International Journal of
Renewable Energy and its Commercialization
https://chemical.journalspub.info/index.php?journal=IJREC

ISSN: 2582-4120
Volume 10, Issue 2, 2024
DOI (Journal): 10.37628/IJREC

Review IJREC

Understanding Marine Biodiversity Around Oil Platforms: Implications for Renewable Energy Reuse

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Abstract

The interaction between offshore oil platforms and marine biodiversity presents a unique opportunity to explore ecological dynamics and the potential for sustainable energy solutions. This study focuses on the Union Oil Platform EVA off Huntington Beach, California, examining how these man-made structures function as artificial reefs and their impact on surrounding marine ecosystems. Through underwater surveys, we assessed the abundance and diversity of fouling organisms, epibenthic populations, and the distribution of benthic species based on proximity to the platform. Our findings reveal significant densities of sea mussels and a thriving community of sea stars and anemones, highlighting the ecological role of oil platforms in supporting diverse marine life. The trophic modeling developed from collected data demonstrates high productivity and turnover rates within these communities, emphasizing the platforms' importance in local food webs. Additionally, this research explores the implications of reusing decommissioned offshore platforms for renewable energy production. By evaluating various scenarios, including the conversion of these structures to support wind or solar energy generation, we present a framework for understanding the economic and environmental viability of such transitions. The potential for integrating renewable energy solutions with existing marine habitats offers a path toward mitigating the ecological impacts of decommissioning while enhancing energy sustainability. As global energy demands increase and the need for decarbonization becomes urgent, this study underscores the significance of rethinking the fate of offshore oil platforms. By fostering marine biodiversity and serving as platforms for renewable energy, these structures can play a critical role in the ongoing energy transition, ultimately contributing to a more sustainable future for both marine ecosystems and energy production.

Keywords: Marine biodiversity, oil platforms, artificial reefs, renewable energy reuse, ecological impact

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Received date: August 30, 2024
Accepted date: September 23, 2024
Published date: November 12, 2024

Citation Bangshidhar Goswami, Sunidhi Rajput. Understanding Marine Biodiversity Around Oil Platforms: Implications for Renewable Energy Reuse. International Journal of Telecommunications & Emerging Technologies 2024; 10(2): 13–17p.

INTRODUCTION

The intersection of marine ecology and energy production has gained increasing attention, particularly regarding the role of offshore oil platforms as artificial reefs. These man-made structures, initially designed for oil and gas extraction, have been shown to significantly alter the surrounding marine environment. Research conducted at the Union Oil Platform, located off Huntington Beach, California, USA, demonstrates the complex interactions between marine life and these platforms. As global energy consumption escalates, the potential for reusing these structures for renewable energy production presents a critical opportunity for sustainability and ecological preservation. This article explores the abundance and diversity of marine life around oil platforms, the implications of these findings for energy

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transition, and the methodology and results of recent studies focused on the environmental impact and potential reuse of these structures [1].

Understanding how man-made offshore structures serve as artificial reefs and how they alter the surrounding marine environment was the goal of our research at Union Oil Platform, off Huntington Beach, California, USA. In order to determine (i) the abundance, standing stock, and productivity of attached fouling organisms, (ii) the density, size-structure, and biomass of epibenthic populations beneath the platform, and (iii) the abundance, species composition, and distribution of epifaunal and infaunal benthos as a function of distance away from EVA, underwater surveys were conducted. Clusters of sea mussels have taken over the platform's substructure. Every day, an estimated cubic meter of mussels drops from the platform, supporting extraordinarily dense populations of sea stars below. On the base of EVA, bands of stinging sea anemones prevent sea stars from ascending to the platform. The presence of EVA has a significant impact on the nearby sand community, with some species' densities being greatly increased and others being significantly decreased by the structure's proximity. The ecosystem of an oil platform's dominant fauna is represented by a trophic model, which shows that the attached community has high productivity and turnover rates [2].

Permanent offshore structures to produce oil and natural gas are becoming more common in coastal marine environments around the world. Since the blowout and oil spill at Platform "A" in the Santa Barbara Channel, California, in 1969, these installations have been the subject of intense public interest and concern. In addition to accelerating the expansion of existing production fields in southern California and the Gulf of Mexico, the North Sea and the Beaufort Sea have seen increased exploration and platform construction due to the industrialized world's soaring rates of petroleum consumption. Most offshore platforms are positioned on soft sediment bottoms to create artificial reefs that serve as attachment points for marine life and vertical relief that fish find appealing. Algal spores and invertebrate larvae quickly colonize the underwater areas of platform structures, creating a "fouling" assemblage that gives the accompanying fishes food and cover. The focus of earlier studies on the ecology of oil platforms was on describing the fouling communities and fish populations [3].

