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# Preface

Amid climate change and global warming's severe manifestation and impacts, world leaders convened at the COP 26 UN Climate Change Conference, (COP26) in Glasgow, UK, from October 31 to November 13, 2021, to tackle and discuss the climate crisis. Before COP26, the leaders of G7 met in Rome, Italy, to deal with and discuss the skyrocketing of prices for energy globally. These meetings highlighted two key global prime challenges and crises: climate change and energy, which are closely interconnected. The COP26 aimed at attaining climate neutrality by 2050 and allocating funding packages for developing countries to enable them to meet climate mitigation and adaption. One of the main topics discussed during COP26 was the role of nature and its benefits as a means to confront climate change risks.

The Glasgow Climate Pact (GCP), which was derived from the COP26 meeting, stated that the serious concern of climate and weather extremes and their adverse impacts on people and nature will continue to increase with additional increments of rising temperature. In terms of adaptation, the outcomes of COP26 emphasized the importance of scaling up action and support, including a) finance, b) capacity building and c) technology transfer, to improve adaptive capacity, strengthen resilience, and lessen vulnerability to climate change in the context of the best available science, taking into consideration the priorities and needs of developing countries. Regarding mitigation, GCP reasserted the long-term global goal to hold the increase in global average temperature to well below 2 °C above pre-industrial levels, in addition to recognizing that limiting global warming to 1.5 °C entails rapid, deep, and sustained reduction in global greenhouse gas (GHG) emissions. The latter includes the mitigation of global carbon dioxide emissions by 45% by 2030 relative to the 2010 level and to net zero by 2050, as well as deep reduction in other greenhouse gases. Among COP26 – GCP decisions are also to emphasize the significance of protecting, conserving, and restoring nature and ecosystems, including protecting the biodiversity while ensuring social and environmental safeguards. In a nutshell, the Glasgow Climate Pact outlines eight main folds: science and urgency, adaptation, adaptation finance, mitigation, finance, technology transfer, and

capacity-building for mitigation and adaptation; loss and damage; implementation; and collaboration.[1]

In view of COP26 outcomes/pact and the prolonged coronavirus (COVID-19) pandemic, can biomimicry and biomimetic architecture inspired by nature be an ingredient of the trail towards achieving climate neutrality by 2050?

Tracey Ryan – Aurecon's New Zealand Managing Director and FIDIC Chair of Sustainable Development Committee – highlighted that "Net Zero 2025 is the right thing to do." She added that biomimicry and the need for a holistic approach to circularity, decarbonization, and resilience are becoming crucial.[2] The legendary and famous architect Frank Lloyd Wright said it is important to *study nature, adore nature, and stay close to nature, it will never fail you*. It is truly said since biomimicry – a new path to attaining sustainability. Thus, biomimicry is an apt approach to confront challenges facing humanity and cities with such huge resource consumption, air pollution, climate change risks, water scarcity, and above all the COVID-19 pandemic. Biomimicry in architecture can also be the right path to drive climate action and foster green and sustainable cities, and yet achieve sustainable development and the SDGs. In its recent report on mapping nature-based solutions and natural climate solutions, the World's Business Council for Sustainable Development (WBCSD) stated that accelerating business solutions for climate and nature is vital.[3]

There is mounting evidence that human overexploitation of nature is a key factor causing the outbreak and spread of new diseases such as COVID-19. Thus, protecting nature and integrating architecture into nature will preserve the global biodiversity and ecosystem. While climate generates the conditions for nature to flourish, nature controls climate via the carbon and water cycles.

Therefore, there is a great deal to learn, discover, and gain from nature, which is seemingly forgotten. Amid the global efforts to confront climate change, biomimicry stands as a motivating approach that has influential impacts on solving multifaceted human problems through imitating the elements, systems, and paradigms of nature. The term "biomimicry" is derived from the Greek word "bios." The latter term means life and "mimesis" implies imitate. Therefore, mimicking nature in architecture can be a substantial helix of inspiration to attain sustainability of the built environment. However, biomimicry is not a new idea, and it goes back to an American inventor and academic – Otto Schmitt, who first coined the world itself as early as 1982.

