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### Research Article

## Is Lahore's urban system ready to sustain climate change? The case in Pakistan

Muhammad Shafaat Nawaz<sup>a\*</sup>, Saqlain Akbar<sup>b</sup>

<sup>a</sup> Lecturer, School of Architecture and Planning, University of Management and Technology, Lahore – Pakistan.

Email: [shafaat.nawaz@umt.edu.pk](mailto:shafaat.nawaz@umt.edu.pk) ; [shafaatzhere@gmail.com](mailto:shafaatzhere@gmail.com) .

<sup>b</sup> Department of City and Regional Planning, University of Engineering and Technology, Lahore – Pakistan.

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### Abstract

Lahore, the second largest city of Pakistan and home to more than 11 million people with annual population growth rate of 2.4%, has experienced deadly smog duration since last three years. Climate Change is a global challenge and administrations in major cities around the globe have started addressing the issue on top level. Lahore has also seen establishment and operation of various public sector institutions/offices which explicitly or implicitly claim to help Lahore sustain changing needs of urban system due to climate change. However, little is documented yet whether how effective have these interventions been at institutional level. This paper investigates policies, plans, procedures and regulations (whichever available) for seven relevant government offices on the basis of five key assessment areas to explore whether Lahore's urban system is ready to sustain the challenge of Climate Change. The investigation covers the debate on policy to the plan level. Institutional abilities of selected government offices have been analyzed to ascertain their efficacy. In essence; the capacity of current system has been documented, the gaps in the system have been outlined and the prospective solutions for the way forward have been suggested in this study.

**Keywords:** Lahore, Climate Change, Urban Planning, Mitigation, Adaptation; Policy.

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### 1. Introduction

Impacts of climate change have found to be significant in Pakistan (Farooqi, Khan and Mir, 2005); the country faced recurrent extreme weather conditions and was ranked among top ten countries on climate risk index (Sönke et al., 2015). High risk of adverse impacts of climate change in Pakistan would cause economy to plummet due to direct negative effect on agriculture of the country, a sector that contributed 18.5% to country's GDP and provided 38.5% employment to national labor force (Government of Pakistan, 2019). Scholars have documented impacts of climate change to agriculture in the country (Hanif et al., 2010; Siddiqui, Samad and Nasir, 2012), farmers' perception to adapt to climate change (Abid et al., 2015) and the economic impacts of climate change on

\*Corresponding author: Email: [shafaatzhere@gmail.com](mailto:shafaatzhere@gmail.com) (M. S. Nawaz).

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agriculture (Ahmed Nomman and Schmitz, 2014). On the counterpart, minimal literature can be found on part of adaptation of climate change at urban system in Pakistan which this paper provides.

United Nations envisage to build resilient communities and combat challenges arising due to climate change (UNDP, 2015). Pakistan apparently considers climate change worth tackling as evident from national climate change policy (Ministry of Climate Change, 2012). The same policy has been translated to provincial level of government (Government of Punjab, 2017). We understand this as an encouraging factor that the recognition of this issue of immense significance has been realized at government's highest level in the country. That could mean that half the job is done (i.e. to gain national level commitment to tackle this situation) while this paper would mention how good the country is doing at later half to implement capable system to deal with climate change.

Interestingly, both above mentioned policy documents fostered the importance of tackling climate change at urban scale. This study investigates the ability of Lahore's urban system to sustain changing dynamics as a result of climate change. To do so, this paper follows a logical sequence to build the case as the study proceeds. Initially a relationship between urban planning systems and climate change considerations has been explained by focusing on diverse examples from literature. This leads to an elaboration of the sources and methods used for the study. Then follows the section on findings and discussion which precedes the final section where way forward has been suggested.

### 1.1 Urban planning system and climate change

Urban planning offers an important entry point, shaping urban form in very particular ways with implications on climate change (Yuen and Kong, 2009). Studies investigating the role of urban planning to deal with climate change assert that urban planning systems can significantly affect the way climate change is being addressed. (Wahlgren *et al.*, 2010) established 10 golden rules for an urban planner to take climate change into account from both mitigation and adaption point of view (Yiannakou and Salata, 2017) discussed the potential of spatial planning to reduce Urban Heat Island Effect by asserting that climate change adaptation could achieved by better land use planning and design. Quite eloquently, as they explored the disaster prevention through Land use Planning, (Chang and Hsieh, 2013) mentioned that land use planning could play a role at various levels of a regional plan, master plan and detailed plan.

Urban planning has been understood to help prevent or adapt to the climate change through a range of options. For example, (Kao, Chiu and Tsai, 2017) suggested that land use zoning plans be prepared by analysis of disaster potential and vulnerability and specified the examples of change of agricultural land or idle to storm-water detention pond, multi-target use of public facilities land, and utilization of road drainage detention etc. A number of other options have been suggested by various scholars previously which include suggestion of restricting use of land to only resilient uses in disaster prone area (Schwab *et al.*, 1998), use of urban greening and high-reflectivity materials and increasing openness to allow cooling winds in warmer areas (Smith and Levermore, 2008) and development control in high risk areas to avoid impacts of high floods (Abdul Mohit and Mohamed Sellu, 2017).

