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Research Article

Exploring the Regenerative Capacity of Architecture in the Anthropocene Era Through Anna Heringer's Architecture

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Abstract

In the Anthropocene era, human-driven destruction of nature, primarily caused by diverse industries worldwide, is significantly worsening the degenerative impacts on nature at varying scales globally. The study aims to discuss the potential and responsibilities of architecture to be regenerative for nature, knowing that nature still has the power to heal despite all that humans have done to nature. In this study, the regenerative potential of architecture in the Anthropocene era is discussed through regenerative design that aims at the co-evolution of human and natural systems. The study focuses on architect Anna Heringer's significant work, particularly the METI Handmade School in Bangladesh's Dinajpur region, where her philosophy of holistic local sustainable development originated. As a method in the study, Heringer's work will be analyzed through deep readings on the potential of architecture to be regenerative and these readings will be presented with a relational diagram/ collage. The study assesses the METI School's condition pre and post-construction. It discusses how Heringer's architecture, rooted in local materials, energy sources, and global knowledge, demonstrates regenerative potential. The findings highlight architecture's ability to generate regenerative effects in a living environment. It is claimed that the construction of local with environmentally focused decisions promotes social and economic development locally and contributes to the community's ability to create strong and well-connected social capital. This study argues that the regenerative effect of architecture in the Anthropocene era requires not solely environmental focus but also the active involvement of strong, interactive local human capital to sustain these decisions.

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1. Introduction

Since the beginning of their existence, human beings have acted as though they were the sole owners of all actions in the world and have caused positive and negative transformations in their environment. For this argument, a striking metaphorical example can be given: the 'handprints' cave art found in Cueva de las Manos in Argentina, Río Pinturas. Its history dates back between 13,000 and 9500 years (“UNESCO World Heritage Centre”. n.d.; Figure 1). This cave painting can be regarded as an indication that, hypothetically, humans have had dominion over nature since ancient times. Although the influence of humans on the planet he lives in has manifested itself since the very moment of his existence, it is a fact that in the past the scope and intensity of this influence were less compared to today. In 1993, Cesare Emiliani proposed a new geological calendar called the Holocene Epoch, in which he claimed the starting point for modern humanity to be approximately 11,000 years ago. It is known that in the Holocene Epoch when the transition to settled life began with the end of the ice age, the influence of humans on nature began to increase slowly. However, in this age of millennia, it is thought that the influence of humans on nature was considerably less than today. The realization that human impact on nature had reached harmful levels is most commonly dated to the Industrial Revolution (Crutzen & Stoermer, 2000). The industrial breakthroughs, especially the invention of steam engines, led to the rapid development of certain countries. Eugene F. Stoermer and Paul J. Crutzen, in their article titled “The Anthropocene”, published in 2000, emphasized that the age we live in has changed considerably due to the results of human actions, and therefore, it should be referred to by a different geological name. As of this date, this age in which human beings cause almost irreversible destruction by putting themselves in the place of nature's only creature is called The Anthropocene Era by the scientific community. This name is derived from the Greek words 'anthropos-' meaning human and '-cene' meaning age. It is defined as ‘The Human Epoch’ in English and as ‘İnsan Çağı’ in Turkish.

Figure 1. ‘Cave of the Hands’ in Argentina, Río Pintura (“UNESCO World Heritage Centre”, n.d.).

In this Anthropocene era, the destruction of nature by humans is primarily driven by the excessive activities of various industries. The use of non-recyclable and toxic materials for nature as a cumulative human action, the production of wastes that will destroy nature, and the occurrence of these actions faster than nature can handle are the main destructive reasons that cause the name of a geological age to change. Alongside the widespread pollution around the world, there are also human actions (such as atomic bombs, and nuclear wastes) that occur singly and leave very destructive traces. The most important consequence of this age is the climate crisis. The deterioration of the balance of nature due to the climate crisis results in drought, floods, fires, deforestation, depletion of freshwater resources, warming of the earth, and extinction of species. Rockström et al. (2009) discuss the Anthropocene Era under nine main topics: climate, ocean acidity, chemical balance, atmospheric emissions, biodiversity, land use patterns, clean water, nitrogen and phosphorus cycles, and ozone layer thickness.

