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EFFECT OF OIL POLLUTION ON GROWING AND DIVERSITY OF AQUATIC PLANTS

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Abstract

There are many studies on the effects of oil pollution on humans, soil, and vegetation, but little is known about its impact on aquatic plants and their diversity in the aquatic environment. This study focused on determining the impact of oil pollution on a local plant regarding availability and the investigation of the levels of pollution in two plants cattle (*Typha domingensis* Pers.) and reeds (*Phragmites australis* (Cav.) Trin ex Steudel) in four different locations in the Baher Al-Najaf Depression in Al-Najaf Al Ashraf, Iraq for a year from February 2016 to January 2017. The results showed that local plant was severely affected in the affected sites and the leaves of the studied plants contained a high proportion of the heavy metals. The frequency of plant distribution varied between 7% and 77% while in affected sites it ranged between less than 5% and 26%., A total of 30 species were distributed to 18 plant families in all studied sites of Baher Al-Najaf Depression**.** Control sites recorded 23 species distributed over 14 families of plants while the affected sites were enumerated in only 19 species in 12 families of plants. Values of heavy metals were relatively higher in studied plants leaves at contaminated sites than those in the control site. High values for heavy metals were associated with plant species and ages, sediment types, and time but more importantly results from a basicity nature of the sediment from oil pollution. The results showed that oil pollution poses a potential risk to biodiversity, food chain, food security, and public health.

Key words: Pollutants, heavy metals, oil spills, plants, reed, and cattle

Introduction

Oil exports contribute more than 90% of Iraq's economy. Iraq was established in 1976 by an Italian group of companies, the Strategic Oil Export Strategic Line, which links the southern oilfields with the northern fields. However, this system has not been operational since 2003 until 2012 which led to destroy many of erosion factors and damage, which led the Ministry of Oil to be rehabilitated to ensure increase pumping Iraqi oil in large quantities across this line to be a link between the northern export line extending from the fields of Kirkuk in northern Iraq and export ports on the Gulf through the oil fields in Basra South of the country. The strategic line is designed to be a two-way route (north to modern or south to the deep port in Basra). The oil and gas sector in Iraq, including the North-South oil pipeline, is already plagued by years of neglect due to the wars and blockade of Iraq. The destruction of parts of the infrastructure of this vital sector, due to the looting and numerous armed attacks targeting refineries, stations, pipeline network, and the pumping of oil abroad after 2003. In 2012 was establishment of an alternative strategic pipeline starts from the first pumping station (PS1) in Zubayr, Basra and passes the second pumping station (PS2) in Samawah to the third pumping station (PS3) in Najaf to reach the station (K3) in Mosul and ending in Kirkuk to connect the oil pipeline to Geyhan Turkish port Zubaidi (2012).

The prevalence of oil pollution has been widely studied in many parts of the world (Baker, *et al.* 1991; Osuji and Onojake, 2004). Important and different publications on oil spills contain relevant information and a new understanding of its impact specifically on environmental components (Odu, 1982 and Evoh, 2002). For example, Osogi *et al*. (2004) studied the Niger Delta community. In that study, hydrocarbons and heavy metals from crude oil adversely affected plants and animals because of the increased concentration of heavy metals in plant cells and their bioaccumulation. It was also reported that severe exposure to oil spills could affect crews in the oil industry, population and members of scientific teams investigating oil contaminants, causing various diseases such as vomiting, abdominal pain, skin irritation, and some cancers. It has been reported that continuous exposure to oil pollution may be associated with high blood lead concentration levels with high blood pressure (Martin *et al.,* 2006) and cardiovascular disease (Menke *et al.,* 2006; exposure to cadmium of oil causes kidney dysfunction (Jarup and Alfven 2004). The consumption of contaminated vegetables in oil production areas is also a potential pathway for exposure to cadmium among the population of these areas (Hellstrom *et al.,* 2007). Since there is no evidence to indicate the threshold for the negative impact of some of these heavy metals, especially lead, cadmium, nickel and chromium, Lanphear, (2007) increasing awareness and concerns about environmental pollutants and increasing the health effects of pollutants have led to increased measures to protect people from direct contamination and exposure to Avoid them (Mckelvey *et al.,* 2007). As the oil pollution that caused the deaths of several hectares of mangrove forests was observed, marshes also make it impossible for plants to survive (Raufu, 2001; Ufot *et al.,* 2003; Obilo and Ogunyemi, 2002). More recently, Duru (2005) has attempted to investigate the effects of oil pollution on the nature and chemistry of sediments at the affected sites in Igbima and Oguta found that increased in concentration levels of cadmium, chromium, lead and nickel in sediments significantly. These findings confirm the argument that ecosystems are particularly vulnerable to oil pollution. Ballou *et al.* (1989) However, despite these results, little is known about the global losses of plants due to oil pollution GESAMP (1993); more information is needed on rates of plant recovery after oil spills (Teas, 1989). More importantly, previous studies have not investigated the effects of oil pollution on local and especially aquatic plant species, which are good indicators of biodiversity change and degradation in ecosystems. Therefore, these studies are needed in the impact of oil pollution on local plant species where information is very limited (Paine and Phillips, 1985). This research studied the effects of oil pollution on sensitive local plant species, the growth indicators, and significantly affects pollution in developing plants in the study area. The aim of this studies was to determine the impact of oil pollution on local plant species regarding abundance and composition and to investigate levels of chromium, cadmium, nickel and lead pollution in aquatic plants (reeds and cattle) in particular.

