Assessment of Short-term Effects of Pollution Accident on Fisheries in River Nile, Egypt

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ABSTRACT

This study outlines the immediate impact on local fisheries of the incident that took place on 21st April 2015. A barge capsized in the Nile in Upper Egypt's Qena governorate after colliding with the foundations of the city's Dandara Bridge. The capsized barge was carrying 500 tons of phosphate (pre-industrial, inert material) for processing in a local factory. The study aimed to record any apparent effect of the incident on the fisheries in the immediate site vicinity and downstream. Also, it described the *status quo* of the fisheries around the incident location to compare it with the situation before the accident to confirm any short-term impact and to establish a baseline for any future, long-term, impact studies. Data were collected on fish assemblage structure in the incident site vicinity, the number of fishing boats and fishing methods that were applied to catch them. Furthermore, some fisheries biological parameters were assessed. The main conclusions derived from the study were that fishing in the vicinity of the incident is artisanal with small boats and simple fishing gears. The fisheries biological parameters of the area's fishery are comparable to that of other similar environs, and that the incident did not have an apparent short term effect on the fishery profile of the area. The main recommendations resulted from this study were that the impact of the incident on fish at the molecular level should be studied and that the state of fisheries in the area should be followed up to detect any long-term impact of the incident.

INTRODUCTION

Egypt has about 8 716 km^2 of inland waters, including rivers, lakes, reservoirs and brackish water lagoons. Both commercial and sport fishing take place on these waters. The inland fishing fleet comprises over 23,158 small wooden boats (4–6 m in length) catching about 231,959 tonne, or 69 percent of Egyptian landings (GAFRD, 2018). Most of the fishermen are unregistered. There are about 270 registered landing sites and many unregistered (El-Bokhty and El-Far, 2014). The most economically important species are tilapia species (*Oreochromis niloticus*, *O. aureus*, *Sarotherodon galilaeus*, *Tilapia zillii*) and freshwater species (*Bagrus bayad*, *Lates niloticus*, *Barbus spp.*, *Clarias spp.* and *Mugil spp.*) caught usually by trammel, cast and gillnets. The catch reached 231,959 tonne in 2016 (GAFRD, 2018).

The inland water resources represent various fisheries ecosystems. These include freshwater fisheries which comprises the River Nile, irrigation canals, and Lake Nasser, and some western desert water bodies.

The River Nile extends for about 1 600 km, with two main branches downstream, and discharges to the Mediterranean Sea, with many small branches and canal covering a great area in the northern region of Egypt. During the last years, the recorded catch of the Nile River Basin in Egypt decreased from 110 000 tonne in 2001 to 73,484 tonne in 2016, with the catch comprising mainly tilapia and catfish from the artisanal fishing sector (GAFRD, 2018).

Qena Governorate is located in Upper Egypt north of Aswan Governorate and south of Sohag Governorate, its Capital is Qena City. Fisheries and Aquaculture contribute to Qena's economy. Artisanal fishing brings in an annual revenue of between LE 7,655,000 and LE 30,620,000 (EEAA, 2005).

On 21st April 2015, a barge capsized in the Nile in Upper Egypt's Qena governorate after colliding with the foundations of the city's Dandara Bridge. The capsized barge was carrying 500 tons of phosphate (pre-industrial, inert material) for processing in a local factory.

This study aims to outline the immediate impact on local fisheries of the accident event of 21st April 2015 through recording any apparent effect of the incident on the fisheries in the immediate site vicinity and downstream, and describing the *status quo* of the fisheries around the incident location to compare it with the situation before the accident (from previous literature) to confirm any short-term impact and to establish a baseline for any future, long-term, impact studies.

MATERIALS AND METHODS

A field trip was carried out on 23rd and 24th April 2015 (two days after the incident) and covered Qena city area of the River Nile around the capsized barge. During the trip, data were collected on fish assemblage structure in the incident site vicinity, the number of fishing boats and fishing methods that were applied to catch them.

