

A review of exploring collaboration and learning about climate change adaptation in BREEAM Communities

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Abstract. This paper aims to establish a better understanding of the adaptation potential that can be provided through the use of Neighbourhood Sustainability Assessment tools, and how the adaptation effects and is affected by stakeholder collaboration and learning issues provided through the use of Neighbourhood Sustainability tools. An analytical framework will be developed which reviews of concepts and theories of system approach to adaptive management is presented. Characteristics of system approach and adaptive management are discussed across the stages of the development process, considering feedback from each stage. The framework will then be applied using BREEAM Communities tool, which illustrates that social adaptation indicators have been considered, but they need more enhancement in the long term. The paper concludes that the application of the framework that has been developed could enable evaluation of the influence of sustainability assessment tools at neighbourhood scale on organisation, participation, monitoring, risks assessment and responsibility issues towards the adaptation process at different stages of sustainable built environment.

Keywords. Neighbourhood Sustainability Assessment Tools/NSAs, Adaptation to Cc, Collaboration, Learning.

1. Introduction

Discussions on cc adaptation have occurred to a great extent outside of focus of the talk about sustainable development [1]. But sustainability is all about change and the ability to maintain to live with change. Confronting change and maintaining adaptation to it is a primary condition in understanding the sustainable resources management as a complex system [2]. It has been acknowledged that existing sustainable development approaches cannot be successful without taking into consideration the risks associated with the impacts of climate change (cc) [3], and interaction with human thinking and attitudes to influence the adaptation process for both the physical and social context. There is, however, a lack of knowledge of how sustainability can be used to manage cc impacts [4], particularly in the social context, in which [5] demonstrates that the social sustainability concept is a concept in chaos. In this paper, Neighborhood Sustainability Assessment tools (NSAs) are presented as systems that might hold potential to adapt to cc in physical and social context [6]. The focus in this paper is to analyse the social context and how it adapts, to address the adaptation of humans (social networks) to climatic events [7]; whilst assisting with general sustainable development [8]. However NSA are complex systems and it's argued that the need investigation follows from the lack of social aspects of sustainability in this sustainable tool that is chosen for the study BREEAM Communities (BC), and in other tools [9], through adopt a system approach to facilitate the understanding of the social complex. In general, it is found that BC focuses more on the social indicators when it comes to issues as community participation and consultation plans than the other two tools [10,6]. With an important research priority for the study of sustainable systems is development of modelling and decision-making approaches that support dynamic,

adaptive management rather than static optimization [11]. The framework is based on the system approach to analyse/evaluate the BC system, to understand the influence of the application of this tool on the dynamic decision making, and the adaptive management as a complementary approach. At which this has made the sustainability context as important for the study to learn of how the application of the sustainability tools affect the adaptation process, and to also diagnose areas that are still ambiguous and that need more investigation in practice. According to [12] the system approach is known as a strategy that can be used to explore the systems functionality and response towards various changes, and it is constructed on the base that the understanding of the system responses should be done in a comprehensive way and not in isolated components. The system approach framework has been utilised by various scientists and resource managers to better recognise the ramifications of the management studies [13], with roots in early work in biology, cybernetics, economics, mathematics, and information theory [14]. Literature shows that the system approach components and characteristics have advantages to guide the sustainability process, as the following points indicate:

System design & organization: The system approach concentrates on the organization of the system as one structure or as an entity [15], by the integrity of its components [16]. To think with a system view, connectedness, relationships, and context should be considered [17], to provide a comprehensive analytical framework. Ermoliev [18] for instance, demonstrates that using system approach can be effective for the management of a basin's environmental system, through its incorporation of individual system components and their interaction. *Interaction among components and operation:* When a problem occurs, and there is a need to conceiving it in a systemic term, the concern is mainly about the way the components work together/interact to achieve a particular target [14]. These interactions, as demonstrated by [18], are complicated not only because they simultaneously involve various system components but because they dynamically occur over time. This task requires a system approach [19], especially that the systems thinking has generated a design high-leverage intervention for problematic system behavior [16]. And understanding these interactions across scales can support to resolve complexity in resource management systems, and provides the stakeholders with a mutual contextual understanding [2]. *System output and response:* The system approach is a useful approach that helps in preparation of various solutions for systems that are complex and ambiguous [12]. For instance, in energy management, when system approach is applied, the propositions of the appropriate technical and managerial interventions which affect the energy consumptions, and the structure of the enterprise as well as the behaviour of operators, middle managers, and top managers, should be considered [20]. Following a brief literature review of the importance of systems approach, evidence shows that the system approach can simply mean that every system should be studied as a whole entity that constitutes parts that integrated together to achieve a certain output. The systems approach focuses on the analysis of inputs, process, and outputs as major phases/stages for the analysis [12, 21, 22], with understanding the feedback for the review actions [21]. However, and despite the importance of system approach in analysing systems in a systematic way, the *adaptive management* can be as a major concept that associates with the adaptive behaviour and facing change and uncertainty. Linkov et al [23] demonstrates in his study that to achieve adaptive management for different environmental and social scenarios, it is essential to reduce the present uncertainties and to raise the awareness and learning levels to provide people in the decision making with new knowledge. The study of Adaptive management aims can play a substantial role in the sustainability and management process. The application of the adaptive management integrated with the system approach could be a beneficial for various reasons, including, Firstly: to raise awareness about the understanding of complex systems and management as continuous

