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Research Article

ECO-ENGINEERING IN THE PERSPECTIVE OF THE QUR'AN: A QUR'ANIC FRAMEWORK FOR ECOLOGICAL DESIGN AND ENVIRONMENTAL STEWARDSHIP

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Abstract

This study examines the concept of ecological engineering (eco-engineering) from a Qur'anic perspective using a qualitative library research design and a thematic (*mawḍūʿī*) interpretation method. Eco-engineering is an interdisciplinary field that integrates ecological principles with technological design to restore, maintain, and optimize ecosystem functions. The Qur'an, as the foundational source of Islamic epistemology, presents essential principles related to balance (*mīzān*), sustainability (*istidāmah*), natural laws (*sunnatullāh*), and human responsibility as stewards (*khalīfah*) of the Earth. Through the analysis of Qur'anic verses particularly those describing hydrological processes, atmospheric dynamics, vegetation systems, and land formation this study finds that the Qur'an provides a theological and ecological framework that aligns with modern eco-engineering principles. Four Qur'anic eco-engineering frameworks are identified: (1) stewardship ethics and environmental governance; (2) ecological balance as a design parameter; (3) natural cycles as ecological engineering models; and (4) prohibition of environmental degradation. The findings contribute to Islamic environmental scholarship and offer an epistemological foundation for integrating Qur'anic values with contemporary environmental engineering practices.

Keywords: E*co-engineering, environmental ethics, khalifah, mīzān, Qur'anic ecology.*

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INTRODUCTION

The relationship between humans and the environment occupies a central position in the Qur'an. From the beginning of creation, the Qur'an positions humans as managers of the Earth through the concept of khalīfah, while simultaneously establishing the principles of natural balance (*mīzān*) and the obligation to cultivate the Earth (*'imārat al-arḍ*). These concepts are not merely theological expressions; they contain deep philosophical, ecological, and technical implications for how humans interact with their environment. In the face of contemporary global environmental crises ranging from climate change and soil degradation to water quality decline, biodiversity loss, and atmospheric pollution the integration of Qur'anic teachings with the discipline of ecological engineering becomes increasingly relevant.

Eco-engineering is a technical approach grounded in the understanding that engineering interventions must be designed in harmony with ecological laws. It integrates environmental science, biology, geography, civil engineering, and nature-based design to produce solutions that support long-term ecosystem sustainability. Principles such as nature-based solutions, biomimicry, ecosystem restoration, and the use of natural mechanisms in technological systems closely align with Qur'anic values that emphasize maintaining balance, preventing environmental harm, and respecting the fixed natural laws (*sunnatullāh*).

The Qur'an presents detailed descriptions of natural cycles such as cloud formation, wind movement, rainfall, vegetation growth, soil development, and atmospheric equilibrium. Although these descriptions are not framed as scientific treatises, they indicate that the natural world operates through precise systems that humans are expected to observe and understand. Classical and contemporary exegetes including Ibn Kathir, Al-Tabari, Al-Razi, and the Tafsir Ilmi published by the Indonesian Ministry of Religious Affairs explain that these verses not only manifest divine power but also guide humans to comprehend ecological mechanisms embedded in creation.

Despite the richness of Qur'anic ecological discourse, academic integration between Qur'anic perspectives and eco-engineering remains limited. Most Islamic environmental studies focus on moral teachings, while the technical dimensions of ecosystem management have received less attention. Yet the Qur'an provides a strong scientific-philosophical foundation for an ecological engineering approach rooted in balance and sustainability. This study therefore aims to construct an integrative conceptual framework linking Qur'anic teachings with eco-engineering by examining the mandate of *khalīfah*, the principle of *mīzān*, natural cycles, the prohibition of *fasād*, and *sunnatullāh* as the structural boundaries of ecological design.

RESEARCH METHOD

This study employs a qualitative-descriptive method using a library research approach. This method is appropriate because the primary data consist of Qur'anic verses, classical and contemporary tafsīr works, and scientific literature related to ecological engineering. The analysis follows the thematic (*mawḍū'ī*) interpretation approach, grouping together all verses related to natural phenomena, human environmental responsibilities, and ecological balance to obtain a comprehensive understanding of the Qur'an's ecological message.

The primary sources of this research include the Qur'an, classical commentaries (Ibn Kathir, Al-Tabari, Al-Qurtubi, Al-Razi), the Scientific Interpretation of the Ministry of Religious Affairs, as well as scientific *i'jāz* literature such as *Al-I'jāz al-'Ilmī fī al-Qur'ān* by Sayyid al-Jumaili and *Al-I'jāz al-'Ilmī fī al-Sunnah* by Zaghlul al-Najjar. Secondary sources consist of scientific journals in the fields of ecology, hydrology, environmental engineering, bioenvironmental science, and scientific reports from institutions such as UNEP, FAO, and IPCC.