As urban planning of Freetown was investigated with respect to system's ability to integrate climate change considerations, the learning lesson was that related institutions were of critical importance for response to the effects of climate change (Macarthy, 2012). A similar exploratory study on urban planning system of Kumasi, Ghana concluded that urban planning agencies worked under severe constraints which limited their response to climate change (Cobbinah *et al.*, 2019). The study suggested that functional clarity and capacity building of planning institutions could improve system's aptitude in this domain.

While providing roadmap to urban climate adaptation justice, (Shi *et al.*, 2016) developed basic research questions to assess how urban system could help in climate related issues. A very satisfying read of valuable articles on role of urban planning for climate change offer potential use of planning techniques (Maheshwari, Singh and Thoradeniya, 2016). Understanding that urban planning has been seen as a tool to deal with challenging situation of climate change, this study aims to assess the ability of Lahore's urban system. This would certainly include the discussion on policy level, and the consequent implementation of the policy at departmental level in the city.

### 1.2 Climate change and Lahore

Lahore, with fastest urbanization rate of 2.4% in the country, is home to more than 11million people (PBS, 2017). The city is still unable to take urbanization as an opportunity. We prepared a list of 237 urban planners working in Lahore in various government and private sector organizations. Yet there is lack of comprehensive and coordinated urban development plans, policies and governance (Nawaz, 2018; Rana and Bhatti, 2018). Due to lack of integrated urban planning, vegetation is decreasing; prediction map of Land cover of Lahore for year 2035 forecasted further decrease in vegetation (Bhatti *et al.*, 2015). A recent research recommends to plant pollution

tolerant trees in the city (Pervaiz *et al.*, 2019). Not only this, the city is also facing severe issue of mobility. This issue has been envisaged to be tackled through integrated public transport system (Aziz *et al.*, 2018).

The city experiences extreme weather conditions in both summer (upto 48°C) and winter (as low as 0°C) (Rana and Bhatti, 2018). Also, the citizens have been exposed to deadly smog which Lahore has been experiencing as measured by (Khanum, Chaudhry and Kumar, 2017) that the city's annual average of particulate matter (PM<sub>2.5</sub>) for last five years was  $136.5 \pm 34.1 \mu\text{g}/\text{m}^3$  which is alarmingly 14 times higher than WHO guidelines. This issue has rightly been pointed out by scholars for immediate attention by the government (Riaz and Hamid, 2018). Not only smog, Lahore's innocent situation in purview of climate change has been documented by many other researchers (Sajjad *et al.*, 2009, 2015; Syed and Ahmed, 2014; Brown *et al.*, 2015). Considering this immediate situation, the ability of city's urban system is assessed in this paper to understand if the city is ready to sustain climate change.

## 2. Sources and Methods

Sian *et al.* (2017) established a theoretical framework to study the policies regarding climate change in Singapore. The study utilized online policy documents from eleven organizations to identify policy levers to address climate change. Case study from Freetown also assessed the institutional arrangement to assess the integration of climate change in urban planning (Macarthy, 2012) and study from Ghana focusing on developing a relationship between urban planning and climate change studied policies from relevant departments (Cobbinah *et al.*, 2019). These examples hint that the ability of an urban system to deal with this challenging phenomenon could be assessed through a study of relevant departments.

To study these departments in Lahore, Secondary data collection sources utilized by the researchers were web, diaries, and articles report postulation and information gathered from various offices and organizations. Information was identified with focus on climate change, its adaptation and mitigation measures. Data regarding climate change policies and measures and other portable document format files were studied in order to gain knowledge about the topic.

The primary data was collected by interviewing the officers in relevant government departments. The technique of structured interviews was utilized because it was proved useful from previous scholarly works. Dubeaux and Sabot, (2018) carried fifty interviews with city planners, users, associations and city bureaucrats to understand the reasons of an undesired situation (urban shrinkage). Earlier, Pearson *et al.* (2010) conducted 40 semi-structured interviews with various local, regional and state actors to create a framework for sustainable land use scenario. Considering this a proven technique, semi-structured interviews from officers of relevant government offices were taken for this study.

The purpose of the interviews from the government departments and institutions was to assess their readiness to deal with climate change in five major areas: (i) awareness of the public institutions regarding climate change and its impacts, (ii) the initiatives taken in adaptation and mitigation of climate change, (iii) amendments undertaken in laws to address climate change, (iv) trainings held to and by the government offices and (v) future proposals regarding climate change.

Selection of the departments for interviews was to be wise. The selection needed to be simultaneously precise yet comprehensive. Therefore, those departments which directly or indirectly relate with urban system were selected for primary data collection. For example, Urban Redevelopment Authority was one of the eleven organizations selected for pilot thematic analyses for a similar study wherein policy approach towards dealing with climate change was investigated Sian *et al.* (2017). Similarly, Lahore Development Authority (LDA) in case of Lahore was selected for interviews along with other departments. A crisp introduction of the departments from which interviews were conducted for this study is provided in table-I.