learning process rather than fixed matter [24]; Secondly: the recognition of behaviour and resistance to change is essential with complex adaptive systems [25], and that requires the involvement of key uncertainties, and continuous monitoring [26]. Thirdly: in dealing with complexity and ambiguity, and in boosting the capacity of adaptation whether through collaboration, evaluating outcomes and link them with the potentials goals [27] are central and they should be adopted as components of the system. So, the hypothesis for this paper is that the system approach and adaptive management could be combined to provide the basis for exploring the issues that can be used to enhance collaboration and learning using NSA tools to address adaptation to cc. These issues can provide information and demonstrate questionable issues, to address the stakeholders' collaboration and learning process, as vital components that required in the context of adaptation to cc.

2. Application of systems approach and adaptive management

It's acknowledged that using both system approach and adaptive management in an integrated way, is to demonstrate how the collaboration among various participants of stakeholders and learning are being depicted in the context of sustainability, and advance the adaptation to cc. It should be said that before exploring the system approach and adaptive management, the definitions of the main points of and sustainability assessment tools, stakeholders and collaboration & learning need to be clarified here. Stakeholders are individuals/groups who affect the regulations and organizations with their preferences and decisions [28]. The stakeholders as - individuals, groups within society, organisations, and governments - are making the decisions on adaptation [29]. And the ways these stakeholders are structured are important to communicate knowledge, ideas and perspectives across scales and communities [30]. For example, in the construction industry the structure of stakeholders involves clients, end-users, designers, consultants, facilities managers, contractors, subcontractors, government agencies, and general public...etc. [28], to exchange the knowledge and information that needed in the decision-making process. Collaboration & learning: Adaptation is a dynamic social process, and the ability of the societies to adapt depends on the ability to act collectively [29]. That the collaboration between various professions is vital in facilitating more preferable performance through sharing best practices [28]; and also, through collaboration, the capability to access different assets and resources is included, and influence the actions to assets and resources management [30]. And this issue is not only including the internal communication among the various stakeholders, but also considering the social networks and how they tie to external agent is important for adaptation process and coping strategies [31]. It's acknowledged that learning is essential element to be considered accordance to its importance in adaptation and in construct a common understanding of the complex matters that face uncertainty [30]. And this why in the environmental and natural resource management literature, there is a need to understand learning as efficient measures of coping with social and ecological complex changes [31]. By understanding how the social learning about adaptation to cc is existed across a range of disciplines of the decision-making process. Finally, the adoption of sustainability assessment tools can provide support in adapting to cc, through their effect on managing resources [7], if this issue has addressed the linkage and analysis of the social context with both the immediate and long-term consequences of cc impacts [32]. The scale of neighborhood can be essential in addressing the sustainability in the physical neighborhood and community asset and the interaction between them. This scale, is regarded as the most effective at which to take account of linkages among the different parts of the urban system, such as population, buildings, land uses, transportation, water, energy, biodiversity, air, geology, and

topography [9]. Regarding the scope of neighborhood sustainability assessment tool/NSA, it can be considered as a tool that evaluates the performance of a given neighborhood against a set of criteria [5,9]. It should connect environmental and social dimensions, and also offers a social learning capability, particularly learning from policy initiatives [33].