Materials and Methods

Description of the study area: The Baher Al-Najaf Depression is located in the province of Najaf in Iraq (fig. 1). It separated from the Euphrates River only 15 km and about 16 km south-east. In the middle of the depression shrinks to 10 km, cutting 40 km northwest of Najaf to the southwest of the city of Al-Hira. While it is bordered to the east by the Mashkhab-Najaf Road, and on the western side by Iraq's strategic oil pipeline from south to north-west.

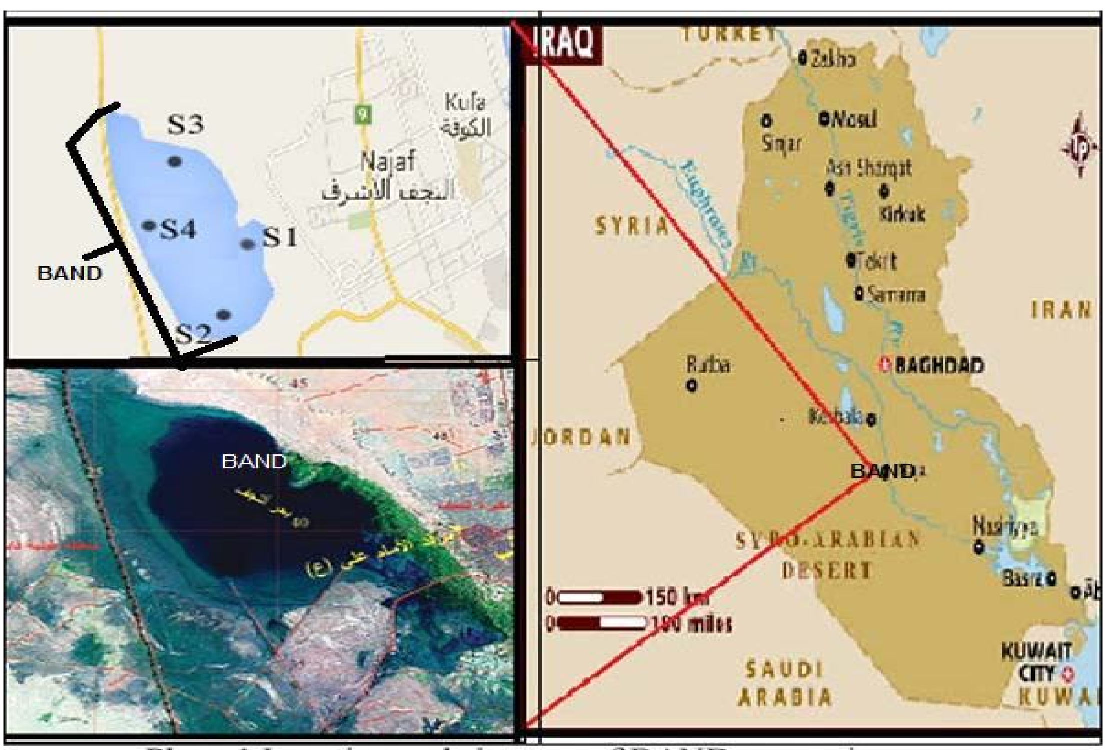

Plate. 1 Location and site map of BAND reservoir

Fig. 1: A map showing the location of the Baher Al-Najaf depression from Iraq and the study sites

Four different stations were selected in the Baher Al-Najaf Depression (fig. 1).

