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STRATEGIES FOR ADAPTING TO THE IMPACT OF THE EMERGING CLIMATE CHANGE RISKS (AIECCR) IN DAMATURU

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ABSTRACT

The Impact of the Emerging Climate Change Risks (IECCR) and its Adaptation strategy (AIECCR) denoted as: the IECCR & AIECCR strategy; the Smart Growth Principles; and the UK Town and Country Planning Association (TCPA) Key Climate Adaptation Principles are strategies which this paper intends to exhibit, and how they can be made use of to achieve a resilient and sustainable urban growth in Damaturu (Yobe State, Nigeria). The research adopted the categorisation made by the Climate Change Risks Observatory (CCRO) for assessing the IECCR on urban infrastructure, the economy and social well-being in the built environment. In addition, previous research on AIECCR has found a consensus among the built environment professionals of some variables with significant difference such as API1a, API3f, AEIb, AEIc and ASWIe after running series of tests using the SPSS statistical tool. The Smart growth principles and the UK TCPA Key Climate Adaptation Principles are well established principles that have been implemented all over the world and highly commendable. Similarly, the IECCR & AIECCR Strategy is a novel strategy that has not been implemented yet as a whole, however, it has been scientifically tested and found to be highly effective. If these three strategies are taken into consideration formally and implemented concurrently, they will positively change the practice of town and country planning at the study area. This is the first research that has brought together these three strategies together, which could bring about a resilient and sustainable urban growth for the town.

KeyWords

Climate Change Adaptation, Climate Change Risks, IECCR & AIECCR Strategy, Resilient Urban Growth, Smart Growth Principles, Sustainable Urban Growth, TCPA Guidelines for Sustainable Design.

INTRODUCTION

Mentioning the fact that the earth's climate has already been altered to such an extent that mitigation (efforts to reduce the concentrations of greenhouse gases in the atmosphere) alone will be inadequate is quite known and widely received. Therefore adaptation (responding to the impacts of climate change) is increasingly necessary [1]. Adaptation to many of the impacts from climate change can be achieved within traditional urban policies, like those connected to risk prevention in relation to extreme events, as well as to physical planning principles, which can mitigate negative impacts [2]. The growing recognition of the need to respond to climate change impacts has placed adaptation at the forefront of societal and governmental agendas around the world [3], an example of this universal recognition is the outcome of COP 21 in Paris, 2015. The IPCC defines adaptation as 'adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, that moderates harm and exploits beneficial opportunities' and 'a process by which individuals, communities, and countries seek to cope with the consequences of climate change, including variability' [4]. This paper aims to describe how IECCR & AIECCR strategy, the Smart Growth Principles, and the UK TCPA Key Climate Adaptation Principles can be used to achieve a resilient and sustainable urban growth for Damaturu (Yobe State, Nigeria). It did so by combining the three strategies together, studied and compared their aim(s) and objectives, and thereafter provided an illustration depicting the three strategies as one guideline/structure that can be integrated to serve as an adaptation strategy.

METHODOLOGY

The research has adopted the categorisation made by the Climate Change Risks Observatory (CCRO) for assessing the IECCR on urban infrastructure such as; housing stock, road transport systems, energy systems and water systems; economic impact (associated with housing stock) and social well-being impact (impact on human health) applicable to the study area. CCRO is a platform that provides a path for climate change mitigation and adaptation, a compendium of peer reviewed papers/works brought together with plenty of evidence that classify the human systems that will likely be affected by the emerging climate change risks. This format has been adopted because the physical, economic and social activities of human beings are inter-related; hence, it is much better to have a wider view and then later on limit it to the study area under investigation. A detailed research design and strategies was used later on to collect data at the initial stages of developing the IECCR & AIECCR. This included the collection and analysis of the survey data obtained from the built environment professionals, that is, architects, engineers & surveyors, town planners and numerous professionals referred to as 'others'. The study questionnaire was validated before embarking on the survey in order to make sure that the survey instrument has covered all the likely impact under investigation, the way the questions were arranged, and other questions contained therein. This was done in this manner to enable the respondents answer the questions with ease and certainty. Subsequently, the feedback provided by the experts was taken into consideration, and has strengthened the hypothesis of the research.