- **Design phase:** The integrity of the system's components is the feature that making the system recognized [16]. When following the essentials of the system approach, the identification of stakeholders is emphasized and sustainability issues in the management as a fundamental step is defined [21], and also assures the interdependence procedures that associate with the organisation between the social structure and the environment [15]. Hopkins [12] argued that the integration between science and policy is a substantial case in directing an integrated governance system, and constructing a required action plan. Adaptive management and the systems approach share the common philosophy that the process of management should be both social and scientific, and should involve stakeholders in structuring conceptual paradigms [34]. The integration among various stakeholders is a key issue for system thinking socially, with various stakeholders whether social or scientific should be included in the process of structuring the policy in practice. This constitutes the first part of the systematic thinking approach, and integrated with this issue is the how would the understanding of various stakeholders to the other environmental inputs such as physical resources, natural resources and the climatic impacts and threats, affect the whole system socially. But, in this context, system approach doesn't consider the stakeholders' mapping as a necessary matter, compared with adaptive management which recommends the investigation of the social networks [34] and the extensive collaboration among the various involved people [35] to realise their needs and choices. Further, many unprecedented ideas and options could be produced with the participation of various stakeholders in the decision making [23]. For instance, in water management, and in particular, water supply, stakeholders include the municipal water utility, key water quality or regulatory agencies, private water market suppliers and civil society organizations [30]. Therefore, it is important to include the stakeholders that are directly related to the management and others who are not in direct relation. This will enhance flexibility, which will enhance institutional flexibility, a component that encourages adaptive management [34]. Finally, the identification of threats, according to the system thinking [23], has to be carried out before the formulation of the sustainability policy, and this is considered through data and past knowledge that to the degree and uncertainty of scenarios [35].
- **Operation phase:** In system approach, there is a transformation process that happens to the system, accordingly to its openness with the environment for inputs, to produce the outputs [36]. It is argued that for assessing the management according to the system approach, the development of the required model or system should consider that the various inputs are changed through the managerial functions of planning, organizing and controlling, which they consider vital points in management operation. At the beginning, in the planning stage, the system should provide a clear plan that constitutes measures and practical indicators, assessed afterwards and be used to monitor the progress. These points are also connected with each other, and any change that happens to one of them, can consequently affect the other. For example, in water management, institutional arrangements for instance can affect an organization or community's capacity to adapt to hydrologic variability by identifying and defining the roles

and responsibilities of core actors in water management [37]. Therefore, it is a crucial aspect when setting any criteria to think about the broader relationship between the impact and its cause. For the social part, the interaction among various individuals/stakeholders need to be understood, not only at the same level, but also among various scales. In order to lessen the complexity that might happen, the system approach allows the consideration of the system design through gathering more than one issue whether social or technical in one indicator, and to minimize the number of indicators in the decision making [21], which this issue is part of the sustainability thinking. These formulated indicators can be evaluated to understand how relevant they could be for the intended scenarios [34]. Monitoring the systems operation and identifying the challenges that might be faced through implementation can also show the responsibility and the degree of the commitment amongst participants. System thinking can be significant in generating highly efficient interventions to problems related with system behavior [16]. Monitoring and assessing the options is highly important matter. Linkov et al [23] indicates that ‘‘monitoring and evaluation of the options and plans are required, to define which option performs the best. This is by far the most heavily emphasized aspect of adaptive management’ because, adaptive management seeks the appraisal of the outcomes of management in relation to particular primary goals, and encourages not only the assessment of the required action, but also the alternative actions simultaneously. Adaptive management mainly depends on assessing the external factors and then designing more than one option to overcome the uncertainty. Continues evaluation should be incorporated if an active adaptive management is aimed for and this again should be conducted in social and environmental issues. Further, the adaptive management differs from the system approach that it deals with the uncertainty issue with more emphasis, and assures its inclusion within the system planning and management. This necessities that the communities should be able to access timely hazard information to enhance the react to climate threats [30].

- **Outcome phase:** The evaluation of the outputs of management process is a key matter for both the system approach and adaptive management. Response towards the results of the system and how that affects people’s life and the physical outcome is of major importance for addressing the function of the system and its dynamism. Basically, the solutions for various environmental matters could be explored and achieved where the interaction between peoples’ attitudes and ecosystem is recognised [12]. When considering the system approach in the management process, the output for the social context is being influenced by various aspects that happened earlier, whether through increased the level of knowledge as an outcome of the integration of thoughts and attitudes for the collaborated stakeholders. This will not reflect the households only as the end users of the services, but also, the managers as they are in direct contact with the local people and their needs. This will indicate how the long-term sustainability is affected by the pressure that has been put/impacted by the human activities, by which in particular affects the ecosystem structure and functioning, diversity, buffering capacity [36]. As mentioned earlier precise planning, collaboration, and evaluation are required to get the best adaptive outcomes [35]. There is also a need to monitor the performance of the outcomes services and evaluate the level of response for the people when they utilize these services. Through the monitoring of outcomes, adaptive management promotes improved understanding about the action works the best and why. Careful monitoring of these outcomes can increase the scientific knowledge and also assist in adjusting policies or processes that formulates the iterative learning process.