Table 1: Departments Interviewed

Sr. No.	Name of the department	Jurisdiction Area	Relevant scope of work	Website
1	Lahore Development Authority (LDA)	Spatial Planning at Lahore Division (regional) Level	<ul style="list-style-type: none"> <li>i. Comprehensive Development Planning</li> <li>ii. Preparation, Implementation, Monitoring and updating of (spatial) Master Plan</li> <li>iii. Development and Land-use control</li> </ul>	<a href="https://www.lda.gop.pk/">https://www.lda.gop.pk/</a>
2	Water and Sanitation Agency (WASA)	City of Lahore	<ul style="list-style-type: none"> <li>i. Planning, designing and construction of water supply, sewerage &amp; drainage facilities</li> </ul>	<a href="https://wasa.punjab.gov.pk/">https://wasa.punjab.gov.pk/</a>
3	Traffic Engineering and Planning Agency (TEPA)	Transport Planning at Lahore Division (regional) Level	<ul style="list-style-type: none"> <li>i. Coordinate and prepare comprehensive transportation plan</li> <li>ii. Carry out research and advise various agencies on traffic and transport policy and planning</li> </ul>	<a href="https://tepa.punjab.gov.pk/">https://tepa.punjab.gov.pk/</a>
4	Pakistan Meteorological Department (PMD)	National Level (Lahore being second most populated city)	<ul style="list-style-type: none"> <li>i. Provide information on weather, climate and geophysical phenomenon</li> </ul>	<a href="http://www.pmd.gov.pk/">http://www.pmd.gov.pk/</a>
5	Punjab Irrigation and Drainage Authority (PIDA)	Provincial Level (Lahore as capital of province)	<ul style="list-style-type: none"> <li>i. Planning, Monitoring and Capacity Enhancement for Surface Water Flow</li> </ul>	<a href="https://kpa.punjab.gov.pk/">https://kpa.punjab.gov.pk/</a>
6	Environment Protection Department (EPD), Punjab	Provincial Level (Lahore as capital of province)	<ul style="list-style-type: none"> <li>i. Administer and implement Environment Protection Act</li> <li>ii. Specify safeguards for the prevention of accidents and disasters which may cause pollution</li> <li>iii. Promotion of sustainable development</li> </ul>	<a href="https://epd.punjab.gov.pk/">https://epd.punjab.gov.pk/</a>
7	Provincial Disaster Management Authority (PDMA), Punjab	Provincial Level (Lahore as capital of province)	<ul style="list-style-type: none"> <li>i. Formulate the provincial disaster management policy</li> <li>ii. Examine the vulnerability of different parts of the province</li> <li>iii. Coordinate response in the event of disaster</li> </ul>	<a href="http://pdma.gop.pk/">http://pdma.gop.pk/</a>

### 3. Findings and Discussion

Policy level recognition of need for Climate Change Adaptation and Mitigation (CCAM) has been noted at national level (Ministry of Climate Change, 2012) and provincial level (Government of Punjab, 2017). However, the translation of the policy to the local level is still underway. Figure-I shows the policy setup for CCAM in Pakistan with particular focus on Lahore.

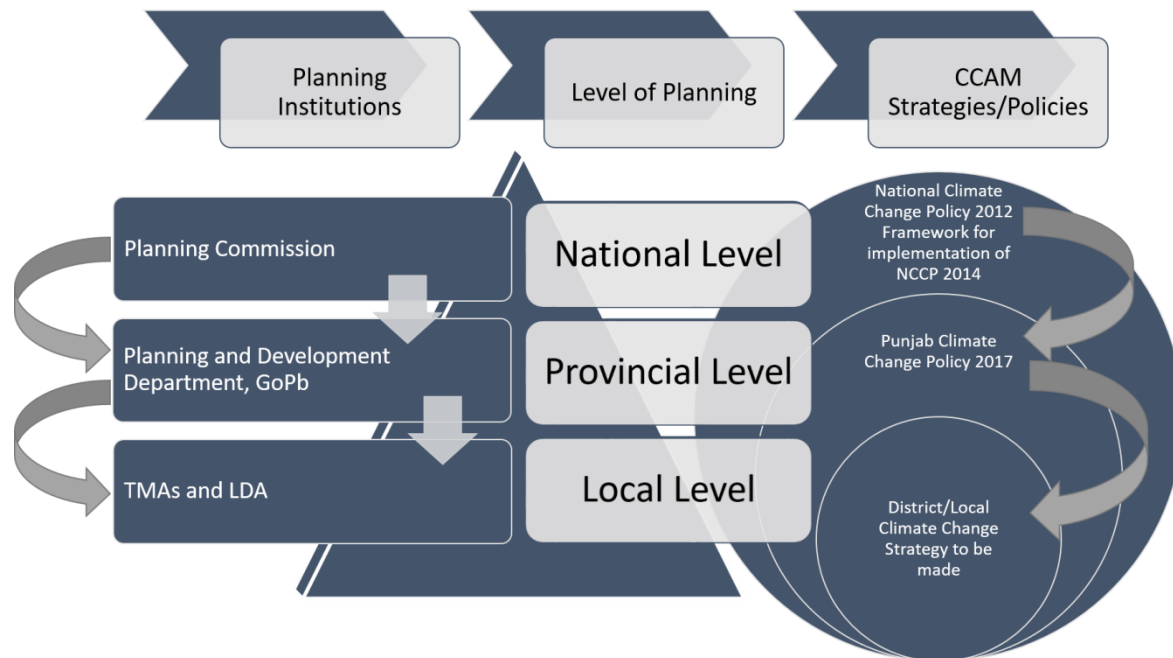


Figure 1: CCAM Policy at Various Levels of Planning.