The underlying benthic ecosystem hasn't gotten much attention. The discovery of an extraordinary concentration of sea stars beneath Union Oil's production platform EVA in southern California, USA, sparked our interest in furthering research in this area. Volume V of "Marine Ecology" will contain an overview of how oil impacts marine life [6]. Two main objectives of our research at Platform EVA were to describe and explain the distributional patterns of benthic populations on and around the platform, and to demonstrate the potential value of platforms like EVA for quantitative biological research. The animal community that is connected to EVA, the sea stars on the platform, the collection of large echinoderms that live there, and the epifaunal and infaunal communities of the nearby soft bottom are all described here. Descriptive data are used to model trophic relationships between the attached community and the benthic echinoderm aggregation, as well as to estimate the standing stock and productivity of the fouling community.

ADJUSTMENT TO SCHEME REJUVENATION

Over the next three decades, there will be several sub-transitions within the current energy transition. In a scenario involving an energy mix, oil and gas will continue to play a crucial role in conjunction with renewable energy sources. With the primary objective of creating a model for the reuse of offshore oil and gas platforms at the end of their useful lives to produce renewable energy, the authors of the current work developed a project called RELife (Renewable Energy for a New Life of Offshore Platforms) in this context. In this context, various technical scenarios are studied and investigated while considering two different types of platforms (4-legged platforms with 3 or 4 production wells). For each scenario, the viability from an economic and environmental standpoint is also assessed. All the sub-models are also contrasted with a typical decommissioning procedure. Both the Adriatic Sea and the North Sea are evaluated because they are geographical regions with different

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renewable resource availability. All the scenarios have undergone a discount cash flow analysis and a life cycle assessment to evaluate their economic and environmental viability [4].

Two major challenges currently facing the energy sector are global climate change and sustainable economic development. Dealing with them is frequently associated with the decarburization of the current energy system brought about by the switch from fossil fuel to renewable energy. There is an important energy transition involving sources, structures, scale, economics, and policy that is taking place globally in the energy sector. Germany's shift to decentralized renewable energy and energy efficiency is one example of this transition to sustainable energy, but there are numerous other examples and varieties that can be mentioned. Reusing offshore oil and gas platforms at the end of their useful lives could serve as a significant example of an energy transition.

Offshore platforms and installations for oil and gas have a finite operational life. There are currently 6500 offshore oil and gas production facilities located on the continental shelves of about 53 different nations. The Gulf of Mexico is home to over 4000, while 950 are in Asia, 700 are in the Middle East, and 600 are in Europe, the North Sea, and the Northeast Atlantic [7]. The Mediterranean basin contains 0.4% of the world's oil and gas reserves, along with 127 offshore platforms that primarily extract gas. These offshore structures are primarily found in the Ionian Sea and the Strait of Sicily, as well as the Northern and Central Adriatic coasts, at depths between 10 and 120 meters.

In the upcoming years, many offshore oil and gas structures will be decommissioned globally as fossil fuel exploration and production come to an end. There will need to be 600 platforms dismantled in the North Sea alone. For instance, the Dutch North Sea structures had an average age of 24 years in 2014. As a result, many of these structures have already reached the end of their useful lives or will in the next ten years. The northern and central regions of the Mediterranean basin have more than 110 offshore gas platforms deployed since the 1960s, which represents the region's highest concentration of fossil fuel extraction platforms. Over the past 50 years, the Italian Oil Company has installed about 80 gas platforms in the Adriatic Sea, which was once a lucrative gas prospect. The staged scenario depicts the Company amid a crucial decision, a plan to decommission the platforms at the lowest cost and risk, as most of these structures are approaching the end of their useful lives. Other international oil companies experience the same problem (Figure 1) [5, 8].