- Feedback:** It is argued previously, that the evaluation of the outcome of each stage of the development process is essential for adapting the components and their interaction to various scenarios. However, it's critical to understand the relation among the outcomes of each stage and their consequence on others, whether negative or positive. Because, a crucial aspect of dynamic models is feedback loops, depending on whether they are positive or negative-, can result a system change through moving it towards a new position [34]. In this regard, a need to think of the alternative options and the consequences on people and physical components, should be seriously addressed from the initial decision making, as significant matter in adaptive management. The selection of alternative options is efficiently performed by people that associated with decision making when they have been incorporated with the inputs of the experts [23]. Alternative options are taken from pre-existing knowledge, but the uncertainties that can be caused socially from uncertainties in human response like future values and objectives [39]. For instance, the actors in the management system must be able to process information and draw meaningful conclusions from it [24], to update the actors and prepare them in the design phase or the outcome. In this view, sustainability reporting can be used to provide information about challenges and achievements to the stakeholders, associating the company with sound environmental management and sustainable activities [21] to preserve the continuous communication and explicitly modify the actions to address the effective response. It can be seen that there are many common components shared between adaptive management and system approach that are considered vital procedures [35]. However, it seems that the adaptive management priorities resilience and adaptation principles as most vital concepts, while the system approach focuses more on the decision-making principles and sustainability issues. As figure 1 shows, and to analyse the two social adaptation issues (collaboration& learning) in the development design, operational, outcome phases, and feedback, both system approach and adaptive management are used for the analysis. Each phase is analysed as it is being a sub system that consists of inputs, process, and outcomes according to the system approach structure, and then apply/integrate the characteristics of the adaptive management.

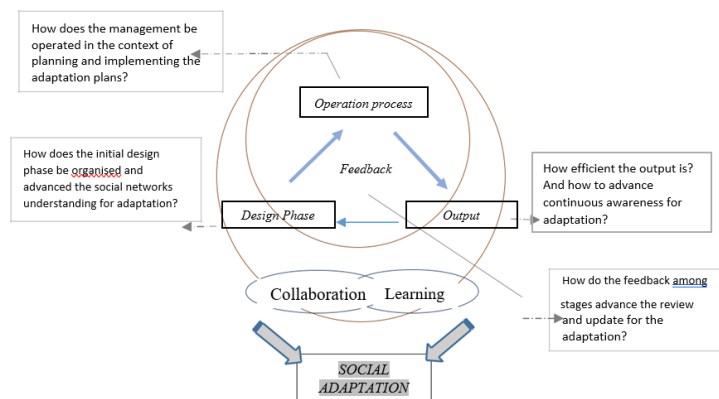


Figure 1: Framework for the analysis of social adaptation in NSAs

3. BREEAM Communities

In this section, the two approaches will be used to depict the adaptive complex context of BC as a system that combines the decision making process, management process and sustainability measure targets, functioning as an integrated system, for dealing with the social needs and preferences in short term and

long-term of neighbourhood scale built environment projects. As pointed out in the description of the framework, this conceptual framework was developed to analyse and diagnose the points that relate to collaboration and learning and knowledge gained as an outcome of each stage of the development process. Based on the difficulty of incorporating all the development sectors in this paper, the water sector has been elected as an example for analysis, and also because that a key matter confronting the management of UK water resources connects to how the water sector is structured and governed [40]. The process for applying the system and adaptive management approaches for the analysis is described below.

