Multilayered Vulnerability Assessment Handbook: Resilience planning for urban, biodiversity and climate action

Under the Resilient Settlements for the Urban Poor (RISE UP) Flagship Programme

United Nations Human Settlements Programme (UN-Habitat)

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Cover image: The vibrant, sprawling Comuna 13 informal settlement on the Western hills of Medellín, Colombia. Lee Michael Lambert, 2024.

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List of Abbreviations

AECID	Spanish Agency for International Development and Cooperation
AR6	Intergovernmental Panel on Climate Change's Sixth Assessment Report
CapEX	Capital expenditure
CCRVA	Climate change risk and vulnerability assessment
CRD	Climate resilient development
CRPT	City Resilience Profiling Tool
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSO	Civil society organization
EbA	Ecosystem-based adaptation
EO	Earth observation
ESRI	Environmental Systems Research Institute
GeoJSON	Geographic JavaScript object notation
GeoTIFF	Geographic tagged image file format
GIS	Geographic information systems
GCF	Green Climate Fund
GCoM	Global Covenant of Mayors for Climate and Energy
GDAL	Geospatial Data Abstraction Library
GLOBIO	Global biodiversity model for policy support
IAP2	International Association for Public Participation
ICLEI	Local Governments for Sustainability
IPBES	The Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
KML	Key markup language
KPI	Key performance indicator
LDCs	Least developed countries
LGU	Local governmental unit
LiDAR	Light detection and ranging
MCA	Multicriteria analysis
MEL	Monitoring, evaluation and learning
MVA	Multilayered Vulnerability Assessment
NAP	National Adaptation Plan
NDC	Nationally Determined Contributions
NbS	Nature-based solutions

NGO	Non-governmental organization
OpEx	Operational expenditure
OSM	OpenStreetMap
PR	Public relations
NASA	National Aeronautics and Space Administration
QA	Quality assurance
QC	Quality control
RACI	Responsible, accountable, consulted and informed
RCP	Representative Concentration Pathway
RISE UP	Resilient Settlements for the Urban Poor
SEP	Stakeholder Engagement Plan
SHP	Shapefile
SIDA	Swedish International Development Cooperation Agency
SIDS	Small island developing states
SOP	Standard operating procedure
SSP	Shared Socioeconomic Pathway
SURGe	Sustainable Urban Resilience for the Next Generation
SWOT	Strengths, weaknesses, opportunities and threats
TIFF	Tagged image file format
TOR	Terms of reference
UKCP	United Kingdom Climate Projections
UN	United Nations
UNEP	United Nations Environment Programme
UNEP-WCMC	United Nations Environment Programme World Conservation Monitoring Centre
UNDRR	United Nations Office for Disaster Risk Reduction
UN-Habitat	United Nations Human Settlements Programme
UNITAR	United Nations Institute for Training and Research
UNOSAT	United Nations Satellite Centre
UNSDCF	United Nations Sustainable Development Cooperation Framework
USD	United States Dollar
UVA	Urban Vulnerability Atlas

Foreword

The rapid pace of urbanization, compounded by the escalating impacts of climate change and biodiversity loss, is creating challenges for cities like never before. As cities grapple with these crises, housing insecurity and homelessness are becoming more pronounced, with vulnerable populations disproportionately affected by climate risks and displacement. Addressing these interconnected vulnerabilities requires integrated, forward-thinking approaches that consider the full spectrum of factors affecting urban resilience, including the urgent need for safe, affordable housing.

This Handbook on assessing multilayered urban, climate change, and biodiversity vulnerabilities and preparing urban climate resilience action plans has been developed under the **Resilient Settlements for the Urban Poor (RISE UP)** programme. It serves as a step-by-step guide to understanding, analysing, and visualizing hotspots of vulnerabilities while preparing responsive urban climate resilience action plans. Developed to support city planners, policymakers, and practitioners, this Handbook provides a robust framework for conducting comprehensive vulnerability assessments. It emphasizes the need to account for urban, social, environmental and climate dimensions simultaneously.

The RISE UP programme mobilizes substantial investments to empower cities in effectively adapting to climate change and enhancing urban resilience. In line with this initiative, UN-Habitat remains committed to enabling cities to take the lead on climate action and sustainable development. This Handbook is an orientation tool, as it is very important to recognize and adapt the proposed methodology to realities on the ground, such as pre-existing participation mechanisms and trajectories and knowledge built by social organizations and academia, multilevel governance and institutional arrangements. This is aimed to be a flexible tool, that should and need to be adapted to the diversity of contexts globally and with respect to existing social, political dynamics as well as policy frameworks. By integrating geographic information systems, geospatial data analysis, and stakeholder engagement, the guidance herein promotes both data-driven decision-making and ecosystem-based solutions and pathways that enhance both human and ecological well-being.

This Handbook is a valuable resource for cities worldwide as they forge pathways toward a more resilient and sustainable urban future.

Anacláudia Rossbach
United Nations Under-Secretary-General and
Executive Director of UN-Habitat

Executive summary

The climate emergency is a profoundly urban crisis that significantly impacts all aspects of urban life. At present, over 55 per cent of the world's population live in cities and it is expected that this will increase to over 65 per cent by 2030.[1] Owing to major population growth and projected urban expansion in the African and Asian continents, another 2.5 billion people will be living in cities. Surging global temperatures, rising sea level rises, and increasing incidences of extreme weather events are just some climatic trends that are having costly impacts on cities' infrastructure, basic services, housing, economic growth, and the livelihoods, health, and wellbeing of citizens.[2] These issues are compounded by other urban challenges, such as rapid urbanization and population growth, rural to urban migration, urban poverty escalation, rising inequality, and biodiversity degradation.[3] Addressing these issues through systemic urban climate resilient development is one of the greatest challenges cities and governments in the global south face.

Currently, more than 90 per cent of cities are located in the world's 36 biodiversity hotspots and are expanding in direct conflict with biodiversity and climate risk.[4] Urban growth and the conversion of natural habitat for human habitation is causing significant biodiversity degradation and nature loss.[5] This is further exacerbated by the impact of climate hazards. Cities are increasingly recognizing the role that spatial planning and urban land management strategies have in the protection and conservation of landscapes, natural assets, and ecosystems. This can provide numerous co-benefits for people and planet.[6] and is also critical to strengthening climate resilience and preventing the destruction of human settlements whose physical and socioeconomic infrastructure fundamentally depends on the social, economic and cultural ecosystem services that biodiversity provides.[7] There is a clear opportunity to improve spatial planning and catalyze investment in targeted climate resilient, pro-biodiversity interventions within and beyond cities and this requires effective tools.

In a rapidly urbanizing world increasingly shaped by the climate emergency, **Resilient Settlements for the Urban Poor (RISE UP)** is UN-Habitat's flagship programme mobilizing significant climate resilient investment for a better urban future for all. Through the support of several organizations, including the Adaptation Fund and Green Climate Fund (GCF), the Spanish Agency for International Development and Cooperation (AECID), Swedish International Development Cooperation Agency (Sida), RISE UP has mobilized over 150 million USD to accelerate global climate action helping cities most in need adapt to the changing climate. Since its inception in 2019, the RISE UP flagship programme operates globally with projects in 28 countries, including in developing countries, least developed countries (LDCs) and small island island developing states (SIDs), demonstrating UN-Habitat's commitment to creating resilient and equitable urban futures amidst climate challenges.

Under the RISE UP Flagship Programme, UN-Habitat takes a multidimensional, multidisciplinary approach to understanding and addressing the aforementioned issues in cities and has focused efforts on building resilience for the one billion urban poor living in informal settlements. These fragile and marginalized communities are often trapped at the intersection between unplanned, inefficient urban expansion,

1 United Nations Department of Social Affairs. World Population Prospects. 2022. New York. Available at: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_summary_of_results.pdf

2 UNEP Finance Initiative. 2024 Climate Risk Landscape Report. 2024. Geneva. Available at: https://www.unepfi.org/wordpress/wp-content/uploads/2024/04/Climate-Risk-Landscape-2024.pdf

3 UN-Habitat. World Cities Report 2022: Envisaging the Future of Cities. 2022. Nairobi. Available at: https://unhabitat.org/world-cities-report-2022-envisaging-the-future-of-cities.

4 UN-Habitat. White Paper. Cities and Nature: Planning for the Future. 2022. Nairobi. Available at: https://unhabitat.org/sites/default/files/2022/12/white_paper_cities_and_nature_rev2.pdf

5 United Nations Environment Programme. Nature-based Solutions for Urban Challenges. Nairobi. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/35864/FB023.pdf

6 World Bank. Urban Nature and Biodiversity for Cities. Policy Brief. 2021. Available at https://www.thegpsc.org/sites/gpsc/files/final_urban_nature_and_biodiversity_for_cities.pdf

7 UN-Habitat. White Paper. Cities and Nature: Planning for the Future. 2022. Nairobi. Available at: https://unhabitat.org/sites/default/files/2022/12/white_paper_cities_and_nature_rev2.pdf

and vulnerable natural habitat, leaving them highly susceptible to climate hazards and disaster risks.[8]

Thus, understanding the how to plan for urban resilience needs a systemic approach considering not only urban pressure points, but also climate impacts and risks, biodiversity degradation due to spatial urban expansion and other socio-economic dimensions. The overlay of these dimension is the backbone of the multilayered vulnerability assessment methodology used in this Handbook.

Multilayered vulnerability in the context refers to the degree which an urban system, community, region, ecosystem, or species is exposed and sensitive to, and unable to cope with and respond to the adverse impacts of interrelated climate change, urbanization, and biodiversity loss conditions and challenges. Multilayered vulnerability is influenced by a combination of factors, such as geographical location, socio-economic characteristics, infrastructure, and governance. The aggregation of multiple and cascading vulnerabilities exacerbates existing overall susceptibility, risk, and adaptive capacity of people, infrastructure, and environment[9] . In confronting these diverse challenges, cities must build and strengthen urban, social, economic and ecological resilience to climate change which requires comprehensive and integrated urban planning and management strategies.