The interpretation of the survey variables was carried out by analysing the Variable and Factor Means in order to clarify the level of significance of the responses established. The Variable Mean was rated on a scale of 1 – 5 based on the Likert scale model used in the Qs. Any responses beyond 4.0 were considered to be high, 3.0 - 4.0 were considered to be moderately high, and 2.5 – 3.0 were considered as moderate, while 2.5 were considered to be low. The Reliability test was carried out in order to examine whether multiple items measure the same construct. The Correlation and Reliability amongst each variable was also carried out by making use of the Cronbach's alpha test. The Cronbach's alpha is a prevalent method to measure reliability, for example, in quantifying the reliability of a score to summarise the data of several items in a questionnaire [5]. Another author pointed out that; a statistic regularly used to measure internal consistency is the Cronbach's alpha (α). That the Cronbach's α can range from 0.0 to 1.0, and it quantifies the degree to which objects on an instrument are correlated with one another [6] in [7].

'A survey must have a good response rate in order to produce accurate, useful results. Acceptable response rates vary by how the survey is administered: Mail: 50% adequate, 60% good, 70% very good; Phone: 80% good; Email: 40% average, 50% good, and 60% very good; online: 30% average; Classroom paper: > 50% = good; and Face-to-face: 80-85% good' [8]. The survey response rate for the research was: 71/105 x 100 = 67.62%. The collection of data began on the 1st April, 2014, and mostly returned after 6 weeks. Furthermore, the built environment professionals were not confined to one organisation at the study area. Hence the reason why the questionnaires were distributed to several Ministries; Institutions of learning and Private Consultancy Firms. A total of 150 printed questionnaires were distributed, 105 were returned. 71 respondents completed the questionnaire in full, while 34 could not. The names of the respondents were coded immediately and imputed, their profession, the institution they belong to, organisation, their duration of practice and their participation in a climate change project. Their feedbacks/views were later analysed using SPSS 22.0 to carry out several statistical analysis associated with this research. Quite a lot of respondents have shown their keen interest in the study.

The other two adaptation strategies that were adopted and merged with IECCR & AIECCR strategy are presented below;

1. The Smart Growth Principles

- Mix Land Uses
- Take Advantage of Compact Building Design
- Create a Range of Housing Opportunities and Choices
- Create Walkable Neighbourhoods
- Foster Distinctive, Attractive Communities with a Strong Sense of Place
- Preserve Open Space, Farmland, Natural Beauty and Critical Environmental Areas
- Strengthen and Direct Development Towards Existing Communities
- Provide a Variety of Transportation Choices
- Make Development Decisions Predictable, Fair and Cost Effective
- Encourage Community and Stakeholder Collaboration in Development Decisions [9]

2. UK TCPA Key Climate Adaptation Principles

- Seek opportunities to incorporate adaptation into new and existing developments
- Work in partnership with communities
- Incorporate flexibility to deal with changing risks
- Understand existing vulnerabilities to climate and identify critical thresholds
- Identify key climate change risks using the latest climate change scenarios
- Look for no regrets, low regrets, win-win and adaptable measures to manage climate risks
- Adopt a sequential and risk-based approach to development decisions
- Avoid actions that will make it more difficult to cope with climate risks in the future
- Review your adaptation strategy regularly [10]

These two principles are well recognised and have been implemented all over the world.