Design phase: BC assessment tool is structured to bring together divergent community members in the consultation plan such as occupants, representative consultation groups, local authority, and specialist service and maintenance contractors. It is acknowledged that the consultation plan has been arranged according to time table and identification of how the local community and stakeholders could participate when the feedback is gotten. With respect to water, the consultation plan should consider all the physical and social indicators, for instance, Ecology strategy, Consultation and engagement, Flood risk assessment and Landscape measures, Design review and community management of facilities. While these measures are acknowledged, but there is no indication that the Water Strategy is a part of the assessment issues included in the consultation plan, in spite it is one of the major indicators in BC Significantly in the tools manual, it has mentioned that “The water strategy aims to ensure that the development is designed to minimise water demand through efficiency and appropriate supply-side options taking full account of current and predicted future availability of water in the area”. Analysis of the adaptive management approach at the design phase shows that the collaboration process is extended, and involves the minority and 'hard to reach' people such as old people, youth, people with disability and others who have restricted time to be involved. Following consultations sessions - part of the consultation and engagement-the feedback is given to the consultation group. In either case, this issue is important in both system approach and adaptive management. Adaptive management needs to be more influenced in the consultation plan when it comes to the risks evaluation and monitoring through including more centralized efforts around facing water risks, whether in flood or drought context. The risks indicators need to be rooted and linked more with the social consultation and engagement, and management as well, to create a stronger linkage between physical/technical and social learning issues. It is essentially, because management learning occurs at lower levels of society and is associated with shorter time and small spatial scales [31]. But it can impact on longer term behavior in other spheres of life. Further, it indicates that climate forecasted and warning services should be incorporated with a higher level of supportive government coordination and technical support, and more understanding the interrelation among social participants' parties. Also, it seems there is still a lack in setting clear plans for water management process in linkage with the demand and technical issues, considering the cc impacts scenarios. Table 1.1 shows the issues that need more investigation in BC with respect to the system approach and adaptive management.

Operational phase: Three indicators are included to influence the operational process in BC straightway are: 1) Consultation and engagement, 2) Design review and 3) Community management of facilities. With acknowledging that the last two indicators are OPTIONAL despite their importance. The analysis of these three indicators according to the system approach shows that the community and the various stakeholders participate during the design process of the development, the review of the master plan design, and finally, in developing and managing the community facilities. Again, the communication among community, stakeholders, authority and experts are seen to be essential. The

needs, opinions, and knowledge of the community have been importantly indicated in the engagement stage, and then they have been reviewed at the review stage with the experts as the latter's responsibility is to appraise the whole design and its quality, and finally inform the participants with review results. The experts are the people who independently work and do not belong to local authority or the developers. Nonetheless, it is still not clear how the consultation and engagement stages focus and discuss the technical issues and adaptation choices that conduct for critical sectors as water. Mostly because these meetings and discussions are indirectly undertaken among the local community and experts on one hand, and the experts and local authority on the other hand. So, if the experts are having the final decisions in design review stage, it is not obvious how that will be translated to the community and other stakeholders, and also whether the opinions of the community are considered back in an iterative learning process, or it is just limited to the form of informing, without interfacing or undertaking more consultations. Both feedback and evaluation of development proposals' choices, are rooted in the system approach and adaptive management. To address the required level of engagement for adaptive management, there might be a need to clarify the required social structure of community engagement and its relation with other parties of BC. It is important to ensure that enough knowledge is available to address appropriate cc impacts, particularly for the long-term adaptation process. The relationship between the local community and other groups involved in the management of the water resources need to be addressed in more detail. The provision of alternative management scenarios through the inclusion of water indicators have been included within a comprehensive physical management plan in BC. This plan addresses water management in terms of supply, consumption and disposal characteristics. The landscaping, planting, availability of water collection facilities, rainwater harvesting facilities are all included within the management plan which aim to minimise water demand and protect watercourses at the neighbouring site. These strategies are extremely important for the context of cc adaptation, but there is still a need to understand how the relation between the water maintenance process and the community management is conducted in practical terms. Despite BC has required the inclusion of all community facilities to be managed during the construction phase, through the prepared training and users' booklets to the responsible group for the operation and maintenance of the community facilities. For the community engagement, both developers and authority are giving the support to an existed community organisation that is called "Community Development Trust". The community development trust is "*an independent community organisation that works with the public sector, private businesses, and other community groups*". Yet, there is no specific indication within the tools' manual to whether this organisation can influence the decisions that associated with multi-scale interaction among the participants to develop and manage the monitoring of the water facilities in the short & long term.

Outcome phase: According to the system approach, it's expected that use of neighbourhood facilities and services, when BC is incorporated should make community more satisfied with physical outcomes of a built environmental projects. This is argued in the Demographic needs and priorities indicator which identifies that development plans for setting and equipping the neighbourhood with required services and facilities that are derived from the local needs, is importantly placed. The prominence of this issue, is also confirmed in the Delivery of services, facilities and amenities indicator, but there's a lack across the indicators with a view to link the performance of services and long-term adaptation, through organizing monitoring reports after the occupancy stage, and whose the responsibility for this lies with. With regards to adaptation, concerns are raised regarding continuous evaluation for the neighborhood facilities performance and also people's satisfaction after usage, including the implementation of longer-term monitoring. Local residents and users could perform these

Feedback: The feedback among stages has been implicitly mentioned above in the three previous points. Analysis among the stages, where it can be achieved boosts the interaction between the consultation and engagement indicators with the community management from aside and with water management indicators on other side. For instance, we can see the linkage and the feedback process between the actions in consultation plan and design review stage, as mentioned earlier. But, the mechanisms to depict the feedback process from the outcomes of community management to the ideas and knowledge in the consultation plan and engagement, and vice versa are still insufficiently covered matters. Issues that are diagnosed and illustrated for all phases are illustrated in Table 1.1 below.