The Multilayered Vulnerability Assessment (MVA) tool addresses the nexus between climate change hazards and risks, urbanization and spatial trends, socioeconomic characteristics, and biodiversity loss and land degradation to identify, map and assess vulnerability hotspots arising from spatial overlaps and interrelations. The development of the MVA tool was an extensive, 1.5-year process that involved multiple stages of research, review, iteration, and collaboration engaging over 100 experts of 15 different organizations. The purpose of the MVA is to help communities, cities, and local leaders to map and assess multilayered vulnerabilities more comprehensively and to operationalize a robust data-driven framework for the precise identification, quantification, and spatial mapping of climate, urban and biodiversity vulnerabilities. It is designed to support advanced vulnerability assessment, inform evidence-based decision-making through integrated geospatial analysis, and enhance urban climate resilience policymaking, programming and investment.

The methodology of the MVA is structured into three key stages, each with corresponding steps and activities designed to systematically guide the assessment process. The first stage, **Preparation,** involves data collection, stakeholder engagement, and the establishment of analytical frameworks. The second stage, **Mapping and analysis,** integrates geospatial data, vulnerability indicators, and stakeholder validation and ground-truthing generate detailed vulnerability maps and analyses. Finally, the third stage, **Intervention planning,** uses the outputs from the analysis to prioritize and design targeted interventions aimed at enhancing climate resilience and reducing identified vulnerabilities of people, infrastructure and ecosystems. Each stage is organized into manageable and sequenced steps and its activities. For each step and activity, there are clearly outlined instructions that include all the necessary information, instructions and resources that users will require.

The main outputs of MVA are designed to provide comprehensive insights and actionable solutions for urban system resilience. These include: **Multilayered Vulnerability Profiles,** which feature detailed assessments of vulnerability hotspots, accompanied by tailored recommendations; **Urban Resilience Action Plans,** offering strategic guidance for cities to enhance climate adaptation; and **3) a pipeline of Bankable Adaptation and Resilience Projects,** which identify and prepare financially viable projects to attract investment and support long-term resilience-building efforts.

8 UN-Habitat. Pro-Poor Climate Action in Informal Settlements. Thematic Guide. 2019. Nairobi. Available at: https://unhabitat.org/sites/default/files/download-manager-files/1553169801wpdm_Pro-poor per cent20Climate per cent20Action per cent20in per cent20Informal per cent20Settlements per cent20- per cent20FINAL.pdf

9 UN-Habitat. Climate Change Vulnerability and Risk: A Guide for Community Assessments, Action Planning, and Implementation. Nairobi. 2020. Available at: https://unhabitat.org/sites/default/files/2020/05/climatechange_vulnerabilityandriskguide.pdf

Children playing at Cigano›s Park, a project developed with the support of UN-Habitat in a precarious settlement of Alagoas, Brazil, © UN-Habitat_Minne Santos

Introduction

Background and context

Climate change, urbanization and biodiversity

The climate emergency is a profoundly urban crisis that significantly impacts all aspects of urban life. At present, over 55 per cent of the world's population live in cities and it is expected that this will increase to over 65 per cent by 2030.[10] Owing to major population growth and projected urban expansion in the African and Asian continents, another 2.5 billion people will be living in cities. Surging global temperatures, rising sea level rises, and increasing incidences of extreme weather events are just some climatic trends that are having costly impacts on cities' infrastructure, basic services, housing, economic growth, and the livelihoods, health, and wellbeing of citizens.[11] These issues are compounded by other urban challenges, such as rapid urbanization and population growth, rural to urban migration, urban poverty escalation, rising inequality, and biodiversity degradation.[12] Addressing these issues through systemic urban climate resilient development is one of the greatest challenges cities and governments in the global south face.

Currently, more than 90 per cent of cities are located in the world's 36 biodiversity hotspots and are expanding in direct conflict with biodiversity and climate risk.[13] Urban growth and the conversion of natural habitat for human habitation is causing significant biodiversity degradation and nature loss.[14] This is further exacerbated by the impact of climate hazards. Cities are increasingly recognizing the role that spatial planning and urban land management strategies have in the protection and conservation of landscapes, natural assets, and ecosystems. This can provide numerous co-benefits for people and planet.[15] and is also critical to strengthening climate resilience and preventing the destruction of human settlements whose physical and socioeconomic infrastructure fundamentally depends on the social, economic and cultural ecosystem services that biodiversity provides.[16] There is a clear opportunity to improve spatial planning and catalyze investment in targeted climate resilient, pro-biodiversity interventions within and beyond cities and this requires effective tools.

UN-Habitat takes a multidimensional, multidisciplinary approach to understanding and addressing the aforementioned issues in cities and has focused efforts on building resilience for the one billion urban poor living in informal settlements. Such populations are arguably the most vulnerable in regard to the adverse impacts of climate change, particularly in least developed countries (LDCs) and small island developing States (SIDs). These fragile and marginalized communities are often trapped at the intersection between unplanned, inefficient urban expansion, and vulnerable natural habitat, leaving them highly susceptible to climate hazards and disaster risks.[17]

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10 United Nations Department of Social Affairs. World Population Prospects. 2022. New York. Available at: https://www.un.org/development/desa/pd/sites/www.un.org.development.desa.pd/files/wpp2022_summary_of_results.pdf

11 UNEP Finance Initiative. 2024 Climate Risk Landscape Report. 2024. Geneva. Available at: https://www.unepfi.org/wordpress/wp-content/uploads/2024/04/Climate-Risk-Landscape-2024.pdf

12 UN-Habitat. World Cities Report 2022: Envisaging the Future of Cities. 2022. Nairobi. Available at: https://unhabitat.org/world-cities-report-2022-envisaging-the-future-of-cities.

13 UN-Habitat. White Paper. Cities and Nature: Planning for the Future. 2022. Nairobi. Available at: https://unhabitat.org/sites/default/files/2022/12/white_paper_cities_and_nature_rev2.pdf

14 United Nations Environment Programme. Nature-based Solutions for Urban Challenges. Nairobi. Available at: https://wedocs.unep.org/bitstream/handle/20.500.11822/35864/FB023.pdf

15 World Bank. Urban Nature and Biodiversity for Cities. Policy Brief. 2021. Available at https://www.thegpsc.org/sites/gpsc/files/final_urban_nature_and_biodiversity_for_cities.pdf

16 UN-Habitat. White Paper. Cities and Nature: Planning for the Future. 2022. Nairobi. Available at: https://unhabitat.org/sites/default/files/2022/12/white_paper_cities_and_nature_rev2.pdf

17 UN-Habitat. Pro-Poor Climate Action in Informal Settlements. Thematic Guide. 2019. Nairobi. Available at: https://unhabitat.org/sites/default/files/download-manager-files/1553169801wpdm_Pro-poor per cent20Climate per cent20Action per cent20in per cent20Informal per cent20Settlements per cent20- per cent20FINAL.pdf

Furthermore, these groups are most often unintentionally contributors to the worsening of these crises through rapid informal urbanization. This is especially pronounced for the urban poor in LDCs and SIDS across the globe.

There is an urgent need to build systemic climate resilience and adaptation in hotspots of urban vulnerability that promotes biodiversity and ecosystems protection, while addressing interconnected issues of climate change, urban poverty, spatial inequality, and informality.[18]

Resilient Settlements for the Urban Poor Flagship Programme (RISE UP)

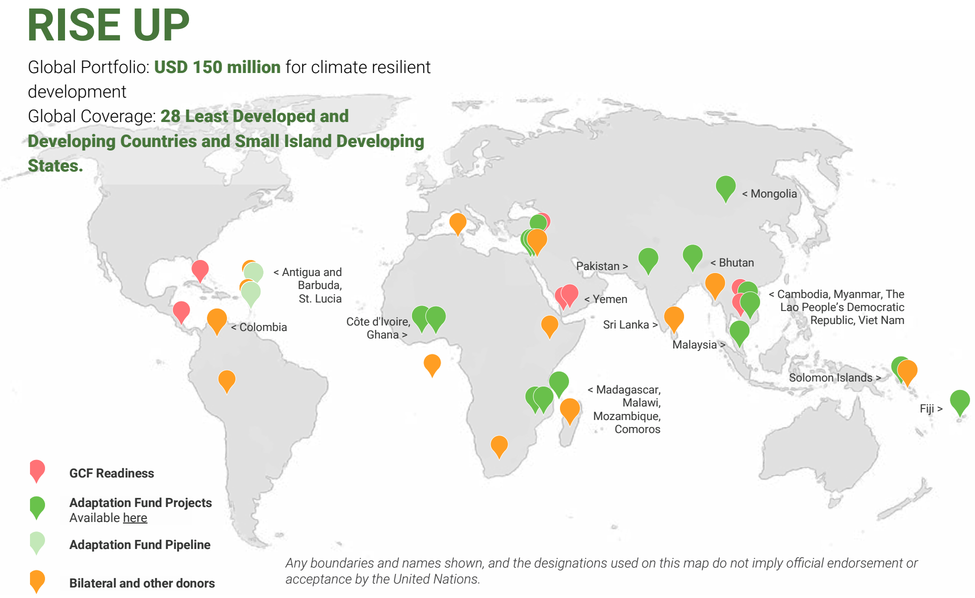
In a rapidly urbanizing world increasingly shaped by the climate emergency, Resilient Settlements for the Urban Poor (RISE UP) is UN-Habitat's flagship programme mobilizing significant climate resilient investment for a better urban future for all. Through the support of several organizations, including the Adaptation Fund and Green Climate Fund (GCF), the Spanish Agency for International Development and Cooperation (AECID), Swedish International Development Cooperation Agency (Sida), RISE UP has mobilized over 150 million USD to accelerate global climate action helping cities most in need adapt to the changing climate. Since its inception in 2019, the RISE UP flagship programme operates globally with projects in 28 countries, including in developing countries, LDCs and SIDS, demonstrating UN-Habitat's commitment to creating resilient and equitable urban futures amidst climate challenges.

Targeting cities most vulnerable and most at need, RISE UP delivers systemic climate resilience projects that successfully support cities to face the climate crisis head-on delivers high-impact projects that help cities through:

FIGURE 1 **RISE UP objectives**
Source: UN-Habitat. 2024.

18 UN-Habitat. Nature-based Solutions to Build Climate Resilience in Informal Areas. 2022. Nairobi. Available at: https://unhabitat.org/strategy-paper-on-nature-based-solutions-to-build-climate-resilience-in-informal-areas

FIGURE 2 **RISE UP global portfolio**
Source: UN-Habitat. 2024.