It would be unfair to hold all humanity or all manufacturing industries responsible for the destruction of the planet that is brought about by the total actions of all humanity. Donna Haraway (2015) blames not all humans for the destruction in the Anthropocene, but the capitalist states, corporations, and their human forms, which have carried production to a point that is too much for the planet to bear. Donna Haraway, when contemplating the Anthropocene, does not attribute responsibility for the damage to all humans but rather blames capitalist states, corporations, and their human forms for pushing production far beyond what the planet can sustain. People in various places of the world consume energy differently depending on their modern level of 'development', and their carbon footprints are quite different from each other. Although not all people are responsible, the consequences affect all humanity.

In this age, one of the important stakeholders of the human-made destruction to nature is undoubtedly the construction sector. Regarding the construction industries, the 'handprint' of human beings on nature appears as the destructive traces of architects, engineers, and contractors on nature. The various applications of this industry, across different scales and in other parts of the world, are having increasingly degenerative impacts on nature. In particular, the rapid urbanized world demands a rapid order that turns villages into towns, towns into cities, and cities into megacities (Roös, 2021). In this rapid order, architecture serves the consumption-oriented progress order of the world as a development subject. It is a fact that the adopted development ideologies are aimed at exploiting nature and living beings. Architectural sustainability paradigms adopted due to the damage caused by architecture to nature and the physical environment have become a series of actions that have been emptied over time. Companies, organizations, or governments may prefer the concept of 'development' to the concept of sustainability especially in sustainable development decisions. The powers that hold capital use seemingly positive concepts like development, progress, and advancement to rationalize their right to harm people, nature, and our physical environment.

With the transition of architecture from "design for need" to "design for profit" for development purposes (Madge, 1993), it is seen that production within the framework of industrial innovation and economic growth creates rapid degenerative effects. Architecture consists of many practices that do not accord with nature, including small and large projects. The practices of 'excavation' and 'filling', which are the basic actions of architecture, are among the most destructive effects as they cause significant ecosystem transformations. As one of the basic

action practices of architecture, 'destroy-build' architecture causes damage to the natural and physical environment by increasing construction waste. Planning decisions, which stand at the intersection of architecture with politics, also contribute to this degenerative order. Irrational and out-of-context planning decisions have other devastating effects like in the case of urban transformation decisions that do not coincide with earthquake risk maps. As another example, mega projects that ignore the context and ecosystem and thus having a destructive effect on operational processes can be given. One of the biggest effects of architecture on the planet is the materials that are incompatible with nature and the pollution caused by the supply of these materials to different regions. In relation to this subject, according to the United Nations Environment Program (2022), the construction industry and built environment are responsible for 39% of global carbon emissions on an annual basis (“UNEP”, n.d.). The construction industry appears to be responsible for a significant portion of the pollution produced on the planet. It is a fact that the common production methods of architecture create a separation between nature and humans and exploit nature.

In environment-friendly works produced in the Anthropocene era, designers' environmental awareness is taken into consideration, while different professionals are brought together by blurring their boundaries. However, the regenerative design approach tries to position designers and different professionals in a holistic system. In this context, the regenerative design will be discussed as a new environmental approach in the Anthropocene era.

1.1. Regenerative Design and Architecture

Regenerative design is about people and aims to develop approaches that support the 'co-evolution of human and natural systems' for both natural and social capital; moreover, regenerative design requires a fundamental re-conceptualization of the act of building design primarily in terms of imagining, formulating and enabling its role within a larger context (Cole, 2012). According to Lyle (1994), the regenerative approach emerged from earlier concepts of sustainable development. While the ecological order or energy lost in a sustainable system cannot be released again, regenerative design allows lost systems to exist by renewing themselves. In the current Anthropocene era, the limitlessness of human intervention in the environment increases the loss of systems, so humans cause a damaging transformation in nature. The Anthropocene offers an integrated socio-cultural-spatial framework for understanding global and environmental change and creates a platform for environmental politics (Polat&Kahraman, 2019). The Anthropocene Age (Castree, 2014), which is a common discussion topic among natural and social sciences with an integrated framework, can be removed from its negative effects with regenerative design, an environmentally holistic approach that supports natural and social sustainability.