1- The first site (S1): fed from the southern reaches of the Euphrates River (control area or control area).

2- The second site (S2): draws water from the first site on the one side and relates to the third site on the other side and it is a low area where municipal wastewater is collected.

3- The third location (S3): Located near the strategic oil line and linked to the third site and suffers from oil spills when a fault in the strategic line carrier of oil.

4- The fourth site (S4): It is supplied with water from wells and saline wells mainly and relates to the second site on the one side and the fourth location on the other.

The scientific studies and climate research indicate that the climate of Najaf province, including the study area, suffers from high temperatures and evaporation values during the hot season of the year, which starts from April until the end of September, which confirms the existence of large water losses, especially the groundwater that provides water to Baher Al-Najaf Depression most days of the year, unlike the cold season, which is characterized by his palace and for four months from December to March (Al-Haidarey, 2009).

The study was conducted for 12 months (February 2015 to January 2016). Two plants (Cattle and cane) were selected for the study of biological indicators such as (Yellowish, welting and dwarfing), concentration of heavy elements and measuring growth after oil pollution is a useful indicator to see the effect of oils over time Becker (1987), Barnard and Scott (1988). The composition and abundance of plant species in the study areas was studied. The method used by Kirshaw (1979) was adopted in the analysis of species abundance: high frequency (very abundant) species represented with four positives (++++), moderate frequency with three Pros (+++), low frequency (rare) with two pros (++), and those (very rare) plus one sign (+). Samples were taken at different seasons of the year to accommodate differences in concentrations of contaminants (cadmium, chromium, lead and nickel) in the leaves of these aquatic plants. These minerals represent some of the natural components of oil in varying proportions (Martin *et al.,* 2006). The analysis was done using atomic absorption spectrometry to determine the concentration of the levels of these pollutants (Butt *et al.,*1986). At the same time, three samples of sediment were collected from all control sites to obtain information on a large area. Thus a total of 18 samples of sediments were collected and analyzed. Two levels of analysis were performed on sediment samples. First, chemical properties (pH, organic carbon, potassium, etc.) were tested to determine their concentration levels as a result of oil pollution. Second, concentration levels of heavy metals (chromium, cadmium, lead, and nickel). The average values and standard deviations of each of these parameters were calculated and recorded. All analyzes were conducted in the Environmental Sciences laboratories in the Department of Environmental Sciences, Faculty of Science. Although the actual dose of specific pollutants received by plants from lubrication is very difficult to assess (Barnard and Scott,1988), the results obtained gave insights into the level of risk posed by the consumption of these plants by animals living in the Baher Al-Najaf Depression such as buffalo and fish. Data were subjected to statistical analysis using SPSS (version 13.0 SPSS, Chicago, IL, USA) and statistical significance was determined at a significant level $p < 0.05$.

Results and Discussion

Table (1) shows the pH values at the affected sites (S3, S4) and tendency towards alkalinity (8.63 and 7.9) where the results showed that the oil pollution affected the pH in the sediment. The chemical properties of sediment samples were also affected by oil pollution. Potassium, available phosphorus, and magnesium showed

Table 1: Sediments chemical properties

sites / Parameters	pH	Organic carbon%	Potassium (mg/kg)	Available phosphorus (mg/kg)	Total hydrocarbon (mg/kg)	Magnesium (C mol/kg)	C/N ratio
S1	7.6	0.7	2120	9.73	74,43	0.53	8.4
S2	8	0.8	2130	8.78	85.23	0.47	9.5
S3	8.6	1.03	120	2.67	150.32	0.23	12.4
S4	7.9	1.01	205	3.21	92.43	0.28	12.3
Mean	8	0.88	1143.75	6.09	100.6	0.37	10.65
SD	0.2	0.06	-1.32	0.4	12.3	0.01	0.05