Why assess multilayered vulnerabilities in cities and urban areas

Multilayered vulnerabilities in cities encompass a wide range of interconnected challenges that cities may face. These vulnerabilities extend beyond physical infrastructure to include all spatial, social, economic, climatic, environmental, political, and technological aspects. For instance, issues like income inequality, environmental degradation, inadequate housing, and insufficient emergency preparedness collectively contribute to a city's multidimensional vulnerabilities.

Multilayered vulnerability in this context refers to the degree which an urban system, community, region, ecosystem, or species is exposed and sensitive to, and unable to cope with and respond to the adverse impacts of interrelated climate change, urbanization, and biodiversity loss conditions and challenges. Multilayered vulnerability is influenced by a combination of factors, such as geographical location, socio-economic characteristics, infrastructure, and governance. The aggregation of multiple and cascading vulnerabilities exacerbates existing overall susceptibility, risk, and adaptive capacity of people, infrastructure, and environment.[19] In confronting these diverse challenges, cities must build and strengthen urban, social, economic and ecological resilience to climate change which requires comprehensive and integrated urban planning and management strategies.

80 years old Ms. Agnes Nguku, who lives with her family next to Chakarail damping site in Taita–Taveta County, Kenya on July 2022 ,28, © UN-Habitat_Julius Mwelu

19 UN-Habitat. Climate Change Vulnerability and Risk: A Guide for Community Assessments, Action Planning, and Implementation. Nairobi. 2020. Available at: https://unhabitat.org/sites/default/files/2020/05/climatechange_vulnerabilityandriskguide.pdf

At present, policymakers and practitioners alike face several challenges in undertaking multilayered vulnerability assessments and action planning for cities and urban areas. These include, but are not limited to, the following problems:

- climate change, biodiversity and urbanization addressed in policy and praxis silos [20];
- lack of evidenced approaches to mapping multidimensional and interrelated vulnerabilities [21];
- limited technical, financial and institutional capacities and resources to comprehensively undertake assessments and action planning [22];
- urban poor and persons living in informal settlements are most affected but least engaged in assessments and adaptation and resilience action planning and decision-making [23];
- insufficient tools for predicting future land-use changes and urban growth [24];
- lack of coordination and cooperation in transboundary and multidisciplinary assessments and planning [25];
- little application of sound, coherent, and prioritized interventions and solutions [26];
- inadequate alignment between assessments and plans and international, national and local policy agendas[27] and
- significant gap in financial investments required to deliver climate adaptation action in cities.[28]

The results of these myriad, compounding challenges are that many cities are unable to (i) undertake comprehensive vulnerability assessments, (ii) understand the specific and nuanced vulnerabilities of their citizens, infrastructure and ecosystems, (iii) produce the evidence-base of urban climate vulnerability to access climate finance, and (iv) implement the critical interventions required to adapt to the impacts of climate change and advance climate resilient development (CRD)[29].

20 UN-Habitat. White Paper. Cities and Nature: Planning for the Future. 2022. Nairobi. Available at: https://unhabitat.org/sites/default/files/2022/12/white_paper_cities_and_nature_rev2.pdf

21 C40 Cities, Global Covenant of Mayors for Climate & Energy, Urban Climate Change Research Network & Acclimatise. The Future We Don't Want. How Climate Change Could Impact the World's Greatest Cities. 2018. Available at: https://www.c40.org/wp-content/uploads/2023/04/1789_Future_We_Dont_Want_Report_1.4_hi-res_120618.original-compressed.pdf

22 Asian Development Bank. Scaling Up Local Adaptation Measures through Climate Responsive Decentralization Processes. Community Resilience Partnership Program Technical Note. 2023. Available at: https://www.adb.org/publications/adaptation-measures-climate-responsive-decentralization

23 Global Center on Adaptation. Locally Led Planning: A Guide for Building Climate Resilience in Urban Informal Settlements. Rotterdam. 2022. Available at: https://gca.org/wp-content/uploads/2023/03/A-Guide-for-Building-Climate-Resilience-in-Urban-Informal-Settlements_web.pdf

24 IPCC. Cities, settlements and key infrastructure. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Plan on Climate Change. 2022. Available at: https://www.ipcc.ch/report/ar6/wg2/downloads/report/IPCC_AR6_WGII_TechnicalSummary.pdf

25 Summary for Urban Policymakers Initiative. What the Latest Science on Impacts, Adaptation and Vulnerability means for Cities and Urban Areas, distilled from the IPCC AR6 Report. 2022. Available at: https://supforclimate.com/wp-content/uploads/2022/11/SUPVol2_15Nov-reduced.pdf

26 UN-Habitat. The Critical Role of Nature-based Solutions for Enhancing Climate Resilience in Informal Areas. 2023. Nairobi. Available at: https://unhabitat.org/the-critical-role-of-nature-based-solutions-for-enhancing-climate-resilience-in-informal-areas

27 UNDP, UN-Habitat, SDU.Resilience & UNESCO. Urban Content of the NDCs. Local Action Explored Through In-depth Country Analyses. 2024. Available at: https://unhabitat.org/sites/default/files/2024/06/ndc_global_report_2023_v4_watermark.pdf

28 Cities Climate Finance Leadership Alliance. The State of Cities Finance 2024. 2024. Available at: https://citiesclimatefinance.org/publications/2024-state-of-cities-climate-finance

29 IPCC. Climate Resilient Development Pathways. Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Plan on Climate Change. 2022. Available at: https://www.ipcc.ch/report/ar6/wg2/chapter/chapter-18/

Newly built bike road on Luthuli Lane, Central Business District, Nairobi, Kenya, October 2019, © UN-Habitat

The Multilayered Vulnerability Assessment tool

Tool development

The Multilayered Vulnerability Assessment (MVA) tool has been developed under the UN-Habitat RISE UP flagship programme. The development of the MVA was an extensive, 1.5-year process that involved multiple stages of research, review, iteration, and collaboration. A comprehensive synthesis of the various approaches to undertaking climate change risk and vulnerability assessments and urban climate action planning across UN-Habitat, United Nations agencies, and international and national thought and practice leaders working in this domain was conducted. This was followed by a detailed review of frameworks, methodologies and tools, which helped refine and align MVA with cutting-edge practices in urban resilience, climate adaptation, and biodiversity conservation.

The process included in-depth research and multiple iterations, ensuring that the tool could address the complexities of interconnected and interdependent vulnerabilities. Expert group meetings were held, drawing on insights from specialists across various disciplines, sectors and geographies, alongside consultations with UN-Habitat key partner organizations, including representatives from cities that face significant climate and urbanization challenges. These collaborative efforts ensured that the MVA was grounded in real-world needs and expert-driven solutions.

To validate its efficiency and effectiveness, the MVA underwent pilot testing and scaling in a selection of cities. This testing phase was critical for evaluating its usability, replicability, and scalability, as adaptability, to different urban contexts. Insights and lessons learned from its application allowed for further refinement and enhancement, ensuring that the final MVA is relevant, practical and adaptable, addressing potential limitations and constraints and meeting the diverse needs of policymakers and practitioners working on urban resilience and climate adaptation.

Purpose

The purpose of the MVA is to help communities, cities, and local leaders to map and assess multilayered vulnerabilities more comprehensively.

The tool addresses the nexus between climate change hazards and risks, urbanization and spatial trends, socioeconomic characteristics, and biodiversity loss and land degradation to identify, map and assess vulnerability hotspots arising from spatial overlaps and interrelations.

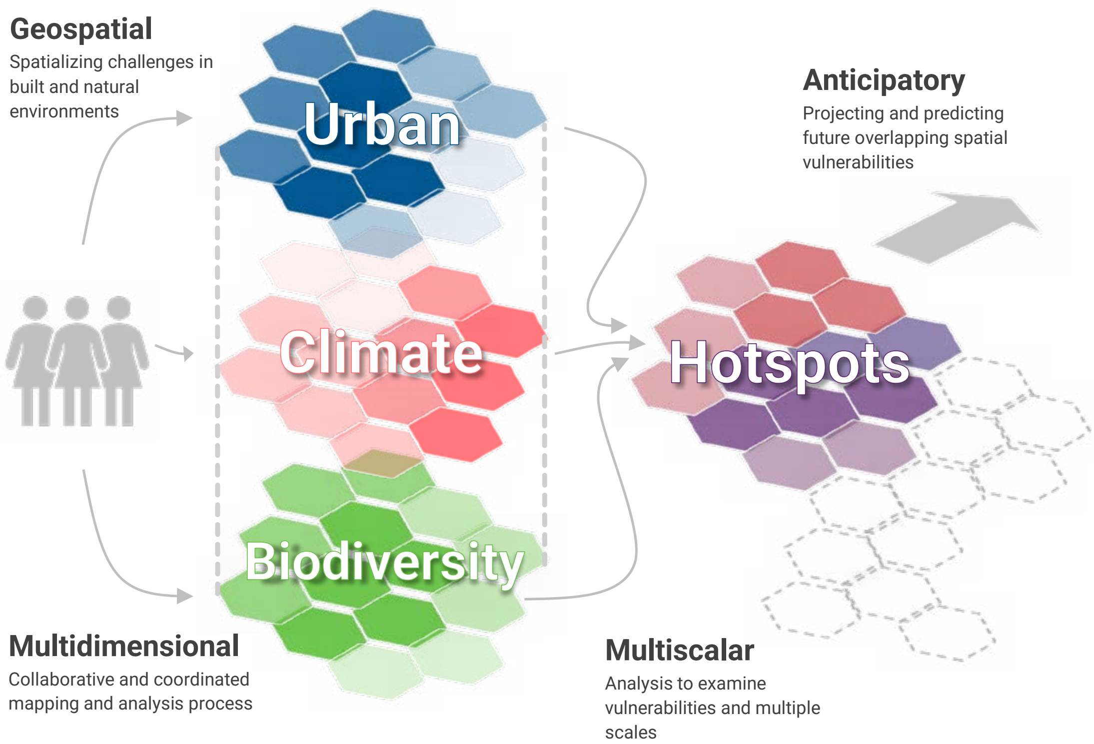
As a simple, practical and replicable tool, it helps to establish a spatial narrative to enhance the understanding of vulnerabilities related to interconnected climate risk, biodiversity loss and urbanization in cities, urban areas, and communities. This allows for the preparation of broadly defined adaptation and mitigation strategies based on mapping and assessment insights.

