Journal of
NUCLEAR
Technology in Applied Science
ISSN 2314-8209 e-ISSN 2314-8217

J. Nucl. Tech. Appl. Sci, Vol. 5, No. 3, PP. 163 : 170 (2017)

Assessment of Distribution of Fishery Activities by Using GIS on North Coastal Zone of Egypt

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Received: 01/05/2017

Accepted: 10/08/2017

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ABSTRACT

The Mediterranean north coastal zone of Egypt is promising area for constructing NPP facilities and will supply large proportion of future electricity needs in Egypt. The Mediterranean north coastal zone of Egypt is about 1200 km long and produce over 60% of the fish catch of Egypt. The conversion of habitat, loss benthic and fishing activities in some region on north coastal zone of Mediterranean Sea of Egypt may be occurred from large quantities of agricultural, industrial and municipal wastes discharge through several drains, factories into their coastal zone. The study in this paper is assessing adversely impact of trace elements resulting from human activities on distributed fishery activities along Mediterranean north coast of Egypt by using a Geographic Information System (Arc GIS 9). It helps to make decision for selection NPP Sites. The results of Potential Ecological Risk Index (RI) of selected heavy metals Cd, Cu, Ni, Pb, and Zn of the collected surface sediment samples at 2017 from the Mediterranean north coast of Egypt are classified in all selected sites of Mediterranean north coast of Egypt < 150 which indicate low ecological risk. The highest values of these results are around coast of Alexandria governorate. These regions are undergoing from different types of wastes discharge in their coasts.

KEYWORDS

Fishery activities, Heavy metals, Sediments, Potential Ecological and Risk Index (RI).

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INTRODUCTION

Egyptian fish resources are depending on Marine Fisheries, lakes, Fresh water and Aquacultures. The major threats to marine and aquatic habitats are a result of increasing human population and coastal development, which contribute to an increase in anthropogenic and containments loads. Uncontrolled development and rapid industrialization along coastal area have brought alarming level of pollutions to the aquatic environment because of their anthropogenic inputs **(Ismail *et al.,* 1993)**. Water, sediment and biota can use as an indicator to determine the level of heavy metal pollution. Sediments are important sinks for various pollutions like organic and inorganic (heavy metal) and also play a heavy metal sources in marine environment include natural sources from atmospheric deposition, land runoff, rock weathering, river bank/coastal erosion **(Yusof *et al.*, 1993; Nobi *et al.*, 2010)** and anthropogenic sources from agriculture activities, disposal of liquid effluents, urban and industrial emission **(Silva, *et al.*, 1996; Mucha *et al.,* 2003; Pekey *et al.*, 2004; Zhu *et al.,* 2011)**.

Heavy metals are accumulated in marine sediments, where they are incorporated in several biological and chemical cycles, affecting the water column and biota. Anthropogenic impacts including; industrial discharges, domestic sewage, non-point source, runoff and atmospheric precipitation are the main sources of toxic heavy metals that enter aquatic ecosystems **(Hart, 1982: Ikram *et al.,* 2010)**.

The aim of this study is measuring potential risk index (RI) of the heavy metal contamination which may be given adversely impact effect on distributed fishery activities along Mediterranean north coast of Egypt and by using GIS as a diagnostic tool for assessment.

MATERIAL AND METHODS

Description of study sites

The Egyptian Mediterranean coast extends between longitude 25° 30′E and 34° 15′E and extends northward to latitude 33° N as in (Figure 1).

Fig. (1): North coastal zone of Egypt.

The study area is extended from Alexandria to Marsa Mutroh. The distribution of fishery activities and the spatial allocation of fishing effort in the studied area represented by using numbers of vessel and sailing boats along Mediterranean coast. The data of percentage of distribution the fishing effort according to using motorized and sailing boats in Egypt **(Mohamed, 2015)** represented in thematic map by using GIS as shown in Figure (2).

