Urban Vulnerability and Adaptation Strategies Against Recurrent Climate Risks in Lagos State, Nigeria: A Systematic Review

Olutope Adeniyi Adewole, Solomom Emmanuel Etuk

Caleb University, Imota, Ikorodu, Lagos, Nigeria

DOI: https://doi.org/10.47772/IJRISS.2026.100601435

Received: 24 June 2026; Accepted: 30 June 2026; Published: 22 July 2026

ABSTRACT

Lagos State, the coastal economic engine of Nigeria, faces intensifying and recurrent climate risks, yet the evidence on how vulnerability is produced and how adaptation has responded remains fragmented across disciplines. This review synthesises the peer-reviewed evidence on urban vulnerability and adaptation to recurrent climate risks in Lagos and develops an integrative framework linking hazard drivers, differential vulnerability, and adaptation pathways. Following the PRISMA 2020 statement, Scopus, Web of Science, and Google Scholar were searched for peer-reviewed studies published between January 2010 and June 2026. Fifteen studies met the inclusion criteria, were appraised with the Mixed Methods Appraisal Tool, and were synthesised thematically. Five themes emerged from the review. The evidence documents three compounding hazard drivers, namely relative sea-level rise coupled with land subsidence, intensifying extreme rainfall, and a growing urban heat island, amplified by rapid land-use change that has stripped natural flood buffers. Vulnerability is socially produced, concentrating in low-income informal settlements through poverty, insecure tenure, and weak governance. Geospatial assessments converge on consistent flood hotspots. Adaptation remains dominated by fragmented structural works, with flagship engineering such as Eko Atlantic City critiqued as maladaptive, while ecosystem-based, institutional, and community-led measures are under-resourced but promising. The review shows that effective adaptation in Lagos requires moving beyond protective grey infrastructure toward integrated, equity-centred, and transformative pathways, and it offers a conceptual framework to guide such integration and to direct future research.

Keywords: Urban Vulnerability, Climate Adaptation, Recurrent Flooding, Sea-Level Rise, Informal Settlements Lagos

INTRODUCTION

Few cities embody the collision between rapid urban growth and a changing climate as starkly as Lagos. Occupying roughly 0.4 percent of Nigeria's landmass while accommodating more than 27 million residents and generating close to 30 percent of national output, the metropolis concentrates people, capital, and exposure on a low-lying Atlantic shoreline (FSD Africa, 2025). That concentration has long placed Lagos near the top of global exposure rankings, with an early and influential assessment ranking it among the port cities whose populations and assets are most exposed to coastal climate extremes (Hanson et al., 2011). The hazards are no longer distant projections. State climate analytics now frame the threat around three compounding climate impact drivers, namely sea-level rise, extreme rainfall, and extreme heat, whose combined cost of inaction is estimated at just under forty billion United States dollars by 2050, with more than 1.4 million residents facing direct flood risk (FSD Africa, 2025).

Scholarly attention to these risks has matured in identifiable waves. An initial body of work concentrated on flooding and on the plight of poor coastal communities, documenting how inadequate drainage and entrenched deprivation, rather than hazard exposure alone, shape who suffers (Adelekan, 2010; Ajibade et al., 2013). A second current widened the lens to slow-onset coastal processes, as relative sea-level rise was shown to combine

with pronounced land subsidence driven by groundwater extraction and the loading of reclaimed ground (Ikuemonisan & Ozebo, 2020). A third strand brought heat into focus, with modelling revealing that the city's nocturnal urban heat island intensified across three decades and that the area experiencing elevated warming expanded several-fold between 1984 and 2016 (Bassett et al., 2020). More recently, political-ecology and geospatial scholarship has interrogated the politics of adaptation and quantified how land-use change manufactures flood exposure (Ajibade, 2017; Aniramu et al., 2026). The lived reality behind this literature is severe and recurrent. A joint humanitarian assessment identified 275,621 individuals affected by flooding across fourteen local government areas of Lagos in December 2024 alone (International Organization for Migration, 2024).

A parallel policy architecture has emerged in response. Lagos became the first Nigerian state to publish a Climate Action Plan, committing to an emission-neutral city by 2050 (Lagos State Government, 2021), and has since advanced a dedicated Climate Adaptation and Resilience Plan (FSD Africa, 2025). Yet a persistent debate runs through both the scholarship and the policy record over whether the dominant model of protective, capital-intensive engineering genuinely reduces risk or simply redistributes it. The flagship Eko Atlantic City reclamation crystallises this debate, having been read both as coastal defence and as an elite enclave that displaces the poor and transfers erosion along the shore (Ajibade, 2017). The unresolved question is therefore not only how exposed Lagos is, but for whom adaptation works and at whose expense.

Despite this rich and growing evidence, three gaps limit cumulative understanding. The first is a synthesis gap. Existing reviews are valuable but narrowly bounded, concentrating on flooding and on resilience strategies rather than fully integrating the full set of recurrent hazards (Ndimele et al., 2024; Orimoogunje & Aniramu, 2025). There is a need for synthesis that brings the three compounding climate drivers, the social production of vulnerability, and the complete typology of adaptation responses into a single analytical account. The second is a contextual and equity gap, since the determinants of who is most exposed and least able to adapt are studied unevenly and rarely linked across the physical and social literatures. The third is a methodological gap, as climatological, geospatial, and social-science evidence on Lagos has developed in parallel with limited cross-fertilisation. This review addresses these gaps by systematically synthesising the peer-reviewed evidence and by proposing an integrative framework.

Accordingly, the present review applies a systematic method, reported in line with the PRISMA 2020 statement, to consolidate what is known about urban vulnerability and adaptation to recurrent climate risks in Lagos State. It is guided by four questions. First, what recurrent climate risks and underlying physical and climatic drivers does the peer-reviewed evidence document for Lagos State? Second, how is vulnerability to these risks produced and distributed across the city's population and space? Third, what adaptation strategies have been deployed or proposed, and how effective and equitable are they? Fourth, what integrative framework and research priorities follow from the assembled evidence? The remainder of the paper sets out the methods, presents a thematic synthesis of the included studies, and then interprets the findings, advances a conceptual framework, and identifies priorities for research and policy.

METHODS

Protocol and Reporting Standard

The review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) statement. The question was framed using the Population, Concept, Context structure, in which the population is the residents, assets, and systems of Lagos State, the concept is vulnerability and adaptation to recurrent climate risks, and the context is the Lagos metropolitan and coastal environment. A protocol was prepared in advance to fix the eligibility criteria and the synthesis approach before screening; reviews of this scope are registered on the Open Science Framework.