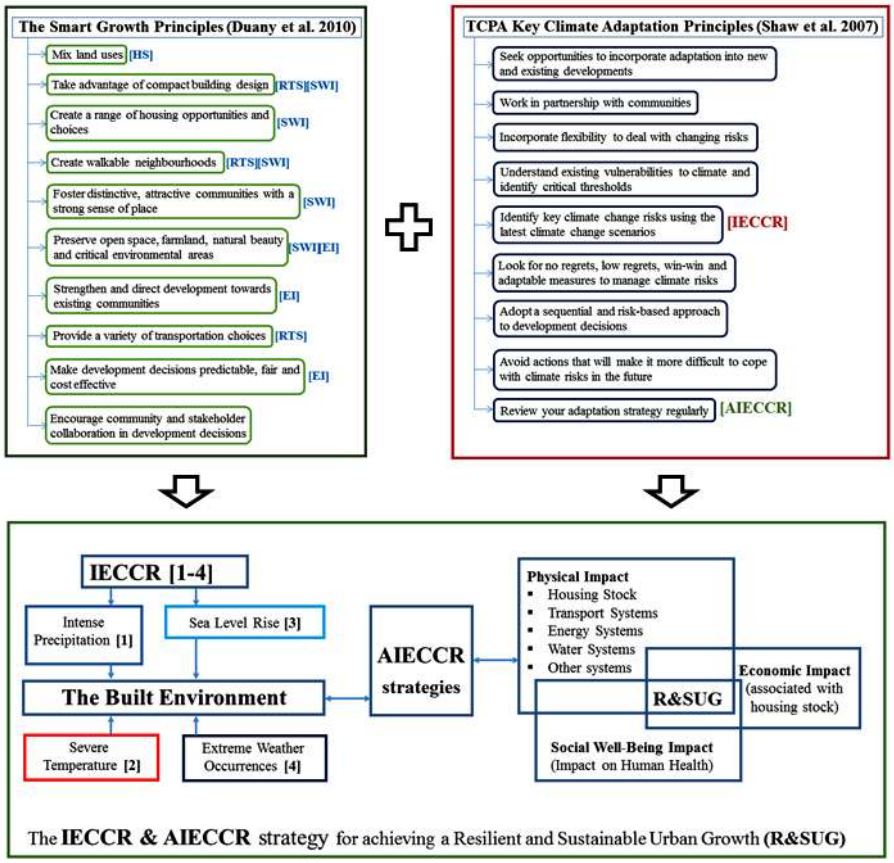

Figure 1: The Three Adaptation Strategies Merged Together

IECCR-1, 2 & 4 depicts an increase in severe temperature, intense precipitation and extreme weather occurrence on urban infrastructure (that is, housing stock, road transport system, energy system, and water system), economy and social well-being (applicable to the study area). While **IECCR-3** depicts an increase in sea level rise (applicable to vulnerable towns/cities around the world), but not a threat to the study area.

Table 1: The AIECCR Table

Strategies for Adapting to the Impact of the Emerging Climate Change Risks (IECCR) on Urban Infrastructure (UI) such as; Housing Stock, Road Transport Systems, Energy Systems and Water Systems; Economic Impact (associated with Housing Stock) and Social Well-being Impact (Impact on Human Health) applicable to Damaturu (Yobe State, Nigeria).	
*__Emerging Climate Change Risks__ (increase in severe temperature, intense precipitation & extreme weather occurrence) **ECCR**	
IECCR on UI (housing stock, road transport systems, energy systems and water systems)	
Research Area	**Adaptation Measures**
Climate Change Adaptation By Design: A Guide For Sustainable Communities	**An effective strategies for adapting to an increase in the ECCR on UI (Housing Stock) are:** The provision of green infrastructure (API1a) The provision of solar control – includes shading, orientation and building morphology (API1b) Increasing ventilation through orientation and urban morphology (API1c) The provision of cool or reflective building materials on roofs or facades (API1d) The provision and making use of cool pavement materials (API1e) [10]
Adapting to Climate Change - Cities and the Urban Poor	Hardening of infrastructure to make it more resilient to extreme weather (API1f) Improving housing quality to make it more resistant to the elements (API1g) Relocation to alternative settlement areas (API1h) Disaster planning to enable more effective evacuation based on improved early warning systems (API1i) Improved enforcement of critical building and land use regulations (API1j) [11]
Adapting Urban Transport to Climate Change - Sustainable Transport	**An effective strategies for adapting to an increase in the ECCR on UI (Road Transport Systems) are:** The Planting of roadside vegetation to decrease the exposure of roads to heat (API2a) Reducing overall exposure to users by providing parks and roadside trees (API2b) Construction of roads and overlaying it with more pothole-resistant asphalt (API2c) Increased cleaning and maintenance of roadways, milling out potholes (API2d) [12]
Adapting Transportation to the Impacts of Climate Change - State of the Practice	More night-time construction to avoid undue heat stress for construction workers with the added benefit of less traffic disruption (API2e) Develop new design standards for hydraulic structures, e.g., culverts and drainage channels (API2f) [13]
Climate Impacts on Energy Systems - Key Issues for Energy Sector Adaptation	**An effective strategies for adapting to an increase in the ECCR on UI (Energy Systems) are:** Improve design of solar panels to withstand storms (API3a) Repair plans to ensure functioning of distributed solar systems after extreme events (API3b) Efficient use of energy through good operating practice (API3c) Regular inspection of vulnerable infrastructure such as wooden utility poles (API3d) [14]
Trade and Climate Change Adaptation: Sustainable	Strengthening of overhead transmission and distribution infrastructure (API3e)