Samples of all available fish species in the incident site vicinity (190 specimen) were collected from five different sites (Fig. 1).
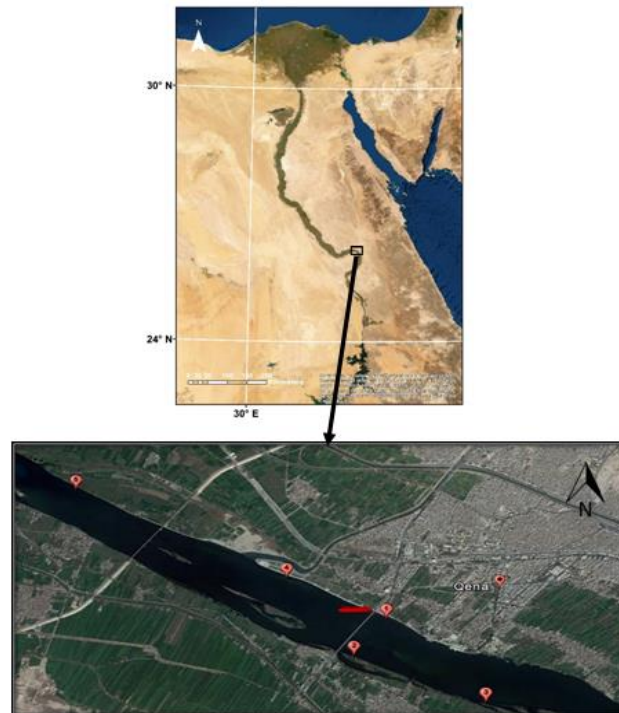

Fig.1: Maps showing the location of the capsized barge and samples collection sites

a. Upstream: Site 1 on north-eastern bank of the river approximately 500 meters far from the capsized barge and sites 2 and 3 on the south-western bank which were approximately 800 and 3000 meters far from the capsized barge respectively.
b. Downstream: sites 4 and 5 on the north-eastern banks which were approximately 500 and 3000 meters far from the capsized barge respectively.

In laboratory, samples were firstly sorted into species to detect species composition, and then each specimen was measured to the nearest 0.1cm and weighed to the nearest gram.

Length-weight relationship in fishes was applied and it can generally be expressed by the following equation: $W = a\ L^b$ (Le Cren, 1951), where W is the fish weight in grams, L is the body total length in cm, a and b are constants.

In this study the Fulton's coefficient of condition (K_c) was used, as it is the simplest and widely used formula for estimating this coefficient. It is as follows: $K= (W/L^3)$ x 100 (Pauly 1983), where W is total or gutted body weight (g) and L is the total body length (cm) of fish.

RESULTS

Fishing methods and gears (Fig. 2):
Boats and fishers

Boats in the vicinity of a capsized barge are made of wood and fitted with paddles. The boat length ranged from 4.25 to 5.5 meters and width ranged from 1.25 to 2.5 meters. Around 50 boats are fishing in the area and two fishermen operate each boat.

Fig. 2: Fishing gears in incident vicinity

Trammel nets (tangling nets)

Nets consist of three layers, two outer layers which are identical in height and mesh size and an inner layer which has smaller mesh size. The three layers are attached to floating line with crocks and lead line to grantee the horizontal extension of the net. Its length is around 50 meters with height of 1 meter and mesh size of the outer layers is 5.5 cm and of 2.5 cm for the inner layer. It is used in areas where water depth ranges between 1.5 to 2 meters. The net is used for fishing process once a day where it is spread before sunset to dawn the next day (about 12 hours).

Traps

Round baskets made of steel wire covered with net with two large holes on the top and the bottom. It is placed next to the grass near the banks. Species caught are tilapia and other species.

The size of the large holes is ranging between 10 and 15 cm. The mesh size is ranging from 2.25 to 2.50 cm. Trapes are placed in the water in the sunset to dawn in depth ranges from 1.5 to 2 meters.

Hooks and lines (Sennar)

They are 50 metres-long lines twisted multifilament with size 11 J-shape hooks. 15 cm between two successive hooks. Live bites, true hooks without bites also used. They are placed in the water in the sunset to dawn.