Proper land use planning and infrastructure design can reduce vulnerability to climate change. Therefore, inclusion of adaptation and mitigation measures in planning process is very vital including the strategies for implementation and monitoring of the plans otherwise the plans may not be successful. Different departments at local level in their own capacity took initiatives for climate change adaptations and mitigations despite the lack of comprehensive and coordinated strategy at local level. Some departments ran projects and some brought amendments to their legislations for the inculcating CCAM in their operations and working.

**LDA** has made adaptation as a part of its rules. In Master Planning rules, the provision of data collection involves gathering of data, studies and analysis regarding environment. Evaluation criteria of Housing scheme involves the condition of Flood Prone Areas. The amendments in Building and Zoning Regulations involve rainwater-harvesting, use of solar panels in commercial building, pillar construction (frame structure) in residential buildings. Future plan include requiring applicant of permits to provide landscape plans in commercial and residential buildings etc. Issuance of online building permits is also reported as one of the pipeline projects (Nawaz, 2019).

**WASA** is currently consulting a private sector consultant company MMP (Mott-McDonalds, Pakistan) for the preparation of Master Plan of Lahore for water supply and sewerage. In the master plan adaptation and mitigation measures shall be provided.

**TEPA** has undergone projects like Green Line metro bus project and currently working on construction of orange line LRT for the adaptation and Mitigation of Climate change. Future proposals include improvement of traffic management of Lahore central area. This will help reduce the overall emissions and mitigate the impacts of climate change.

**PMD's** senior specialist was of view that the impacts of climate change are not as visible in Lahore in a macroscopic view, but the congestion in Lahore is the reason of feeling high temperatures in summers and low temperatures in winter seasons. This viewpoint is also in harmony with observation of the temperature differences in Lahore (Sajjad *et al.*, 2015); yet this is amazingly contrary to the measurements reported by Khanum *et al.* (2017) that the city's annual average of  $PM_{2.5}$  for last five years was  $136.5 \pm 34.1 \mu\text{g}/\text{m}^3$  which is alarmingly 14 times higher than WHO guidelines. However, the main reasons identified for the climate change of Lahore were the development and expansion of Lahore, traffic congestion and air pollution and deforestation.

**PIDA** has increased the flood levels from 3 feet to 6 feet considering the adaptation to changing climate. Moreover, flood fighting

plan for Lahore Drainage division is also prepared. The amendments in laws were regarding the treatment of sewerage water from housing schemes and factories on their own before exposing to surface water. Another policy intervention was regarding necessary requirement from PIDA for large scale development projects.

**EPD** has established Climate Change Cell. The Cell prepared Punjab Climate Change Policy 2017 in which it has given policy measures regarding adaptation and mitigation. Furthermore, EPA has launched awareness campaigns to alert people regarding effect of Climate change and the ways to mitigate and adapt the impacts. Ban on CFCs in Refrigerators and implementation of Basel Convention are also included in mitigation measures.

**PDMA** has prepared disaster management plan for the Punjab province. The plan intends to guide the government institutions, NGOs and public to work in a coordinated manner to mitigate the disaster. This plan defines the role of PDMA, Punjab, provides guidelines for the roles of different public institutions in case of a disaster situation involving pre-disaster, during and post-disaster scenarios. A Disaster Management Plan for Lahore district was prepared in 2016. The plan aimed to provide a well-coordinated response at the district level to mitigate disaster situations. Main objectives of the disaster management plan included defining roles of different stakeholder departments in case of a disaster situation, raising awareness in various stakeholders for immediate response and introduction of coordination mechanism at the district level. The disaster management plan provides a framework of mitigation strategy for coordinated efforts in times of situations like urban flooding, flash flooding, earthquakes, epidemics, fire incidents and other emergencies.

Comparative analysis of the selected departments on the key areas which have been investigated regarding CCAM is shown in table-2. The scoring was done on the basis of conducted interviews with higher score (approaching 10) representing more efficiency in respective key area and lower score (approaching 0) meaning no progress at all. The cumulative score indicates that EPD and LDA have comparatively more CCAM considerations as compared to other departments.

There is a need to develop the regional CCAM plan under the umbrella of Provincial climate change policy. LDA, PDMA, EPD and local governments should jointly make a regional Climate Change Plan. This plan would highlight different climate sensitive zones and provide provisions for climate smart development. Legislative backing is essential for the provision of resources and budgetary allocations. The implementation framework for projects under the umbrella of CCAM Strategy is necessary for efficient and timely integration of Climate smart infrastructure in Lahore. Figure-2 shows the framework proposed for climate change adaptation and mitigation proposed for a joint policy.

CCAM strategy should be devised to achieve goals and objectives of the regional climate change plan in the light of Punjab Climate change policy. A comprehensive climate change adaptation strategy should be developed which analyses the impacts of climate change and in future as well. The main goal of the strategy is to reduce the vulnerability of the people of Lahore. This strategy should include short and long term projects for development and climatic resilience.