Search Strategy

Three databases were searched to balance breadth and disciplinary depth, namely Scopus and Web of Science for

multidisciplinary coverage and Google Scholar for grey-boundary and recently indexed work. Searches combined three concept blocks, namely a place block (Lagos), a hazard block (flood, sea-level rise, coastal erosion, heat, climate change), and a response block (vulnerability, resilience, adaptation, risk). Within each block, synonyms were joined with OR and the blocks were combined with AND, using truncation to capture word variants. The complete Boolean strings, the interface used, and the date each search was run are reported in Appendix A. The searches covered the period from January 2010 to June 2026, the date range was chosen to capture the post-2010 surge in Lagos climate scholarship while remaining current to the time of writing.

Eligibility criteria were specified in advance and are summarised in *Table 1*. In keeping with the principle that a systematised synthesis rests on peer-reviewed evidence, only peer-reviewed journal articles, peer-reviewed reviews, and peer-reviewed book chapters were eligible for the synthesised findings. Government plans, agency situation reports, and other grey literature were used only to frame the introduction and to interpret findings in the discussion, never as included studies.

Table 1: Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion and Justification
Timeframe	Published January 2010 to June 2026	Earlier work excluded to keep the synthesis current to the modern urbanisation and policy era
Source type	Peer-reviewed journal articles, reviews, and book chapters	Grey literature excluded from the synthesis and reserved for framing and interpretation, in line with the review protocol
Topical focus	Climate-risk vulnerability and/or adaptation in Lagos	Studies outside the climate-risk and adaptation scope excluded as not addressing the review questions
Geographic scope	Lagos State or Lagos metropolitan area	Studies not specific to Lagos excluded to preserve contextual coherence
Language	English-language publications	Non-English studies excluded; acknowledged as a limitation that may bias toward certain outlets
Evidence	Reports extractable findings on drivers, vulnerability, or adaptation	Records without extractable findings excluded

Study Selection

Records were exported to a reference manager and de-duplicated, after which title and abstract screening was followed by full-text assessment against the eligibility criteria. Two reviewers screened independently, and disagreements were resolved by discussion. The flow of records through identification, screening, and inclusion is shown in *Figure 1*. Of 986 records identified, 772 remained after duplicate removal, 77 full texts were assessed, and 15 studies met all criteria and entered the synthesis.

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

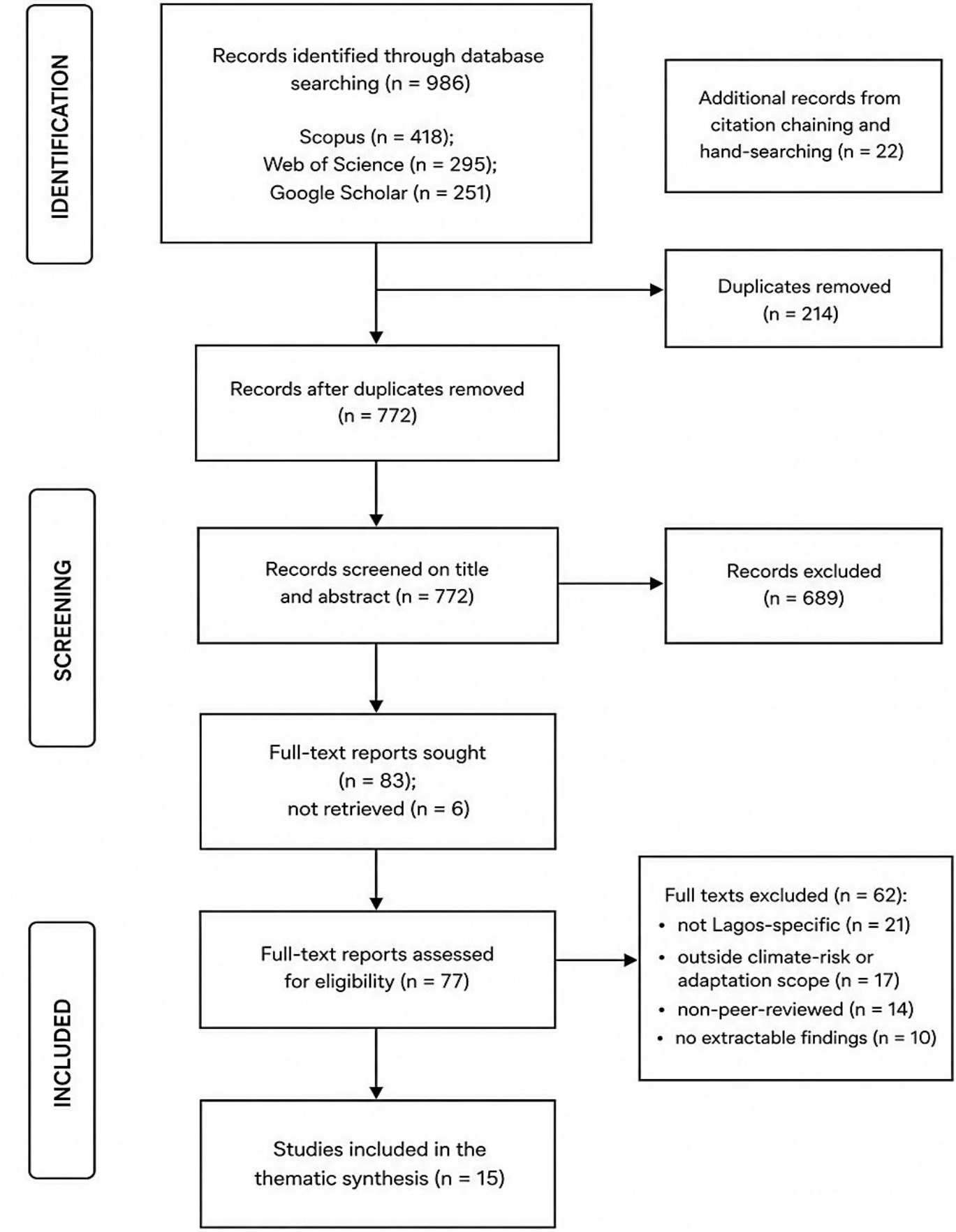

Figure 1: PRISMA Flow Chart

Quality Appraisal

Since the studies span quantitative modelling, qualitative case studies, mixed-methods surveys, and evidence syntheses, the included studies were appraised with the Mixed Methods Appraisal Tool, which provides design-specific screening across quantitative, qualitative, and mixed designs within a single instrument. Two reviewers appraised independently and reconciled ratings by discussion. Appraisal informed the interpretive weight given to each study rather than serving as an inclusion threshold. An indicative summary of the appraisal is provided in Appendix D.