Table 2: Sediments average concentration of heavy metals

sites \ Parameters	Chromium (mg/kg)	Nickel (mg/kg)	Cadmium (mg/kg)	(mg/kg)Lead
S1	0.3	1.23	0.001	5.61
S2	0.24	2.13	0.002	5.57
S3	4.65	5.45	0.07	7.65
S4	4.34	4.53	0.009	8.67
Mean	2.38	3.33	0.02	6.87
SD	0.04	0.17	0.12-	0.4

high values at sites (S1, S2), while decreased in contaminated sites. For example, by the control to the mean sample, potassium concentration decreased per cent 5.26% in S3, and 5.20% in S4. The concentration of available phosphorus decreased per cent 14.01% in S3, 9.45% in S4. Magnesium concentration decreased per cent 2.70% in S4 and 21.60% in S3. In contrast, the levels of organic carbon concentration, total hydrocarbon content, and C/N ratio showed high rate values in the affected sites S4 and S3 at control sites S2 and S1 as shown in table 1. The results obtained at contaminated sites showed a high level of biodegradation due to oil pollution (B, S., 1975 and APHA, 1995). Heavy metal results showed a marked increase in contaminated sites at control sites. For example, by a control to the mean sample, chromium concentration levels in affected sites increased 40% in S3, 30.90% in S4. The same increase was observed on cadmium, which increased by 59.70% in S3, 57.30% in S4, while the concentration levels of these heavy metals in control sites S1 and S2 were very small as shown in table 2.

The results of Table 3 showed that plants appeared in control sites (S1, S2) were as follows:

Table 3: Frequency distribution and appearance

Plant species	Family	%Frequency		Remark	
		S1+S2	S3+S4	S1+S2	S3+S4
Aeluropus litoralis (Gowan) Parl.	Poaceae	-	10	-	+
Aeluropus lagopoides (L)Trin.ex Thw.	Poaceae	24	14.3	+++	++
Alhagi graccorum Boiss.	Leguminosae	-	7	-	+
Amaranths blitoides L.	Amaranthaceae	12	-	++	-
Arthrocnemum macrostachyum L.	Amaranthaceae	27	13	+++	++
Astragalus spinosus (Forssk.) muschl.	Leguminosae	15.2	9	++	+
Capparis spinosa L.	Capparaceae	29	-	++	-
Ceratophyllum demersum L.	Ceratophyllaceae	36	-	+++	-
Chenopodium vulgaria L.	Amaranthaceae	8	-	+	-
Citrullus colocynthis (L.)Schrad.	Cucurbitaceae	-	6	-	+
Convolvulus arvensis L.	Convolvulaceae	18	-	++	-
Cynodoncum dactylon (L.) Pers.	Poaceae	16.3	15	++	++
Ephedra alata (Deche.)	Ephedraceae	7	5	+	+
Haloxylon salicornicum (Moq.)Tand.	Amaranthaceae	12.5	9	++	+
Imperata cylindrica (L.) P.Beauv.	Poaceae	18.3	-	++	-
Juncus Aschers. (Et Buch.)Adams	Juncaceae	-	15.9	-	++
Malva parviflora L.	Malvaceae	38	-	+++	-
Paspalum dilatatam Poir.	Poaceae	8	-	+	-
Peganum harmala L.	Nitrariaceae	10	-	+	-
Phragmites australis (Cav.)Trin ex Steudal	Poaceae	77	6	++++	+
Plantago boissieri Hausska.et Bornm.	Plantaginaceae	-	7	-	+
Potamogeton pectinatus L.	Potamogetonaceae	22	26	++	++
Rumex cyprius Murb.	Polygonaceae	-	8	-	+
Rumex dentatus L.	Polygonaceae	-	7	-	+
Salsola cyclophylla Baker.	Amaranthaceae	11	10	+	+
Schoenoplectus litoralis (Schrad.)Palla	Cyperaceae	45	-	+++	-
Sonchus asper (L.)Vill.	Compositae	18.4	5	++	+
Suaeda fruticosa (L.) Forsk.	Amaranthaceae	15.2	-	++	-
Tamarix aucherana (Pecne. ex Walp) Baym	Tamaricaceae	57	20	++++	++
Typha domingensis Pers.	Typhaceae	45	12	+++	++