Table 1.1: The identification of issues that need more investigation in practice in BC

Phases	Issues that need more investigation in relation to collaboration and learning in BC	
	System approach	Adaptive Management
Design Phase	<p>Community participation in the decision making and how it is affected by various issues as participants identity, number,..etc.</p> <p>Methods applied to avoid conflicts among the stakeholders,</p> <p>The inclusion of indicators and associated aspects as water strategy in the consultation plans, and designed workshops to better understand these indicators,</p> <p>The focus on the cc and adaptation strategies within the consultation plan</p>	<p>Inclusion of climate scientists and identify how they fit in the consultation plan and interact with the other participants,</p> <p>Role of the assessors' team to address focus on advancing the link between water management and CC,</p> <p>The amount of consultation processes on cc impacts and potential threats,</p> <p>The ways climate forecasting and warning services be included with a higher level of supportive government coordination and technical support,</p> <p>Setting clear plans for water management process in linkage with the demand and technical issues,</p>
Operation phase	<p>Communications and meetings among the local community and experts' interventions,</p> <p>Mechanisms that show the interaction among the sustainability assessors with local community and authority,</p> <p>Conflicts management regarding priorities physical actions and sustainability indicators,</p> <p>Local government coordination and technical support organizations,</p>	<p>Multi-scale interaction among the participants, regarding monitoring in the long term,</p> <p>Provision of alternative management scenarios, for water management considering the cc and risks scenarios,</p> <p>The ways local community and stakeholders participate in short/long term management, and how they can access this information, particularly when risks occur,</p> <p>The existence of monitoring and evaluation plans,</p> <p>Increased/continuous training programs for community groups</p>
Outcome phase	<p>Mechanisms for receiving technical support,</p> <p>Improve public health surveillance,</p> <p>Government/authority role in support the water supply and sanitation management,</p>	<p>Organizing monitoring reports after the occupancy stage,</p> <p>Community understanding the technical issues and fixtures,</p> <p>Public information on flood hazard and evacuation,</p>
Feedback	<p>Inclusion of post occupancy stage in water governance plan,</p> <p>The review of progress as reports,</p> <p>Update the consultation plans,</p>	<p>Feedback from the experts to the local community in the consultation and management process,</p> <p>Update the consultation plans and management plans based on sustainability reports of the outputs' performance,</p> <p>Inclusion of plans for health surveillance issue as indicators.</p>

4. Conclusion

A framework has been developed that could be used to evaluate of the influence of sustainability assessment tools at neighbourhood scale on organisation, participation, monitoring, risks assessment and responsibility issues towards the adaptation process at different stages of sustainable built environment. The paper demonstrates that the adoption of a system approach and adaptive management process provide a useful means for exploring and enhancing stakeholders' collaboration and learning in a systematic way. Adaptation to cc requires studying the different components in detail to understand holistic view, and analysis is complex which the methods can provide a solution for when combined [41]. The system approach, in particular, makes analysis easier, through exploring functional thinking in design, operation and outcomes stages, and provides feedback. Through the application of the proposed framework it has been found that Neighbourhood Sustainability Assessment tools have the potential to assist with cc adaption, but lack a focus on social sustainability which requires further research. It has been found, through the application of this framework to BC, that there is a consideration of system thinking principles for integrating the social networks and physical measures to effectively address short term adaptation, in various development stages. The application of adaptive management shows that more investigation is required to explore the iterative consultation process, considering climatic threats, and setting clear plans for water demand management particularly in the design phase. At the operation stage, the provision of long-term monitoring plans for water management, multi scale integration among the various participants regarding the long-term accessibility to information, and community management plans should be explicitly indicated. Monitoring reports, the level of awareness of climate impacts, and risks, and responsibility tasks for community and other stakeholders in the long term at the output stage also require more emphasis. Feedback analysis shows that the feedback from the community management at the design phase should be taken into consideration in both short and long terms. All these points are recommended as necessary issues that impact on collaboration and learning which are essential for long term appropriate cc adaptation