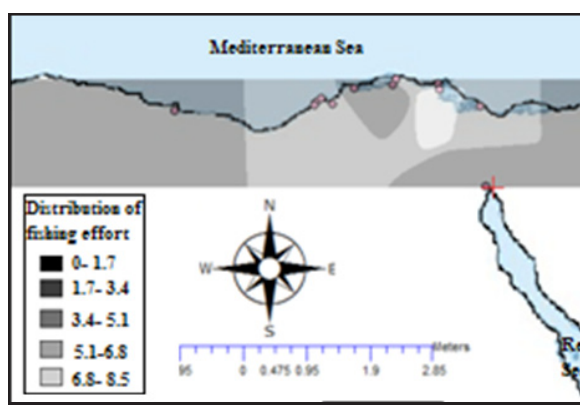

Fig. (2): Thematic map of percentage distribution of fishing effort along Mediterranean coast by using GIS.

The highest fishing effort was registered in Ezbet El-Borg port on north Mediterranean coast as shown in Figure (2).

In the study area Alexandria governorate coastal zone receives a large amount of metal pollution from the principle industries of this region include fertilizers, agrochemicals, pulp, paper, power plant, food processing, detergents, fibres, dyestuffs, textile, and building materials where, the daily average industrial discharge amounts to 30,000 and 128–261,000 m3 per day domestic sewage and 1–2 million cubic meters per day of agricultural wastes **(El-Nemr *et al*., 2007)**. This industrial discharge may be caused concentrating of trace elements levels which will give an adverse affect to fishery activities in the studied area.

The surface of sediment controls the exchange of metals between surface sediments and discharge waters from different sources along Mediterranean coastal zone as well as constitutes a reserve of metals to which benthic organisms are exposed **(Nasr *et al*., 2014)**. Potential ecological risk index method is depended on the characteristics of heavy metal (Cd, Cu, Ni, Pb, and Zn) and its environmental behavior. It is used to evaluate the heavy metal contamination from the perspective of sedimentology.

Sampling and analytical procedures

The selected sediment samples were collected at 2017 from different stations along Meditterenean Sea of Egypt. For metal analysis sediment samples were dried, then the samples were digested by using the microwave digestion method. Milestone Digester (Ethose-D) which is used by specific program **(Kingeston *et al.*, 1997)** for digesting sediment samples. The Leeman (ICP) optical emission Spectroscopy (USA) with measuring concentration error from 1- 5% was used to measure concentration heavy metals in digested sediment samples.

The assessment of sediment contamination was performed based on Hakanson's procedures **(El-Nemr, 2007)** the contamination factor is the ratio between the mean concentration of single metal in the surface sediment and the background level as a general reference and could be calculated from the equation as:

$$Cif = Ci / Cin \qquad (1)$$

Where *Ci* is the mean concentration of an individual metal examined and *Cin* is the baseline or background value of the individual metal. Lowest metals concentrations in sediment from the sampling sites were used as background value in this study. Potential ecological risk index (RI) was introduced originally by Hakanson **(Long *et al.*, 1995)** to assess the degree of heavy metal pollution in sediment, according to the toxicity of heavy metals and the response of the environment:

$$RI = \Sigma\, Eri \qquad (2)$$

Table (1) *Risk grades Indices and Rates of Potential Ecological Risk of heavy Metal pollution* ***(Macdonald et al., 1996).***

Eri	Risk grade	*RI*	Risk grade
<40	Low potential ecological risk	<150	Low potential ecological risk
40-80	Moderate potential ecological risk	150- 300	Moderate potential ecological risk
80-160	Considerable potential ecological risk	300-600	High potential ecological Risk
160-320	High potential ecological risk	≥600	Significantly high potential ecological risk
≥320	Significantly high potential ecological risk		

RI is the potential ecological risk index for all the heavy metals in the surface sediments, which is the sum of *Eri*.

Eri= Tri Cfi **(3)**

Where: *Eri* is the potential ecological risk index of an individual metal, *Tri* is the metal toxic response factor given by Hakanson **(Long *et al.*, 1995)** as (*Zn*=1, *Pb*=*Cu*=*Ni*=5, *Cd*=30) *Cfi* is the metal pollution factor.

Average shale was used as reference baseline in this study to provide elemental background concentration.

Hakanson **(Long *et al.*, 1995)** has defined five and four categories of *Eri* and *RI* respectively and was used by **(Macdonald *et al.*, 1996)** as shown in Table (1).