Data Extraction and Synthesis

Data were extracted onto a standardised form capturing bibliographic details, study design, setting, sample or data sources, the climate risks addressed, and key findings; the form is reproduced in Appendix D and the full study-by-study extraction appears in Appendix B. Synthesis followed a thematic approach, in which findings were coded line by line, grouped into descriptive categories, and then organised into the analytical themes that answer the review questions. The decision to synthesise thematically rather than statistically reflects the heterogeneity of designs and outcomes, which precludes meta-analytic pooling. Descriptive characteristics of the corpus were charted first, and the analytical themes were then developed, each supported by a matrix linking the contributing studies to their specific contribution.

RESULTS

Characteristics of the Included Studies

The fifteen included studies span the period from 2010 to 2026 and reflect a clear acceleration of scholarship, with nine of the fifteen studies (60 percent) published from 2022 onward. The studies are methodologically diverse. Six studies use social surveys, qualitative interviews, or mixed methods; three are climatological or climate-modelling analyses; two apply geospatial and hydrological modelling; three are evidence syntheses or flood-risk-management analyses; and one is a policy desk study. The distribution by hazard focus is uneven and itself informative. Ten of the fifteen studies (67 percent) centre on flooding, whether pluvial or coastal, whereas only one focuses primarily on extreme heat and one primarily on coastal erosion and sea-level rise, with the remaining three addressing climate trends or multiple hazards together. This imbalance signals that flooding has absorbed most research effort while heat, despite robust evidence of its intensification, remains comparatively understudied. The distribution is summarised in *Table 2*.

Table 2: Distribution of Included Studies by Design, Period, and Primary Hazard Focus

Characteristic	Category	Studies (n)
Study design	Social survey, qualitative, or mixed methods	6
	Climatological or climate-modelling analysis	3
	Geospatial or hydrological modelling	2
	Evidence synthesis or risk-management analysis	3
	Policy or desk analysis	1
Publication period	2010 to 2016	4
	2017 to 2021	2
	2022 to 2026	9
Primary hazard focus	Flooding (pluvial or coastal)	10
	Coastal erosion or sea-level rise	1
	Extreme heat	1
	Climate trends or multiple hazards	3

Five analytical themes were developed, and they structure the remainder of the results. The first two characterise the problem, namely the compounding hazard drivers and the social production of vulnerability. The third concerns how vulnerability is assessed and where it concentrates. The final two address the response, distinguishing structural and engineering adaptation from ecosystem-based, institutional, and community adaptation. Each theme is presented as a synthesis followed by a matrix that names every contributing study and its specific contribution.

Theme 1: Compounding Hazard Drivers and Climatic Trends

The evidence consistently frames Lagos as exposed not to a single hazard but to a stack of interacting drivers. On the climatological side, trend analyses establish that the city's temperature and rainfall regimes have measurably shifted, providing the observational basis for treating recurrent risk as a real and changing phenomenon rather than an assumption (Sojobi et al., 2016). Rainfall behaviour is heterogeneous in space and season, with rising dry-season totals and station-dependent annual signals indicating that the rainfall hazard varies within the city itself (Njoku et al., 2023). Heat constitutes a distinct and intensifying driver, since modelling demonstrates that the nocturnal urban heat island strengthened over three decades and that the area experiencing elevated warming expanded markedly between 1984 and 2016 (Bassett et al., 2020). On the coastal side, scenario simulation shows that progressive sea-level rise inundates low-lying settlements as a slow-onset complement to episodic rainfall flooding (Adegun, 2023).

Importantly, the finding shows that these drivers do not act on a passive landscape. Land-use change is repeatedly identified as the mechanism that converts hazard into exposure, as the loss of forests and water bodies erodes the natural buffers that once absorbed floodwaters, and as built-up land is projected to dominate the metropolis within decades (Aniramu et al., 2026). The direct coupling of rapid urban expansion with rising flood occurrence reinforces this point, positioning urbanisation as a primary amplifier of the rainfall hazard (Dossa et al., 2025). The recurrent character of flooding and the shortcomings of prevailing responses are documented alongside these drivers (Adelekan, 2016). Theme 1 therefore answers the first review question by establishing a compound, partly human-made hazard profile.

Table 3: Studies Contributing to Theme 1

Study	Contribution to Theme
Sojobi, Balogun & Salami (2016)	Detected statistically grounded shifts in Lagos temperature and rainfall regimes, anchoring the recurrent-risk premise in observed data.
Njoku et al. (2023)	Applied modified Mann-Kendall and Sen's slope tests to 1984 to 2013 rainfall, finding heterogeneous trends and rising dry-season totals, underscoring intra-urban variability in the rainfall hazard.
Bassett, Young, Blair, Samreen & Simm (2020)	Modelled three decades of urban heat island growth, showing intensified nocturnal heat and a several-fold expansion of the area exceeding one degree of warming, establishing heat as a distinct driver.
Adegun (2023)	Simulated 0.5 to 2 metre sea-level-rise scenarios over an informal settlement, evidencing progressive coastal inundation as a slow-onset driver.
Aniramu, Iyanda & Orimoogunje (2026)	Linked land-use change to flood hazard, quantifying loss of natural buffers and projecting built-up dominance by 2050, showing how urban transformation manufactures exposure.
Dossa et al. (2025)	Established a direct relationship between rapid urban expansion and increased flood occurrence, identifying urbanisation as a primary amplifier of the rainfall hazard.
Adelekan (2016)	Identified the hydrological and urban factors driving recurrent flooding and the shortcomings of prevailing management.

Theme 2: The Social Production of Vulnerability

A second, equally consistent finding is that vulnerability in Lagos is socially produced and unevenly distributed. The earliest survey evidence established that poor coastal communities experience a multidimensional vulnerability rooted in inadequate drainage and layered deprivation rather than in hazard exposure alone (Adelekan, 2010). Read through a sustainable-livelihoods lens, flooding is shown to erode the very assets on which the urban poor depend, compounding deprivation and constraining recovery (Ajibade et al., 2013). Within flood-prone slums, residents cope with minimal resources, revealing both the resourcefulness and the precarity of autonomous adaptation (Adegun, 2022). The same dynamic recurs in coastal informal settlements, where the severity of flood damage to the built and natural environment is tied directly to conditions of informality (Adegun, 2023).

The political dimension of this production is made explicit by interview-based work showing that flood vulnerability is differentiated by income, tenure, and the activities of landowners, and that the failure of the state to provide services and protection actively shapes who is at risk (Ekoh & Teron, 2023). Syntheses of the coastal evidence converge on the same conclusion, identifying the segments of the population whose social conditions heighten their susceptibility (Ndimele et al., 2024), while spatial analysis frames the resulting pattern as one of inequity, in which uneven exposure tracks the geography of urban growth (Dossa et al., 2025). Theme 2 thus answers the second review question by locating vulnerability less in nature than in the distribution of poverty, tenure, and governance.