Spatial variances in fishery profile

Cluster analysis technique using Minitab© 17 software was applied to classify the sampling sites with respect to their number of species, number of fish and average condition factor. Fig. (3) was obtained. The figure reveals that there is not distinctive difference between upstream sites (Q1, Q2 and Q3) and downstream sites (Q4 and Q5).
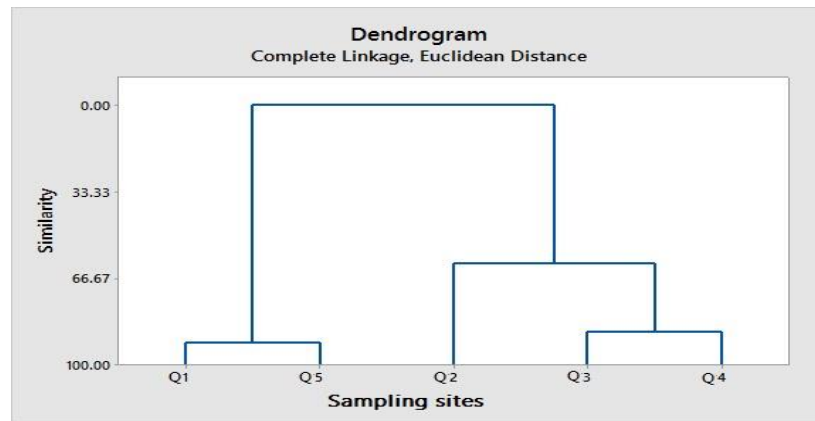

Fig. 3: Cluster of sampling sites based on number of species, number of fish and average condition factor.

Species composition

The fish catch from the incident site vicinity was comprised of three tilapia species namely; *Oreochromis niloticus, Tilapia zillii and Sarotheredon galilaeus*. In addition, the catch included specimens of *Clarias gariepinus* and *Bagrus bayad,* and one specimen of *Oreochromis mossambicus*. The pooled data (by number) revealed that *O. niloticus* was the most common species constituting about 48%, followed by *T. zillii* (39%) , whereas *S. galilaeus* represented about 8 % of the total catch. The least frequent species were *B. bayad* (3%) and *C. gariepinus* (1%). Species composition according to weight also ranked *O. niloticus* as the 1st species (about 34 % of the total catch), whereas *T. zillii* is the 2nd species, while *S. galilaeus* was the lowest one (Fig. 4).
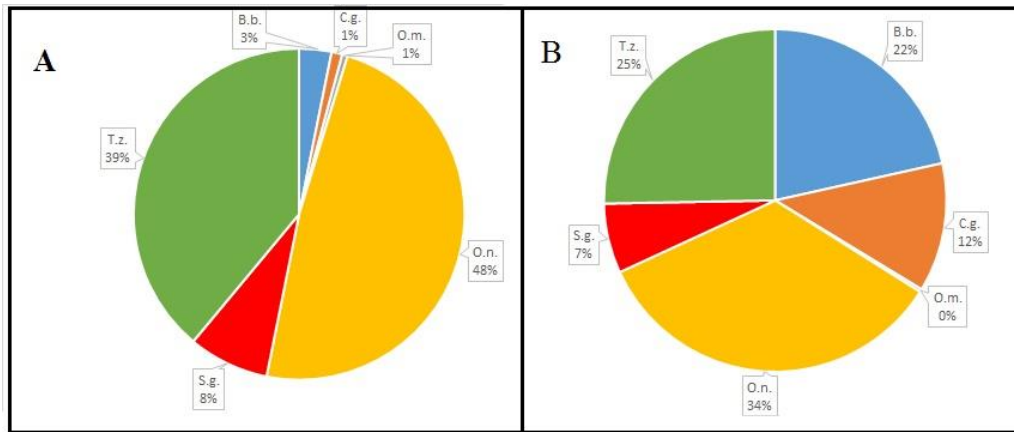
Fig. 4: Species composition of the catch from the incident site vicinity as number percentage (A) and weight percentage (B).

Length-weight relationship

Only two species have adequate number to apply this analysis, *O. niloticus* (92 specimens) and *T. zillii* (74 specimens). Figure 5 shows the output of the analysis. The value of (a) and (b) were 0.0174 and 3.0053 for *O. niloticus* and 0.0236 and 2.9387 for *T. zillii* which indicates that both species have isometric growth as (b) is close to 3.