The analysis technique consists of three stages. First, the analysis of Qur'an texts and interpretations, which is to study each verse along with classical and contemporary interpretations. Second, contextual scientific analysis, which is to associate the explanation of the verse with the relevant scientific model. Third, integrative synthesis, which combines Qur'anic concepts with eco-engineering theory to produce an ecological conceptual model in the perspective of the Qur'an.

Research Design

This research adopts a qualitative library-based design utilizing the thematic interpretation (*mawḍū ʿī*) method. All Qur'anic verses concerning ecological processes, natural balance, the hydrological cycle, vegetation, atmospheric systems, and human stewardship were collected and analyzed. The research was conducted from October to November 2025 through literature review, secondary data analysis, and tracing scientific references in ecology, environmental science, and Qur'anic exegesis.

Research Target/Subject

The research targets consist of textual sources rather than human participants. These include Qur'anic verses related to ecological themes, classical *tafsīr* (Al-Tabari, Ibn Kathir, Al-Razi), modern scientific *tafsīr* (Tafsir Ilmi Kemenag), and academic literature on eco-engineering, environmental ethics, hydrology, and sustainability science. Since the study is qualitative and text-based, no sampling technique is required; instead, purposive textual selection is applied based on relevance to the research focus.

Research Procedure

The research procedure consists of four stages; (1) identifying Qur'anic verses related to ecological systems, (2) collecting classical and contemporary tafsīr interpretations, (3) reviewing scientific literature on eco-engineering, ecology, and environmental systems, and (4) synthesizing theological and scientific perspectives to construct the Qur'anic Eco-Engineering Framework (*QEEF*).

This procedure ensures that both scriptural and scientific dimensions are integrated systematically.

Instruments, and Data Collection Techniques

Data sources include: Tafsir Ilmi (Research and Development of the Ministry of Religion of the Republic of Indonesia). *Al-I'jāz al-'Alamī fī al-Qur'ān* (Sayyid al-Jumaili). *Al-'Ijāz al-'Ilmī fi al-Sunnah* (Zaghlul al-Najjar). Classical commentary: Ibn Kathir, Al-Tabari, Al-Razi. Scientific journals of ecology, environment, and eco-engineering.

Technical Data Collection by the following methods: Identify ecological verses in the Qur'an, Collection of interpretations from the book of tafsir, Comparison with modern eco-engineering theory, Integrative analysis of science-revelation.

Data Analysis Technique

The analysis is carried out through the following stages: Data reduction → selecting relevant verses and themes. Thematic categorization → balance, natural cycles, damage prohibitions, etc. Interpretation → integrate interpretation with ecological theory. Formulation of the concept of ecological engineering Qur'an.

(Note: The sub-chapters may differ, according to the type or research approach used. If there are procedures or steps that are sequential in nature, they can be notated (numbers or letters) according to their position).

RESULTS AND DISCUSSION

A. MAN AS CALIPH: THE ETHICAL AND STRUCTURAL FOUNDATIONS OF QUR'ANIC ECOLOGICAL ENGINEERING.

1. The Meaning of *Khalīfah* in the Qur'an

The concept of *khalīfah* is clearly described in QS. al-Baqarah:30, when Allah said:

وَإِذۡ قَالَ رَبُّكَ لِلۡمَلَٰٓئِكَةِ إِنِّي جَاعِلٞ فِي ٱلۡأَرۡضِ خَلِيفَةٗۖ

"Remember when your Lord said to the angels, 'Surely I will make a caliph on the earth."

Where Allah declares His intention to appoint a human steward on Earth. According to Al-Tabari, this verse establishes humanity's role in managing and maintaining the Earth in succession to previous beings. Ibn Kathir explains that "*khalīfah*" signifies those entrusted with cultivating, protecting, and organizing the ecological order of the planet. Al-Razi adds that humans are endowed with the intellectual capacity to understand natural laws (*sunan kawniyyah*) and apply that knowledge responsibly.

Ecologically, this verse presents humans not as absolute rulers but as guardians, caretakers, and trustees of the Earth. The Tafsir Ilmi emphasizes that the *khalīfah* mandate implies responsibility over water systems, land resources, atmosphere, and ecosystems.