Table 4: Studies Contributing to Theme 2

Study	Contribution the Theme
Adelekan (2010)	Showed that poor coastal communities experience multidimensional vulnerability driven by inadequate drainage and deprivation rather than exposure alone.
Ajibade, McBean & Bezner-Kerr (2013)	Used the sustainable-livelihoods framework to show how floods erode the assets of the urban poor and constrain recovery.
Adegun (2022)	Documented the limited coping capacities of residents in a flood-prone coastal slum, revealing adaptation undertaken with minimal resources.
Adegun (2023)	Found significant flood damage to the built and natural environment, tying impact severity to conditions of informality.
Ekoh & Teron (2023)	Demonstrated through 21 resident interviews that vulnerability is differentiated by income, tenure, and landowner activity, and that state failure shapes risk.
Ndimele et al. (2024)	Synthesised the population segments most exposed and the social conditions that heighten their susceptibility.
Dossa et al. (2025)	Highlighted spatial inequity in flood resilience, linking uneven exposure to patterns of urban growth.

Theme 3: Spatial Patterning and Assessment of Vulnerability

A third theme concerns how vulnerability is measured and where it concentrates. Geospatial and hydrological modelling has become the dominant assessment idiom, integrating multi-date satellite imagery, rainfall-runoff simulation, and predictive land-cover modelling to map current and future flood hotspots and to quantify inundation under alternative land-use trajectories (Aniramu et al., 2026). At the settlement scale, mapping of land-use and land-cover change over three decades pinpoints where exposure is intensifying within informal coastal areas (Adegun, 2023), while metropolitan-scale analysis traces the spatial coupling of urban expansion and flood occurrence (Dossa et al., 2025).

These primary assessments are reinforced by syntheses that aggregate the locations repeatedly flagged as most at risk. Review evidence identifies consistently high-vulnerability districts within the central urban core and

benchmarks existing resilience structures against them (Orimoogunje & Aniramu, 2025), and collates the low-lying and lagoon-margin segments that recur across studies as the most flood-prone (Ndimele et al., 2024). The convergence of independent methods on the same hotspots strengthens confidence in the spatial diagnosis, and it provides a concrete geography for targeting adaptation, which is the subject of the final two themes.

Table 5: Studies Contributing to Theme 3

Study	Contribution to Theme
Aniramu, Iyanda & Orimoogunje (2026)	Integrated multi-date imagery, HEC-HMS hydrological modelling, and Markov prediction to map current and future flood hotspots and quantify inundation under land-use scenarios.
Adegun (2023)	Mapped land-use and land-cover change from 1990 to 2020 to locate intensifying exposure within an informal coastal settlement.
Dossa et al. (2025)	Analysed the spatial coupling of urban expansion and flood occurrence across the metropolis.
Orimoogunje & Aniramu (2025)	Identified consistently high-vulnerability locations within the central urban districts and benchmarked resilience structures against them.
Ndimele et al. (2024)	Collated the low-lying and lagoon-margin segments repeatedly identified as the most flood-prone.

Theme 4: Structural and Engineering Adaptation and Its Limits

Turning to the response, the findings shows that adaptation in Lagos has been dominated by structural and engineering measures, and that their record is mixed. The most prominent intervention, the Eko Atlantic City reclamation, is read critically as an elite-serving project that can transfer risk and displace low-income residents, which reframes flagship engineering as a potential source of maladaptation rather than an unambiguous defence (Ajibade, 2017). Syntheses catalogue the broader structural repertoire, including shoreline-protection works and large-scale drainage, while also recommending that development of flood-prone land be halted, an implicit acknowledgement that hard defences alone are insufficient (Ndimele et al., 2024). Assessments of structural strategies such as drainage improvement find that weak enforcement and fragmented implementation blunt their effectiveness (Orimoogunje & Aniramu, 2025).

Complementary analyses reinforce these limits. Reviews of prevailing flood-risk-management practice document persistent shortcomings and advocate model- and remote-sensing-based approaches to target investment more intelligently (Adelekan, 2016). Sectoral policy analysis finds that grey and infrastructural measures, including bus rapid transit and light rail, remain modest and uncoordinated at the city scale (Abubakar et al., 2025). Projections of future inundation are used to argue that current defences are inadequate and that a more anticipatory, robust disaster-reduction framework is required (Aniramu et al., 2026). Theme 4 therefore answers part of the third review question by showing that structural adaptation, while necessary, is neither sufficient nor reliably equitable.

Table 6: Studies Contributing to Theme 4

Study	Contribution to Theme
Ajibade (2017)	Critiqued the Eko Atlantic City project as elite-serving and potentially maladaptive, transferring risk and displacing low-income residents.
Ndimele et al. (2024)	Catalogued structural responses including shoreline protection and large-scale drainage, alongside a recommendation to halt flood-plain development.
Orimoogunje & Aniramu (2025)	Assessed structural strategies such as drainage improvement and found weak enforcement and fragmented implementation limit their effectiveness.

Adelekan (2016)	Reviewed prevailing flood-risk-management practices and shortcomings, advocating model- and remote-sensing-based approaches.
Abubakar et al. (2025)	Assessed grey and infrastructural measures across five sectors, including bus rapid transit and light rail, finding city-level efforts modest and uncoordinated.
Aniramu, Iyanda & Orimoogunje (2026)	Argued from inundation projections for a more robust, anticipatory disaster-reduction framework than current defences provide.

Theme 5: Ecosystem-Based, Institutional, and Community Adaptation

The final theme assembles the alternative and complementary pathways that the evidence increasingly endorses. Ecosystem-based adaptation features prominently, with calls to restore the decimated coastal ecosystems that once provided natural protection and to integrate indigenous water-management knowledge into formal planning (Adegun, 2023). At the household and neighbourhood scale, the evidence identifies prospects for strengthening autonomous coping as a complement to formal measures (Adegun, 2022), and it documents genuinely endogenous resilience built through Community Development Associations, while cautioning that such local agency cannot substitute for governance reform (Ekoh & Teron, 2023).

Pro-poor and institutional measures complete the picture. Survey-based work recommends infrastructure upgrading and livelihood-sensitive interventions to raise the adaptive capacity of the urban poor (Adelekan, 2010; Ajibade et al., 2013). Syntheses advocate a multi-stakeholder mix of non-structural measures, including community-based mitigation, improved waste management, and stronger adaptation policy, and they highlight institutional partnerships and public awareness as resilience levers (Ndimele et al., 2024; Orimoogunje & Aniramu, 2025). Policy analysis positions urban greening, planning enforcement, and stakeholder synergy as central to integrating adaptation with mitigation (Abubakar et al., 2025). Taken together, Theme 5 completes the answer to the third review question by showing that the most promising pathways are integrative, equity-centred, and only partially realised.