Along with other surveys and data collection, Hazard mapping and zoning of climate sensitive areas should be done to identify sensitive zones e.g. water channels, drainage channels, katchi-abadis especially along different water channels and low-lying areas which are vulnerable. Further, disaster risk reduction strategies should also be inculcated in the Development plans for proactive approach to adapt and mitigate the impacts of changing climatic conditions. This would help in climate smart urban development as shown in figure-3. Research and analysis should be done in assessing the future climate change impacts on Lahore and its surroundings with the coordination of Pakistan Meteorological Department and other Research Organizations. The urban development plan should guide the city into climate-smart development by giving policies, plans and proposing long and short-term improvement and adaptive projects. All the plans and policies regarding urban development especially with reference to climate change must have a strategic environment assessment before their implementation. This will make the plans more comprehensive and implementable.

Table 2: Assessment of selected department for CCAM.

Assessment Areas	Departments							
	LDA	WASA	TEPA	PMD	PIDA	EPD	PDMA	
Awareness	Score	8	5	5	5	5	8	8
	Remarks	Knowledge of climate change, its impacts and mitigation measures	Knowledge of climate change, its impacts	Knowledge of climate change, its impacts	Knowledge of climate change, its impacts	Know the phenomena and its impacts	Knowledge of climate change, its impacts and mitigation measures	Knowledge of climate change, its impacts and mitigation measures
Initiatives Taken	Score	6	6	7	5	6	7	6
	Remarks	Master Planning of Lahore division	Master planning of Lahore for water supply, sewerage and drainage is underway	Construction of mass transit public transport	Provision of information and data	Flood Fighting Plan for Lahore Division Large scale development projects to take NOC from PIDA (for example a new housing scheme or a factor)	Provincial climate change policy is made. Climate change cell established on EPA Punjab Awareness raising campaign	Disaster Management Plan for Lahore district was prepared in 2016
Amendments undertaken in Laws	Score	9	0	0	5	5	9	0
	Remarks	Rooftop Gardening Rainwater Harvesting Mandatory open spaces Pillar construction in Residential buildings			Stopping draining hazardous waste and water in surface water	Increase of the flood embankment levels from 3 feet to 6 feet as a policy decision	Delegation of powers for environmental approvals Update in Punjab Environmental Quality Standards	
Training Regarding CC	Score	6	6	3	6	0	8	8
	Remarks	Seminars and workshops	Seminars and workshops	Minor Seminars	Seminars and workshops		Seminars, workshops and Trainings	Seminars, workshops and Trainings
Future Proposals Regarding CC	Score	6	6	7	3	5	8	8
	Remarks	Landscape plan in residential and commercial buildings Online Building Permits	Installation of water treatment plants	Improvement of traffic management of Lahore central area	To increase the ways through which information could be disseminated	Check on waste water and sewage being disposed in surface water	Project may be initiated on individual trend like using less motor vehicles.	Initiate training scouts through collaboration with Rescue 1122
<b>Cumulative Score</b>		<b>35</b>	<b>23</b>	<b>22</b>	<b>24</b>	<b>21</b>	<b>40</b>	<b>30</b>

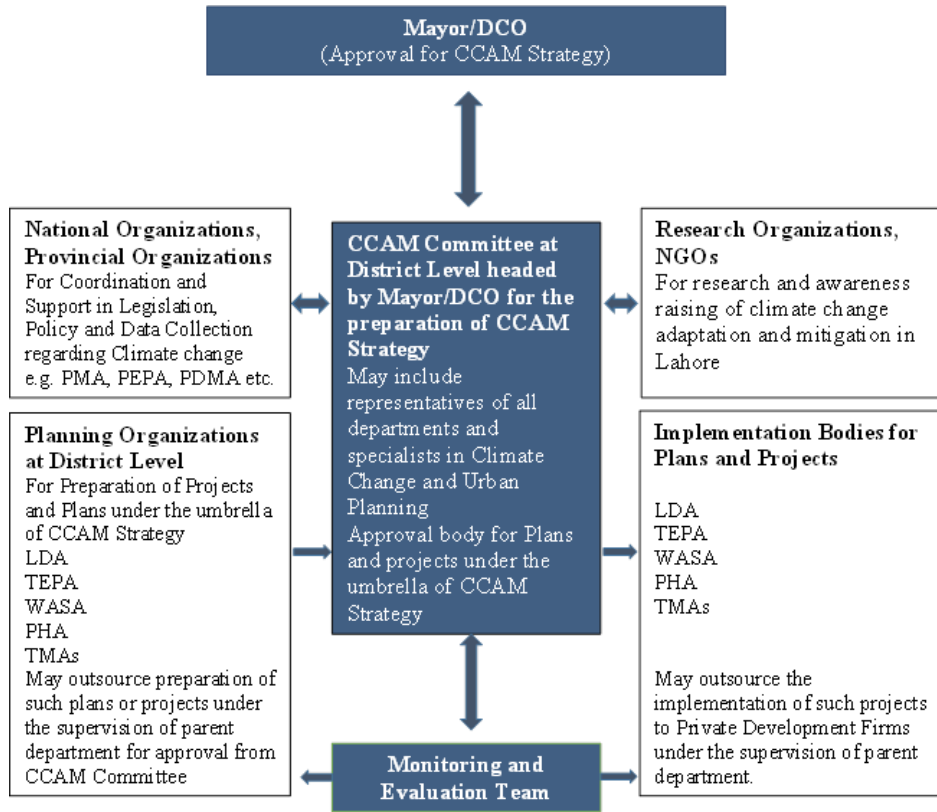


Figure 2: Proposed Framework for CCAM in Lahore.

