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Impact of Derna Flood on Selected Fish Species along Derna Coast, Insights from Diver's Surveys

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ABSTRACT

This study examined the impact of the Derna flood on fish species along the coast from Ras Elteen to Karsa. A survey was conducted with 35 divers in Derna city to collect data on fish species abundance and condition following the flood. The average age of participants was 31.17 years (± 6.53), with an average of 9 years (± 5.50) of diving experience. Most participants held university degrees (42.85%), and rocky environments were the preferred diving locations (71.42%). Divers reported varying observations regarding species recovery and decline after the flood. Species such as *Sarpa salpa*, *Epinephelus guaza*, *Mugil cephalus*, and *Diplodus* were observed at specific sites post-flood, with differing rates of decline. Statistical analysis using SPSS 23 revealed significant differences ($P \leq 0.05$) in species distribution and health after the flood. The data collected indicate how natural disasters affect marine ecosystems, underlining the importance of ongoing monitoring and conservation measures to minimize impacts and support in the recovery of biodiversity in impacted areas.

تأثير فيضان درنة على أنواع مختارة من الأسماك على طول ساحل درنة: رؤى من مسوحات الغواصين

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قامت هذه الدراسة بفحص تأثير فيضان درنة على أنواع الأسماك على طول الخط الساحلي من رأس التين إلى كرسة. تم إجراء مسح شمل 35 غواصًا في مدينة درنة لجمع البيانات حول وفرة الأسماك وحالتها بعد الفيضان. بلغ متوسط عمر المشاركين 31.17 سنة (± 6.53)، وبمتوسط خبرة في الغوص يبلغ 9 سنوات (± 5.50). كان معظم المشاركين من حملة الشهادات الجامعية (42.85%)، وفضل 71.42% منهم البيئات الصخرية كمواقع للغوص. أبلغ الغواصون عن ملاحظات متباينة بشأن تعافي بعض الأنواع وانخفاض أعداد أخرى بعد الفيضان. تم رصد أنواع مثل *Sarpa salpa*، *Epinephelus guaza*، *Mugil cephalus* و *Diplodus* في مواقع محددة بعد الفيضان، مع تباين في معدلات الانخفاض. أظهرت التحليلات الإحصائية باستخدام SPSS 23 فروقًا ذات دلالة إحصائية ($P \leq 0.05$) في توزيع الأنواع وصحتها بعد الفيضان. تشير البيانات التي تم جمعها إلى تأثير الكوارث الطبيعية على النظم البيئية البحرية، مما يؤكد على أهمية المراقبة المستمرة واتخاذ تدابير الحماية للحد من التأثيرات ودعم استعادة التنوع البيولوجي في المناطق المتضررة.

INTRODUCTION

On September 11, 2023, Derna, a city on Libya's coast, faced an extreme tragedy when storm Daniel brought intense rainfall, causing the dams to collapse and resulting in devastating floods (Imran *et al.*, 2024). Adapting to severe flash floods in semi-arid areas particularly throughout the Middle East and North Africa (MENA) has become increasingly challenging. This difficulty is driven

by large uncertainties surrounding how often these events occur and how intense they may be, along with the limited availability of dependable hydrological studies and the lack of urban planning designed to withstand flooding in wadi systems. Following Storm Daniel on September 11, 2023, Derna experienced two major flood surges after the collapse of two dams. These events led to the death or disappearance of roughly 10–20% of the city's residents. The disaster also forced more than 35,000 people from their

homes and caused the total destruction of 737 houses, while another 2,859 suffered partial damage (Ashoor and Eladawy, 2024).

Most ecosystems are shaped by disturbance regimes that vary widely across space and time (Elmqvist *et al.*, 2003). These disturbances can be chronic low in intensity yet occurring frequently or catastrophic, which involve powerful and infrequent events. Both types play a significant role in determining the composition, distribution, and abundance of species in terrestrial and marine habitats (Denny, 1994). Marine environments, in particular, are exposed to disturbances more often than many terrestrial systems because of the higher kinetic energy inherent in their fluid surroundings (Koch *et al.*, 2006). Among the key drivers of disturbance in coastal ecosystems are hydrodynamic forces generated by waves, which exert strong physical pressure on coastal habitats (Hughes, 1994). The extent of a storm's impact across both spatial and temporal dimensions—can profoundly influence how ecosystems operate, often interrupting critical ecological functions and processes (Elmqvist *et al.*, 2003). Animals respond to disturbances in different ways, largely depending on their life-history characteristics (Sousa, 1980). Response diversity the variation in how species fulfilling similar ecological roles react to environmental stress is regarded as crucial during disturbance events (Elmqvist *et al.*, 2003). Compared with sessile organisms, mobile marine species have received less attention in this field [see, for example, 4, 23, 24], despite the fact that extreme environmental conditions can lead to considerable mortality among mobile fauna (Sousa, 2001). Unlike stationary habitat-forming species, mobile organisms can avoid lethal conditions through behavioral strategies. Highly mobile species, in particular, are capable of relocating to areas where hydrodynamic pressures are reduced (Sousa, 1984). In general, there is still a notable shortage of research that investigates how organisms particularly with respect to behavioural responses cope with and recover from different types of disturbance events (Hooper *et al.*, 2005).

