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The impact of afforestation on climate change in the city- cast Study Kingdome of Bahrain

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Abstract— **The Glasgow Climate Pact, a landmark outcome of COP26, marks significant progress in global climate action. Adopted in November 2021, the pact formulates a strong strategy to confront Earth's warming challenges. These brief abstract captures focal aspects of the Glasgow Climate Pact, highlighting commitments to limit global warming, strengthen Nationally Determined Contributions (NDCs), and allocate climate finance for developing nations. The pact also acknowledges the top importance of adaptation, sustainable land use, and transitioning to cleaner energy sources. Cities worldwide confront escalating climate challenges, from the increasing urban heat island effect to more frequent extreme weather events and rising sea levels. Also, underscore the critical need for adaptation and resilience strategies to protect urban areas from evolving climate dynamics. Bahrain, like many nations, contributes to climate change through fossil fuel reliance and industrial activities. Localized efforts are crucial for global climate initiatives and sustainable practices. In addition, explores Bahrain's commitment to achieve net-zero carbon emissions by 2060, emphasizing the significance of decarbonization, efficiency programs, and renewable energy integration. Post-COP26, Bahrain's National Plan for Afforestation shows ambitious targets for expanding tree coverage and mangrove areas. Moreover, discusses the afforestation strategy's potential impact on greenhouse gas mitigation, along with broader implications for soil quality and environmental changes. The path to resilient cities amid climate change necessitates embracing cutting-edge technologies, smart urban planning, circular economy principles, and international collaboration. Finally, emphasizes adaptive frameworks leveraging technology, sustainable practices, and community engagement to construct resilient cities resilient to climate change's challenges.**

Keywords—component; (afforestation, climate change, Kingdome of Bahrain,COP26)

I. INTRODUCTION (COP26 - GLASGO)

The Glasgow Climate Pact, emerging from the 26th UN Climate Change Conference of the Parties (COP26), stands as a focal achievement in the global action to fight climate change (UNFCCC, 2021). Formally adopted in November 2021, this pact outlines a comprehensive strategy to handle the challenges proposed by a warming Earth. The following points offer briefing of each issue in promoting a sustainable and resilient future.

1. The commitment to restrict global warming to 1.5 degrees Celsius above pre-industrial levels is emphasized in the Glasgow Climate Pact (UNFCCC, 2021).
2. The pact underscores the necessity for countries to enhance their Nationally Determined Contributions (NDCs), which represent individual nations' commitments to reducing greenhouse gas emissions (UNFCCC, n.d.).
3. A crucial element of the pact involves the commitment by developed nations to mobilize $100 billion annually in climate finance to aid developing countries in their climate mitigation and adaptation efforts (UNFCCC, n.d.).
4. The pact recognizes the significance of implementing measures for adaptation and resilience, particularly in vulnerable communities facing the impacts of climate change (UNFCCC, n.d.).
5. The pact includes pledges to combat deforestation and promote sustainable land use, such as the protection and restoration of forests (UN REDD Programme, n.d.).
6. The encouragement to expedite the reduction of unabated coal power highlights a commitment to transitioning toward cleaner and sustainable energy sources (UK Government, 2021).
7. The acknowledgment of loss and damage associated with climate change impacts addresses situations where adaptation measures may prove insufficient (UNFCCC, n.d.).
8. The emphasis on technology transfer and capacity building aims to reduce the technological disparity between developed and developing nations (UNFCCC, n.d.).

II. IMPACT OF CLIMATE CHANGE ON THE CITY

Cities face escalating climate challenges with the urban heat island effect intensifying, extreme weather

events increasing in frequency, and rising sea levels threatening coastal areas (Rizwan et al., 2008; IPCC, 2014; Nicholls et al., 2011). Adaptation and resilience strategies are imperative to safeguard urban environments from these changing climate dynamics. Firstly, Climate change contributes to the enhanced intensity of the urban heat island effect, resulting in elevated temperatures within cities compared to their surrounding rural areas (Rizwan, Dennis, & Chunho, 2008). This increasing establishes challenges related to heat for urban populations and infrastructure. Secondly, Climate change correlates with an increased occurrence and difficulty of extreme weather events, including heatwaves, storms, and floods. These events present substantial risks to urban infrastructure, human health, and overall city resilience (IPCC, 2014). Thirdly, Elevated global temperatures contribute to the melting of ice caps leading to a rise in sea levels. Coastal cities are consequently at risk of heightened flooding, placing both infrastructure and communities in vulnerable situations (Nicholls et al., 2011).

III. Bahrain share causing the climate change

Bahrain, similar to other nations, plays a contributing role in climate change through various mechanisms. The country heavily relies on fossil fuels, oil and gas, for its energy needs, leading to substantial greenhouse gas emissions, including carbon dioxide (CO2). Industrial activities, such as oil refining and manufacturing, further contribute to air pollution and climate change, releasing greenhouse gases into the atmosphere. Additionally, Bahrain's rapid urbanization and extensive infrastructure development result in heightened energy consumption and emissions, with urban expansion, construction, and transportation demands collectively shaping the nation's carbon footprint. Although Bahrain's individual impact on global emissions may be comparatively modest, addressing these localized factors remains essential for the country's commitment to global climate initiatives and sustainable practices.

IV. Bahrain's announcement on COP26

Global warming is a new challenge for human civilization as a result of industrialization, excessive fossil fuel consumption, and agricultural activities (Srivastava, 2021). The effects of climate change are widespread, yet they take different forms. Small and developing nations frequently find themselves at the forefront (Doelman et al., 2020).