Development Objectives for LDCs, SVEs, and SIDS	Underground cabling for utilities (API3f) Reduced dependence on single sources of energy (API3g) [15]
Climate Change Adaptation By Design: A Guide For Sustainable Communities	**An effective strategies for adapting to an increase in the ECCR on UI (Water Systems) are:** Making use of Sustainable drainage systems (API4a) Making use of Flood resilient materials (API4b) Making use of Xeriscaping (the designing of residential and park land by making use of methods which minimises the use of water) API4c Making use of Grey water recycling (Sewage water) API4d Making use of Rainwater harvesting system and storage API4e [10]
Climate change - Impacts, vulnerabilities and adaptation in developing countries	Protection of groundwater resources (API4f) Improved management and maintenance of existing water supply systems (API4g) Development of flood controls and drought monitoring (API4h) [16]
Economic Impacts (associated with Housing Stock)	
National Adaptation Strategy and Plan of Action on Climate Change for Nigeria (NASPA-CCN)	**An effective strategies for adapting to an increase in the ECCR on the Economy (associated with Housing Stock) are:** Increasing knowledge and awareness of climate change risks and opportunities (AEIa) Undertaking and implementing risk assessments and risk reduction measures (AEIb) Incorporating climate change into on-going business planning (AEIc) Providing business-oriented programmes with climate change impacts report (AEId) Planning Authorities should review and enforce land use plans in high risk areas (AEIe) [17]
Social Well-being Impacts (Impact on Human Health)	
Adaptation to Climate Change - International Policy Options	**An effective strategies for adapting to an increase in the ECCR on Social Well-being Impacts (Impact on Human Health) are:** Strengthening of public health systems, including monitoring and surveillance, public health infrastructure, and the development of effective adaptation measures (ASWIa) [18]
Climate change - Impacts, vulnerabilities and adaptation in developing countries	Improved housing and living conditions (ASWIb) Improved emergency response (ASWIc) Better and/or improved disease/vector surveillance and monitoring (ASWId) Improvement of environmental quality (ASWIe) Changes in urban and housing design (ASWIf) [16]