Principles

The MVA is grounded in a set of principles that prioritize the integration of geospatial data, technical analysis across sectoral, thematic, spatial and temporal scales, and foresight thinking. Building on these, the MVA systematically addresses the intersections of urbanization drivers, spatial disparities, and environmental stressors to identify and quantify vulnerability hotspots. The principles are:

- **Geospatial:** Spatializing challenges in the built and natural environments. Identifying exactly where vulnerabilities are located - what is their impact on the people, infrastructure, and environment.
- **Multidimensional:** Integrated mapping that brings together actors from different disciplines and diverse stakeholders from different sectors and levels of governance.
- **Multi-scalar:** Analysis that is conducted at different scales – local/neighbourhood – city / city-region / sub-national / national – depending on the city or country context and desired geographic scope.
- **Anticipatory:** Anticipating overlapping spatial issues and considering development pressures and vulnerability drivers to identify opportunities for improving climate resilience and strengthening environmental protection.

FIGURE 3 **Principles of the Multilayered Vulnerability Assessment methodology**
Source: UN-Habitat. 2024.



Objectives

The objectives of MVA are to operationalize a robust data-driven framework for the precise identification, quantification, and spatial mapping of climate, urban and biodiversity vulnerabilities. It is designed to support advanced vulnerability assessment, inform evidence-based decision-making through integrated geospatial analysis, and enhance urban climate resilience policymaking, programming and investment The four key objective of this tool are to:

Precisely identify, locate, assess and visualize urban vulnerabilities, focusing on the intersections of climate change, biodiversity, and socioeconomic factors across various levels and scales.

- Enable multilayered analysis by integrating various datasets, including open-source and local geospatial and socio-economic data, to perform multilayered and multidimensional assessments that highlight complex hotspots of intersecting and concentrated vulnerability both currently and in the future.
- Support evidence-based decision-making by producing actionable insights and recommendations to determine priority actions required to address critical vulnerabilities and build climate resilience in a systemic way, such as through such as nature-based solutions (NbS) or ecosystem-based adaptation (EbA) interventions.
- Enhance the capacity of cities and governments to develop data-driven, robust, proactive, forward-looking urban resilience strategies, adaptation plans and bankable projects that respond to the dynamic and evolving nature of urban, climate and biodiversity vulnerabilities.

Methodology

The methodology of the MVA is structured into three key stages, each with corresponding steps and activities designed to systematically guide the assessment process. The first stage, ***Preparation,*** involves data collection, stakeholder engagement, and the establishment of analytical frameworks. The second stage, ***Mapping and analysis,*** integrates geospatial data, vulnerability indicators, and stakeholder validation and ground-truthing generate detailed vulnerability maps and analyses. Finally, the third stage, ***Intervention planning,*** uses the outputs from the analysis to prioritize and design targeted interventions aimed at enhancing climate resilience and reducing identified vulnerabilities of people, infrastructure and ecosystems.

FIGURE 4 **Overview of Multilayered Vulnerability Assessment methodology**
Source: UN-Habitat. 2023.

Outputs

The main outputs of MVA are designed to provide comprehensive insights and actionable solutions for urban resilience. These include: ***Multilayered Vulnerability Profiles,*** which feature detailed assessments of vulnerability hotspots, accompanied by tailored recommendations; ***Urban Resilience Action Plans***, offering strategic guidance for cities to enhance climate adaptation; and ***3) a pipeline of Bankable Adaptation and Resilience Projects,*** which identify and prepare financially viable projects to attract investment and support long-term resilience-building efforts. These outputs are further elaborated below:

- **Multilayered Vulnerability Profiles:** These profiles offer a comprehensive assessment of urban vulnerabilities by integrating geospatial, socioeconomic, and environmental data into a multilayered framework, highlighting critical vulnerability hotspots, and providing targeted recommendations for policy and intervention.

- **Urban Resilience Action Plans:** These plans translate the vulnerability assessments into strategic, actionable roadmaps for enhancing urban resilience, outlining prioritized actions, adaptation measures, and resource allocation to strengthen climate adaptation and reduce current and future vulnerability and risk.

- **Pipeline of Bankable Adaptation and Resilience Projects:** This pipeline identifies and develops tailored, financially viable adaptation and resilience projects, aligning them with investment criteria, funding opportunities and financial instruments and mechanisms, to support sustainable urban development and attract climate finance for short, medium and long-term implementation

Accessible urban public transport in the city of Pasto, Colombia
2024 © UN-Habitat_Lee Michael Lambert

Escaleras de comuna 13 take residents up into a hillside community in Medellín, Colombia 2014, © UN-Habitat_Julius Mwelu

Overview of Handbook

Purpose and users

This Handbook is intended to serve as a practical tool for applying the MVA methodology in urban contexts. It is structured to guide users through each stage of the assessment process, from preliminary data collection to final analysis and decision-making, offering a step-by-step approach that can be adapted to different cities and regions.

The MVA Handbook is designed for policymakers and practitioners who are at the forefront of urban planning, climate adaptation, and biodiversity management. The Handbook serves as a practical tool, equipping them with the necessary framework and methodologies to comprehensively assess the complex interplay between urbanization, climate change, and biodiversity. Given that these interrelated vulnerabilities occur at multiple levels — from the neighbourhood to the city and regional scale — and across different dimensions such as socioeconomic conditions, infrastructure resilience, and ecological health, the Handbook provides an integrated approach to tackle these challenges.

For policymakers, the Handbook acts as a strategic guide to inform decision-making processes. It enables them to identify areas that are most vulnerable and prioritize action in ways that are both inclusive and evidence based. With a strong focus on multiscalar approaches, it helps national and local governments recognize vulnerabilities not only within their immediate jurisdictions but also in neighbouring regions that might impact or be impacted by their actions. This can assist in crafting policies that are proactive and targeted, ensuring that they address both present challenges and future risks. The Handbook emphasizes cross-sectoral collaboration, supporting policymakers in developing coherent responses that align with climate action, sustainable urban growth, and biodiversity conservation. It is important to note that local leaders and decision-makers are envisaged to make use of the outputs of the MVA, and not to necessarily conduct the MVA, per se.

For practitioners, such as urban planners, environmental specialists, and climate adaptation professionals, the Handbook offers practical tools for implementation. It guides users through a structured and process of data collection, analysis, and scenario planning, incorporating geographic information system (GIS) tools, vulnerability risk assessments, and other technical methodologies. The methodology can be adapted to specific urban contexts, scaling it accordingly to the available resources, data, and unique challenges faced by the city or region. Guidance on how to ensure that diverse voices are incorporated into assessment and decision-making processes through participatory methods is included. Practitioners can use the Handbook to identify critical vulnerability hotspots by layering socioeconomic, environmental, and climate data, enabling them to focus their interventions where they are most needed. This evidence-based approach ensures that interventions are precise and impactful, supporting cities and regions in building resilience in the face of complex, interconnected vulnerabilities.

The secondary audience for this Handbook includes ***researchers, educators, and civil society organizations*** with an interest in understanding the complexities of urban vulnerabilities. For these readers, the Handbook offers a comprehensive overview of the methodologies and strategies used in the field, making it a valuable resource for broadening knowledge on how cities can better prepare for and respond to evolving challenges. This audience can use its framework, methodology and tools to further academic research and inquiry, enhance capacity building, and advocate for more resilient, sustainable urban environments.

By deploying the MVA tool in communities, cities and urban areas, local and national leaders and policymakers in climate-vulnerable cities and communities can better plan and deliver inclusive, sustainable and resilient urban development strategies for human and non-human inhabitants. This would allow city decision-makers to make informed decisions about where and how to expand and adapt urban areas, as well as address urgent cascading and compounding challenges relating to climate change.

The Handbook is both a policy-shaping guide and a technical manual that can be used by diverse stakeholders to bridge the gap between high-level decision-making and on-the-ground action. Its multilevel and multidimensional approach ensures that urban vulnerability is understood and addressed holistically, fostering more resilient and sustainable cities.

Structure of the Handbook

The Handbook is organized into the three stages of the MVA process. Each stage contains an overview of the stage and the key steps, followed by several corresponding activities (e.g., Step 1.1. Activity A) and concludes with a checklist to ensure the requisite outputs have been produced.

The detailed, technical, step-by-step guidance is organized into manageable and sequenced tasks. For each step and activity, there are clearly outlined instructions that include all the necessary information, instructions and resources that users will require. This includes:

- Activity summaries and guidance: The purpose, objectives and intended outputs of each activity is provided. A summary of tasks to be completed and instructions on how they can be undertaken follow. Details on the roles and responsibilities of key actors for each activity are explained, as are the recommended human, technical and operational and financial resources required. Finally, a progress bar provides visual guidance on the indicative timeline for each activity along the MVA process.

- Toolkits, resources and considerations: Supplementary technical materials, practical templates, checklists, and data sources are provided, allowing users to easily access the resources tools they need for each step and activities. Important aspects to consider when working through each activity are listed.

- Annexes to support the conduct of various activities are included at the end of the Handbook. These annexes include templates and examples of outputs, guidance documentation, and other information helpful for the implementation of the MVA. Annexes are organized by the Stages they are related to, and reference to the relevant annexes are made within each Stage.

It is important to note that while some steps and activities are mandatory to ensure a thorough and accurate assessment, others are optional and can be tailored to the specific needs, resources, and context of the city.

- Mandatory steps are those critical to establishing a solid baseline, ensuring data accuracy, and generating reliable outcomes. Skipping these steps may compromise the quality of the assessment.

- Optional steps are designed to provide additional insights or enhance the analysis. These steps are highly recommended when resources, data availability, or specific urban challenges call for a deeper exploration, but they can be adjusted based on the project scope or constraints.

Throughout the Handbook, mandatory steps and activities are clearly marked, while optional steps are identified with suggestions on when and why they might be applied. This flexible structure allows users to customize the methodology while maintaining its core integrity.