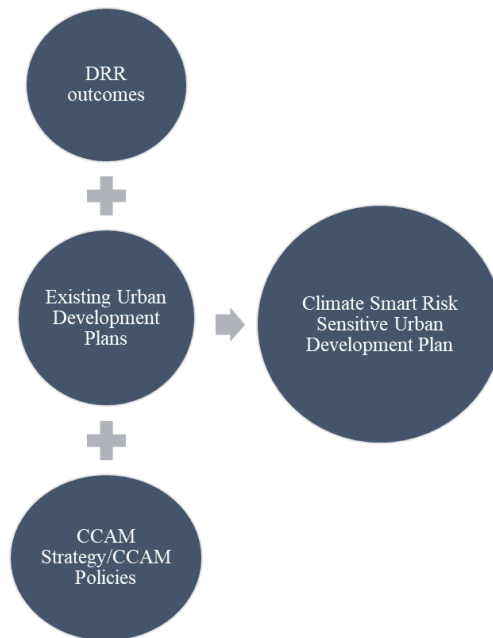


Figure 3: Climate Smart Urban Development.



Table 3: Suggested amendments in Laws.

Sr. No.	Rules/Regulations/Byelaws	Proposed Amendments
1	Building and Zoning Regulations	<ul style="list-style-type: none"> <li>i. Increase in Green Spaces in buildings including roof top gardening and urban farming</li> <li>ii. Placement of different types of trees in front, back and sides of the houses to prevent from heat from sun and increase wind circulation</li> <li>iii. Solar Water Heating in commercial and public buildings</li> <li>iv. Solar and wind powered residences for energy efficiency</li> <li>v. Energy and Water resilient building codes (points of research)</li> </ul>
2	Master Planning Rules	<ul style="list-style-type: none"> <li>vi. Inclusion of CCAM in plan making</li> <li>vii. Special planning and projects for Climate Sensitive areas e.g. water channels, green areas, urban slums, and squatter settlements in low-lying areas.</li> <li>viii. Saving Green Areas in Lahore</li> </ul>
3	Land use Rules	<ul style="list-style-type: none"> <li>ix. Assessment of the Land use change w.r.t. Climate Change and Its impact on the locality.</li> <li>x. Provision of facilities to reduce the impact</li> </ul>
4	Private Housing Scheme Rules	<ul style="list-style-type: none"> <li>xi. The provision regarding maximizing Solar Orientation of Plots</li> </ul>

Lahore Development Authority being main organization for urban development planning, implementation and monitoring in Lahore has taken the responsibility to prepare relevant rules and by-laws. For various rules by LDA, suggested incorporations for CCAM are shown in Table 3. The provision of high performance and green infrastructure is mandatory. Designing adaptive infrastructure can decrease the vulnerability of Lahore. Therefore, such materials should be used which tend to reduce flash flooding and recharge the ground water reservoirs more rigorously. Materials like open-jointed block, pervious concrete, porous surfacing like porous asphalt can help increase the aquifer recharge. It is essential to target the areas which are most vulnerable to Climate Change Impacts i.e. in case of Disaster. These include the low-lying areas in case of flash flooding and the slums and squatter settlements along different drainage channels. WASA, TEPA, and LDA need to undergo such projects in collaboration with the Local government, under the supervision of CCAM Monitoring Unit.

Urban Forestry should be promoted along major corridors of traffic to mitigate high temperatures in Lahore due to infrastructure development and massive urbanization. This will help absorb Carbon emissions and reduce the temperature of the areas. Moreover, Plantation of Trees along major Nallahs and water channels can also reduce the impact of emissions on the local people as well as provide retention of water in case of over flow. These projects should be launched as early as possible in order to reduce the impacts of climate change. PHA should plan and execute such projects under the supervision of CCAM Monitoring Unit.

Another recommendation is green roofing. Green roofs not only slow down the runoff of rain but also absorb the water itself. This reduces the load on the drainage system as well as provides treatment to the water as well. Moreover, the rainwater should be harvested in underground tanks for usage. All Government Buildings should have green roofing to make aware the people regarding the climate change adaptation and mitigation. TMAs and LDA should ensure Green Roofing in Govt. Buildings and provision in laws for private buildings. There is a need of political influence in planning strategies to adapt and mitigate climate change effects in Lahore. Political influence on people is very strong as they are elected representatives of the general public. Committees at the UC level should be given the task for the implementation of Climate change adaptation measures by the residents and public at large.

## References

- Abdul Mohit, M. and Mohamed Sellu, G. (2017) 'Development of Non-structural Flood Mitigation Policies and Measures for Pekan town, Malaysia', *Asian Journal of Behavioural Studies*, 2(6), p. 9. doi: 10.21834/ajbes.v2i6.33.
- Abid, M. et al. (2015) 'Farmers' perceptions of and adaptation strategies to climate change and their determinants: The case of Punjab province, Pakistan', *Earth System Dynamics*, 6(1), pp. 225–243. doi: 10.5194/esd-6-225-2015.
- Ahmed Nomman, M. and Schmitz, M. (2014) 'Economic assessment of the impact of climate change on the agriculture of Pakistan', *Business and Economic Horizons*, 4, pp. 1–12. doi: 10.15208/beh.2011.1.
- Aziz, A. et al. (2018) 'Examining suitability of the integrated public transport system: A case study of Lahore', *Transportation Research Part A: Policy and Practice*, 117, pp. 13–25. doi: 10.1016/j.tra.2018.08.003.