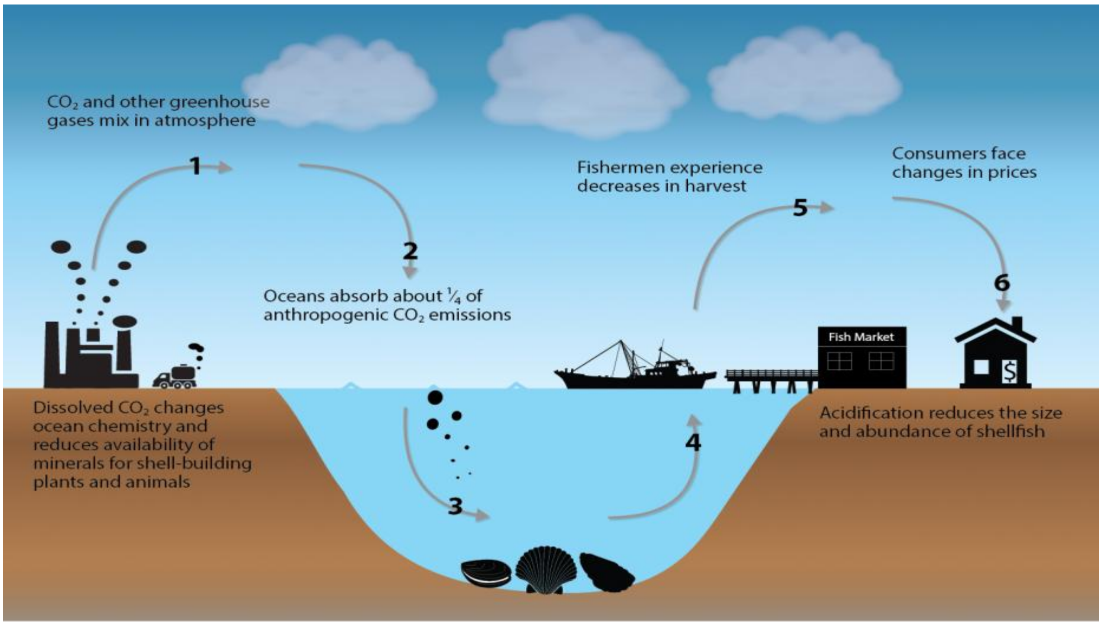

Figure 1. Impact of offshore oil platforms on marine diversity and ecosystems.

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METHODOLOGY

To investigate the marine biodiversity around oil platforms, underwater surveys were conducted focusing on several key aspects: (i) the abundance, standing stock, and productivity of fouling organisms, (ii) the density, size structure, and biomass of epibenthic populations beneath the platform, and (iii) the species composition and distribution of epifaunal and infaunal benthos based on their distance from the platform.

Site Selection

The Union Oil Platform EVA was selected as the primary research site due to its extensive substructure and the diverse marine life it supports.

Data Collection

Surveys included direct observations and sampling of marine organisms attached to the platform and those inhabiting the seabed. Specific metrics measured included the density of sea mussels, the biomass of epifauna, and the diversity of benthic species.

Trophic Modeling

The collected data was utilized to develop a trophic model that illustrates the relationships between the attached communities on the platform and the surrounding benthic ecosystems. This modeling aimed to quantify productivity and turnover rates, providing insights into the ecological significance of oil platforms as artificial reefs.

Comparative Analysis

In addition to focusing on marine life, the research involved a comparative analysis of potential reuse scenarios for the platforms, examining the economic and environmental viability of converting these structures for renewable energy production.

RESULTS

The study revealed significant findings regarding the marine biodiversity around the Union Oil Platform:

Fouling Organisms

The platform’s substructure was densely populated with clusters of sea mussels, with estimates suggesting that approximately one cubic meter of mussels detaches from the platform daily. This abundance creates a food source and habitat for various marine species, particularly predators, such as sea stars, which thrive in this environment.

Benthic Populations

Underneath the platform, the density and size structure of epibenthic populations were markedly high. The presence of stinging sea anemones formed barriers that influenced the movement and distribution of sea stars, indicating a complex food web and competitive interactions among species.

Ecosystem Impact

The research found that the oil platform had a profound effect on the nearby sand community. Certain species saw a dramatic increase in density due to the platform’s proximity, while others were significantly reduced, underscoring the transformative role these structures play in the local marine ecosystem.

Trophic Model Outcomes

The developed trophic model illustrated high productivity and turnover rates within the fouling community. This indicates that oil platforms can serve not only as habitat but also as vital components of marine food webs, supporting diverse species and enhancing local biodiversity.

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Renewable Energy Potential

The study also assessed the potential for reusing oil platforms for renewable energy production. Various scenarios were evaluated, including the conversion of platforms to support wind or solar energy generation. Economic and environmental viability analyses highlighted that such transitions could mitigate ecological impacts and provide sustainable energy solutions [9, 10].

CONCLUSIONS

The findings from the research at the Union Oil Platform underscore the complex relationship between offshore oil structures and marine biodiversity. These platforms act as artificial reefs, fostering diverse communities of marine life and significantly altering local ecosystems. As the world grapples with the dual challenges of climate change and sustainable development, rethinking the fate of decommissioned oil and gas platforms presents a vital opportunity.

The transition from fossil fuel-based energy systems to renewable energy sources is essential for achieving long-term sustainability. Reusing these offshore structures for renewable energy generation not only addresses the ecological concerns of decommissioning but also capitalizes on the established marine habitats these platforms create.

Future research should continue to explore the ecological roles of offshore platforms and develop frameworks for their sustainable reuse. By understanding the dynamics of marine biodiversity around these structures, stakeholders can make informed decisions that align environmental health with energy needs, paving the way for a more sustainable future.

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