Regenerative design requires changes in the existing design and planning processes by shifting from a piecemeal, technological, and mechanical approach to a model that better reflects the understanding of how the universe as a whole actually works (Roös, 2021). Regenerative design supports a holistic environmental approach instead of a piecemeal modern working system. Although the technical strategies of the green design/sustainable approach, one of the approaches popularized before regenerative design, will remain valid, the purpose and language of regenerative design offers a significant potential for a broad-

based environmental approach, especially for the partnership and coexistence of human and natural systems (Roös, 2021). According to Robinson and Cole (2015), all future goals in the Anthropocene age should be brought together in a common pot with a certain understanding of the social, economic, technological, and ecological constraints to change. Reed (2007) states that regenerative design is a living systems approach as a whole, unlike piecemeal and technologically based green buildings. At this point, the concepts of regenerative and Anthropocene are associated with each other, both in terms of their meanings and their positions in practice. As a different perspective on these two concepts that can leak into each other, regenerative design can be suggested as a key to the search for a common holistic system in the Anthropocene era.

The importance of understanding and caring for place is realized and promoted in the regenerative design literature (Mang, 2007). For example, Littman (2009) proposes an expanded definition of architecture in this context as the art or practice of designing and building place through the integration of space and building. Regenerative design is a holistic approach that cares about considering all stages of design such as place, area, building, construction, process, and application together. The architectural results that emerge with regenerative design are expected to emerge by responding carefully and thoughtfully to the unique social, cultural, and ecological opportunities and constraints of place, and making equal use of the appropriate use of contemporary technological capabilities (Cole, 2012). Since regenerative design emphasizes a holistic view, it can be said that it aims to provide different types such as social, economic, and environmental sustainability at the same time. Since a holistic view requires considering theoretical and practical factors together in design, it makes it possible to be sustainable as it allows the continuity of these factors together.

Regenerative design directs the design process as well as the application, production, and relationships for the sustainability of the environment. Within regenerative design and development, built projects, stakeholder processes, and inhabitation are collectively focused on enhancing life in all its manifestations (human, other species, and ecological systems) through an enduring responsibility of stewardship (Mang&Reed, 2012). Regenerative design responsibilities are suitable for design work at different scales and contexts such as city, urban, neighbourhood, and building. In this context, to summarize regenerative design, its prominent principles can be listed as follows:

- By their nature, regenerative approaches require an adaptable direction to building design and operations.
- They allow combined human-technical systems in the construction process to adapt to change over time.
- Many of the core aspects of regenerative design and development (systems thinking, community engagement, and respect for place) are well-defined and accepted practices.
- They collectively emphasize a qualitative context for building design, together with the concepts of partnering, co-evolution, and socio-ecological.
- Developing the ‘capacity to take transformative action and to navigate transformation’ (Griffith et al., 2010) is a primary objective of regenerative design and development.

- It assumes that neither human systems nor natural systems are embedded in each other, but rather they co-evolve (Cole et al., 2013).
- Regenerative design requires changes in the temporal and spatial scope of the design process. The first change is to think of buildings as processes that can be adapted over time, rather than as human artefacts. The second is to focus on the neighbourhood in which the building is located, rather than to focus on the individual building and its location. Both of these changes apply not only to ecological systems but also to socio-cultural processes.