As the MVA Handbook is currently being implemented in 9 RISE UP project countries, it is envisioned that the MVA methodology and tool will evolve and be enhanced. As it is an iterative, demand-driven resource for support practitioners and policymakers in conducting multilayered vulnerability assessments, UN-Habitat aims to ensure the tool is relevant, responsive and impactful. While this current edition of the Handbook provides a comprehensive framework and practical tools, it is not exhaustive. Certain sections and advanced methodologies are in development and will be added in future iterations. The second iteration will include:

- Expanded case studies from diverse urban contexts, offering deeper insights, lessons learned and recommendations from application of the methodology across different regions.

- Advanced analytical tools and technologies to enhance data collection, climate, urban and biodiversity vulnerability projection and modelling, and assessment accuracy.

- Additional guidance on emerging challenges, such as biodiversity impacts, digital vulnerability mapping, and integrating climate action with urban policy frameworks.

- Resources such as the RISE UP Urban Vulnerability Atlas (UVA) advanced virtual and interactive digital platform designed to visualize and communicate vulnerability hotspots and MVA vulnerability profiles, action plans and projects.

UN-Habitat encourages users to apply the current methodology, knowing that this Handbook will continue to grow and evolve, incorporating new findings, feedback, and innovations in urban climate resilience practices.

How to use the Handbook

Stage 1, Preparation, concerns laying the groundwork for the MVA and includes setting up a delivery team and steering committee, conducting a rapid diagnostic, and developing an MVA plan. Stage 1 is the critical foundation of the entire multilayered vulnerability assessment process. The success of subsequent stages depends heavily on the quality and thoroughness of the preparation carried out here.

What to expect:

- Defining scope and objectives: This stage involves clearly defining the scope, goals, and key objectives of the vulnerability assessment. It is essential to align these with the city›s context, the available resources, and the specific vulnerabilities being assessed (e.g., climate risks, social inequities, infrastructure fragilities).

- Stakeholder engagement: Early and meaningful engagement with key stakeholders — including local government officials, community representatives, technical experts, and civil society — is crucial at this stage. Identifying and involving these groups ensures that the assessment reflects diverse perspectives and gains buy-in for future actions.

- Data and resource planning: Stage 1 also includes reviewing the availability of data and resources, such as technical tools, funding, and expertise. Understanding the current data landscape helps identify any gaps that need to be addressed before moving to technical stages.

Recommendations for users:

- Set clear goals: Take time to ensure that the assessment's scope and objectives are realistic and well-communicated to all stakeholders. A clear roadmap at this stage will guide decision-making throughout the process.

- Engage stakeholders early: Identify relevant stakeholders and create a strategy for engaging them throughout the process. Early involvement builds trust, ownership, and collaboration, and ensures the assessment considers local knowledge and priorities.

- Ensure adequate resources: Review the necessary resources, such as financial, human, and technical capacity. If there are gaps, this is the stage to plan for resource acquisition or capacity building.

By thoroughly completing Stage 1, users will establish a strong foundation that supports the technical and analytical rigor required in the later stages of the assessment. It ensures clarity of purpose, inclusivity, and the alignment of resources with the intended outcomes.

Upon completion of Stage 1, 5-10 per cent of the MVA is achieved.

A busy street in downtown Port-au-Prince, Haiti
2013 © Julius Mwelu_UN-Habitat

Stage 2, Mapping and analysis, involves data collection and preparation, mapping and analysing vulnerability hotspots, and interpreting and analysing hotspots. Stage 2 of this methodology involves highly technical processes that require specialized skills and a strong understanding of data analysis, geospatial tools, stakeholder engagement and the key technical intricacies of climate, urban and biodiversity vulnerabilities. This stage is the most demanding in terms of human, technical and financial resources and will also take the most time. It is essential that users approach this stage with adequate preparation, as it forms the backbone of the multilayered vulnerability assessment.

What to expect:

- Advanced data collection and analysis: This stage involves gathering and processing complex datasets (e.g., climate models, socioeconomic indicators, infrastructure data). Users will need strong technical proficiency in GIS, particularly in the application of GIS for urban climate vulnerability assessments. Advanced skill and competency in geospatial data processing and management, spatial analysis techniques (e.g. overlay analysis and bivariate mapping), multilayered data integration, and technical communication of geospatial analysis are all required for this stage.

- Use of specialized tools: Several technical tools, such as geospatial mapping software (e.g., ArcGIS, QGIS, etc.) and data visualization platforms, will be required to assess vulnerabilities accurately. Familiarity with these tools is critical for successfully completing this stage.

- Collaboration with experts: If users lack the necessary technical skills, collaboration with technical experts — such as urban planners, GIS specialists, climate scientists, and data analysts — is highly recommended. Partnering with professionals in these areas will ensure accuracy and efficiency in completing this stage.

Recommendations for users:

- Prepare in advance: Before starting Stage 2, review the required skills and resources. If necessary, seek training in relevant technical areas or collaborate with experts who can provide the necessary support.

- Break down complex tasks: Divide the technical activities into smaller, more manageable tasks, and use the provided templates, checklists, and toolkits to guide you through each step.

- Consult the Handbook's resources: This Handbook offers step-by-step guides, examples, and additional resources to assist users in navigating the technical aspects of stage 2. Ensure that all tools and data sources are thoroughly reviewed before beginning the technical work.

While Stage 2 is highly technical, it is essential for producing a thorough, data-driven vulnerability assessment. With proper preparation, support, and resources, users can successfully complete this critical phase.

Upon completion of Stage 2, 60-65 per cent of the MVA is achieved.

Participatory multilayered vulnerability mapping with community stakeholders in St. John's, Antigua and Barbuda 2024 © UN-Habitat_Lee Michael Lambert

Stage 3, Intervention planning, transforms findings from the previous stage into resilience-building actions and includes objective setting, developing action plans, and disseminating, campaigning, and scaling the plans. Stage 3 is the analytical core of the multilayered vulnerability assessment. This stage involves synthesizing the data collected and applying analytical frameworks to interpret vulnerabilities across multiple layers — climate, socioeconomic, environmental, and infrastructural. The insights generated here will inform decision-making and the prioritization of actions.

What to expect:

- Data integration and analysis: During this stage, users will need to integrate diverse datasets (e.g., geospatial, statistical, and qualitative data) to identify vulnerability hotspots. Advanced data analysis techniques and modelling tools will be employed to understand the relationships between different vulnerability factors.

- Critical interpretation: The focus is not only on technical analysis but also on the interpretation of results. Understanding the interconnections between different layers of vulnerability is essential for drawing meaningful conclusions and developing targeted resilience strategies.

- Cross-sectoral insights: Stage 3 provides the opportunity to generate cross-sectoral insights by examining how vulnerabilities in one area (e.g., infrastructure) may exacerbate risks in others (e.g., social or environmental). This holistic analysis is key to developing integrated urban resilience action plans.

Recommendations for users:

- Ensure analytical accuracy: Given the complexity of data at this stage, ensure that your analytical methods are accurate and transparent. Use the guidelines provided in the Handbook to apply best practices in geospatial analysis, statistical modelling, and qualitative assessments.

- Interpret with context: When interpreting the results, always consider the local context — cultural, political, and environmental factors that may influence vulnerabilities. Engage with stakeholders to validate findings and gather local insights that complement technical analysis.

- Collaborate with experts: If necessary, work with subject matter experts (e.g., climate scientists, data analysts, urban planners) to help analyse and interpret complex data. Their expertise will enhance the reliability and depth of the findings.

By completing Stage 3 with care and precision, users will generate a comprehensive, data-driven understanding of urban vulnerabilities. This stage is critical for ensuring that future recommendations and interventions are well-targeted and based on robust evidence.

Upon completion of Stage 3, 100 per cent of the MVA is achieved.

How to use this Handbook – Process summary

Stages

Three stages guide the MVA process—beginning with groundwork activities, moving into data collection and analysis of vulnerability hotspots, and concluding with the development, scaling, and implementation of actionable resilience strategies.

click on boxes to go directly to the Stage

Steps

Each stage includes a series of steps, ranging from two to seven activities, designed to systematically guide the process

click on boxes to go directly to the Step

1 Stage one

Preparation

Stage overview

- Step 1.1 Set up the Delivery Team and Steering Committee
- Step 1.2 Conduct rapid diagnostic of the city or urban area
- Step 1.3 Develop Assessment Plan

Checklist

Annexes

1. Stakeholder tools
2. Suggested project workplan and timelines
3. RACI matrix template

2 Stage two

Mapping and analysis

Stage overview

- Step 2.1 Mapping assessment preparation
- Step 2.2 Data acquisition and collection
- Step 2.3 Map historic, current, and future vulnerabilities
- Step 2.4 Map multilayered vulnerability hotspots
- Step 2.5 Develop Multilayered Vulnerability Profile

Checklist

Annexes

4. Data Requirements template
5. Data Inventory template
6. Data Collection Plan template
7. Multilayered Vulnerability Profile template

Data collection and analysis technical brief

3 Stage three

Intervention planning

Stage overview

- Step 3.1 Visioning and objective setting for Resilience Action Plan
- Step 3.2 Develop Resilience Action Plan
- Step 3.3 Disseminate, campaign, and scale
- Step 3.5 Disseminate, campaign and scale

Checklist

Checklist

Each stage includes a checklist at the end that outlines all outputs to ensure completeness.

click on boxes to go directly to the Checklist

Annex

Stage 1 and Stage 2 include annexes with tools and templates, supporting stakeholder engagement, data collection, and analysis tasks.

click on boxes to go directly to the Annex

Click on box to go directly to the Data collection and analysis technical brief

How to use this Handbook – Navigating the activities

Optionality

This label indicates when an activity is optional.

Set up the Delivery Team and Steering Committee

Step 1.1
Activity A

Establish and mobilize the Delivery Team

Activity description [optional]

Summary

Establishing a multidisciplinary Delivery Team is fundamental to undertaking the MVA. The purpose of the Delivery Team is to undertake all the key phases, steps and activities of the MVA. The Team is the lead implementation agency and has the primary goal of collaborating with all technical experts and key stakeholders to carry out the specific tasks within the MVA process.

The Delivery Team should comprise of personnel with a range of skills that support the MVA. Recommended roles within the Delivery Team include:

- a Team Lead or Coordinator,
- a GIS specialist,
- an urban planner,
- a climate change specialist,
- a biodiversity specialist,
- a country-context specific institutional, governance, and policy expert, and
- a representative of the city or local area.