Table 7: Studies Contributing to Theme 5

Study	**Contribution to the theme**
Adegun (2023)	Argued that resilience requires restoring decimated coastal ecosystems and integrating indigenous water-management knowledge into planning.
Adegun (2022)	Identified prospects for strengthening autonomous household and community coping as a complement to formal measures.
Ekoh & Teron (2023)	Documented endogenous, community-driven resilience through Community Development Associations, while cautioning these cannot replace governance reform.
Ajibade, McBean & Bezner-Kerr (2013)	Recommended infrastructure upgrading and livelihood-sensitive interventions to build adaptive capacity among the urban poor.
Adelekan (2010)	Called for pro-poor infrastructure upgrading and drainage provision as adaptation priorities.
Orimoogunje & Aniramu (2025)	Advocated a multi-stakeholder mix of non-structural measures, including community-based mitigation, waste management, and stronger adaptation policy.
Ndimele et al. (2024)	Highlighted institutional partnerships such as the 100 Resilient Cities programme and public awareness as resilience levers.
Abubakar et al. (2025)	Positioned urban greening, planning enforcement, and stakeholder synergy as central to integrated adaptation and mitigation.

DISCUSSION

Summary of Findings

This review synthesised fifteen peer-reviewed studies to answer four questions about urban vulnerability and adaptation to recurrent climate risks in Lagos State, and it yields four central insights. First, in answer to the question of drivers, the evidence describes a compound and partly human-made hazard profile in which intensifying rainfall, slow-onset sea-level rise compounded by subsidence, and a strengthening urban heat island interact with rapid land-use change that has stripped the city of its natural flood buffers (Bassett et al., 2020; Sojobi et al., 2016; Aniramu et al., 2026).

Second, in answer to the question of vulnerability, exposure is not distributed by nature but by society, concentrating in low-income informal settlements through the combined operation of poverty, insecure tenure, and the failure of the state to provide services and protection (Adelekan, 2010; Ekoh & Teron, 2023).

Third, in answer to the question of adaptation, the dominant model of protective grey engineering is necessary but insufficient and frequently inequitable, with the flagship reclamation read as maladaptive, while ecosystem-based, institutional, and community-led pathways are demonstrably promising yet under-resourced (Ajibade, 2017; Adegun, 2023; Orimoogunje & Aniramu, 2025).

Fourth, in answer to the integrative question, the physical, spatial, and social literatures point to the same conclusion from different directions, namely that effective adaptation must couple hazard reduction with the deliberate reduction of socially produced vulnerability.

Interpretation Against the Wider Evidence

These findings extend rather than contradict the broader literature. The compound-driver picture aligns with regional assessments that warn of tens of billions of dollars in damages to African coastal cities by mid-century absent adaptation (Africa Center for Strategic Studies, 2023), and with downscaled projections of substantial sea-level rise for the Nigerian coast over the century (Intergovernmental Panel on Climate Change, 2022). What the Lagos evidence adds is the decisive role of local land subsidence, which can make relative sea-level rise outpace the global mean and which is rarely integrated into adaptation planning (Ikuemonisan & Ozebo, 2020).

The interpretation of Eko Atlantic as risk transfer rather than risk reduction is consistent with the wider critique of hard coastal defences, which can displace erosion along the shore even as they protect a single frontage. By contrast, the ecosystem-based pathway that the Lagos studies endorse is supported by global evidence that mangrove and wetland restoration offers cost-effective flood protection that disproportionately benefits low-income coastal populations (Menendez et al., 2026). The convergence is important, because it means the equity-centred direction the Lagos evidence points toward is not idiosyncratic but part of an international reorientation away from purely protective engineering.

Theoretical Contribution

The principal theoretical contribution of this review is to integrate three literatures that have developed in parallel into a single account of how recurrent climate risk becomes uneven harm in Lagos. Drawing on the established conception of vulnerability as a function of exposure, sensitivity, and adaptive capacity, and on political-ecology insights into how risk is produced, the review proposes a compound-risk, differential-vulnerability, and adaptation-pathways framework, shown in *Figure 2*.

The framework reads from left to right. Compounding hazard drivers, namely relative sea-level rise with subsidence, intensifying extreme rainfall, and the growing heat island, do not act on a neutral surface but are mediated by urban transformation, as unplanned growth and the loss of wetlands and forests remove the buffers that would otherwise attenuate them. The drivers, so mediated, generate differential vulnerability, in which exposure follows the low-lying coastal and lagoon-margin geography, sensitivity follows poverty, informality, and insecure tenure, and adaptive capacity is suppressed by weak governance and service deficits. Adaptation pathways then operate on this vulnerability through four channels, namely structural and grey, ecosystem-based

and green, institutional and policy, and community and autonomous. The framework's critical feature is a feedback loop, since outcomes are not only protective but can be maladaptive, as when an engineering response reshapes vulnerability by displacing residents or transferring erosion, returning risk to the social system rather than removing it.