Condition factor

In the present study, total weight was used for calculating the condition factor (K_c). The average K_c for *B. bayad*, *C. gariepinus, O. niloticus*is, *S. galilaeus* and *T. zillii* were 0.56, 0.88, 1.77, 2.04 and 2.01, respectively.
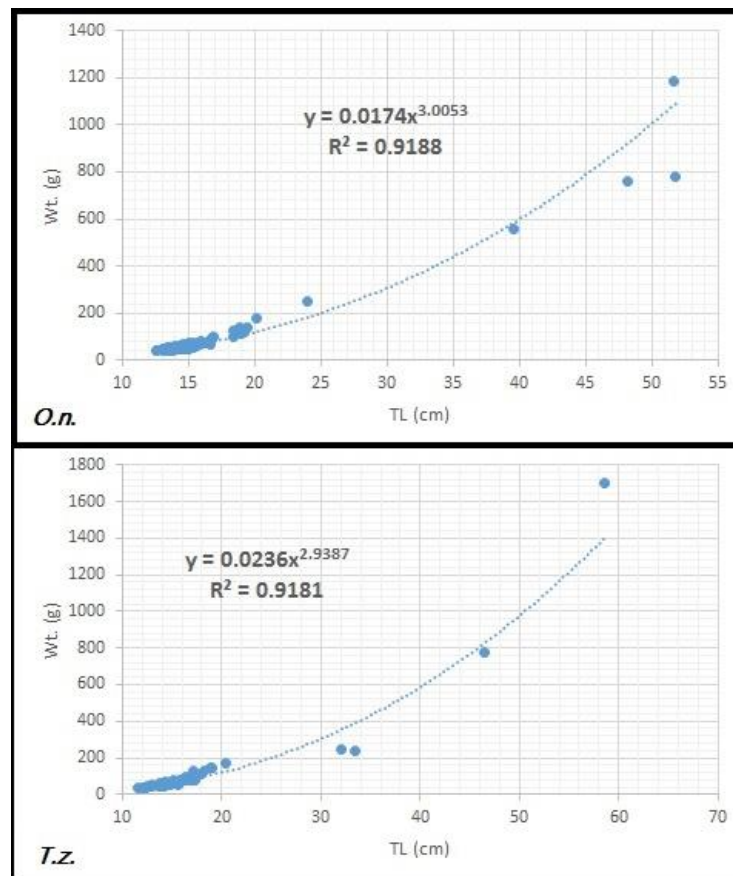

Fig. 5: Length-weight relationship of *O. niloticus* and *T. zillii*.

DISCUSSION

Pollution effects on fisheries and the possible management activities that should be undertaken to reduce any demonstrated effects have always occupied the attention of fisheries scientists. They have to confront two responsibilities considering pollution effects on fisheries: one is to demonstrate that pollution is really affecting fish and stocks, and the second is to propose management measures to mitigate damage if it exists. These responsibilities can be satisfied in many stages, one of them is to conduct critical examinations of pollution effects at levels of the individual, the local population, and the species. However, the stress from chemical pollutants can have significant quantifiable effects on resource species abundance is much more difficult to demonstrate, and has not been documented satisfactorily (Sindermann, 1980).

This study is trying to outline the immediate impact on local fisheries of the incident that took place on 21st April 2015. Where a barge capsized in the Nile in Upper Egypt's Qena governorate after colliding with the foundations of the city's Dandara Bridge. The capsized barge was carrying 500 tons of phosphate (pre-industrial, inert material) for processing in a local factory.

The fishing in the vicinity of the incident are artisanal with small boats and simple fishing gears, however, according to the FAO's Advisory Committee on Fishery Research (ACFR) Working Group on Small-Scale Fisheries "small-scale fisheries make an important contribution to nutrition, food security, sustainable livelihoods and poverty alleviation, especially in developing countries" (FAO, 2012).

When examining the fishery profile upstream and downstream of the incident site, the results shows no distinctive difference (Fig., 3). According to fishery profile (number of species, number of fish and average condition factor) site Q1 (upstream) formed a distinctive group with site Q5 (downstream); while the other 3 sites (Q2 and Q3 upstream and Q4 downstream) formed another group. Also, the fish catch from the incident site vicinity was comprised of the species that expected to be caught in this time of year (Shalloof and El-Far, 2010). This implies that the incident did not have an effect on the fishery profile of the area on the short term.

Knowledge of length-weight relationship of a fish species is an important biological tool in the management of fish population (Mendes *et al*., 2004). The study of length- weight relationship provides mathematical expiration between these two measurements as that one may be converted to the other (Richter *et al*., 2000). A fish is growing isometrically if the increasing in all dimensions at the same rate. The length-weight relationship is affected mostly by various factors such as, the availability of food, rate of feeding, spawning ...etc (Froese, 2006).