Since regenerative design is in its embryonic period, it also has some outstanding difficulties. For example, since this approach is still in its development stage, it must be clearly and firmly proven that the claimed benefits can be achieved and that the necessary efforts will yield results (Cooper, 2012, p.358). Additionally, the concept of co-evolution points to a developing future. For this reason, it raises a number of problems such as sociocultural and ecological systems, cycles, uncertainties of results, constant commitment, and participation. Since the built environment is located in an overlapping region between culture and nature, the fact that it has the potential to be a problem in both areas which are cultural and natural can be shown as one of the challenging aspects of this design approach.

The city plays a role as an initiator and as a consequence of the Anthropocene, many cities around the world face a variety of challenges and opportunities linked to changing demographic and environmental pressures, which means that cities need to be well coordinated and respond effectively to different pressures so that they and their inhabitants survive and develop (Polat&Karaman, 2019). At this point, regenerative design can be mentioned as an effective method to solve problems because it is an approach that can be adapted to all scales and scopes in a city. Regenerative design is a suitable approach to discuss problems such as biodiversity loss, changes in atmospheric and ocean chemistry, urbanization, and globalization triggered by the Anthropocene era. It is also suitable to address problems such as democracy, sustainability, and sustainable development, which have become distant from their purposes and distorted in a way adapted to the Anthropocene era. As seen in Figure 2, the regenerative principles of regenerative design can bring environmental, social, and economic sustainability to the causes and consequences of the Anthropocene. In this context, regenerative design must accept the complex and constantly evolving interrelationship between socio-cultural-ecological systems and understand the role of construction within this evolving context. To understand this role, Aga Khan award-winning architect Anna Heringer, who tries to achieve social, economic, and environmental sustainability in the best possible way, can be mentioned. Her architectural approach has become valuable in exploring the potential of regenerative design in the Anthropocene era through her works.

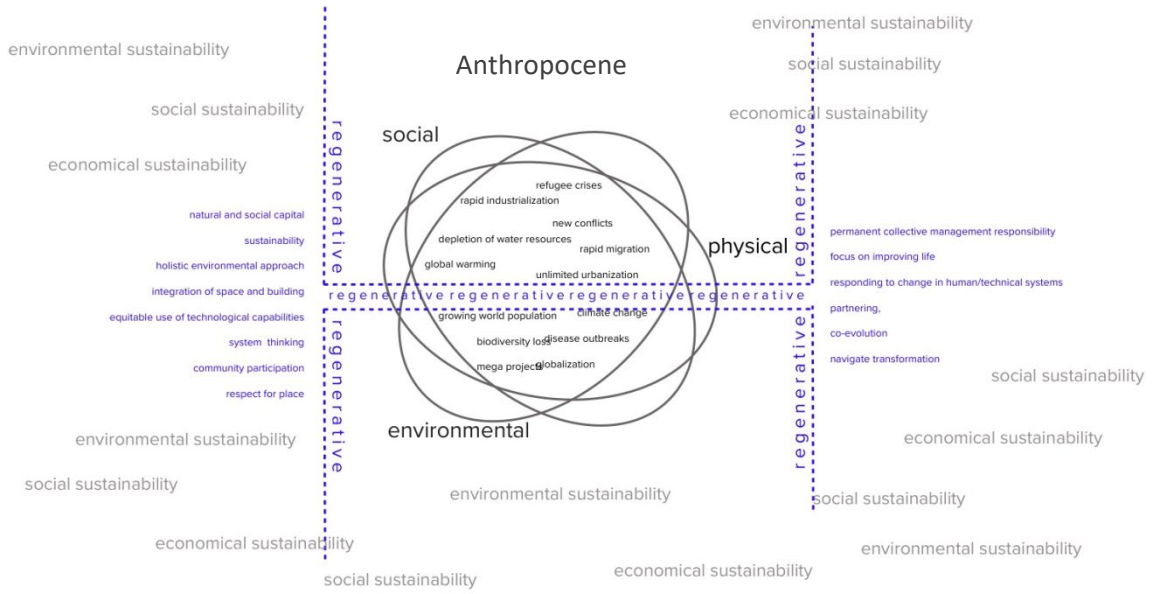

Figure 2. Diagram of Regenerative Design in Anthropocene Era (Created by the Authors).