- Bhatti, S. S. et al. (2015) 'A multi-scale modeling approach for simulating urbanization in a metropolitan region', *Habitat International*. Elsevier Ltd, 50, pp. 354–365. doi: 10.1016/j.habitatint.2015.09.005.
- Brown, R. D. et al. (2015) 'Designing urban parks that ameliorate the effects of climate change', *Landscape and Urban Planning*. Elsevier B.V., 138, pp. 118–131. doi: 10.1016/j.landurbplan.2015.02.006.
- Chang, H.-S. and Hsieh, H.-Y. (2013) 'An Exploratory Study on Land use Planning of Disaster Prevention: A Case Study of Kaohsiung New Town', *Procedia Environmental Sciences*. Elsevier B.V., 17, pp. 382–391. doi: 10.1016/j.proenv.2013.02.051.
- Cobbinah, P. B. et al. (2019) 'Urban planning and climate change in Ghana', *Journal of Urban Management*. Elsevier B.V., (September 2018), pp. 1–11. doi: 10.1016/j.jum.2019.02.002.
- Dubeaux, S. and Cunningham Sabot, E. (2018) 'Maximizing the potential of vacant spaces within shrinking cities, a German approach', *Cities*. Elsevier, 75(July 2016), pp. 6–11. doi: 10.1016/j.cities.2017.06.015.
- Farooqi, A. B., Khan, A. H. and Mir, H. (2005) 'Climate Change Perspective in Pakistan', *Pakistan Journal of Meteorology*, 2(3), pp. 11–21. Available at: [http://www.pmd.gov.pk/rnd/rnd\\_files/vol2\\_Issue3/2.CLIMATE\\_CHANGE\\_PERSPECTIVE\\_IN\\_PAKISTAN.pdf](http://www.pmd.gov.pk/rnd/rnd_files/vol2_Issue3/2.CLIMATE_CHANGE_PERSPECTIVE_IN_PAKISTAN.pdf).
- Government of Pakistan (2019) *Pakistan Economic Survey*. Islamabad. Available at: [http://finance.gov.pk/survey/chapters\\_19/Economic\\_Survey\\_2018\\_19.pdf](http://finance.gov.pk/survey/chapters_19/Economic_Survey_2018_19.pdf).
- Government of Punjab (2017) *Punjab Climate Change Policy*. Lahore. Available at: [https://epd.punjab.gov.pk/system/files/PCCP\\_Draft%28internatl%29.pdf](https://epd.punjab.gov.pk/system/files/PCCP_Draft%28internatl%29.pdf).
- Hanif, U. et al. (2010) 'Economic Impact of Climate Change on the Agricultural Sector of Punjab', *The Pakistan Development Review*, 49(4), pp. 771–798. Available at: [file:///G:/Research\\_Downloads/Climate\\_Change\\_and\\_Lahore/41428690.pdf](file:///G:/Research_Downloads/Climate_Change_and_Lahore/41428690.pdf).
- Kao, L. S., Chiu, Y. H. and Tsai, C. Y. (2017) 'An evaluation study of urban development strategy based on of extreme climate conditions', *Sustainability*, 9(2). doi: 10.3390/su9020284.
- Khanum, F., Chaudhry, M. N. and Kumar, P. (2017) 'Characterization of five-year observation data of fine particulate matter in the metropolitan area of Lahore', *Air Quality, Atmosphere and Health*. *Air Quality, Atmosphere & Health*, 10(6), pp. 725–736. doi: 10.1007/s11869-017-0464-1.
- Macarthy, J. M. (2012) *Integrating climate change considerations in planning for urban development in Sierra Leone : the case of Freetown*. Newcastle University. Available at: [http://hdl.handle.net/10443/1405\\_HL\\_-\\_British\\_Library%0ANewcastle\\_University\\_Libraries](http://hdl.handle.net/10443/1405_HL_-_British_Library%0ANewcastle_University_Libraries).
- Maheshwari, B., Singh, V. P. and Thoradeniya, B. (2016) *Balanced Urban Development: Options and Strategies for Liveable Cities*. Edited by U. V.P.Singh, Texas A&M University, College Station, TX. TEXAS: SpringerOpen. doi: 10.1007/978-3-319-28112-4\_10.
- Ministry of Climate Change, G. of P. (2012) *National Climate Change Policy*. Islamabad. Available at: [http://www.gcisc.org.pk/National\\_Climate\\_Change\\_Policy\\_2012.pdf](http://www.gcisc.org.pk/National_Climate_Change_Policy_2012.pdf).
- Nawaz, M. S. (2018) 'Learning lessons from Comparative Urban Governance and suggesting approaches for Pakistan', in *International Business Conference and Exhibition on Architecture, Planning and Construction*. Lahore: University of Management and Technology (UMT). Available at: <https://admin.umd.edu.pk/Media/Site/ibce/FileManager/2018/Agenda.pdf>.
- Nawaz, M. S. (2019) 'Use of information technology in building permit system in pakistan, a case study of Lahore Development Authority', in *The 3rd International Conference on Urban and Regional Planning (CURP) - 2019*. Karachi: NED University of Engineering and Technology.
- PBS (2017) 'Pakistan Census - 2017'. Available at: [http://www.pbs.gov.pk/sites/default/files//DISTRICT\\_WISE\\_CENSUS\\_RESULTS\\_CENSUS\\_2017.pdf](http://www.pbs.gov.pk/sites/default/files//DISTRICT_WISE_CENSUS_RESULTS_CENSUS_2017.pdf).
- Pearson, L. J. et al. (2010) 'Sustainable land use scenario framework: Framework and outcomes from peri-urban South-East Queensland, Australia', *Landscape and Urban Planning*. Elsevier B.V., 96(2), pp. 88–97. doi: 10.1016/j.landurbplan.2010.02.006.
- Pervaiz, S. et al. (2019) 'Spatial analysis of vegetation cover in urban green space under new government agenda of clean and green Pakistan to tackle climate change', *Journal of Ecological Engineering*, 20(4), pp. 245–255. doi: 10.12911/22998993/103370.
- Rana, I. A. and Bhatti, S. S. (2018) 'Lahore, Pakistan – Urbanization challenges and opportunities', *Cities*, 72, pp. 348–355. doi: 10.1016/j.cities.2017.09.014.
- Riaz, R. and Hamid, K. (2018) 'Existing Smog in Lahore, Pakistan: An Alarming Public Health Concern', *Cureus*, 10(1), pp. 1–3. doi: 10.7759/cureus.2111.
- Sajjad, S. H. et al. (2009) 'Urbanization effects on temperature trends of Lahore during 1950-2007', *International Journal of Climate Change Strategies and Management*, 1(3), pp. 274–281. doi: 10.1108/17568690910977483.
- Sajjad, S. H. et al. (2015) 'the Long-Term Variability in Minimum and Maximum Temperature Trends and Heat Island of Lahore City , Pakistan', *Sci. Int. (Lahore)*, 27(2), pp. 1321–1325.
- Schwab, J. et al. (1998) *Planning for Post-Disaster Recovery and Reconstruction*. Chicago, IL, USA. Available at: <https://www.planning.org/publications/report/9026831/>.
- Shi, L. et al. (2016) 'Roadmap towards justice in urban climate adaptation research', *Nature Climate Change*. Nature Publishing Group, a division of Macmillan Publishers Limited. All Rights Reserved., 6, p. 131. Available at: <https://doi.org/10.1038/nclimate2841>.