RANKING OF THE FINDINGS

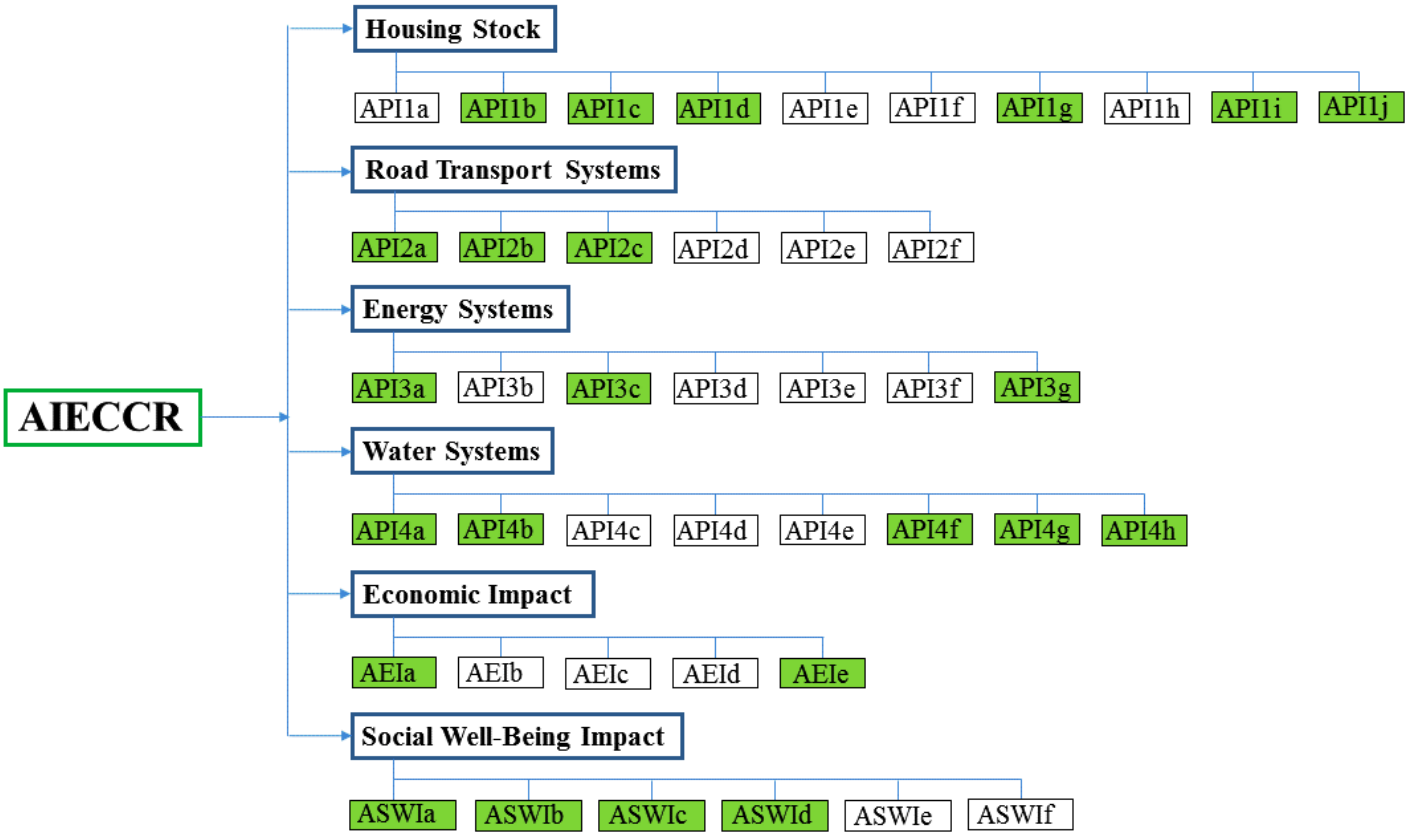

Figure 2: Ranking - Kendall's Coefficient of Concordance (W)

Kendall's Coefficient of Concordance *(W)* was carried out in order to assess the variables that have a high coefficient of concordance among the built environment professionals. The overall mean rank was calculated, and rankings that are above average were depicted in green. The coefficient of concordance, θ, is defined as the ratio of sum of squared deviations of rank totals from the average rank total to the maximum possible value of the sum of squared deviations of rank totals from the average rank total [19] [20] in [21]. It is a measure of the agreement among several (m) quantitative or semi quantitative variables that are assessing a set of *n* objects of interest. In the social sciences, the variables are often people, called judges, assessing different subjects or situations [22]. Other statistical tests such as Coefficient of Variation (CV), Severity Index (S.I) were also used to measure the effectiveness of each adaption strategy.

CLIMATE CHANGE ADAPTATION VARIABLES WITH SIGNIFICANT DIFFERENCE

The provision of green infrastructure API1a ($H_{0:\,1=0}$) was retained, underground cabling for utilities API3f ($H_{0:\,1=0}$) was retained, undertaking and implementing risk assessments and risk reduction measures AEIb ($H_{0:\,1=0}$) was rejected, incorporating climate change into on-going business planning AEIc ($H_{0:\,1=0}$) was rejected, improvement of environmental quality ASWIe ($H_{0:\,1=0}$) was retained. This by no means depict the weaknesses or lack of approval or effectiveness of the variables that were rejected or a preference of the variables that were retained, it was an outcome of a survey carried out, and its feedback assessed using SPSS One-way ANOVA to test the significant difference between the perception of the built environment professionals on the impact and adaptation strategies of the emerging climate change risks applicable to Damaturu. The One-way ANOVA is carried out in a situation where there are three or four groups under investigation; it compares the means between the groups and determines whether any of those means are significantly different from each other, for example the null hypothesis (H_0) assumes that all group population means are equal, and the alternative hypothesis (H_1) is when there are at least two group means that are significantly different from each other [23].

AIECCR AND THE PRACTICE OF TOWN & COUNTRY PLANNING AT THE STUDY AREA

The IECCR & AIECCR Strategy is a novel strategy that has not been implemented yet as a whole, but has been tested scientifically and found to be highly effective. The second strategy; the Smart Growth Principles was developed by Andres Duany and partners, whose idea for smart growth and new urbanism has been implemented in many cities around the world. The third strategy is the UK TCPA Key Climate Adaptation Principles (Climate Change Act has been passed in the United Kingdom since 2008, compared to Nigeria whose Bill for Climate Change has been passed since 2010 and has not become an Act at the time of writing this paper). Initiatives to identify adaptation needs and to improve adaptive capacity increasingly start with an assessment of the vulnerability of the system of interest, in terms of who and what are vulnerable, to what stresses, in what way, and what capacity exists to adapt to changing risks [24]. With risk reduction and adaptation being a cross-cutting topic, city authorities and planners do not only have to be familiar with the different ways as to how risk in a specific location can be reduced. They also need to know how adaptation can be integrated or mainstreamed into urban planning practice [25] in [26]. Most built environment professionals usually deliberate the parameters of a site as a constant and not a variable, and most planners are not familiarised, and often not trained to incorporate environmental change-induced site changes into their designs and master plans [27]. This is the first research carried out for the study area that has produced a comprehensive list of AIECCR strategies, which when implemented could lead to a resilient and sustainable growth of the town.