2. Method and Material

The Anthropocene has comprehensive literature in the context of sustainability through socio-cultural and ecological systems as a new topic of discussion, but it has not yet been subjected to serious scrutiny within the framework of new design approaches and its concepts. In this study, a discussion is initiated on how the Anthropocene can be connected to the concept of regenerative design by drawing upon interdisciplinary literature. In the study, Heringer's work has been analysed through deep readings on exploring the capacity of architecture to embody regenerative principles and these readings have been presented with a relational diagram/collage.

In the study, various examinations are presented on how, in the Anthropocene era, an environmentally focused regenerative design can provide a stronger theoretical framework for sustainability. This analysis is carried out in conjunction with diagrams, which explain the facets and potentials of regenerative design, using Heringer's works as a focal point. The methodological steps of the study are as follows: providing a literature review on the Anthropocene era and regenerative design, establishing a conceptual relationship between these two subjects, conducting an in-depth analysis with a focus on regenerative design within Heringer's works, and interpreting the findings within the context of the Anthropocene era.

2.1. General Features of METI Handmade School

Anna Heringer has created many significant architectural products aimed at preserving and fostering ecological balance. She aims to utilize architecture as a tool to enhance people's lives, depending on local materials and sources to promote and empower communities and individuals (Parkes, 2022). The experiences she gained during her travels to Bangladesh during her student years played a significant role in Heringer's perspective on architecture (“Architects not Architecture”, 2023). She has a profound interest in the sustainable development of diverse societies and their built environment. She has been participating actively in the development cooperation efforts in Bangladesh since 1997. The METI (Modern

Education and Training Institute) School is significant in terms of being the first building where Heringer's architectural principles took shape. Heringer conducted the design and concept development of the structure, while the architectural construction process was a collaborative work with Eike Roswag. The main purpose of the project was to enable sustainable development in rural areas to prevent mass migration from rural to urban areas.

The METI Handmade School is located in Rudrapur, a district in Bangladesh's Dinajpur (Figure 3). The school presents an alternative to the typical frontal teaching method. The design of the new school aligns with this concept, offering various types of spaces and functions to support this teaching and learning approach. On the ground floor, which features sturdy earthen walls, three classrooms are situated, each of which with its own entrance is leading to an organically designed system of 'caves' located at the back of the classroom. These cosy interiors are intended for tactile engagement, relaxation, exploration, or focused study, whether individually or in groups (“Archdaily”, 2010). The school is a perfect example of sustainable architectural practices and was awarded the Aga Khan Award for Architecture in 2007. The jury emphasized that the structure ''creates beautiful, meaningful and humane collective spaces for learning, so enriching the lives of the children it serves' in their evaluation (“Anna Heringer Architecture”, n.d.). It was recognized for its simple yet compassionate design, its striking visual appeal, and the exceptional level of collaboration that took place among the architects, craftsmen, clients, and beneficiaries.