References

- [1] Siri, E. & Aldunce, P. & Sekhar Bahinipati, C. & Martins, R. & Molefe, J. & Nhemachena, C. & O'Brien, K. & Olorunfemi, F. & Park, J. & Sygna, L. & Ulsrud, K., "When Not Every Response to Cc Is a Good One: Identifying Principles for Sustainable Adaptation." *Climate and Development* 3 (1), pp. 7–20, 2011.
- [2] Rammel, C. & Stagl, S. & Wilfing, H., Managing complex adaptive systems—a co-evolutionary perspective on natural resource management. *Ecological economics*, 63 (1), pp.9-21, 2007.
- [3] Godschalk, D. R., Urban hazard mitigation: creating resilient cities. *Natural hazards review*, 4(3), pp.136-143, 2003.
- [4] Bond, A. & Morrison-Saunders, A. & Pope, J., Sustainability assessment: the state of the art. *Impact Assessment and Project Appraisal*, 30(1), pp.53-62, 2012.
- [5] Vallance, S. & Perkins, H.C. & Dixon, J.E., What is social sustainability? A clarification of concepts. *Geoforum*, 42(3), pp.342-348, 2011.
- [6] Naji, S., Towards an Integrated Approach to Address Social Adaptation in Sustainability Neighbourhoods: The Potential of Governance and Community Indicators in BREEAM Communities (Doctoral dissertation, Cardiff University), 2019.
- [7] Parry, M. & Parry, M.L. & Canziani, O. & Palutikof, J. & Van der Linden, P. & Hanson, C. eds., Cc 2007-impacts, adaptation and vulnerability: Working group II contribution to the fourth assessment report of the IPCC (Vol. 4), *Cambridge University Press*, pp. 81-84, 2007.
- [8] Reith, A. & Orova, M., Do green neighbourhood ratings cover sustainability? *Ecological Indicators*, 48, pp.660-672, 2015.
- [9] Sharifi, A. and Murayama, A., A critical review of seven selected neighborhood sustainability assessment tools. *Environmental impact assessment review*, 38, pp.73-87, 2013.