In fact, cities globally are encountering huge challenges. With the number of megacities to reach 43 by 2030, this puts colossal pressure on natural resources in

[1] UNFCCC. (2021). *Decision -/CP.26 Glasgow Climate Pact* (pp. 1–8). Glasgow: United Nations Framework Convention on Climate change. Retrieved 9 December 2021, from https://unfccc.int/sites/default/files/resource/cop26_auv_2f_cover_decision.pdf

[2] Pearson, G. (2021). *"Net zero 2025 is the right thing to do," says Aurecon's Tracy Ryan – Infrastructure Global.* Infrastructure Global. Retrieved 9 December 2021, from https://infraglobal/net-zero-2025-is-the-thing-to-do-says-aurecons-tracy-ryan

[3] Docs.wbcsd.org. (2021).Retrieved 10 December 2021, from https://docs.wbcsd.org/2021/12/WBCSD-Accelrating-Buisness-Solutions-for-Climate-and-Nature.pdf

terms of energy, water, and material consumption. Moreover, the rapid population increase worldwide adds other dimensions to these immense challenges. With the global climate crisis and severity of the COVID-19 pandemic, which hit the world in the year 2019 and is still at large today, are megacities resilient enough to withstand the devastating impact of the ongoing SARS-CoV-2 pandemic coupled with climate change? Statistics published globally indicated that cities' infrastructure and sectors are not resilient. For example, as of December 6, 2021, the total confirmed cases amount to 265.8 million, and the total deaths reached 5.2 million and more to be recorded in the next months. Thus, there is an urgent need to build and transform cities to be resilient by focusing more on nature and exploiting biomimicry in architecture and urban spaces in the context of livability and sustainability.

The relationship with nature transformed into a more adaptive form through organic architecture in an attempt to integrate the spaces into a coherent whole, and the adaptation between the site and the built environment. For creating green, sustainable, and resilient cities in the age of the COVID-19 pandemic and attaining climate neutrality, biomimicry in architecture is key in this equation. Thus, there is a need to accelerate climate action, including (a) enhancing air quality, (b) protecting biodiversity, (c) ensuring clean energy transition, (d) fostering circular economic system and e) engaging local stakeholders. All of the above can be achieved through the implementation of nature-based development, low-emission development, circular development, and resilient development as well as equitable and people-command development.

Noticing the City Climate Finance Gap Fund, which wires cities in emerging and developing countries, to grasp and apprehend their climate ambition, turning low-carbon, climate-resilient concepts into strategies, policies, and finalizing projects, biomimicry in architecture could be a core and revolving point in reaching such goals, especially amid the COVID-19 crisis.

With more than 1430 cities in 210 countries around the world (e.g., the USA, India, Brazil Russia, and the UK) distressed and impacted by the coronavirus (COVID-19) and over 95% of the total cases being in urban areas and megacities, finding a solution through biomimicry is urgent and essential. Most of the people at risk are those living in informal settlements and slums in teeming and imperfect housing, estimated at more than one billion dwellers. Thus, biomimicry lingers as relevant to the health of our planet and cities as it was before the COVID-19 pandemic where nature has produced the ultimate medicines and design solutions. A wide range of multinational corporations and institutions now adjust their strategies and embrace biomimicry in their mission to efficiency, effectiveness, and sustainability. Related to climate change, organizations created applications and solutions to fight CC impacts, such as carbon mix (a new type of concrete which is inspired by coral), vertically aligned wind turbines (arrangement in the formation as seen in schools of fish), BioWAVE (which converts the energy of ocean waves into usable energy by imitating the movement of kelp under water to generate energy), and AirCarbon (which furnishes a distinctive way out of the current problem of plastics

by producing plastics that are derived from greenhouse gases akin to methane instead of petroleum – the traditional source of material).[4]

Nature is a well of knowledge during the COVID-19 crisis. According to the Organization of Economic Co-operation and Development (OECD), the total number of unemployed workers in the OECD regions fell to 38.3 million, still 2.8 million higher than the pre-pandemic level.[5] Hence, taking inspiration from nature in promoting healthy and green buildings and cities by virtue of biomimicry and biomimetic architecture can foster the transition toward green and livable cities by creating new job opportunities. Therefore, crises can present opportunities for cities and their economic recovery and growth. For instance, evidence has indicated that the quality of air has improved in cities across the world since transportation, road congestion, and heavy traffic were lessened, more people were working from home, and economic activities were decreased. This had a direct impact on people's health but on the other hand, created a challenge to existing well-ventilated buildings or air-tight buildings and spaces. In this context, biomimicry in architecture can play a major role in creating livable spaces and healthy buildings. With the high cost of climate change impacts globally, specifically the devastating floods in Europe (Belgium, Germany, The Netherlands, and Spain) and other parts of the global, city leaders must utilize the current crisis to plan and manage how net zero carbon aspiration can be achieved and how cities can become more resilient and sustainable in environmental, economic, and social stipulations. After all, Professor Tim Dixon – Chair of Sustainable Future in the Built Environment, University of Reading, UK, and the Oxford COVID-19 Evidence Service Team, University of Oxford – in his essay "What impacts are emerging from COVID-19 for urban future?" indicated that 1496 cities in 30 countries had affirmed climate emergencies before COVID-19 affected people's lives. In the UK, for example, cities like Oxford and Reading have not only set out their vision for 2050 but also have climate change strategies in place or under revision.[6] Ultimately, net zero carbon and managing "'transition" remains a huge challenge for cities and regions alike, but coupling these goals to innovating thinking for the future is primarily essential if cities worldwide are to become resilient enough and meet COP26 outcomes and the Glasgow Climate Pact.