Key: ++++ Very abundant +++ Moderate; ++ Rare; + Very rare

Aeluropus lagopoides (L) Trin.ex Thw., *Amaranths blitoides* L. *Arthrocnemum macrostachyum* L., *Astragalus spinosus* (Forssk.) muschl., *Capparis spinosa* L., *Ceratophyllum demersum* L., *Chenopodium vulgaria* L., *Convolvulus arvensis* L., *Cynodoncum dactylon* (L.) Pers., *Ephedra alata* (Deche.), *Haloxylon salicornicum* (Moq.) Tand., *Imperata cylindrica* (L.) *P. Beauv., Malva parviflora* L., *Paspalum dilatatam* Poir, *Peganum harmala* L., *Phragmites australis* (Cav.) Trin ex Steudal, *Potamogeton pectinatus* L., *Salsola cyclophylla* Baker., *Schoenoplectus litoralis* (Schrad.) Palla, *Sonchus asper* (L.) Vill., *Suaeda fruticosa* (L.) Forsk., *Tamarix aucherana* (Pecne. ex Walp) Baym and *Typha domingensis* Pers. The appearance of ++++ is very abundant to +++ moderate in most plants and different seasons. The plants appeared in affected sites (S4, S3) were: (*Aeluropus litoralis* (Gowan) Parl., *Alhagi graccorum* Boiss. *Citrullus colocynthis* (L.) Schrad., *Juncus Aschers.* (Et Buch.) Adams Plantago *boissieri* Hausska.et Bornm., *Rumex cyprius* Murb. and *Rumex dentatus* L.) with a rare occurrence of only + rare; + very rare in most studied areas. in general, a total of 30 species were recorded in 18 plant families in all studied sites of Baher Al-Najaf Depression. Control sites (S1, S2) recorded 23 species distributed over 14 families of plants while the affected sites (S4, S3) were enumerated 19 plant species only in 12 families.

The results showed differences in concentration levels of heavy metals in reed and cattle at affected and control sites. In (S1 and S2) control sites, the average concentration of heavy metals was negligible except S2 where the maximum nickel level in reeds (0.16) (mg/kg), cadmium in reeds (0.08) (mg/kg) and crayfish) (mg/kg). Otherwise, the concentrations are negligible. The results were in the affected sites (S3, S4) in cattle, average levels of chromium concentration ranged from 0.35 (mg/kg) in S3 to 0.20 (mg/kg) in S4; and nickel from 0.03 (mg/kg) in S4 to 0.04 (mg/kg) in S3 and cadmium from 0.06 (mg/kg) in S4 to 0.08 (mg/kg) in S3; and lead from 0.12 (mg/kg) in S4 to 0.22 (mg/kg) in S3; As for reeds, the average concentration of chromium ranged from 0.43 (mg/kg) in S3 to 0.220 (mg/kg) in S4; nickel from 0.04 (mg/kg) in S4 to 0.05 (mg/kg) in S3 and cadmium from 0.17 (mg/kg) in S4 to 0.16 (mg/kg) in S3; and from 0.11 (mg/kg) in S4 to 0.12 (mg/kg) in S3 as shown in table 4.

Table 4: Average pollutants concentration in cattle leaves (*Typha domingensis* pers.) and reed leaves (*Phargmites australis* (Cav.) Trin ex steudal (mg / kg)

sites \ Parameters	Chromium (mg/kg)		Nickel (mg/kg)		Cadmium(mg/kg)		Lead (mg/kg)	
	T	P	T	P	T	P	T	P
S1	0	0.01	0.01	0.01	0	0	0.01	0.02
S2	0 .03	0.16	0.01	0.02	0.04	0.08	0.01	0.03
S3	0.35	0.43	0.04	0.04	0.08	0.16	0.22	0.12
S4	0.2	0.22	0.03	0.05	0.06	0.17	0.12	0.11
Mean	0.14	0.2	0.023	0.027	0.045	0.102	0.09	0.07
SD	0.03-	0.01	0.002	0.002	0.12-	0.03	0.04	0.01