- [10] Naji, S. & Gwilliam, J., Neighborhood sustainability assessment tools: a conceptual framework for their use in building adaptive capacity to cc. *International Journal of Civil, Environmental, Structural, Construction and Architectural Engineering* 10 (2), pp.180-186, 2016
- [11] Fiksel, J., Sustainability and resilience: toward a systems approach. *Sustainability: Science, Practice and Policy*, 2(2), pp.14-21, 2006.
- [12] Hopkins, T.S. & Bailly, D. & Elmgren, R. & Glegg, G. & Sandberg, A. & Støttrup, J.G., A systems approach framework for the transition to sustainable development: potential value based on coastal experiments. *Ecology and Society*, 17(3): 39, 2012
- [13] Moore, K.M., *The sciences and art of adaptive management: Innovating for sustainable agriculture and natural resource management*. Ankeny, IA: Soil and Water Conservation Society, pp. 3-9, 2009.
- [14] Simeone, R. & Carnevale, J & Millar, A., A Systems Approach to Performance-Based Management: The National Drug Control Strategy. *Public Administration Review*, 65(2), pp.191-202, 2005.
- [15] Yuchtman, E. & Seashore, S.E., A system resource approach to organizational effectiveness. *American sociological review*, pp.891-903, 1967.
- [16] Hjorth, P. & Bagheri, A., Navigating towards sustainable development: A system dynamics approach. *Futures*, 38(1), pp.74-92, 2006.
- [17] Gallopín, G.C., *A systems approach to sustainability and sustainable development*. ECLAC: United Nations Headquarters, New York, 2003.
- [18] Ermoliev, Y.M. & Ermolieva, T.Y. & MacDonald, G.J. & Norkin, V.I. & Amendola, A., A system approach to management of catastrophic risks. *European Journal of Operational Research*, 122(2), pp.452-460, 2000.
- [19] Guo, H.C. & Liu, L. & Huang, G.H. & Fuller, G.A. & Zou, R. & Yin, Y.Y., A system dynamics approach for regional environmental planning and management: a study for the Lake Erhai Basin. *Journal of Environmental Management*, 61(1), pp.93-111, 2001.
- [20] Kouloura, T.C. & Panagiotakopoulos, P.D. & Safigianni, A.S., A systems approach to corporate sustainability in energy management of industrial units. *IEEE Systems Journal*, 2(4), pp.442-452, 2008.
- [21] Azapagic, A., Systems approach to corporate sustainability: a general management framework. *Process Safety and Environmental Protection*, 81(5), pp.303-316, 2003.
- [22] Arnold, R.D. & Wade, J.P., A definition of systems thinking: A systems approach. *Procedia Computer Science*, 44(2015), pp.669-678, 2015.
- [23] Linkov, I. & Satterstrom, F.K. & Kiker, G. & Batchelor, C. & Bridges, T. & Ferguson, E., From comparative risk assessment to multi-criteria decision analysis and adaptive management: Recent developments and applications. *Environment International*, 32(8), pp.1072-1093, 2006.
- [24] Pahl-Wostl, C. & Sendzimir, J. & Jeffrey, P. & Aerts, J. & Berkamp, G. & Cross, K., Managing change toward adaptive water management through social learning. *Ecology and society*, 12(2), 2007.
- [25] Plsek, P.E. & Wilson, T., Complexity, leadership, and management in healthcare organisations. *Education and debate*, 323(7315), pp.746-749, 2001.
- [26] Williams, B.K., Adaptive management of natural resources—framework and issues. *Journal of environmental management*, 92(5), pp.1346-1353, 2011.
- [27] Plummer, R. & Crona, B. & Armitage, D.R. & Olsson, P. & Tengö, M. & Yudina, O., Adaptive comanagement: a systematic review and analysis. *Ecology and Society*, 17(3), 2012.
- [28] Abuzeinab, A. & Arif, M., Stakeholder engagement: a green business model indicator. *Procedia Economics and Finance*, 18, pp.505-512, 2014.
- [29] Adger, W.N., Social capital, collective action, and adaptation to cc. *Economic Geography*, 79 (4), pp. 327-345, 2010.
- [30] Tyler, S. & Moench, M., A framework for urban climate resilience. *Climate and development*, 4(4), pp.311-326, 2012.
- [31] Nkhata, B.A. & Breen, C., A framework for exploring integrated learning systems for the governance and management of public protected areas. *Environmental Management*, 45(2), pp.403-413, 2010.
- [32] Turner II, B.L., 2010. Vulnerability and resilience: Coalescing or paralleling approaches for sustainability science? *Global Environmental Change*, 20(4), pp.570-576.
- [33] Naji, S. & Gwilliam, J., 2016. Neighbourhood Sustainability Assessment Tools and Water System Adaptation: A Framework to Analyse the Adaptive Capacity in the Physical- Social Context. *Environmental & Economic Impact on Sustainable Development*, 11 (6), pp. 907-919, 2016.
- [34] Tomlinson, B. & Sastre, S. & Blasco, D. & Guillén, J., The systems approach framework as a complementary methodology of adaptive management: a case study in the urban beaches of Barcelona. *Ecology and Society*, 16(4), 2011.

- [35] Schreiber, E.S.G. & Bearlin, A.R. & Nicol, S.J. & Todd, C.R., Adaptive management: a synthesis of current understanding and effective application. *Ecological Management & Restoration*, 5(3), pp.177-182, 2004.
- [36] Graymore, M.L. & Sipe, N.G. & Rickson, R.E., Sustaining human carrying capacity: a tool for regional sustainability assessment. *Ecological economics*, 69(3), pp.459-468, 2010.
- [37] Jackson, S.E. & Schuler, R.S., Understanding human resource management in the context of organizations and their environments. *Annual review of psychology*, 46(1), pp.237-264, 1995.
- [38] Ivey, J.L. & Smithers, J. & De Loë, R.C. & Kreutzwiser, R.D., Community capacity for adaptation to climate-induced water shortages: linking institutional complexity and local actors. *Environmental management*, 33(1), pp.36-47, 2004.
- [39] Haasnoot, M. & Middelkoop, H. & Van Beek, E. & Van Deursen, W.P.A., A method to develop sustainable water management strategies for an uncertain future. *Sustainable Development*, 19(6), pp.369-381, 2011.
- [40] Brown, L.E. & Mitchell, G. & Holden, J. & Folkard, A. & Wright, N. & Beharry-Borg, N. & Berry, G. & Brierley, B. & Chapman, P. & Clarke, S.J. & Cotton, L., Priority water research questions as determined by UK practitioners and policy makers. *Science of the Total Environment*, 409(2), pp.256-266, 2010.
- [41] Perdomo, A. & Hussain, O., A multisystem cc adaptation approach for water sustainability in regional Australia. *International Journal of Global Warming*, 3(1-2), pp.39-54, 2011.