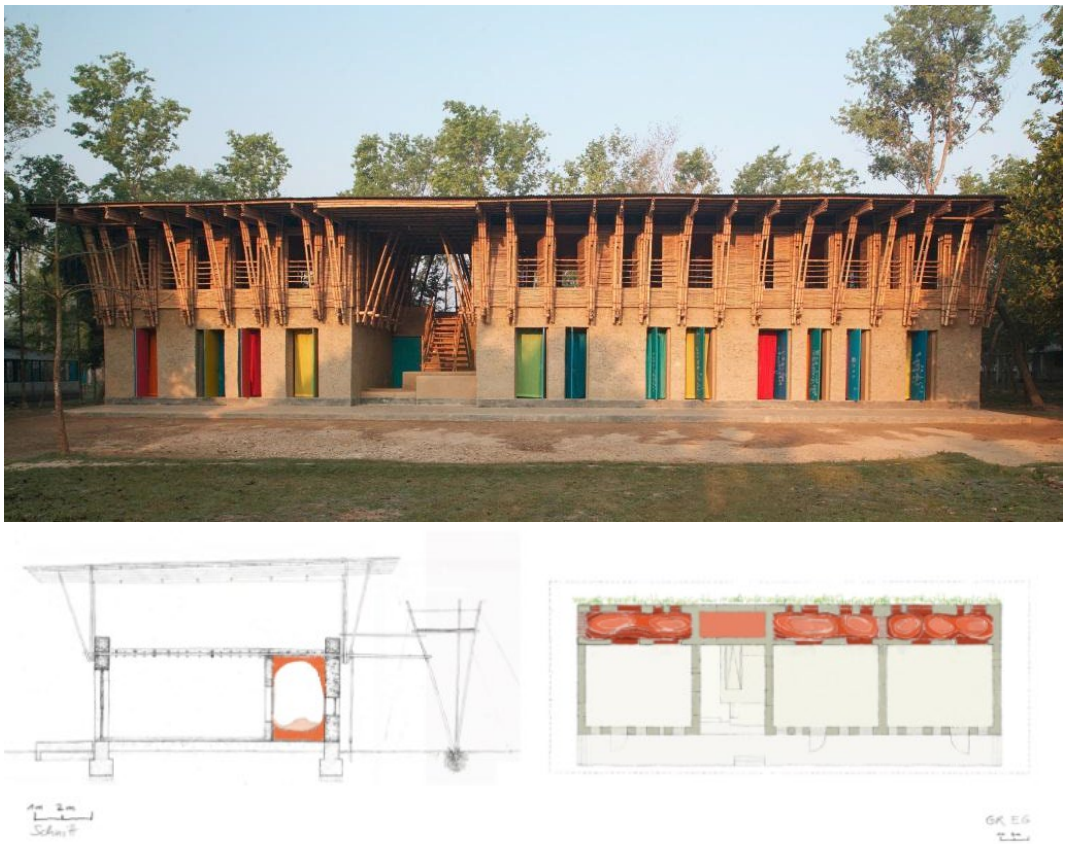

Figure 3. The Overall Appearance and Drawings of the Building (“Anna Heringer Architecture”, n.d.).

2.2. Exploring the Regenerative Potentials of Architecture through the METI Handmade School

The concept of regenerative design, based on the idea of the co-evolution and systemic integration of human and natural capital (Cole, 2012), can be discerned in Heringer's structure. Heringer aimed to use local resources and reduce external dependencies in her architectural approach, which is rooted in respect for nature, in the METI School project. This section explores the environmental, social, and economic regenerative impacts of the school generated during both the construction process and its ongoing existence. The structure's regenerative potential is being revealed. This discovery is presented through a relational diagram (Figure 4). The diagram illustrates how the environmentally oriented decisions targeted during the construction of the structure are interconnected with social outcomes.

Figure 4. Regenerative Potentials of MEDI Handmade School (Created by the Authors).

In the METI School project, Heringer implemented the working principle of local materials, local energy sources, and global knowledge (“Architects not Architecture”, 2023). This design principle has served as a fundamental catalyst for sustainable development through architecture. The principle adopted by Heringer for the construction process of the structure continues to be applied during its usage phase as well. During the process of renewing aging parts of the structure, this working principle is revisited to re-establish regenerative effects.