Tasks

1. Review the Multilayered Vulnerability Assessment Handbook (this document). Execute a rapid capacity needs assessment to determine the technical and political profiles required to undertake the MVA.
2. Establish a multidisciplinary team with the required expertise and experience, including technical proficiency as well as political and organizational agency
3. Establish tailored terms of reference (TOR) for any external support (such as individual consultants) required.
4. Engage Delivery Team members, through internal or external procurement of staff, consultants, interns or volunteers, following organizational procurement procedures.
5. Agree on project management and coordination arrangements, communications protocols, working arrangements, reporting arrangements, and roles and responsibilities. This should include the sequence of meetings, workplan, timelines, and milestone delivery.

Suggested resources

Human

Expert profiles in the following areas: project management; climate change adaptation; urban climate resilience; urban planning and design; sustainable infrastructure; gender, equity and social inclusion; GIS and spatial analysis; data management and visualization; stakeholder engagement; capacity development; and communications and knowledge management.

Technical and operational

Delivery Team Terms of Reference (TOR) tailored to each local areas/city/country.

Financial

Budget for procuring Delivery Team, including any external technical expertise to be engaged.

Considerations

The composition and profiles of Delivery Teams may differ in different cities, as there will be different capacities in each country.

The expert profiles detailed in the resources section are recommended for the Delivery Team. However, this does not cover all possible / specific roles that could be relevant for every city or country. It is important to determine whether other subject matter experts and other inter- or multidisciplinary experts are required when forming the Delivery Team.

Members with specific experience working in the local areas and cities in which the MVA will be undertaken is essential. Where this is not possible, it is recommended to have experts who have at least worked in the selected country.

Objectives

Set up Delivery Team

Outputs

Delivery Team established and mobilized

I S1 S2 S3 A

Wayfinder

Click on the buttons to navigate to key sections of the handbook: Introduction, stage 1, stage 2, stage 3, and the Annex

The section you are currently viewing will be highlighted in colour.

Progress bar

A progress bar will be shown to indicate your current stage within the handbook, giving a visual representation of how far you've progressed.

Handbook

Citizens enjoying the green spaces and public facilities of the Santa Ana city's main square, El Salvador 2024 © UN-Habitat_Lee Michael Lambert

Preparation

Stage 01

Green streetscape in Almaty, Kazakhstan
2024 © UN-Habitat_Lee Michael Lambert

Stage 1
Preparation

Stage overview

Summary: The Preparation Stage of the MVA involves laying the groundwork and establishing the framework for the assessment process. It focuses on identifying key contributors and establishing the relationships necessary to complete the MVA and analysis. This stage is crucial for ensuring that the assessment is comprehensive, well-organized, and aligned with the goals and objectives of the organization or community undertaking the assessment.

Objective: The main objective of this stage is to thoroughly identify and address all important aspects, requirements, and considerations of the MVA to set the foundation for a robust, efficient, and effective assessment process.

Outputs: There are three key steps in Stage 1, each with several corresponding activities that need to be undertaken. The completion of these steps and activities will produce several outputs which are critical to support the MVA process.

The key steps are:

1. Setting up the Delivery Team and Steering Committee
2. Conducting a rapid diagnostic of the city or urban area
3. Developing a MVA Assessment Plan

The activities conducted under each step are shown below and described in detailed step-by-step guidance in the following sections:

Stage one

Step 1.1

Set up the Delivery Team and Steering Committee

Activity A
Establish and mobilize the Delivery Team

Activity B
Set up MVA Steering Committee

Activity C
Map and analyze stakeholders

Activity D
Prepare Stakeholder Engagement Plan

Step 1.2

Conduct rapid diagnostic of the city or urban area

Activity A
Assess city capacities and resources

Activity B
Conduct City Context Analysis

Step 1.3

Develop Assessment Plan

Activity A
Define geographic scope

Activity B
Develop Work Plan and schedule of activities

Set up the Delivery Team and Steering Committee

Step 1.1 Activity A

Establish and mobilize the Delivery Team

Activity description

Summary

Establishing a multidisciplinary Delivery Team is fundamental to undertaking the MVA. The purpose of the Delivery Team is to undertake all the key phases, steps and activities of the MVA. The Team is the lead implementation agency and has the primary goal of collaborating with all technical experts and key stakeholders to carry out the specific tasks within the MVA process.

The Delivery Team should comprise of personnel with a range of skills that support the MVA. Recommended roles within the Delivery Team include:

- a Team Lead or Coordinator,
- a GIS specialist,
- an urban planner,
- a climate change specialist,
- a biodiversity specialist,
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- a representative of the city or local area.

Tasks

1. Review the Multilayered Vulnerability Assessment Handbook (this document). Execute a rapid capacity needs assessment to determine the technical and political profiles required to undertake the MVA.
2. Establish a multidisciplinary team with the required expertise and experience, including technical proficiency as well as political and organizational agency
3. Establish tailored terms of reference (TOR) for any external support (such as individual consultants) required.
4. Engage Delivery Team members, through internal or external procurement of staff, consultants, interns or volunteers, following organizational procurement procedures.
5. Agree on project management and coordination arrangements, communications protocols, working arrangements, reporting arrangements, and roles and responsibilities. This should include the sequence of meetings, workplan, timelines, and milestone delivery.

Suggested resources

Human

Expert profiles in the following areas: project management; climate change adaptation; urban climate resilience; urban planning and design; sustainable infrastructure; gender, equity and social inclusion; GIS and spatial analysis; data management and visualization; stakeholder engagement; capacity development; and communications and knowledge management.

Technical and operational

Delivery Team Terms of Reference (TOR) tailored to each local areas/city/country.

Financial

Budget for procuring Delivery Team, including any external technical expertise to be engaged.

Considerations

The composition and profiles of Delivery Teams may differ in different cities, as there will be different capacities in each country.

The expert profiles detailed in the resources section are recommended for the Delivery Team. However, this does not cover all possible / specific roles that could be relevant for every city or country. It is important to determine whether other subject matter experts and other inter- or multidisciplinary experts are required when forming the Delivery Team.

Members with specific experience working in the local areas and cities in which the MVA will be undertaken is essential. Where this is not possible, it is recommended to have experts who have at least worked in the selected country.

Objectives

Set up Delivery Team

Outputs

Delivery Team established and mobilized

Set up the Delivery Team and Steering Committee

Step 1.1 Activity B

Set up MVA Steering Committee

Activity description

Summary

It is important to identify, organize, and mobilize a Steering Committee to support the Delivery Team in undertaking the MVA. Comprised of key actors at national, regional and local levels of government, as well as other key stakeholder groups, the Steering Committee serves as a strategic advisory group responsible for providing guidance, oversight, and decision-making support for the MVA mapping and analysis, as well as the intervention planning phases.

The key functions and responsibilities of the Steering Committee in the MVA are:

1. **Strategic alignment:** Inform the strategic direction of the MVA and assist in aligning it with local, regional, and national strategic agendas, policies and plans
2. **Scope and location selection:** Help determine the scope of the MVA and identify the urban areas in which to focus the MVA and analysis
3. **Data collection and acquisition:** Support in knowledge sharing and information/data collection, particularly facilitating data acquisition and sharing from different local and government agencies and departments
4. **Technical support:** Contributing with technical support and oversight, where relevant and appropriate to MVA activities, including rapid diagnostic and profiling, multilayered vulnerability mapping and analysis, vulnerability hotspot mapping, intervention planning, and development of city resilience strategies and action plans
5. **Stakeholder engagement:** Facilitating engagement with local stakeholders, such as NGOs, CSOs, academia, international development institutions, government departments, local communities, and the private sector, throughout the lifecycle of the MVA
6. **Internal communication:** Communicating the MVA activities and outputs to government agencies and to relevant stakeholders to foster transparency and engagement
7. **External communication:** Communicating the MVA activities and outputs, such as the City Resilience Strategies and Action Plans externally to international audiences, such as donors and city networks, at global and regional knowledge forums
8. **Decision making and issues resolution:** The Steering Committee will have the authority to make decisions with regards to the direction and outputs of the MVA which, will help the project overcome obstacles and ensure that the outputs of the MVA have the correct political buy-in, sign-off, and approval. Resolve potential issues and conflicts related to MVA and provide guidance to the Delivery Team on how to overcome challenges

The Delivery Team should consider identifying a knowledgeable government 'champion' at the local level (e.g. the Mayor or executive staff at the Mayor's office) to lead and chair the Steering Committee. Together with this champion, the Delivery Team will determine the structure and membership of the Steering Committee and identify and engage suitable members.

The Steering Committee should include representatives who have technical expertise (e.g. in key sector and thematic areas related to the MVA, such as climate change adaptation, urban climate resilience, disaster risk management, vulnerable populations) and availability and commitment to support the MVA. It is imperative that the Steering Committee members also reflect the key principles of multilevel governance, including horizontal and vertical integration. The following stakeholders may typically be engaged in the Steering Committee:

- **National government ministries or agencies** (e.g. Ministry of Environment)
- **Provincial/regional government ministries or agencies** (e.g. Department of regional and territorial planning)
- **Municipal/local government ministries or agencies** (e.g. Executive staff of Mayor's office)
- **Local authority technical staff** (e.g. GIS officer)
- **Utility companies and statutory bodies** (e.g. Water operators)
- **Civil society organizations** (e.g. Community-based organizations) and/or non-governmental organizations
- **Academia** (e.g. Urban planning faculty at local university)

Objectives

Set up Delivery Team

Outputs

Steering Committee established and mobilized

Set up the Delivery Team and Steering Committee

Step 1.1 Activity B (continued)

Set up MVA Steering Committee

Activity description

Summary

Through the project, it is imperative that the Steering Committee are engaged and kept informed on the progress of the MVA. The Delivery Team should strive to ensure that progress, challenges, and achievements are always communicated to the Steering Committee.

Tasks

1. Identify potential members of the Steering Committee
2. Engage selected Steering Committee members, ensuring commitment to the Committee roles and responsibilities
3. Mobilize the Steering Committee with formal agreement in place

Required resources

Human

Committee members representing various stakeholders, including local, municipal, and national government, technical experts, sectoral experts, community representatives, and civil society.