- 
- Sian Ng, A., Lwin, M. O. and Pang, A. (2017) 'Toward a theoretical framework for studying climate change policies: Insights from the case study of Singapore', in 6th World Sustainability Forum, Cape Town, South Africa, 2017 January 27-28. Research Collection Lee Kong Chian School Of Business. doi: 10.3390/su9071167.
- Siddiqui, R., Samad, G. and Nasir, M. (2012) 'The Impact of Climate Change on Major Agricultural Crops: Evidence from Punjab, Pakistan', *The Pakistan Development Review*, 51(4), pp. 261–276. Available at: <https://www.jstor.org/stable/pdf/23734755.pdf?refreqid=excelsior%3A0022120e8afb78cef3235098e3dc6768>.
- Smith, C. and Levermore, G. (2008) 'Designing urban spaces and buildings to improve sustainability and quality of life in a warmer world', *Energy Policy*, 36(12), pp. 4558–4562. doi: 10.1016/j.enpol.2008.09.011.
- Sönke, K. et al. (2015) *Global Climate Risk Index 2016*. Available at: <https://germanwatch.org/fr/download/13503.pdf>.
- Syed, A. and Ahmed, S. I. (2014) 'Climate Change trend analysis in Two-Urban Cities of Pakistan', in Chemistry, D. of (ed.) 2nd international Conference on Environmental Horizons. Karachi: University of Karachi. Available at: [https://www.researchgate.net/publication/306118443\\_Climate\\_Change\\_trend\\_analysis\\_in\\_Two-Urban\\_Cities\\_of\\_Pakistan](https://www.researchgate.net/publication/306118443_Climate_Change_trend_analysis_in_Two-Urban_Cities_of_Pakistan).
- UNDP (2015) 'Sustainable Development Goals', UNDP, p. 24. doi: 10.1017/CBO9781107415324.004.
- Wahlgren, I. et al. (2010) 'Climate Change and Urban Planning', in *Building a Better World. CIB World Congress 2010*. Manchester: CIB world congress 2010 - Building a better world, 'Programme & book of abstracts'. Available at: [https://www.researchgate.net/publication/47524996\\_Climate\\_change\\_and\\_urban\\_planning](https://www.researchgate.net/publication/47524996_Climate_change_and_urban_planning).
- Yiannakou, A. and Salata, K. D. (2017) 'Adaptation to climate change through spatial planning in compact urban areas: A case study in the City of Thessaloniki', *Sustainability (Switzerland)*, 9(2), pp. 16–19. doi: 10.3390/su9020271.
- Yuen, B. and Kong, L. (2009) 'Climate change and urban planning in Southeast Asia', *SAPI EN. S. Surveys and Perspectives Integrating Environment and Society*, 2(2.3), pp. 1–20.