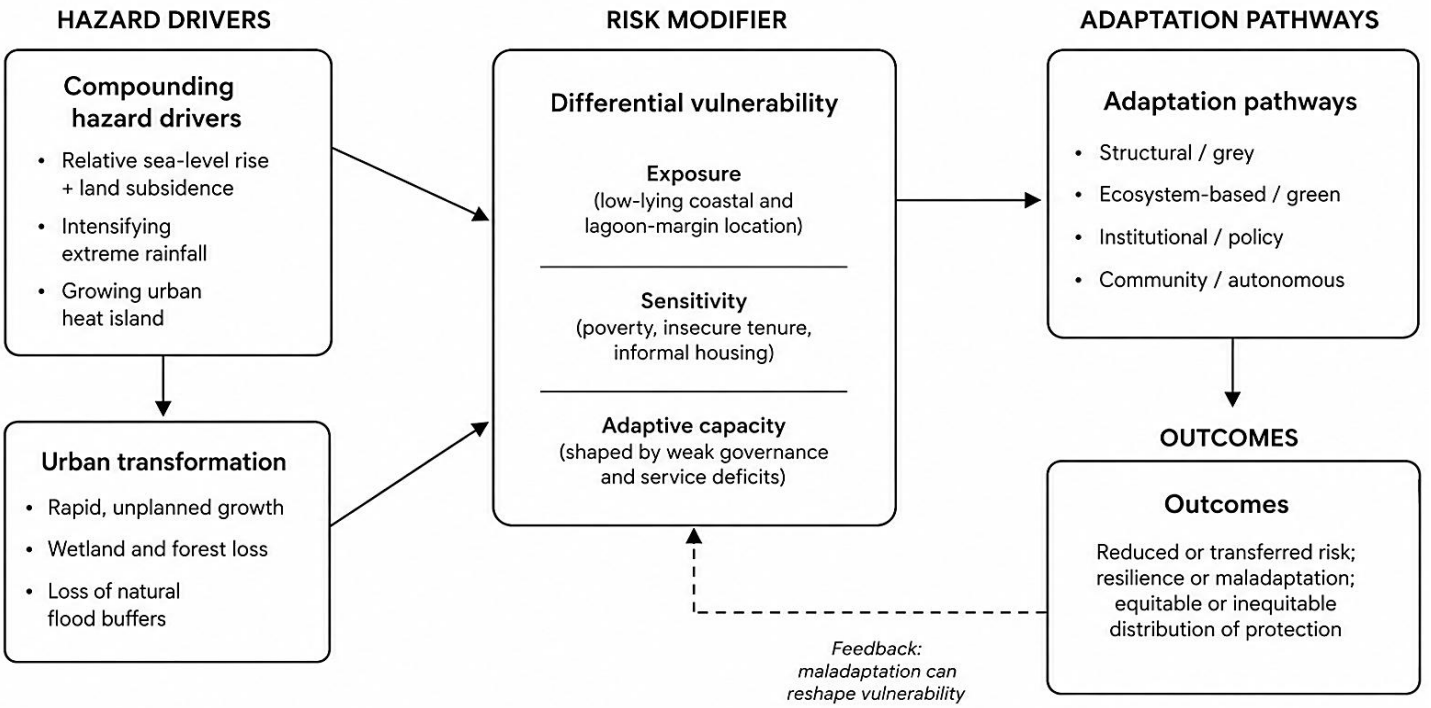

Figure 2: An Integrative Compound-Risk, Differential-Vulnerability, And Adaptation-Pathways (CVAP) Framework for Lagos State

The value of the framework is threefold. It makes explicit that hazard and vulnerability are co-produced, so that adaptation aimed only at the hazard, such as a sea wall, may leave or even worsen the social distribution of harm. It positions the four adaptation pathways as complementary rather than competing, which reframes the structural-versus-transformative debate as a question of integration and sequencing rather than of choosing one over the other. Additionally, it foregrounds the feedback loop, which gives maladaptation a formal place in the model and provides a diagnostic for distinguishing interventions that reduce risk from those that merely relocate it.

Practical and Policy Implications

Several implications follow for those who govern and finance adaptation in Lagos. For state planners, the evidence suggests that investment should shift from single-frontage protective works toward integrated portfolios that pair targeted drainage and shoreline protection with wetland and mangrove restoration, since the latter delivers protection and co-benefits while disproportionately serving the poor. For city authorities, the recurrent finding that weak enforcement and fragmented implementation undermine otherwise sound strategies implies that the binding constraint is institutional rather than technical, so that strengthening development control, halting construction on flood-prone land, and coordinating across agencies may yield more risk reduction per unit of spending than new megaprojects.

For policymakers concerned with equity, the demonstration that vulnerability is socially produced means that adaptation and poverty reduction are not separable agendas, and that secure tenure, basic-service provision, and the formal inclusion of Community Development Associations in planning are themselves adaptation measures. For development partners, the maladaptation feedback identified here argues for appraising flagship projects against a distributional test, asking not only whether risk falls overall but whether it falls for the most exposed. Finally, the relative neglect of heat in the research base should not be read as a neglect of heat in reality, and city heat-action planning, including urban greening and cool-roof programmes, deserves the same priority that flooding now commands.

Limitations and Future Research

Several limitations qualify these conclusions, and each points to a research priority. First, restricting the synthesis to peer-reviewed, English-language studies, while protecting evidentiary quality, may understate knowledge held in agency reports, theses, and non-English outlets, and it concentrates the corpus on flooding; future syntheses could incorporate appraised grey literature and, in particular, build the thin evidence base on extreme heat and on health outcomes.

Second, the corpus is modest in size and dominated by case studies and reviews, which limits generalisation and precludes meta-analysis; primary comparative studies across multiple local government areas, using shared vulnerability indicators, would allow firmer quantitative synthesis. Third, the physical, geospatial, and social literatures still rarely speak to one another within single studies, so the integration achieved here at the level of synthesis has yet to be achieved at the level of primary research; coupled assessments that link subsidence-adjusted sea-level rise, hydrological modelling, and household-level social vulnerability across all twenty local government areas would directly test the framework proposed in *Figure 2*.

Fourth, almost no included study evaluates adaptation outcomes longitudinally, so the field knows far more about vulnerability than about what works; rigorous, before-and-after evaluation of specific interventions, including the contested reclamation and any future ecosystem-based schemes, is the most pressing gap. Addressing these priorities would convert the integrative account offered here into a tested basis for equitable, transformative adaptation in Lagos and in comparable coastal megacities of the Global South.

CONCLUSION

Lagos is often described as a city on the front line of climate change, and the peer-reviewed evidence assembled here clarifies what that description means and what it omits. The recurrent risks the city faces are compound and partly self-inflicted, as intensifying rainfall, rising and subsidence-amplified seas, and a hardening heat island meet an urban fabric that has paved over its own defences. The harm those risks cause is not distributed by chance but by the geography of poverty, informality, and weak governance, so that the same flood that inconveniences the affluent can dispossess the poor. The dominant response, protective engineering, has too often moved risk rather than removed it, while the ecosystem-based, institutional, and community pathways that the evidence increasingly favours remain promising but starved of investment. The contribution of this review is to show that these strands are one story, and to offer a framework in which hazard reduction and the reduction of socially produced vulnerability are pursued together rather than apart. What the field now knows that it did not know as clearly before is that adaptation in Lagos will be judged not by how high its walls stand, but by whether the people most exposed to the water and the heat are any safer because of them.