Technical and operational

- Understanding of national, provincial/ subnational, municipal and local governance systems, structures and stakeholders.
- Availability, engagement and commitment of Committee members, representing different stakeholder groups and areas of expertise.
- Communication and reporting/ documentation channels and protocols.

Institutional

- Strong coordination and communication with key government representatives and technical staff.
- High-level local government champion to lead and chair the Steering Committee. Official, formal endorsement from the city's leadership ensures support, legitimacy and authority.
- Alignment of Steering Committee function with local or national policy frameworks to ensure activities are supporting and integrated with wider governance structures

Financial

Funding for Steering Committee meetings and operations, including missions to selected areas and/or cities. Where appropriate and if the context allows, meetings can be held virtually.

Considerations

The organization of Steering Committees will differ city to city and country to country due to different urban governance systems, structures and stakeholders. It is recommended that the formulation of the Steering Committee should take a multilevel governance approach whereby key activities and milestones of the MVA is supported through engagement and decision-making among local, regional and national governments through the full process.

Selecting a local champion is a political decision and may be determined by the local, municipal and national government counterparts that the Delivery Team are working with. It is the role of the Delivery Team to liaise closely with the government to select the most suitable champion.

It is recommended that the Committees are comprised of members with diverse perspectives and experiences, and technical, sectoral and thematic expertise and roles, representing different ages, genders and ethnicities.

The Steering Committee should be set up as early as possible in the MVA process to secure political buy-in and allow for formal endorsement from all stakeholders and to enable quick operationalization.

The Steering Committee should meet at key intervals and stages of the project, tied to the MVA outputs and key activities as detailed in the project workplan.

It is important to note that over the course of the MVA, the Steering Committee's membership may change (i.e. due to changing of government in political cycles).

It is recommended that, if possible, Leadership / Charing of the Committee remains the same through the duration of the MVA.

Objectives

Set up Steering Committee

Outputs

Steering Committee established and mobilized

Map and analyze stakeholders

Activity description

Summary

Stakeholder mapping helps identify and categorize individuals, groups, or organizations that have a stake in or are affected by urban and climate-related risks. This includes government agencies, local communities, businesses, NGOs, academia and other relevant entities. By analyzing stakeholders, you gain insights into their perspectives, concerns, and interests. This understanding is essential for creating comprehensive vulnerability assessments that consider diverse viewpoints and potential impacts.

Tasks

1. **Identify and list stakeholders:** Firstly, list all potentially relevant and affected stakeholders by brainstorming and creating an exhaustive list of individuals, groups, or organizations that may have an interest or influence in the MVA and/or city climate resilience strategy and action plan. With this list, categorize all identified stakeholders by grouping them based on their level of influence and interest. This could result in categories like high influence-high interest, low influence-high interest, etc.
2. **Map stakeholder influence and interest:** This activity should be conducted using a Stakeholder Influence-Interest Matrix which will allow visualization of the relative influence and interest of each of the different stakeholders in the project. This matrix will result in 4 categories of stakeholders; i) High Influence, High Interest (Manage Closely), ii) High Influence, Low Interest, (Keep Informed), iii) Low Influence, High Interest (Keep Satisfied), iv) Low Influence, Low Interest (Monitor).

   When developing the grid, consider factors such as their decision-making power, resources, and potential impact. It is possible to create this matrix in-person using a large card or flipboard with sticky notes or via a digital tool such as a MiroBoard. This is recommended as a collaborative activity with the Project Delivery Team.
3. **Conduct the IAP2 spectrum analysis:** Implement the International Association for Public Participation (IAP2) Spectrum of Public Participation as a structured approach to assess and enhance stakeholder engagement. See Annex 1C.

   Encourage stakeholders to self-assess their preferred level of participation, considering the five modes outlined in the Spectrum: Inform, Consult, Involve, Collaborate, and Empower. Utilize the Spectrum to guide stakeholders towards appropriate levels of involvement based on the Stakeholder Influence-Interest Matrix and facilitate discussions to determine which mode best aligns with stakeholders' goals and preferences. Document agreed-upon participation levels using the IAP2 Spectrum of Participation Table for ongoing reference and communicate outputs with the Project Delivery Team.
4. **Create stakeholder profile:** For each stakeholder, a summary Stakeholder Profile should be developed. This will involve developing detailed profiles for each, summarizing their key information, interests, influence, preferred level of engagement, and potential contributions to the project (for example, this could be making note if they are a possible data source). Note that it may be possible to request such profiles from highly engaged stakeholders.

Objectives

Map and analyze all stakeholders relevant to the MVA and action plans.

Outputs

Stakeholder mapping and analysis, complete with a Stakeholder List, Stakeholder Influence-Interest Matrix Completed, IAP2 Spectrum of Participation Table, and Stakeholder Profiles

Map and analyze stakeholders

Suggested resources

Human

- Delivery Team members with expertise and experience in stakeholder engagement and participatory urban and climate action planning, can lead the stakeholder mapping process, facilitate discussions, and ensure the overall success of the analysis.
- Community representatives, government-community liaison officers, or civil society organizations with direct connections to and relationships with local communities and vulnerable populations, should be engaged to facilitate expanded and enhanced stakeholder participation.

Technical and operational

- Detailed understanding of stakeholder groups for the local area or city. This is often available in pre-existing stakeholder databases or documentation from past project or programme reports, climate risk and vulnerability assessments, urban and climate policy and planning documents, socioeconomic studies. Government agencies, development actors and agencies, civil society and academia in the local area or city typically have such information.
- Stakeholder mapping and analysis activity templates (see Annex 1), which assist in identifying, appraising, and documenting the stakeholders to be engaged and impacted by the MVA.

Institutional

- Partnerships that the city leadership have with NGOs, civil society, community groups, local businesses, and local communities are important as they can help to identify and reach important and target stakeholder groups.

Considerations

It is critical that all potentially vulnerable or marginalized stakeholders, communities and groups residing within or near the MVA city or study area are identified, their possible exposure, sensitivities and adaptive capacities relating to multilayered vulnerabilities are analyzed, and their potential participation in the MVA process is assessed and documented.

Objectives

Map and analyze all stakeholders relevant to the MVA and action plans.

Outputs

Stakeholder mapping and analysis, complete with a Stakeholder List, Stakeholder Influence-Interest Matrix Completed, IAP2 Spectrum of Participation Table, and Stakeholder Profiles

Set up the Delivery Team and Steering Committee

Step 1.1 Activity D

Prepare Stakeholder Engagement Plan

Activity description

Summary

The Stakeholder Engagement Plan (SEP) will build on the stakeholder mapping exercise conducted in Step 1.1 Activity C. The plan will outline strategies and approaches for effective communication, collaboration, and involvement of key stakeholders throughout the full MVA process.

Tasks

1. Thoroughly **review the stakeholder mapping results,** taking into consideration the identified stakeholders, their interests, influence, and preferred level of engagement. Consider the project plan, and the moments at which stakeholders must be involved. Identify which stakeholders will be engaged for different components of the MVA. Based on the results of the IAP2 Spectrum of Participation analysis, develop a timeline that outlines key milestones for stakeholder engagement during the project. For instance, some consultations may only require sharing information with "Inform" stakeholders, while direct workshop engagements may be more suitable for stakeholders listed as "Consult" or "Empower".
2. **Identify the most effective communication channels** for each stakeholder segment. Consider a mix of methods such as meetings and workshops, emails, social media, and direct consultations. Ensure that the chosen channels align with stakeholders' preferences and accessibility as identified in the Annex 1, specifically IAP2 Spectrum of Participation Table.
3. **Combine all elements** including stakeholder profiles into a Stakeholder Engagement Plan document and clearly communicate with the Project Delivery Team to ensure everyone understands the roles and responsibilities within the context of the MVA process.

Suggested resources

Human

Delivery Team members who have expertise and experience in stakeholder engagement and gender, equity, disability and social inclusion, should lead on the development of the SEP, with support from the team technical experts.

Technical and operational

Stakeholder Mapping and Analysis (Step 1.1 Activity C)

Considerations

The Stakeholder Engagement Plan (SEP) is an integral document to be used by the Delivery Team. This document should not be shared with external stakeholders outside of the Steering Committee.

If available, an expert with a profile in development communication and awareness raising could be beneficial to ensure that the communication, outreach and engagement channels and activities detailed in the SEP are the most appropriate for the MVA and are tailored to specific groups.

The preparation of the SEP may require meetings, workshops or community consultation. Budgeting may need to be allocated for such stakeholder engagement activities.

Objectives

To develop a comprehensive stakeholder engagement strategy for the duration of the MVA process.

Outputs

Stakeholder Engagement Plan

Conduct rapid diagnostic of the city or urban area

Step 1.2
Activity A

Assess city capacities and resources

Activity description

Summary

Local governments in many cities and countries often face several capacity constraints and weaknesses across technical, financial, administrative, organizational, and technological domains. These challenges can lead to increased vulnerability including, inter alia, unplanned growth in hazard-prone areas, destruction of natural habitats and loss of ecosystem services and public health risk due to strain on city services.

A key component of the planning stages of the MVA therefore includes a rapid assessment of capacities and resources within the areas considered for the MVA. The results of this rapid capacity and resource assessment should inform the final selection of the geographical scope of the MVA (Step 1.3 Activity A), as well as the intervention planning in Step 3.

The MVA is also an opportunity to build the capacities of local government executive and technical personnel, as well as other key stakeholder partners, in technical topics related to the MVA, such as climate change adaptation, climate resilient infrastructure, sustainable and participatory urban planning, biodiversity and ecosystem services, equity and inclusion, geospatial analysis, data management and visualization, etc. The rapid city Capacity and Resource Needs Assessment should identify key resource and capacity gaps where knowledge and information sharing can be prioritized.