SITE AND METHODS

In this study, we targeted the coast of Derna city, directly affected by flooding or debris accumulation from Ras Elteen in the east to Karsa in the west Figure (1).

A survey was distributed to a number of divers in Derna city. The survey aimed to collect information to study and evaluate the status of fish species on the beaches of Derna after the flood. 35 interested divers completed the survey and provided their observations regarding fish species after the Derna flood, including identifying thriving or declining species, their availability, and physical changes observed in the species post-flood. Divers were selected using a purposive sampling approach through local diver gatherings in Derna city, targeting experienced individuals familiar with the study area. All statistical analyses were

performed using SPSS software (version 23), with differences considered significant at $P \leq 0.05$.



Fig. 1. Study Area along the coast of Derna city from Ras Elteen to Karsa.

RESULTS AND DISCUSSION

a. Results

From Table(1) and Figure (2), The participants in the survey had a mean age of 31.17 years (± 6.53) and a mean diving experience of 9 years (± 5.50).

Table. 1 Mean the Age and Experience of divers Divers

	Mean the Age and Experience of divers Diver
Mean of age	31.17 \pm 6.53
Mean of experience	9 \pm 5.50

Each result represent the mean \pm SD. Deviation. (n=35). * means significant at $P < 0.05$

The educational qualifications of the participating divers are distributed as follows: 14.28% Elementary, 2.85% Intermediate Institute, 25.71% Secondary, 5.71% Higher Diploma, 42.85% University, 2.85% Master's, and 5.71% None , Table(2) and Figure (3)

Table. 2 Percentage Distribution of Divers' Qualifications (n=35).

Qualifications	Mean Percentage of Divers (%)
Elementary	14.28
Intermediate Institute	2.85
Secondary	25.71
Higher Diploma	5.71
University	42.85
Master's	2.85
None	5.71

The preferred marine environments for diving among the participants are as follows: 71.42 prefer rocky environments, 5.71 prefer sandy environments, and 8.57 indicated a preference for all types of environments.

Additionally, 14.28 did not provide a response regarding their preferred diving environment, Table(3).

Table. 3 Percentage Distribution of Divers in Different Marine Environments in Derna (n=35)

Diverse marine environments	Percentage (%)
Rocky	71.42
Sandy	5.71
All types	8.57
No answer	14.28

Based on the survey participation of divers assessing species flourishing after the Derna flood, the following percentage distribution was observed across different sites.

At Karsa, 2.85 of participating divers confirmed sightings of *Sarpa salpa*, while at Cornice Derna, 5.71 observed *Epinephelus Marginatus*. Additionally, *Mugil cephalus* was noted at Karsa (5.71) and The port (2.85), as well as Cornice Derna (2.85). *Diplodus sargus* was also confirmed at Karsa (2.85). The mean percentage of participating divers confirming species flourishing post-flood was calculated at 3.80 with a standard deviation of ± 1.47 .

These findings highlight diver-reported perceptions of species recovery in the wake of the Derna flood. Such insights are crucial for understanding ecological resilience and guiding conservation efforts to support marine biodiversity in affected areas. Continued monitoring and adaptive management strategies are essential to sustain these positive trends and mitigate further environmental impacts. Table(4)

Table. 4 Percentage of Participating Divers Confirming Species Flourishing After Derna Flood

Order	Family	Genus	Percentage Distribution of Participating Divers	No. of Divers	Site
Spariformes	Sparidae	<i>Sarpa salpa</i>	2.85	1	Karsa
Perciformes	Serranidae	<i>Epinephelus Marginatus</i>	5.71	2	Cornice Derna
Mugiliformes	Mugilidae	<i>Mugil cephalus</i>	5.71	2	Karsa
Mugiliformes	Mugilidae	<i>Mugil cephalus</i>	2.85	1	The port
Mugiliformes	Mugilidae	<i>Mugil cephalus</i>	2.85	1	Cornice Derna
Spariformes	Sparidae	<i>Diplodus sargus</i>	2.85	1	Karsa
mean \pm SD			3.80\pm1.47		

Each result represent the mean \pm SD. Deviation, (n=35).

Based on the survey participation of divers assessing species decline along the Derna coast after the Derna flood, the following percentage distribution was observed:

At Cornice, *Seriola dumerili* and *Epinephelus Marginatus* were each reported by 5.71 of participating divers. At Karsa, *Epinephelus Marginatus* was reported by 17.14 of divers, while *Sphyraena sphyraena* was noted by 2.85. Ras Elteen and The port both reported *Mugil cephalus* at 2.85. Additionally, *Diplodus sargus* was observed at Cornice by 5.71 of divers.