The solution to the problems of climate change will stand as a challenge to Nigerian planners and other environmental disciplines to confront and control, if sustainable livelihood is to be maintained. However the solutions requires a paradigm shift in institutional attitudes and planning environments. Nigerian policy acknowledge that human actions are causal of changes and that the technical scope to solutions needs to be innovative and widely collaborative at the international and the various national levels. In Nigeria, climate change is acknowledged within the central government bureaucracy, especially with the creation of a climate change unit in the Federal Ministry of Environment. But in the context of perception of changing climate little has been consolidated nationwide, and much less was done to adapt to the culture of solving the problem. What exists is the culture of environmental consciousness cultivated within government departments and through laws on environmental optimization and protection. Some of these laws were enacted and operated since the colonial times. They were not enacted with climate change challenges in mind. The problem is that there is no integrated intervention framework within which physical planning can contribute to tackling the problems of human impact of climate change on the environment. Having such a framework is critical especially since Nigerian environmental policies are articulated in spatial terms whereby political and developmental territories coincide and overlap [28].

DISCUSSION

Cities all over the world are increasingly becoming acquainted with the need to prepare for the impacts of climate change [29]. It has also been observed that; cities are getting more organised in putting climate adaptation on the political agenda, and the request for data on the impacts of climate change on cities, buildings, urban infrastructure, and the efficiency of the adaptation alternatives is growing [30]. Dealing with the threat of climate change requires populations to develop or improve their ability to cope with, adapt to, and outline change without losing alternatives for future adaptability [31] in [32]. It has been revealed that when planners talk about carrying out an 'environmental impact assessments', more or less of what is being assessed is invariably how the construction would change the existing environment, and not how a changing environment might affect the construction. The author described further that; although engineers and planners may carry out a site inspection before designing an installation, they usually deliberate the parameters of that site as a constant, and not a variable. That; most planners are not familiarised, and often not trained, to incorporate environmental change-induced site changes into designs [27].

The right decision on urban policies is said to be predominantly important so as to make sure that long-lived infrastructures such as; residential and commercial buildings, roads and other transport networks are designed in such a way that they will be able to withstand the projected increase in climate variability and mean change [33] [34] in [35]. Some examples of such decisions include urbanisation plans, building design and norms, infrastructural development for water management or transportation, and risk management strategies [36]. Hence, local actors (stakeholders, experts, keen environmental enthusiast, and others) frame resilience as a flexible approach to adaptation that would be more appropriate and personalised to suit local situations, than the rigid top–down code of practice [37].

CONCLUSION

Efforts to gradually reduce or drastically reduce the emission of greenhouse gases (GHG) are now a subject of ridicule by some policy makers around the world. How long should those who are already extremely vulnerable to the Impact of Climate Change wait when there are already proven and existing strategies such as the Smart Growth Principles; the UK Town and Country Planning Association (TCPA) Key Climate Adaptation Principles and the IECCR & AIECCR strategy which policy makers and non-governmental organisations could initiate and implement. It is said that when it comes to climate change, one should 'think global, [and] act local'. Seeking for an alternative to the existing pattern of development and growth in the study area does not mean that the authors are suggesting for skyscrapers with hanging gardens, or the most technologically advanced means of transportation, an abrupt cut in the use of fossil fuels to be implemented all at once, the paper attempt's to portray sustainable adaptation strategies that has worked and is working for some least developed, developing and developed countries.

This paper had studied and gave examples of various adaptation strategies that have been developed all over the world, tested their effectiveness on urban Infrastructure, the economy and social well-being applicable to the study area by issuing and assessing the feedback of numerous built environment professionals; recommended the association of the smart growth principles, and the TCPA guidelines for sustainable design, which if studied, assessed and implemented sequentially could change the way the built environment professionals plan, design and construct towns and cities to ensure a resilient and sustainable urban growth.

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