species to be vulnerable to trawl nets areas. Therefore, the shipwrecks, whether

originated by accident or purposely ad hoc sunken, provide a beneficial opportunity to act as MPA and NTZ. Moreover, Kingsley (2009) indicated the importance of comprehensive mapping and planning of shipwrecks sites in the Atlas Zone, Western English Channel and Western Approaches, to differentiate between heritage-rich shipwrecks, those need to be avoided by fishermen, and the greater majority of modern wrecks that are devoid of historical significance and can be exploited by the fishing community.

Due to technical reasons pertaining with limitation of underwater survey facilities, no attempt has been undertaken on the fish assemblage around the shipwreck sites, whether in the Shatt Al-Arab River or the marine waters in comparison with other natural sites. It is of great importance to initiate a comprehensive action plan investigating fish species composition at shipwreck sites to find out the role of these artificial structures in aquatic ecosystems as this be crucial issue on worldwide scale due to the implications generated on biodiversity notably the fish diversity.

Conclusions

The shipwrecks throughout the inland and marine Iraqi territorial waters are mostly resulted due to military operations during the wars since 1980, which heavily affecting the aquatic ecosystems. The impacts on geomorphological aspects were obviously indicated due to erosional and depositional processes and creation of artificial islands that noticeably retreating the Iraqi side of the Shat Al Arab. The locations of the shipwrecks substantially disturb the fishing activities either by trawling nets or gillnets where the fishing boats are crowded within limited fishing area for safe fishing practices. The shipwreck sites act as an artificial complex bed providing the opportunity to attract fishery species; however, no attempt has been made to investigate fish species composition around these sites. These shipwrecks represent a potential source of different pollutants released may significantly affect the physiochemical and biological properties at area characterized by biological importance as nursery, spawning and feeding grounds enhancing the estuarine and marine shared fishery stock in the northwest Arabian Gulf among Iraq, Kuwait and Iran. Consequently, it is of great importance to initiate a regional survey to assess the levels and types of pollutants in this area and to take a cooperation action on salvaging the sunken vessels.

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Conflict of interest

The authors declared that they have no conflict of interest.

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التحليل الزماني والمكاني لحطام السفن في نهر شط العرب والمياه البحرية العراقية شمال غرب الخليج العربي

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المستخلص: ينجم عن حطام السفن الغارقة تأثيرات مختلفة تتمثل في الغالب في التغيرات الجيومورفولوجية في المجاري المائية، وكونها مصدرًا محتملاً للملوثات فضلاً عن إعاقة أنشطة الملاحة وصيد الأسماك. تم في هذه الدراسة تحديد 141 موقعًا لحطام السفن في المياه العراقية شملت المياه الداخلية واالإقليمية. شملت منطقة الدراسة أربعة مواقع تمثلت بشط العرب ومصب شط العرب وخور عبد الله وخور الزبير. أجري تحليل البيانات على أساس النهج المكاني والزماني بناءً على الإنتشال ونوع وحجم السفن الغارقة في هذه المواقع. وقد صنف حطام السفن حسب الحجم إلى ثلاث فئات. أظهرت النتائج أن عدد الغوارق في مناطق الدراسة الأربعة بلغ 141 موزعة الى 34 و57 و24 و26 في شط العرب ومصب شط العرب وخور عبدالله وخور الزبير على التوالي. تم إنتشال 43 سفينة فقط من حطام السفن معظمها في خور الزبير، ومع ذلك، لم يتم إجراء أي محاولة لإنتشال أي من حطام السفن في أهم مناطق الصيد الواقعة داخل مصب شط العرب. بينت نتائج التحليل على أساس التغاير الزمني إن معظم حطام السفن قد سجل بالتزامن مع الحروب. وبالنسبة للحجم، وجد أن غالبية حطام السفن الغارقة صغيرة الحجم وبمجموع 94 موقع (67 ٪)، إلا أن الكثير منها لا يزال غير محدد حسب النوع والحجم وخاصة تلك المنتشرة في مصب شط العرب. تم تحليل آثار الغوارق بناءً على نتائج إستبيان أجري لعينات من منتسبي الموانئ والبيئة ومديرية الزراعة وعينات عشوائية من الصيادين. علاوة على ذلك، فإن نتائج البيانات المنشورة ذات الصلة فيما يتعلق بالخصائص الهيدرولوجية ونوعية المياه والصيد والتنوع البيولوجي قد تم أخذها في الاعتبار بشكل خاص في المنطقة المشتركة بين العراق والكويت وإيران. وأوصت الدراسة بأهمية البدء بإجراء مسح إقليمي لتقييم مستويات وأنواع الملوثات في شمال غرب الخليج العربي والتعاون المشترك لإنتشال السفن الغارقة.

الكلمات المفتاحية: حطام غوارق، الموانئ العراقية، شط العرب، خور عبدالله، خور الزبير، الصيد، العراق.