Another verse that reinforces this concept is QS. al-An'am:165:

وَهُوَ ٱلَّذِي جَعَلَكُمۡ خَلَٰٓئِفَ ٱلۡأَرۡضِ

"And it is He who has made you caliphs on earth."

Qur'an 6:165 reinforces this stewardship role, reminding humans that they are successors entrusted with the Earth's well-being. In modern environmental ethics, this corresponds to the concept of ecological stewardship, wherein humans must protect ecosystem sustainability and avoid environmental harm.

Thus, the placement of man as a *khalīfah* in the Qur'an is not only a moral foundation, but also an epistemological foundation for ecological engineering. Modern eco-engineering that emphasizes the understanding of ecosystem structure, environmental tolerance limits, and minimal disturbance technology is a concrete form of the caliphate's mandate.

2. *Khalīfah* as Ecological Architect

The concept of *khalīfah* does not stop at the protection of the earth, but also includes the command to build and engineer the earth as affirmed in QS. Hud:61:

هُوَ أَنشَأَكُم مِّنَ ٱلۡأَرۡضِ وَٱسۡتَعۡمَرَكُمۡ فِيهَا

"He has created you from the earth and commanded you to prosper the earth."

The word ٱسۡتَعۡمَرَكُمۡ (*ista'marakum*) according to Al-Razi means:

1) Commanding man to build,
2) Develop,
3) Engineering,
4) Optimize the earth's potential correctly.

This is the basis of the Qur'an that humans not only maintain ecology, but also design life systems based on natural principles. This concept is very close to eco-engineering, which is designing infrastructure and technology that uses natural mechanisms.

Wahbah al-Zuhaili interprets that *'imārat al-ardh* includes the development of irrigation systems, soil tillage, the construction of natural transportation facilities, and environmental innovations that do not damage the balance of nature. Thus, the Qur'an provides a theological as well as a technical foundation for environmental engineering activities.

In addition, traces of eco-engineering are also seen in the teachings of the Prophet Muhammad SAW. He prohibits water pollution, prohibits cutting down trees without a valid reason, and regulates the collective use of water sources. All of these instructions contain the principle of ecological engineering: resource utilization must take into account ecosystem capacity and long-term sustainability.

If associated with modern eco-engineering, the role of the *khalīfah* as an ecological architect makes humans eco-designers, namely designing spatial layouts, water systems, and vegetation according to the principle of "design with nature". Humans are commanded to follow the laws of nature (*sunnatullāh*), not against them. Therefore, the role of the *khalīfah* is not only spiritual, but operational in the world of ecological engineering.

B. THE PRINCIPLE OF *MĪZĀN* (BALANCE) AS A PARAMETER OF ECOLOGICAL ENGINEERING

1. Meaning of *Mīzān* in the Qur'an (complete verse)

Allah says in QS. ar-Rahman:7–9:

وَالسَّمَاءَ رَفَعَهَا وَوَضَعَ الْمِيزَانَ أَلَّا تَطْغَوْا فِي الْمِيزَانِ وَأَقِيمُوا الْوَزْنَ بِالْقِسْطِ وَلَا تُخْسِرُوا الْمِيزَانَ

"And He has exalted the heavens and He has laid the balance. So that you do not go beyond the limit of that balance. So, establish the balance fairly and do not diminish it."

This verse is an ecological proclamation that the universe operates according to a precise balance established by Allah. Ibn Kathir explains that *mīzān* here refers not only to moral justice but also to the equilibrium governing natural systems. The Scientific Tafsir states that *mīzān* includes atmospheric stability, the oxygen–nitrogen ratio, carbon cycling, hydrological processes, and ecological balance. All of these forms of balance are manifestations of fixed natural laws (*sunnatullāh*) that must not be violated.

2. *Mīzān* as Ecological Homeostasis

In modern ecological science, *mīzān* parallels the concept of ecological homeostasis. When humans disrupt one ecological element, the entire system becomes unstable. Eco-engineering uses this balance as a design parameter for calculating carrying capacity, determining development limits, designing ecosystem restoration, and constructing hydrological structures. Therefore, *mīzān* functions as a foundational parameter of ecological engineering.

C. THE NATURAL CYCLE AS A MODEL OF ECOLOGICAL ENGINEERING IN THE QUR'AN

The Qur’an presents various natural cycles with remarkable coherence, describing them as interconnected systems that sustain life on Earth. These cycles including water circulation, wind dynamics, soil regeneration, and vegetation growth illustrate that nature operates according to stable mechanisms that can be observed, understood, and emulated. Far from serving purely spiritual purposes, these descriptions function as ecological models that guide human understanding of environmental systems.