Post COP26, the prime global warming is to be curbed to 1.5 °C, and all cities need to be net zero by 2050. The very concern is how to reach climate neutrality and curb the severity of climate change, and attain Sustainable Development Goals (SDGs), which have been hindered globally by COVID-19 crises. As the supply chain and food crises led to the increase in inflation worldwide, the authors intended

[4] Fransen, B. (2020). *Learning from Mother Nature – Biomimicry – EcoMatcher*. EcoMatcher. Retrieved 9 December 2021, from https://www.ecomatcher.com/learning-from-mother-nature-biomimicry

[5] *Post-Covid-19 Recovery Plan Key to Bolstering Growth and Public Finance*. oecd.org. (2021). Retrieved 10 December 2021, from https://www.oecd.org/post-covid-19-recovery-plan-key-to-bolstering-growth-and-public-finance

[6] Dixon, T, (2021). *What impacts are emerging from Covid-19 for Urban Futures? – The Centre for Evidence-Based Medicine.* The Centre for Evidence-Based Medicine. Retrieved 10 December 2021, from https://www.cebm.net/covid-19/what-impacts-are-emerging-from-covid-19-for-urban-futures

to write this book due to the importance of the topic globally in terms of nature, biodiversity, and ecosystem. Going back to nature is a key issue that was discussed by leading international institutions during COP26, for instance, the United Nations, The World Bank, ICLEI – Local Governments for Sustainability, and OCED as well as the Biomimicry Institute, International Institute for Sustainable Development (IISD), C40 Cities Climate Leadership Group, and many more.

In articulating this book, the authors contemplated this topic since it is in the forefront and tackled globally, especially with reference to urban climate and challenges facing megacities and regions post COP26. Thus, we developed this book to focus mainly on biomimicry and biomimetic architecture as a means to green megacities and to fully comprehend biomimicry's approach through learning its background and history as well as to provide the origins of biomimetic architecture and its meaning, and how to integrate such an approach as a way of thinking to achieve climate and carbon neutrality. We also highlight the biomimicry role in the early conceptual design, overlapping between architecture and nature by virtue of taking nature as an inspiring model, measure, and mentor for the biomimicry design spiral. In addition, the authors emphasize the importance of biomimetic architecture amid the COVID-19 pandemic and climate crisis.

It was essential to highlight why the book focuses on biomimicry and biomimetic architecture's definitions, and the significance of biomimicry in the age of COVID-19 in terms of attitudes, connectivity to nature, and pro-environmental behaviors during COVID-19, yet learning through neighborhood's access to green spaces amid COVID-19. It is imperative to state that nature, a great source of inspiration to biomimicry, is a daily lifestyle these days, and the need for new approaches to attain livability, sustainable development and, SDGs in cities including biomimicry and energy efficiency, and circular economy and built environment are vital. There is a key question that this book is trying to answer. Can biomimicry aid in developing urban spaces and creating healthier buildings indoors? The book also highlights the interwoven relationship between biomimicry and urban design as well as biomimicry and climate change adaptation, in addition to biomimicry and post-COVID regulations, and showcases innovation in biomimicry and biomimetic architecture.

One of the challenges deduced from the literature in this book is that the topic occupies a large scale; therefore, we dived in to intensely read the literature, and research deeply to address such topic briefly, coherently, and holistically. This was really a time-demanding chore, and the COVID-19 pandemic lockdown delayed the process of writing this book, but the authors managed to overcome such a challenge in a timely manner. Another challenge derived from the literature is that people living next to coastal areas reported more than half of the world population, thus putting a severe strain on natural ecosystems and resources in addition to climate change (extreme threats including strong storms, devastating floods, and heat waves). Also, biodiversity loss and climate change – strongly interlinked – are major challenges of a similar significance and urgency to achieve SDGs. Obviously, nature and biodiversity have many possible solutions and inspiration to future pandemics and existing viruses. The green and inclusive recovery to COVID-19 has been

focusing largely on climate change (CC), but less attention on biodiversity. Therefore, in any post-COVID regulation, biodiversity loss, and climate action should be mutually addressed as part of wider efforts to attain a green, sustainable, and resilient recovery in addition to attain the Glasgow Climate Pact and Climate neutrality by 2050.