The collection data as *RI* is the potential ecological risk index of the study area are interpolated using IDW (Inverse Distance Weighted) method, GIS analysis tool **(Xu *et al.*, 2001)**.

RESULTS AND DISCUSSION

In this study the monitoring of the sampling sites at 2017 where, the sediments samples were selected along the coastal zone of Egyptian Mediterranean Sea to cover the expected polluted area due to industrial and other activities. The results of heavy metals concentration (µg/g) (Cd, Cu, Ni, Pb, and Zn) obtained in this study were in the range observed in other measurement in Mediterranean sea and Average shale was used as reference baseline in this study to provide elemental background concentration as shown in Table (2).

Table (2) *Measurement of heavy metal concentrations of the collected samples from the Egyptian Mediter ranean north coast.*

Location	Cd	Cu	Ni	Pb	Zn	Reference
Mediterranean Sea Egypt	**0.21- 1.32**	**0.18- 13.5**	**1.6- 17.7**	**2.8- 48**	**1.9- 45.6**	**Present study**
Eastern Mediterranean Sea Egypt	**1.8–2.3**	**4–9.44**	**-**	**18.4–24.8**	**33.1–42.2**	**(Kaiser *et al.*, 2012)**
Average shale	**0.3**	**45**	**68**	**20**	**95**	**(Perin *et al.*, 1997)**

Results of potential ecological risk (*Eri*) of single metal and the potential ecological risk index (*RI*) of these metals in sediments are presented in Table (3)

From the data of the previous studied. The *Eri* for all the sampling sites were less than 40 except for Cd. The *Eri* values for Cd were generally slightly above 40 in sites (3, 4) as in Al Max beside western hourber and Dekhelia in Alex. It is attributed to the industrial and other activities in these sites. The studied metals could be ranked by decreasing severity of ecological risk as: Cd >Pb> Ni > Cu > Zn, and according to the calculated RI, Cd was the most serious polluting metal in the present study. Figure (3) is thematic map representing by using GIS which is illustrated the risk grades of potential ecological risk (RI).

From figure (3) the potential ecological risk index (RI) accounting for the contamination caused by heavy metals Cd, Cu, Ni, Pb, and Zn indicated that

Table (3) *Evaluation on potential risk of heavy metals pollution in surface sediments samples from the Egyptian Mediterranean north coast.*

S.No	Stations	Potential ecological risk factor Eri					RI	Risk grade
		Cd	Cu	Ni	Pb	Zn		
1	Abu Qir	15.0	0.7	1.14	2.4	0.17	19.41	low
2	El-Mex	35.0	0.9	0.9	1.9	0.21	39.0	low
3	Western hourber hourber Harbour	50.0	0.15	1.13	7.5	0.24	59.0	low
4	Al Dakahilh	42.0	1.2	0.67	2.5	0.34	47.0	low
5	Sidi Krier	28.0	1.0	1.1	1.4	0.18	30.5	low
6	Burj Al Arab	25.0	0.5	0.39	0.7	0.48	27.0	low
7*	El-Salloum*	28.7	1.54	0.52	4.09	0.41	35.3	low
8*	Baghoush*	7.4	0.02	0.12	0.9	0.02	8.5	low

*7*and 8** ***(Soliman et al., 2015)***

all sites < 150 indicate low ecological risk however, higher values of potential ecological risk (RI) are illustrated in sites (3, 4) Dekhilia and Al Max beside western hourber in Alexandria which are associated industrial wastewater discharge in these sites.

Heavy metals are accumulated in marine sediments, where they are incorporated in several biological and chemical cycles, affecting the water column and biota. Pollution of aquatic ecosystems by heavy metals is an important environmental problem **(Caeiro *et al.*, 2005)** because of its permanent disturbances in marine ecosystems, leading to environmental and ecological pollution.