The results of the multiple regression analysis showed that the concentration levels of heavy metals in *Typha domingensis* Pers and *Phragmites australis* (Cav.) Trin ex steudal in sites affected by oil pollution were significantly high and were associated with four variables: plant type (P=0.012, correlation coefficient=0.372); plant age (p=0.013, correlation coefficient=0.368); and sediment type (clay sand deposits in S3 and S2 were higher levels of sandy clay deposits in S4, p=0.019, correlation coefficient=0.353); and time (high in March 2015 than in May 2015, p=0.028). These four variables accounted for 68 percent of the total variance. But more importantly, they can be explained by high concentration levels of mineral elements recorded in the sediments of contaminated sites. This study showed that oil pollution had specific effects on local plant species in the four studied sites where the impact of spilled oil was more important than other environmental factors (Emara, 1990). It was generally observed that young plants in affected sites were more susceptible to oil contamination than older plants during the study period, although all plants also showed wilt signs. S3 recorded the highest levels of heavy metals, pH, organic carbon, total hydrocarbons, C/N ratio and lowest levels of potassium ions, phosphorus, and magnesium available in sediments. This observation specifically supported the argument that variable loadings in oil may have different effects under different conditions. Barnard and Scott (1988) It was also observed that after 12 months of study in which there was no spillage of oil at contaminated sites, the rate of recovery of plants remained very slow, not exceeding 2 percent in 6 months. This observation may also demonstrate previous results that crude oil reduces the level of essential elements in the sediments necessary for plant growth Bartha *et al.,* 1993. Oil pollutants caused extensive damage to plants in the affected sites, leading to the predominance of weeds and a few shrubs that appear to bear the toxic environment caused by the spill. It is likely that the heavy metals and chemical properties in the sediments of contaminated sites followed a pattern of distribution almost identical to each other and this proves that the pollution is the result of the same oil spill and caused the reduction of the number and death of plants in affected sites, and the contaminants of oil in plant leaves from site to site. Some plant changes such as yellowing and dwarfing signs that were observed in S3 and S4 confirmed these results. Also, the weak growth of cattle, mainly observed in S3 and S4 (quite unlike those in S1 and S2), are some of these observed differences. Results in this area agree with the results of a recent study that oil pollution causes changes in plant leaf colors, poor productivity, and plant death (Brooks, 1989). In many plant species, high level of heavy metals found in plant leaves at contaminated sites initially caused cellular changes, followed by the breakdown of chloroplasts, which subsequently resulted in a gradual loss of chlorophyll, in some cases cause plant death (Odum, 1971). These phenotypes can also be associated with the pH change of contaminated sediments, affecting the solubility of nutrients, thereby reducing their availability for plant growth and maintenance Akwiwu *et al.,* 2002 and Kaupenjohann *et al.* 1989 leading to nutrient imbalances such as nitrogen/magnesium dislocation and carbonate and nitrogen ratios (Manahan, 1994). Basal sediments usually have a high concentration of soluble minerals that become toxic to plants and affect nitrogen fixation and plant growth (Hauhs, 1989).

Conclusion

This study was one of the evidence supporting the hypothesis of oil spillage in the Baher Al-Najaf Depression from the Strategic Line is causing environmental degradation (SPDC, 2004 and Chinedum 2007). The results showed that oil pollution not only led to reducing rare plant species but also greatly reduced plant distribution frequencies in affected sites, a basal level of sedimentation, reduction of nutrition levels, increased levels of heavy metals. The main result of this study was that oil pollution led to contamination of the local food chain. It is likely that the source of heavy metals found in the leaves of aquatic plants in contaminated sites due to oil pollution. High levels of heavy metals were observed in reed and cattle at contaminated sites. If the high level of pollution in this study was caused by the mere leakage of oil, urgent and serious studies should be conducted to assess the levels of pollution in the entire Iraqi water, especially in areas suffering from repeated oil spills. There were several constraints in this study. First, statistical strength is small due to the small number of sampling sites, yet it was sufficient to detect important relationships. Second, concentrations of pollutant concentrations were only analyzed in aquatic plants (cattle and reeds) because the rest plants were not present at all sites. It was interesting to investigate the impact of oil pollution on many other aquatic plants in the affected sites. However, the strengths of this study are the affected and control sites have consistently shown homogeneity in seasons, sediments and plant species, which means that selection biases will have little impact on the results obtained from these sites. Despite these few constraints, the results of this study are sufficient and convincing to justify future studies in the region to obtain systematic information on the general and specific impacts of oil pollution on plant biology and plant society, as this area will help to understand the level of risk and various environmental impacts, Precautionary measures to be taken by those concerned to ensure environmental security both in the present and in the future.

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