Thirty years ago, world leaders convened to jointly confront climate change. Countries were invited by the UN to sign a climate convention pledging their commitment to cut greenhouse gas emissions. Ever since the signatory nations to the agreement have convened annually to deliberate on advancements and obstacles. Leaders from every nation gathered for the United Nations Climate Change Conference, or COP26, to discuss ways to intensify international action in response to the climate emergency. Taking action to address climate change is imperative. World leaders came together at COP26 to take coordinated action to slow down global warming and climate change. During the summit, countries reviewed their progress towards meeting the target set in the Paris Agreement which is to keep global warming well below 2°C over pre-industrial levels and to pursue efforts to limit it to 1.5°C (Climate change summit, 2020). Furthermore, the primary goals of the 26th COP summit were to adopt more aggressive goals to cut greenhouse gas emissions by 2030 and talk about ways to prepare for the effects of climate change that will inevitably occur. Bolster financing for combating climate change, especially for developing countries. In 2021, during the COP26 His Highness Prince Salman Al Khalifa the prime minister of Bahrain has announced that Bahrain is dedicated to achieving net zero carbon emissions by 2060 and has established several challenging short-term targets to guarantee that Bahrain moves forward without any delays. Through decarbonization and efficiency programs, Bahrain will cut emissions by thirty percent by 2035, and it will double the amount of renewable energy Bahrain that uses compared to the COP21 targets. In addition, Bahrain's 2035 goals include for doubling Bahrain's tree cover, quadrupling the area covered by mangroves, and direct investment in carbon capture technologies (Climate change summit COP26. (n.d.).

V. Bahrain National Plan for Afforestation

Bahrain committed to meeting the global climate targets with great ambition, pledging to achieve net zero emissions by 2060 and a 30% reduction in emissions by 2035. The targets of 2035: (1) solutions for removing carbon by quadrupling the coverage of mangroves, (2) doubling tree coverage, (3) making direct investments in technology for carbon capture. It has been highlighted that afforestation has been promoted recently as one of the primary ways to stop disastrous climate change (Doelman et al., 2020). Therefore, a National Plan for Afforestation (2022–2035) was unveiled in the wake of the COP26 announcements. Its goal is to increase the number of trees from 1.8 million to 3.6 million by 2035, or 270,000 trees annually, in recognition of the important role that mangroves and trees play in reducing the effects of climate change (UN-Habitat and FAO Support Bahrain's Afforestation Plans, 2022). As part of the national afforestation plan, Bahrain has limited the afforestation to twenty-one species of trees, these trees are suitable to the arid environment and are characterized by the ability to withstand the environmental constraints and challenges of water security and salinity, as well as the extreme hot climate. Furthermore, the main components of the afforestation strategy are fast-growing tree species to help in achieving the ambitious greenhouse gas (GHG) mitigation targets (Forster et al., 2021). These trees are moringa, cassia senna, hibiscus, neem, tamarix, prosopis, and acacia nilotica.

VI. Impact of Afforestation on Climate Change

Under strict mitigation scenarios, afforestation has significant trade-offs with other policy domains when used as a climate change mitigation strategy. Afforestation is preferred over other more costly initiatives like electrification of industry, decarbonization of transportation, and widespread deployment of renewable

energy sources due to its relative affordability (Doelman et al., 2020). Furthermore, afforestation is one of the most widespread methods for removing carbon dioxide from the atmosphere, however, it is limited by the availability of suitable land and enough water resources (Caldera & Breyer, 2023). According to the Supreme Council of Environment in Bahrain

According to research, afforestation influences soil quality, carbon (C) stocks, long-term sustainability, greenhouse gas (GHG; mainly CO2, CH4, and N2O) fluxes and environmental changes. It has been highlighted that this shift may take place in reaction to modifications in the political, social, economic, or environmental context. Many people agree that afforestation improves soil quality and makes it easier for heavily anthropic soil to return to its original function (Haghverdi & Kooch, 2019). Additionally, afforestation aids in restoring the water cycle and combat the growing problems of desertification, soil erosion, and floods (Caldera & Breyer, 2023).

VII. The Way Forward for a Resilient City

In the context of climate change, several overarching themes of urban resilience have emerged. For example, expanding the use of renewable energy sources like solar and wind energy could help build cities that are more resilient to natural disasters and climate change (Almulhin and Cobbinah, 2024). Reuse and recycling, solid waste separation to reduce the amount of waste dumped in landfills, and numerous other tactics have drawn a lot of attention lately. To endure the consequences of climate change, metropolitan areas need to be more adaptive. One of the nation's national development frameworks and policy initiatives is the Bahrain afforestation national strategy initiative, for instance.

- Embracing cutting-edge technologies and smart solutions to enhance city operations (Meijer & Bolívar, 2016). Employing data analytics, sensors, and real-time monitoring systems to manage and respond effectively to climate-related challenges.
- Employing smart urban planning and technology, such as data analytics, the Internet of Things (IoT), and real-time monitoring, to optimize city operations, boost energy efficiency, and improve disaster response (Caragliu et al., 2011; Ramcilovic-Suominen et al., 2021).
- Embracing circular economy principles and sustainable practices in infrastructure development, waste management, and resource utilization to minimize environmental impact (Ghisellini et al., 2016; European Commission, 2020).
- Accelerating the integration of renewable energy sources like solar and wind into the urban energy mix, coupled with energy storage solutions, to enhance energy resilience (Fthenakis & Kim, 2020; IEA, 2021).
- Fostering international collaboration and knowledge exchange through city networks, partnerships, and platforms to share best practices, innovations, and lessons learned in climate resilience (Bulkeley et al., 2013; UN-Habitat, 2021). As This approach emphasizes a adaptive framework, leveraging the latest advancements in technology, sustainable practices, and community engagement to build resilient cities in the face of climate change.

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