The mean percentage of participating divers confirming species decline post-flood was calculated at 6.07 with a standard deviation of ± 4.69 .

These findings provide insights into diver-reported perceptions of species decline following the Derna flood. They underscore the importance of continued monitoring and conservation efforts to address environmental impacts and support the recovery of affected species along the Derna coast. Table(5).

Table. 5 Percentage of Divers Confirming Species Decline After Derna Flood

Order	Family	Genus	Percentage Distribution of Participating Divers	sites
Perciformes	Carangidae	<i>Seriola dumerili</i>	5.71	Cornice
Perciformes	Serranidae	<i>Epinephelus Marginatus</i>	5.71	Cornice
Perciformes	Serranidae	<i>Epinephelus Marginatus</i>	17.14	Karsa
Perciformes	Sphyraenidae	<i>Sphyraena sphyraena</i>	5.71	Cornice
Perciformes	Sphyraenidae	<i>Sphyraena sphyraena</i>	2.85	Karsa
Mugiliformes	Mugilidae	<i>Mugil cephalus</i>	2.85	Ras Elteen
Mugiliformes	Mugilidae	<i>Mugil cephalus</i>	2.85	The port
Spariformes	Sparidae	<i>Diplodus sargus</i>	5.71	Cornice
mean \pm SD			6.07\pm4.69	

Each result represent the mean \pm SD. Deviation. (n=35).

b. Discussion

The severe floods that hit Derna after Storm Daniel serve as a strong reminder of how little we still understand about the consequences of extreme weather on nearby marine environments, especially in semi-arid areas such as the Middle East and North Africa (MENA). These events resulted in heavy loss of life, widespread damage to homes and infrastructure, the displacement of many thousands of residents, and considerable disturbances to the local ecosystem (Imran et al., 2024; Ashoor and Eladawy, 2024).

The disturbance regimes, both chronic and catastrophic, have profound effects on ecosystems, influencing species distribution, abundance, and overall ecosystem functioning (Elmqvist *et al.*, 2003; Denny, 1994). Marine ecosystems, in particular, are highly susceptible to disturbances due to the increased kinetic energy of their fluid medium (Koch *et al.*, 2006). The hydrodynamic forces generated by Storm Daniel caused significant disruptions in the coastal and marine ecosystems along the Libyan coast, with potential long-term impacts on species composition and ecosystem health (Hughes, 1994).

Our study aimed to assess the impact of the Derna flood on fish populations along the coast from Ras Elteen to Karsa. The findings from diver surveys provided valuable insights into the immediate effects of the flood on various fish species. Notably, species such as *Epinephelus marginatus*, *Sarpa salpa*, and *Mugil cephalus* showed varying responses to the flood event, with some species thriving and others experiencing declines in population (Ashoor and Eladawy, 2024).

The response diversity among fish species highlights the importance of life-history traits in determining species resilience to environmental disturbances (Sousa, 1980). Highly mobile species, such as some fish, can avoid disturbances by relocating to less affected areas, whereas sessile or less mobile species may suffer more direct impacts (Sousa, 1984). This behavioral adaptability is crucial for survival in the face of extreme events and emphasizes the need for further studies on the behavioral responses of marine animals to disturbances (Hooper *et al.*, 2005).

The results of our study align with previous research on the significant impact of coastal storms on marine ecosystems. Major storms can transport organic carbon from shallow to deep waters, affecting benthic communities and contributing to carbon sequestration (Sanchez-Vidal *et al.*, 2012). However, there remains a gap in understanding the deep-sea impacts of such storms, particularly in the Mediterranean region, which is prone to cyclogenesis and extreme weather events (Lionello *et al.*, 2006).

The Libyan coast, with its relatively unpolluted waters and rich marine biodiversity, plays a crucial role in the productivity of the Mediterranean marine life (Haddoud and Rawag, 1995; Hassan and Silini, 1999). However, the flooding event has likely altered the habitat characteristics

and availability, impacting fish physiology and population dynamics (Lloret and Rätz, 2000; Yaragina and Marshall, 2000). The observed fluctuations in fish production along the Derna coast over the years further highlight the sensitivity of marine life to environmental changes and human activities (Abziew, 2016).

CONCLUSION

In conclusion, the Derna flood event serves as a stark reminder of the vulnerability of coastal and marine ecosystems to extreme weather events. The findings from this study underscore the need for comprehensive hydrometeorological assessments and effective flood management practices to mitigate the impacts of such events. Additionally, further research is necessary to understand the long-term ecological effects and to develop strategies for enhancing the resilience of marine ecosystems in the face of climate change. Effective communication, evacuation plans, and regular monitoring of marine life are essential components of a holistic approach to managing the risks associated with extreme weather events (Imran *et al.*, 2024)

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