REFERENCES

1. Abubakar, I. R., Onyebueke, V. U., Lawanson, T., Barau, A. S., & Bununu, Y. A. (2025). Urban planning strategies for addressing climate change in Lagos megacity, Nigeria. *Land Use Policy, 153*, 107524. https://doi.org/10.1016/j.landusepol.2025.107524
2. Adegun, O. B. (2022). Climatic disasters within a flood-prone coastal slum in Lagos: Coping capacities and adaptation prospects. *International Journal of Disaster Resilience in the Built Environment, 14*(2), 212–228. https://doi.org/10.1108/IJDRBE-11-2021-0154
3. Adegun, O. B. (2023). Flood-related challenges and impacts within coastal informal settlements: A case from Lagos, Nigeria. *International Journal of Urban Sustainable Development, 15*(1), 1–3. https://doi.org/10.1080/19463138.2022.2159415
4. Adelekan, I. O. (2010). Vulnerability of poor urban coastal communities to flooding in Lagos, Nigeria. *Environment and Urbanization, 22*(2), 433–450. https://doi.org/10.1177/0956247810380141
5. Adelekan, I. O. (2016). Flood risk management in the coastal city of Lagos, Nigeria. *Journal of Flood Risk Management, 9*(3), 255–264. https://doi.org/10.1111/jfr3.12179
6. Africa Center for Strategic Studies. (2023). *Rising sea levels besieging Africa's booming coastal cities*. https://africacenter.org/spotlight/rising-sea-levels-besieging-africas-booming-coastal-cities-lagos-dakar-alexandria-maputo-nile/

7. Ajibade, I. (2017). Can a future city enhance urban resilience and sustainability? A political ecology analysis of Eko Atlantic City, Nigeria. *International Journal of Disaster Risk Reduction, 26*, 85–92. https://doi.org/10.1016/j.ijdrr.2017.09.029
8. Ajibade, I., McBean, G., & Bezner-Kerr, R. (2013). Climate change and livelihood vulnerabilities of low-income coastal communities in Lagos, Nigeria. *International Journal of Urban Sustainable Development, 6*(1), 42–60. https://doi.org/10.1080/19463138.2013.878348
9. Aniramu, O., Iyanda, O., & Orimoogunje, O. (2026). Remote sensing and GIS-based modelling of land use dynamics and urban flood risk in Lagos megacity for future flood mitigation. *Scientific Reports, 16*, Article 38544. https://doi.org/10.1038/s41598-026-38544-1
10. Bassett, R., Young, P. J., Blair, G. S., Samreen, F., & Simm, W. (2020). The megacity Lagos and three decades of urban heat island growth. *Journal of Applied Meteorology and Climatology, 59*(12), 2041–2055. https://doi.org/10.1175/JAMC-D-20-0059.1
11. Dossa, K. F., Miassi, Y. E., Banco, P. A. C., & Akdemir, S. (2025). Drowning in urban growth: Rethinking flood resilience and spatial equity in Lagos, Nigeria. *Frontiers in Sustainable Resource Management, 4*, 1659930. https://doi.org/10.3389/fsrma.2025.1659930
12. Ekoh, S. S., & Teron, L. (2023). Vulnerable spaces, unequal responses: Lessons for transformative climate resilience in Lagos. *Frontiers in Sustainable Cities, 5*, 929121. https://doi.org/10.3389/frsc.2023.929121
13. FSD Africa. (2025). *Lagos State climate adaptation and resilience plan (LCARP)*. https://fsdafrica.org/publication/lagos-state-climate-adaptation-and-resilience-plan-lcarp/
14. Hanson, S., Nicholls, R., Ranger, N., Hallegatte, S., Corfee-Morlot, J., Herweijer, C., & Chateau, J. (2011). A global ranking of port cities with high exposure to climate extremes. *Climatic Change, 104*(1), 89–111. https://doi.org/10.1007/s10584-010-9977-4
15. Ikuemonisan, F. E., & Ozebo, V. C. (2020). Characterisation and mapping of land subsidence based on geodetic observations in Lagos, Nigeria. *Geodesy and Geodynamics, 11*(3), 151–162. https://doi.org/10.1016/j.geog.2019.12.006
16. Intergovernmental Panel on Climate Change. (2022). *Climate change 2022: Impacts, adaptation and vulnerability*. Cambridge University Press. https://doi.org/10.1017/9781009325844
17. International Organization for Migration. (2024). *Nigeria: Joint post-flood situation report, Lagos State (30 December 2024)*. Displacement Tracking Matrix. https://dtm.iom.int/reports/nigeria-joint-post-flood-situation-report-lagos-state-30-december-2024
18. Lagos State Government. (2021). *Lagos climate action plan: Second five-year plan 2020–2025*. Ministry of the Environment and Water Resources. https://moelagos.gov.ng/wp-content/uploads/2021/09/C40-Lagos_Indesign-Document-Full-Report-Revert-2_Update-2.pdf
19. Menendez, P., Losada, I. J., Beck, M. W., Torres-Ortega, S., & Narayan, S. (2026). Mangrove restoration and coastal flood adaptation: A global perspective on the potential for hybrid coastal defenses. *Proceedings of the National Academy of Sciences, 123*. https://doi.org/10.1073/pnas.2510980123
20. Ndimele, P. E., Ojewole, A. E., Mekuleyi, G. O., Badmos, L. A., Agosu, C. M., Olatunbosun, E. S., Lawal, O. O., Shittu, J. A., Joseph, O. O., Ositimehin, K. M., Ndimele, F. C., Ojewole, C. O., Abdulganiy, I. O., & Ayodele, O. T. (2024). Vulnerability, resilience and adaptation of Lagos coastal communities to flooding. *Earth Science, Systems and Society, 4*, 10087. https://doi.org/10.3389/esss.2024.10087
21. Njoku, C. A., Daramola, M. T., Tofu, D. A., Ifabiyi, I. P., & Anjorin, A. (2023). Analysis of rainfall trend and variability in Lagos, southwestern Nigeria. In *Sustainable development goals series* (pp. 1–14). Springer. https://doi.org/10.1007/978-3-031-21007-5_7
22. Orimoogunje, O., & Aniramu, O. (2025). Systematic review of flood resilience strategies in Lagos Metropolis: Pathways toward the 2030 sustainable development agenda. *Frontiers in Climate, 7*, 1603798. https://doi.org/10.3389/fclim.2025.1603798
23. Sojobi, A. O., Balogun, I. I., & Salami, A. W. (2016). Climate change in Lagos State, Nigeria: What really changed? *Environmental Monitoring and Assessment, 188*(10), 586. https://doi.org/10.1007/s10661-016-5549-z

APPENDIX

Appendix A: Search Strings

Searches were run in June 2026. Each string was adapted to the syntax of the host interface; truncation symbols and field tags follow each platform's conventions. The three concept blocks are the place block, the hazard block, and the response block, combined with the Boolean operator AND.

Scopus (Title-Abstract-Keyword), run 3 June 2026:

TITLE-ABS-KEY ("Lagos" AND (flood* OR "sea-level rise" OR "coastal erosion" OR "storm surge" OR heat OR "urban heat" OR "climate change" OR "climate variability") AND (vulnerab* OR resilien* OR adapt* OR "risk"))

Web of Science (Topic), run 3 June 2026:

TS = (Lagos AND (flood* OR "sea level rise" OR "coastal erosion" OR "storm surge" OR heat* OR "climate change" OR "climate variability") AND (vulnerab* OR resilien* OR adapt* OR risk))

Google Scholar (advanced, title and full text), run 4 June 2026:

Lagos ("climate change" OR flooding OR "sea-level rise" OR "urban heat") (vulnerability OR resilience OR adaptation), 2010–2026

Note: Strings are reported so the search can be reproduced; date ranges were applied within each interface.