In the present study, the length- weight relationships were calculated for two Cichlid species (*O. niloticus* and *T. zillii*) show that the values of the constant "b" in both regressions were very close to three. This indicates that fishes grow almost symmetrically or isometrically in weight with length if its specific gravity remains constant which agree with the previous studies on these species in Egyptian waters (Ibrahim *et al*., 2007). Also, the result of this study agree with that of Shalloof and El-Far, (2017) who found in their study of length-weight relationship of some fishes from the River Nile that the value of (a) and (b) were 0.018 and 3.017 for *O. niloticus* and 0.019 and 2.997 for *T. zillii*.

The condition of a fish species is a measure of the degree of wellbeing, plumpness or fatness and is a function of several factors such as age, sex and season

(Lagler, 1956). It is greatly affected by the quantity and quality of the available food as well as the environmental conditions of the water-body in which the fish lives.

The condition factor "Kc" has been widely used by fishing biologists to express the suitability of an environment to a certain species. It is also called the coefficient of condition or Ponderal index (Anene, 2005).

In the present study total weight was used for calculating the condition factor. It was noted that, for all species, the condition factor mostly varies slightly from species to another in the incident vicinity. Average condition factor for the species are close to these recorded for the same species. Shalloof and El-Far, (2017) reported in their study of condition factor of some fishes from the River Nile that the average K_c for *B. bayad, C. gariepinus, O. niloticusis, S. galilaeus* and *T. zillii* were 0.954, 0.710, 1.919, 2.006 and 1.917, respectively which are comparable to that recorded in this study.

CONCLUSION

The main conclusions derived from the above results are that the fishing in the vicinity of the incident is artisanal with small boats and simple fishing gears, the fisheries biological parameters of the area's fishery are comparable to that of other similar environs, and the incident did not have an effect on the fishery profile of the area over the short term. The impact of the incident on fish at the molecular level should be studied, and the state of fisheries in the area should be followed up to detect any long-term impact of the incident.

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ARABIC SUMMARY

تقييم الآثار قصيرة الأجل لحادث التلوث على مصايد الأسماك في نهر النيل ، مصر

وليد على ، كريمان شلوف
معمل بيولوجيا المصايد ، شعبة المصايد ، المعهد القومى لعلوم البحار والمصايد، مصر

توضح هذه الدراسة التأثير الفوري للحادث الذي وقع في 21 أبريل 2015 على مصائد الأسماك المحلية. إنقلبت سفينة في النيل بمحافظة قنا في صعيد مصر بعد تصادمها مع جسر مدينة دندرة . كان البارجة المقلوبة تحمل 500 طن من الفوسفات (قبل تصنيعها ، مادة خاملة) وذلك بهدف معالجتها في مصنع محلي. هدفت الدراسة إلى تسجيل أي تأثير واضح للحادث على مصائد الأسماك في المنطقة المجاورة مباشرة وكذلك المصب. كذلك تم وصف الوضع الراهن لمصايد الأسماك حول موقع الحادث لمقارنته بالوضع قبل وقوع الحادث لتأكيد أي تأثير قصير الأجل على مصيد تلك المنطقة ، وكذلك وضع الأسس لأى خطط ودراسات مستقبلية طويلة المدى. تم جمع بيانات الأسماك في محيط موقع الحادث ، وكذلك عدد قوارب الصيد وطرق الصيد التي تم استخدامها لصيد تلك الأسماك . علاوة على ذلك ، تم تقييم بعض الخصائص البيولوجية لمصايد الأسماك فى تلك المنطقة. كانت النتائج الرئيسية المستخلصة من الدراسة هي أن صيد الأسماك في المنطقة المجاورة للحادث هو صيد حرفي باستخدام قوارب صغيرة وطرق بسيطة للصيد . وعند مقارنة الأنواع الموجودة من الأسماك من محيط موقع الحادث بالأنواع التي من المتوقع أن يتم صيدها في هذا الوقت من العام فى الدراسات السابقة ـ وجد أنها نفس الأنواع . كما كانت المعايير البيولوجية لمصائد الأسماك في المنطقة مماثلة لتلك الموجودة في المناطق المحيطة الأخرى . هذا يعني أن الحادث لم يكن له تأثير على المصايد في المنطقة على المدى القصير . كانت التوصيات الرئيسية الناتجة عن هذه الدراسة هي أنه ينبغي دراسة تأثير الحادث على الأسماك ، وكذلك متابعة حالة المصايد في المنطقة للكشف عن أي أثر طويل الأجل للحادث.