Another defy is that global urban areas are the most affected regions when it comes to the spread of COVID-19, as seen in many cities in the USA, Europe, Africa, and Asia. What are the set policies, strategies, and action plans needed to curb the pandemic that hindered the progress effort done before 2019 in terms of the Sustainable Development Goals (SDGs)? This has also instigated the authors to write this book. Additionally, the current policies and mechanisms need to address the strategic actions to meet low-carbon communities, and yet integrate net zero process with the SDGs, specifically Goal 4 – Quality Education; Goal 7 – Affordable and Clean Energy; Goal 9 – Industry, Innovation and Infrastructure; Goal 11 – Sustainable Cities and Communities; Goal 12 – Responsible Consumption and Production, as well as Goal 13 – Climate Action; Goal 14 – Life on Land; and Goal 17 – Partnerships for the Goals.

This book furnishes the information needed to learn and comprehend biomimicry thinking, types, levels, and approaches as well as the six sustainability elements to achieve biomimetic concept for creating biomimicry in architecture. The aim is to highlight the importance of nature as a source of inspiration in order to withstand the severe impacts of climate change as well as natural disasters in megacities, in addition to the impacts of the COVID-19 crisis in more than 1400 cities worldwide.

The book also portrays a comprehensive overview on innovative approaches and sustainable biomimetic architecture examples in Asia, Europe, Africa, and the USA to assist the reader in facilitating and comprehending the content. The book is structured into two main parts. The first part presents some of the key issues related to biomimicry and architecture. Part I portrays a full review of biomimicry and nature – milieu, history, and approaches as well as design methods and process. It highlights the evolution of mankind and its relationship with nature biomimicry, and early conceptual design, as well as overlap between architecture and nature by taking nature as a model, measure, and mentor. Part I also furnishes the readers with a full comprehension of biomimicry through different aspects and underlines the drivers of the entire unsustainable practice of modern civilization that lies in the dualistic detachment of nature and culture. Additionally, it presents a review on the influence of biomimicry on architectural design and the built environment through several points. It also highlights and discusses the cause of biomimicry thinking, biomimicry in architecture, approaches, and levels of biomimicry as well as the levels of biomimetics information and the application types of biomimicry in architecture, and yet focuses on inspiration levels in nature and showcases many iconic global exemplary buildings. Moreover, it portrays the biomimicry design lens and nature's design principles and how biomimicry attains sustainability. While the second part of this book encompasses four chapters dedicated to highlighting the key issues of biomimicry in relation to sustainability and global applications of biomimicry approaches and levels in architecture, it also presents an overview and discusses

climate change efforts, and actions concerning mitigation and adaptation in three countries (Egypt, Italy, and Germany). Part II also depicts biomimicry in criticism including the argument and defense as well as the direction towards a sustainable future. Moreover, it presents an overview of the COVID-19 pandemic and addresses how biomimicry innovation and post-COVID regulations can curb the devastating impacts of such a crisis. At the end of this book, an important question is highlighted – "Can biomimicry innovation assist in limiting the spread of COVID-19?"

With contributions from the lead author, an international and national expert who has more than 35 years of experience in higher education, government, senior management, and consultancy in strategy and policy related to sustainable urban development, sustainable energy policies, and climate change mitigation and adaptation, this book portrays an important and indispensable knowledge resource on the topic of **biomimetic architecture and its role in developing sustainable, regenerative, and livable cities.**

The *authors s*trongly believe that the book will be a valuable resource to governments, policy makers, and professionals, along with research centers, libraries, and academicians as well as researchers and students who are interested in this field, in addition to industry stakeholders involved in the development of cities and buildings, for attaining climate neutrality by 2050 and offsetting climate change and achieving climate neutrality by adopting biomimicry approaches in architecture and getting inspired from nature, especially amid the COVID-19 pandemic and global crises.

You are welcome to contact the lead author through the e-mail address – maboulnaga@eng.cu.edu.eg – to share your thoughts and comments upon reading this book or afterward. I assure you to get back to you in a speedy manner.

Giza, Greater Cairo, Egypt Mohsen Aboulnaga

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