Appendix B: Characteristics of All Included Studies

Study	Design	Setting	Sample or Data	Key Findings
Adelekan (2010)	Questionnaire survey	Poor coastal communities, Lagos	Household survey respondents	Multidimensional vulnerability of poor coastal residents driven by inadequate drainage and deprivation; pro-poor upgrading recommended.
Ajibade, McBean & Bezner-Kerr (2013)	Survey, livelihoods framework	Low-income coastal communities	Household survey	Floods erode livelihood assets of the urban poor; multiple deprivations compound vulnerability and constrain recovery.
Adelekan (2016)	Flood-risk management analysis	Coastal city of Lagos	Documentary and institutional analysis	Identifies flooding drivers and management shortcomings; advocates model- and remote-sensing-based approaches.
Sojobi, Balogun & Salami (2016)	Climatological trend analysis	Lagos State	Multi-decadal meteorological records	Detects measurable shifts in temperature and rainfall regimes.
Ajibade (2017)	Political-ecology case study	Eko Atlantic City and Victoria Island	Documentary, policy, and field analysis	Critiques flagship coastal engineering as elite-serving and potentially maladaptive, displacing the poor.
Bassett, Young, Blair, Samreen & Simm (2020)	Numerical climate (WRF) modelling	Lagos metropolis	1984-2016 land-use and reanalysis data	Nocturnal urban heat island intensified; area exceeding one degree of warming expanded from 254 to 1,572 square kilometres.
Adegun (2022)	Qualitative case study	Flood-prone coastal slum	Residents	Limited coping capacities; adaptation pursued with minimal resources; prospects for strengthening autonomous coping.
Ekoh & Teron (2023)	Qualitative interviews (urban political ecology)	Mainland and island Lagos	21 residents (telephone interviews)	Vulnerability differentiated by income, tenure, and landowner activity; state failure shapes risk; endogenous resilience via CDAs.
Adegun (2023)	Mixed methods and GIS	Coastal informal settlement	14 interviews; 300-resident survey; LULC	Significant flood impacts on built and natural environment; calls for ecosystem restoration and integration of indigenous systems.

Study	Design	Setting	Sample or Data	Key Findings
			1990-2020; SLR 0.5-2 m simulation	
Njoku et al. (2023)	Rainfall trend and variability analysis	Two Lagos stations	1984-2013 monthly rainfall	Heterogeneous trends; rising dry-season rainfall; station-dependent annual signals.
Ndimele et al. (2024)	Systematic review (PICO)	Lagos coastal communities	Peer-reviewed and documentary corpus	Synthesises vulnerability, resilience, and adaptation; recommends shoreline protection, large-scale drainage, halting flood-plain development, and resilience partnerships.
Orimoogunje & Aniramu (2025)	Systematic review	Lagos metropolis	Peer-reviewed corpus	Evaluates flood-resilience strategies against the 2030 agenda; finds weak enforcement, limited community engagement, and ineffective early warning; urges multi-stakeholder mix.
Dossa et al. (2025)	Geospatial analysis	Lagos metropolis	Remote-sensing and urban-growth data	Rapid urban expansion drives increased flood occurrence; flags spatial inequity in resilience.
Abubakar et al. (2025)	Policy desk research	Lagos megacity	Literature and secondary data across five UN-Habitat sectors	City-level adaptation and mitigation at an early stage; urban greening, transport, and planning enforcement under-used; calls for stakeholder synergy.
Aniramu, Iyanda & Orimoogunje (2026)	Remote sensing, HEC-HMS, Markov modelling	Lagos megacity	Landsat 1984/2002/2023; Sentinel-2; hydro-climatic data	Forest and water-body loss reduced flood buffers; built-up area projected to dominate by 2050; maps current and future flood hotspots.

Note: Compiled from the 15 included studies. CDAs = Community Development Associations; LULC = land use and land cover; SLR = sea-level rise; WRF = Weather Research and Forecasting model.

Appendix C: Full-Text Records Excluded, With Reasons

Sixty-two full-text records were assessed and excluded. The reasons are summarised below by category; the complete record-level list is retained in the review file and is available on request.

Reason for exclusion at full-text stage	Records (n)
Not specific to Lagos State (national or other-city focus)	21
Outside the climate-risk or adaptation scope	17
Not peer-reviewed (reports, theses, preprints, editorials)	14
No extractable findings on drivers, vulnerability, or adaptation	10

Note: Totals correspond to the full-text exclusions shown in Figure 1.

Appendix D: Data-Extraction Form and Quality Appraisal

D.1 Data-Extraction Form (Fields)

Each included study was charted on a standardised form capturing the following fields: (1) author and year; (2) journal or source and document type; (3) study design and methods; (4) setting within Lagos; (5) sample, data sources, and study period; (6) climate risks addressed; (7) vulnerability dimensions examined; (8) adaptation strategies examined; (9) key findings; and (10) appraisal notes. The completed charting is reproduced in Appendix B.

D.2 Indicative Quality Appraisal (Mixed Methods Appraisal Tool)

All fifteen studies passed the two MMAT screening questions, namely clear research questions and data that address them. The indicative overall ratings below reflect design transparency and methodological completeness

ISSN No. 2454-6186 | DOI: 10.47772/IJRISS | Volume X Issue VI June 2026

and should be confirmed against the full MMAT criteria when this corpus is extended.

Study	MMAT Category	Indicative Quality
Adelekan (2010)	Quantitative descriptive	High
Ajibade, McBean & Bezner-Kerr (2013)	Mixed methods	High
Adelekan (2016)	Qualitative or analytic review	Moderate
Sojobi, Balogun & Salami (2016)	Quantitative descriptive	High
Ajibade (2017)	Qualitative	High
Bassett, Young, Blair, Samreen & Simm (2020)	Quantitative (modelling)	High
Adegun (2022)	Qualitative	Moderate
Ekoh & Teron (2023)	Qualitative	High
Adegun (2023)	Mixed methods	High
Njoku et al. (2023)	Quantitative descriptive	Moderate
Ndimele et al. (2024)	Systematic review	High
Orimoogunje & Aniramu (2025)	Systematic review	High
Dossa et al. (2025)	Quantitative (geospatial)	Moderate
Abubakar et al. (2025)	Qualitative or analytic review	Moderate
Aniramu, Iyanda & Orimoogunje (2026)	Quantitative (modelling)	High

Note: Ratings are indicative of design transparency and completeness and are to be confirmed against the full Mixed Methods Appraisal Tool criteria.