- **Local materials:** In the project, materials reachable in the construction area, including mud, bamboo, and textiles produced by local artisans, were utilized. These materials are locally recognized and commonly used in the traditional construction methods of the region. Heringer believed that the creative potentials of materials could be combined through a fusion of traditional and modern methods. In addition to being used in the ground walls of the school, mud was also utilized to construct the back corridor, which functions as an unexplored cave for students. The cave was creatively constructed to facilitate activities such as play, relaxation, exploration, and interaction for the students. The most important environmental characteristics of mud/earth as a material include its easy availability from the local environment, its traditional use by the native community, its non-toxic nature making it usable for everyone, its suitability for low-tech processing, and the ease of renewal when needed, utilizing local human and material resources. Another important material in the structure is bamboo, which was creatively combined into the first floor and roof of the building using innovative joining methods. Bamboo, with its significant environmental features, such as being a natural material, locally grown, familiar to the native community, having a high load-bearing capacity, and the ease of sourcing new bamboo when needed, was utilized in the project due to its regenerative potential. In addition to the sustainable properties inherent to the plant, the architect creatively and aesthetically integrated the material into the design. It can be said that traditionally these materials had limited usage patterns. However, the combination of traditional materials with global knowledge and creativity is believed to create a highly regenerative cycle for the native community. The creative and aesthetic use of locally sourced materials is also seen as contributing to the formation of a local identity.

Another material that shapes the character of the structure is textiles produced by local women. Fabrics were used as a semi-open divider between the interior and exterior on both the ground and first floors. The utilization of textiles produced by women is considered regenerative from environmental, social, and economic perspectives, serving as both an empowerment tool for women and a means to reduce external material dependency.

- **Local Energy Sources:** During the construction process, local energy sources were used to minimize external dependency. Local energy sources included local labourers, volunteer community members, craftsmen, and even buffaloes. In an area considered economically disadvantaged, even the supply of electrical power is a challenge. Hence, the construction maximized the community's self-sufficiency capacity. For instance, during the construction, buffaloes and people were employed to mix the mud. Human labour was utilized in various stages, including sourcing bamboo, preparing it for construction, and making necessary adjustments during the building process. In the plastering of mud materials, initially, men started working, but as women in the area showed interest, Heringer requested their involvement (“TED”, 2017). Children also participated in the production of this communal space alongside women. The non-toxic nature of the material, made primarily from pure natural earth, allowed all members of the community to willingly participate in the production. In this sense, the earth stands out as an inclusive material environmentally, socially, and economically. In achieving environmental sustainability, the individuals living within the community actively participated in these actions, becoming an essential part of

sustainable development. This sustainability concept has been holistically realized not by certain individuals but by the entire community. This participatory approach can be said to have paved the way for the development of social capital, to have increased social interaction and empowerment of women, and to have enhanced community production responsibility and engagement within the community. Active involvement in the construction process of the structure not only fostered a sense of place and belonging but also maintained feelings of pride and a host of positive feelings associated with the space's utilization.

- **Global Knowledge**: The construction involving earth building and bamboo was carried out by local labourers, with building techniques being developed and implemented in collaboration with architects and craftsmen from Germany and Austria. This project also provided training to 25 local tradesmen from the area, creating employment opportunities and offering professional assistance for self-sufficiency (“Archdaily”, 2010). The convergence of traditional knowledge with global knowledge has created a regenerative impact in the field. A sustainable system has been established where individuals who participated in the construction process can undertake restoration if the structure deforms in the years following its construction. These same individuals have also acquired the knowledge to construct similar buildings without the need for external sources. This situation defines a process that can contribute to the regenerative sustainable development of the region.

Within the sixteen-year lifespan of the structure, the ability to repair and restore damaged areas using local knowledge, resources, and capital is a significant regenerative effect for the region. The capacity to complete repairs using materials sourced from nature without leaving toxic ruins is a notable example of environmental sustainability. Additionally, relying on local energy and human capital instead of exporting high-tech solutions for repairs showcases social sustainability. The fact that the region does not have to depend on other countries or engage in commercial relationships to repair this architectural structure demonstrates efficient resource utilization for economic sustainability. The strong relationship this building establishes with the local environment refers to all dimensions of sustainability, affirming the region's sustainable development.

3. Conclusion

The study investigates the regenerative potential of architecture, which has significantly caused the planet's mass degenerative effects during the Anthropocene Era. Through the examination of Heringer's METI Handmade School structure, the article has produced several findings indicating regenerative potential. It is believed that Heringer's environmentally-focused design ultimately fosters community spirit creation.