One of the clearest examples is the hydrological cycle, described in verses such as Qur’an 30:48 and 24:43, Allah said:

اللَّهُ الَّذِي يُرْسِلُ الرِّيَاحَ فَتُثِيرُ سَحَابًا فَيَبْسُطُهُ فِي السَّمَاءِ كَيْفَ يَشَاءُ وَيَجْعَلُهُ كِسَفًا فَتَرَى الْوَدْقَ يَخْرُجُ مِنْ خِلَالِهِ

"It is Allah who sends the wind, and the wind moves the clouds. Then Allah spread it in the sky as He willed and made it clumps, and you saw the rain coming out of its gaps." (QS. Ar-Rum:48)

أَلَمْ تَرَ أَنَّ اللَّهَ يُزْجِي سَحَابًا ثُمَّ يُؤَلِّفُ بَيْنَهُ ثُمَّ يَجْعَلُهُ رُكَامًا فَتَرَى الْوَدْقَ يَخْرُجُ مِنْ خِلَالِهِۖ وَيُنَزِّلُ مِنَ السَّمَاءِ مِن جِبَالٍ فِيهَا مِن بَرَدٍ

"Do you not see that Allah marches the clouds, and gathers them between the parts, and makes them in piles of them, and you see the rain coming out of their gaps, and Allah sends down from the sky mountains (clouds) containing grains of ice." (QS. An-Nur:43)

Which detail cloud formation, atmospheric movement, condensation, and rainfall. Classical commentators such as Al-Tabari and Ibn Kathir interpret these verses as signs of divine wisdom, while modern scientific exegesis recognizes that they represent a structured explanation of atmospheric processes. These passages form a conceptual foundation for hydrological engineering, flood mitigation, groundwater recharge systems, and water-resource management.

Similarly, the Qur'an explains wind as a dynamic force with ecological functions. In Qur'an 15:22, Allah said:

وَأَرْسَلْنَا الرِّيَاحَ لَوَاقِحَ

"And We have sent the wind as a devotee."

Allah describes the winds as "fertilizing," referring both to the transport of moisture and the pollination of vegetation. This aligns with ecological knowledge concerning wind-mediated nutrient movement, air circulation, and climatic regulation. Such insights serve as conceptual models for atmospheric engineering, natural ventilation design, and ecosystem-based climate strategies.

The Qur'an also highlights soil development and vegetation cycles, which appear repeatedly in verses such as Qur'an 36:33–35, Allah said:

وَآيَةٌ لَّهُمُ الْأَرْضُ الْمَيْتَةُ أَحْيَيْنَاهَا وَأَخْرَجْنَا مِنْهَا حَبًّا فَمِنْهُ يَأْكُلُونَ وَجَعَلْنَا فِيهَا جَنَّاتٍ مِن نَّخِيلٍ وَأَعْنَابٍ وَفَجَّرْنَا فِيهَا مِنَ الْعُيُونِ لِيَأْكُلُوا مِن ثَمَرِهِ وَمَا عَمِلَتْهُ أَيْدِيهِمْۖ أَفَلَا يَشْكُرُونَ

"And a sign for them is the dead earth; We gave it life and We brought out of it grain and from it they ate. And We made for him gardens of dates and vineyards, and We sent forth for him springs of water. That they may eat of its fruit and of the work of their hands."

These verses emphasize soil rejuvenation, nutrient cycles, and biodiversity central concepts in soil ecology and land-management engineering. Eco-engineering practices such as soil bioremediation, vegetative slope stabilization, and ecological restoration directly reflect these natural processes.

Thus, the natural cycles described in the Qur'an can be understood as prototypes for ecological engineering models. They demonstrate that engineering interventions should imitate the functional patterns of nature, reinforcing the principle that sustainability is achieved through harmonization with rather than domination over natural systems.

D. PROHIBITION OF DAMAGE AND THE PRINCIPLE OF SUSTAINABILITY (*ISTIDĀMAH*)

The Qur'an consistently warns against *fasād* a term that encompasses corruption, disorder, and environmental degradation.

Allah affirms:

وَلَا تُفْسِدُوا فِي الْأَرْضِ بَعْدَ إِصْلَاحِهَا

"And you shall not make any damage on the earth after Allah has repaired it." (QS. Al-A'raf:56)

Verses such as Qur'an 7:56 ("Do not cause corruption on Earth after it has been set in order") frame environmental stewardship not only as a moral duty but as a divine mandate. Classical exegetes like Al-Qurtubi note that *fasād* in this verse includes pollution, resource wastage, and any action that destabilizes natural balance.