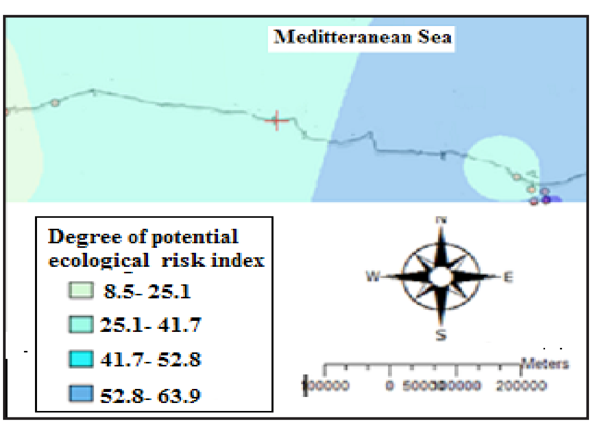

Fig. (3): Thematic map of potential ecological risk (RI) along Mediterranean Coast by using GIS.

CONCLUSIONS AND RECOMMENDATIONS

Continuous of economic activities in the studied coastal zone include agriculture, industry, fishes/aquaculture, and recreation beaches may be caused concentrating of trace elements levels which will give an adverse affect to the benthic organism especially to the micro-invertebrate species and other organisms (e.g., egg and larval stage of fish) that spend all or part of their life cycle associated either within or on the bottom sediment along north coast of Mediterranean Sea. The representation by using GIS of Potential Ecological Risk Index (RI) results of heavy metals Cd, Cu, Ni, Pb, and Zn in surface sediment samples collected along Mediterranean Sea which was classified in all sites < 150 indicating low ecological risk showed that the highest values of RI results in industrial sites in Alexandria which receives a large amount of metal pollution from the principle industries of this region include.

Aquatic organism responses to various environmental stimuli may be generated by different types of discharge wastes as cooling waters from nuclear or electricity power stations. Protecting all individual aquatic organisms of a species from adversely impact resulting from different types of discharge wastes is made by understanding and studying ecosystem level characteristics and limiting discharge wastes to the coastal zone.

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مجلة
التقنيات النووية
فى العلوم التطبيقية
مجلد 5 ، عدد 3 ، ص 163 : 170 ، (2017)

تقييم توزيع النشاط السمكى باستخدام نظام المعلومات الجغرافية (GIS) على الساحل الشمالى بمصر

حنان بدوى حسن

الساحل الشمالى الواقع على البحر الابيض المتوسط بمصر منطقة واعدة لاقامة وانشاء محطات نووية لتكفى حاجة مصر من انتاج الكهرباء. ويبلغ طول الساحل الشمالى حوالى ١٢٠٠ كم ويبلغ انتاجه السمكى حوالى ٦٠٪ من الانتاج السمكى بمصر. وربما يحدث تحول للموطن وفقد البيئة التحتية للكائنات البحرية ونقص للمصدر السمكى فى بعض مناطق الساحل الشمالى نتيجة صرف النفايات الناتجة من الزراعة والصناعة اوصرف محطات انتاج الكهرباء التى تصب على بعض المناطق بالساحل. وهدف هذه الدراسة تقييم التاثير السلبى للعناصر الثقيلة الناتجة من هذه الانشطة الانسانية على البيئة المائية وربما تؤثر على توزيع انشطة الصيد بالساحل الشمالى وذلك بتجمع عينات رواسب بحرية على طول الساحل لحساب مؤشر المخاطر البيئية المحتملة (RI) الناتج من قياس تركيزات العناصر الثقيلة كادميوم و نحاس و نيكل و رصاص و زنك لهذه العينات. وكذلك تطور توزيع نتائج مؤشر المخاطر البيئية المحتملة (RI) لرواسب الساحل الشمالى باستخدام نظام المعلومات الجغرافية (GIS).

وبحساب مؤشر المخاطر البيئية المحتملة (RI) الناتج من قياس تركيزات العناصر الثقيلة بعينات الرواسب البحرية للساحل الشمالى ادى الى تصنيف المخاطر البيئية فى الحدود المنخفضة وكانت اعلى قيم لهذه الحدود تخص ساحل محافظة الاسكندرية التى تستقبل نسبة عالية من النفايات الناتجة من الانشطة الانسانية بالساحل الشمالى والتى قد تؤثر سلبا على الانتاج السمكى وتوزيعه.

1. قسم المواقع والبيئة - هيئة الرقابة النووية والاشعاعية- القاهرة.