Bangladesh, specifically the Dinajpur region where METI School is situated, is characterized by rural-to-urban migration, poverty, and a lack of established local development. Local nongovernmental organizations collaborated with the METI organization with the goal of promoting the level of education in the area and creating a school where students can freely showcase their abilities. METI School was constructed based on Heringer's holistic design

principles of local materials, local energy sources, and global knowledge. The study has focused on the regenerative outcomes of these design principles. As a result of the analysis, it has been observed that these design principles work in conjunction with each other. The environmentally oriented design decisions have generated outcomes in the field that contribute to social and economic development. Local materials like mud and bamboo have enabled the entire native community to participate in the construction process. The use of non-toxic materials is believed to reinforce strong social sentiments such as community participation, social interaction, and a sense of place within the local population. It is believed that the community members who participated in the construction process will establish a different type of pride, ownership, loyalty, and appreciation relationship with the building during its use. In the event of the building's restoration, the building material is demolished by mixing it with the earth, ensuring that no harmful waste is generated. This offers a regenerative proposal to counteract the degenerative act of demolishing and rebuilding in current architectural tendencies. Additionally, a cyclical regenerative effect has been generated by teaching local individuals the global know-how for using these materials in construction through creative designs in this field. In production which utilizes the resources of the land, economic sustainability is established by not allowing the economic resources of the region to flow outwards. The study reveals that positive impacts can be generated without the need for high-tech solutions. The school was produced through the alternative design power with the community against technological determinism.

The study concludes that one-dimensional actions often struggle to create regenerative effects. For instance, in environmentally oriented decision-making, the lack of community involvement causes unsustainable situations. The sense of inclusion within the community is an inevitable factor in regenerative impact. In the Anthropocene era, it is believed that the regenerative potential of architectural work can only be realized through environmentally conscious decisions and the understanding, adoption, and preservation of these decisions by the community. Regenerative potential varies according to the context. This variation is influenced by various factors such as rural-urban distinctions, scale, level of development, political circumstances, climate, opportunities within the context, and human resources. In determining regenerative effects through architecture, it is important to thoroughly analyse the context and define its possibilities. The regenerative impact generated by Heringer's example in Bangladesh may not necessarily be applicable in the same way in another context. Understanding the context is crucial in achieving regenerative effects. The carbon footprint of individuals in Bangladesh is different from that of individuals in Western countries. It can be argued that people in Bangladesh have the least impact on the destructive causes affecting the Anthropocene era. Therefore, the regenerative impact generated for our planet in Bangladesh through architecture should be quite different from the regenerative impact generated through architecture in Western countries.

By conducting an in-depth analysis of a specific region's challenges and implementing unique measures, it can be established a sustainable development cycle. This cycle can strengthen local attachment within the community and mitigate migration. It has been understood that rural areas can contribute to their own social and economic development through environmentally conscious architectural design decisions. The development of local areas can potentially

reduce urban migration and allow cities to remain more manageable, thereby reducing cities' destructive impact on the environment. As a result, in this study, the belief that the solution of the climate crisis will be possible not by nature itself but by changing the life of the human species is defended. It is suggested that the regenerative potential of architecture will be possible with the analysis of contextual information and the application of the analysis based on local resources and knowledge.

In the study, potential outcomes of the environmental-social relationship have been discussed. To obtain more concrete results regarding regenerative impact, methods such as on-site observation and in-depth interviews in these areas could be operated, contributing to a deeper conceptual understanding of regenerative effects.

Declaration of Ethical Standards

The article complies with national and international research and publication ethics. Ethics Committee Approval was not required for the study.

Conflict of Interest

There was no conflict of interest between the authors during the research process.

Authors' Contributions

All authors contributed equally to the article.

Declarations

The authors take full responsibility for the content and any modifications made during this process.

Originality Report

According to the originality report obtained from the iThenticate software, this article's similarity rate is 15%.

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