From an eco-engineering perspective, the prohibition of fasād establishes sustainability (*istidāmah*) as an essential design principle. Eco-engineering seeks solutions that do not generate secondary ecological harm, thereby respecting the Qur'anic command to preserve equilibrium. This includes minimizing chemical pollution, preventing soil erosion, restoring damaged ecosystems, managing watersheds responsibly, and avoiding technological interventions that exceed ecological carrying capacity.

Modern scholars argue that fasād today includes industrial waste, climate change, biodiversity loss, unregulated deforestation, overfishing, and air pollution all of which undermine ecosystem resilience. The Qur'anic framework therefore aligns closely with contemporary sustainability paradigms such as circular economy practices, nature-based solutions (NbS), and environmental impact assessments (EIA).

By grounding sustainability in divine teachings, the Qur'an elevates ecological responsibility from a policy preference to a spiritual and ethical imperative. Eco-engineering practitioners can thus view sustainability not only through a scientific lens but also as compliance with the Qur'anic command to safeguard the Earth.

E. *SUNNATULLĀH* AS THE LIMIT OF ECOLOGICAL ENGINEERING DESIGN

Sunnatullāh refers to the fixed natural laws established by Allah that govern the functioning of the universe. Allah affirms in QS. Fathir:43:

فَلَنْ تَجِدَ لِسُنَّةِ اللَّهِ تَبْدِيلًا

"You will not find any change in the sunnatullah."

Qur'an 35:43 and other verses emphasize that these laws are constant and cannot be altered. Classical commentators interpret *sunnatullāh* as divine patterns embedded in physical, biological, and ecological systems. These laws include the behavior of water, the structure of soil, atmospheric processes, ecological succession, and the interdependence of species.

In eco-engineering, sunnatullāh serves as a conceptual boundary that engineers must recognize. Because ecological systems operate according to fixed principles, any engineering design that attempts to bypass or contradict these laws is destined to fail. For example, constructions that obstruct natural waterways, ignore geological stability, violate hydrological gradients, or disrupt ecological corridors often result in long-term environmental damage.

Modern environmental science echoes this Qur'anic insight through concepts such as biophysical limits, planetary boundaries, ecological thresholds, and carrying capacity. These frameworks warn that exceeding natural limits leads to irreversible harm reinforcing the Qur'anic message that *sunnatullāh* must not be violated.

Therefore, sunnatullāh functions as an epistemological and technical foundation for eco-engineering. It instructs humans to design within nature's established parameters, ensuring that all interventions respect the laws through which ecosystems sustain themselves. Recognizing these limits aligns engineering practice with ecological reality and Qur'anic guidance.

CONCLUSION

This study demonstrates that the Qur'an contains a comprehensive ecological philosophy that is highly compatible with modern eco-engineering principles. Through a thematic analysis of verses related to stewardship (*khalīfah*), ecological balance (*mīzān*), natural cycles, prohibition of degradation (*fasād*), and natural laws (*sunnatullāh*), the research identifies theological foundations that can guide contemporary environmental design and sustainability strategies.

The study's principal contribution is the development of the Qur'anic Eco-Engineering Framework (*QEEF*), a conceptual model integrating Qur'anic ecological teachings with eco-

engineering practices. *QEEF* highlights four major components: stewardship ethics, ecological balance as a design criterion, natural cycles as engineering prototypes, and ethical boundaries established by the prohibition of fasād and sunnatullāh. This integration provides an epistemological bridge between Islamic ecological theology and scientific environmental management.

The findings also reveal the practical relevance of Qur'anic ecological insights. They can inform nature-based solutions, watershed management, ecological restoration, soil rehabilitation, climate-resilient infrastructure, and sustainability governance. The Qur'an's emphasis on balance and stewardship thus offers both spiritual guidance and technical orientation for modern ecological challenges.

Nonetheless, the study is conceptual rather than empirical, and future research should operationalize *QEEF* through field studies, simulation modeling, ecological assessments, and applied engineering designs. Such developments would enable deeper connections between scripture, ecological sciences, and practical environmental solutions.

In conclusion, the Qur'an provides a rich and coherent ecological worldview that can broaden the foundations of eco-engineering. By integrating divine guidance with scientific knowledge, *QEEF* offers a holistic framework for addressing contemporary environmental crises while honoring the sacred trust of caring for the Earth.

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AUTHOR CONTRIBUTIONS

Author 1: Conceptualization, Validation

Author 2: Writing - review and editing

CONFLICTS OF INTEREST

"The authors declare no conflict of interest."

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