Tasks

1. **Define the scope:** Determine what specific information about the city or region's capacities and resources will be gathered. Identify relevant time periods to consider and which information formats will be prioritized. Note that this is intended to be a rapid assessment, and speed should be balanced with gathering sufficient information to inform decision-making.
2. **Capacity and Resource Needs Assessment:** Consult local, regional, national and international sources to gather existing data and information about the city or region. Consider reports, statistics, maps, and any other documentation about the city or region's infrastructure, services, demographics, economy, etc. Special attention should be given to identifying key or critical systems and services within the area. The Delivery Team may benefit from using digital surveys and consultations (including Strengths, Opportunities, Weakness and Threats analysis exercises) with local government agencies to complete this task. If possible, the rapid assessment should also include an assessment of capacity needs and gaps across the relevant levels and agencies of key city or regional government counterparts engaged in the MVA. It is important to use the outputs of the survey to inform any deeper discussions on specific capacity issues to ensure these are validated with the Steering Committee and are well understood by the Delivery Team.
3. **Identify and engage key stakeholders:** Ensure that any marginalized or vulnerable groups or neighbourhoods identified in the capacity and resource assessment are identified and included as stakeholders. This may require a revision to tasks completed in Step 1.1. Similarly, ensure that the stakeholders identified and mapped in Step 1.1 have been consulted for relevant information to support the capacity and resource assessment.
4. **Capacity Building Plan:** Using the findings of the Capacity and Resource Needs Assessment, a set of priority areas and technical topics for possible capacity building support should be identified. This may take the form of in-person, virtual or hybrid technical trainings and workshops. Consider also which resource and capacity gaps can potentially be addressed in the intervention planning stage (Step 3).

Objectives

Assess the technical capacity and resource gaps within the city or region

Outputs

Capacity and Resource Needs Assessment and Capacity Building Plan

Assess city capacities and resources

Suggested resources

Human

- Delivery Team members who have expertise and experience in resource and capacity assessments should lead this Activity.
- Local and regional government and technical staff should be consulted extensively for the city capacity and resource assessment.

Technical and operational

- Capacity needs assessment survey
- Capacity needs SWOT analysis template and guidance

Considerations

Capacity limitations and constraints will differ from each city and country. It is important that the specific and unique capacity challenges faced by a city are identified so that targeted capacity building support can be provided by the Delivery Team.

Please note that this task is not an exhaustive institutional capacity assessment of the government partners. It focuses on technical capacities related to the MVA topics and tools which can be built through the project implementation, and potentially through subsequent activities.

Please note that comprehensive capacity building initiatives are contingent on project finance allocations.

Objectives

Assess the technical capacity and resource gaps within the city or region

Outputs

Capacity and Resource Assessment and Capacity Building Plan

Conduct rapid diagnostic of the city or urban area

Step 1.2 Activity B

Conduct city context analysis

Activity description

Summary

A rapid, holistic analysis should be conducted to identify any key characteristics, challenges or opportunities relevant to climate change, urbanization and biodiversity within the city area or region. This should be a comprehensive examination of factors to gain insights into the social, economic, environmental, and cultural dynamics which shape the urban landscape.

Tasks

A rapid analysis should be conducted by undertaking a literature review, policy review and by having consultations with key informants such as local and national government, local academia and civil society. It should cover at minimum the following:

1. **Location and geography:** A basic review of the location and geography such as the topography and current climate conditions, this might include observations of nearby natural resources or constraints.
2. **History of city development and growth:** Review of any relevant historical development and growth factors, such as key growth phases, land use changes or cultural heritage.
3. **Demographics:** analysis of the social fabric of the city, including population demographics, social structures and cultural diversity.
4. **Key economic sectors:** identify the key economic sectors and subsectors, identify areas of economic growth and potential challenges.
5. **Environment, biodiversity and climate:** assess environmental conditions including air and water quality, green space, waste management. Critically, an initial assessment of the status of biodiversity and climate hazards should be included.
6. **Urbanization trends:** identify any prevalent trends in urbanization which might include population growth and migration, changes in land use, housing and transportation.
7. **Physical and social infrastructure assets:** Identify key assets including their status and location. Consider water and sanitation infrastructure, healthcare and education facilities and social services. It is useful to note all the key infrastructure elements which are particularly vulnerable to climate change or directly relevant for biodiversity, which should be factored into the MVA. Where possible, these data should be collected and stored in a GIS.
8. **Institutional and policy frameworks:** Review landscape of local and national policies, plans, legislation, etc. on climate change, urban development, biodiversity protection, informal settlements, in relation to the project. The MVA and subsequent outputs should be aligned with the policies and enabling environment of the municipality, as such having an understanding of this will help the projects output enhance the enabling environment and work within it, therefore enhancing the ability of measures to be implementable and actioned.

Objectives

Gain insights into the social, economic and environmental dynamics that have shaped the urban landscape

Outputs

A City Context Analysis, containing a high-level summary analysis of the urban context

Conduct rapid diagnostic of the city or urban area

Step 1.2 Activity B (continued)

Conduct city context analysis

Suggested resources

Human

- The City Context Analysis should be led by a country-context specific institutional, governance, and policy expert and/or a representative of the city or local area. Key inputs and additional context can be gleaned through consultation with the Steering Committee, particularly local government and local authority technical staff.

Technical and operational

- Key development documentation, such as local development plans, city masterplans, national climate change strategies, etc.
- National and local government policy documentation, such as environmental and planning laws and regulation, urban governance frameworks, regional development policies.
- City and community-specific documentation related to climate change, urbanization and biodiversity, such as project reports, existing or past assessments, etc.
- GIS datasets which provide a location of key infrastructure.

Considerations

This analysis is not expected to be an exhaustive analysis of every dimension of the city context. It should be a high-level summary identifying the key aspects which will be pertinent to key climate change, urbanization, biodiversity related vulnerabilities prevalent in the city or study area, that are key to the delivery of the MVA.

At this stage in the MVA, the Delivery Team should make use of all existing and available data to conduct the analysis. Some datasets may not be available and may need to be collected during Stage 2 of the MVA. This should not delay the completion of this output.

The City Context Analysis can be updated during the development of the Multilayered Vulnerability Profile later in the MVA process, as further data and information is collected or becomes available.

Objectives

Gain insights into the social, economic and environmental dynamics that have shaped the urban landscape

Outputs

A City Context Analysis, containing a high-level summary analysis of the urban context

Define geographic scope

Activity description

Summary

In preparation for the MVA, define the spatial boundaries of the mapping assessment. Clearly outline the borders of the geographical area being assessed. Determine at which level the MVA should focus (i.e. local/community level in informal settlements, settlement clusters, city level, city-region level, island level, national level etc.).

Tasks

Consider the following factors to define the geographic scope for the MVA:

a. **Physical boundaries:** Natural physical boundaries such as rivers or mountains, political boundaries such as the city limit or administrative regions, or human made such as urban and rural zones.

b. **Vulnerabilities:** Areas and sites where known and documented existing exposure and vulnerability to climate change hazards are present may be considered high-priority areas for the MVA.

c. **Ecosystems:** As the MVA includes both biodiversity and climate factors, key ecological zones or habitats (including protected areas) within or near the city should be identified and considered within the scope.

d. **Scale:** The scale will influence the level of detail of the MVA for example a larger scale such as national or regional will often have lower resolution than a smaller scale such as neighbourhood or community level.

e. **Data availability:** Anticipate data collection challenges by considering the scale at which data is routinely collected. For example, neighbourhood level data may be more challenging to source and may require more primary data collection.

f. **Population density and distribution:** Assess the distribution and density of the population, noting that more densely populated areas may face heightened risks to hazards. Likewise, consider the distribution of more potentially vulnerable and marginalized communities (such as women, persons with disabilities, the elderly, urban poor, etc.) in the city.

g. **Topography:** The elevation, slope and other topographical features can influence vulnerability to hazards including flooding, landslides or wildfires

It is recommended that this activity includes a collaborative discussion with the Delivery Team. It may also be beneficial to engage key stakeholders.

Suggested resources

Human

The Delivery Team should work together to determine the geographic scope of the MVA. Input from each of the various fields of expertise represented on the Delivery Team will be valuable in the final boundary determination. The Delivery Team may also wish to consult the Steering Committee for additional guidance on priority areas or populations.
GIS Expertise, including strong proficiency in advanced geospatial analysis, data processing and management, and GIS software techniques related mapping and overlay analysis

Technical and operational

- Rapid city diagnostic, including analysis of city context and sectors
- Stakeholder mapping and analysis summary

Considerations

The selection criteria for defining the geographic scope of the MVA is to be determined by the Delivery Team and Steering Committee, following consideration of the above factors. It is important to note that the selection criteria may differ across cities and countries. For example, in some cities, it may be favourable to select a study area in which there is already existing data, ongoing resilience interventions or activities, or earmarked investments or allocated resources. Whereas, in other cities, it may best to select study areas in which data is limited or non-existent, communities are underserved, and there is a lack of development initiatives or support.

Objectives

To identify and delineate the geographic boundary for the MVA.

Outputs

An agreed geographic boundary for the MVA.

Develop assessment plan

Step 1.3
Activity B

Develop Work Plan and schedule of activities

Activity description

Summary

The Work Plan provides a systematic and structured approach to conducting the MVA. It outlines the key stages, steps, activities and tasks to be completed, ensuring that the assessment process follows a logical and practical sequence. The Work Plan also highlights key milestones within the project. It also helps to facilitate the coordination and collaboration of the key MVA stakeholders, providing a shared understanding of roles, responsibilities, timelines, and dependencies.

The Work Plan helps the Delivery Team allocate and manage human, financial, and technological resources appropriately to ensure the MVA is conducted efficiently and effectively. It also helps to establish accountability by assigning specific MVA tasks to individuals or teams. This ensures that everyone involved in the assessment understands their role and responsibilities, contributing to the overall success of the project.

As a communicative tool, the Work Plan also helps stakeholders (such as the Steering Committee) understand the timeline and milestones of the MVA. It facilitates effective engagement with relevant stakeholders, keeping them informed about progress and expectations.

The Schedule of Activities with the Work Plan sets specific timelines for each task. This helps in managing time effectively, ensuring that the assessment stays on track and is completed within the desired timeframe.

The Work Plan and schedule of activities are crucial for organizing, managing, and successfully completing the MVA. They contribute to efficiency, accountability, and effective collaboration throughout the full assessment process. The Work Plan should be shared with the Steering Committee and other key MVA stakeholders, such as funding partners and implementation partners, for review, feedback and approval.

Tasks

1. **Draft Work Plan** to include the key activities, timelines and key milestones for the full MVA process. Use the Handbook to guide the development of the Work Plan to define activities, sequence tasks, set timelines and establish milestones. A gantt chart can be useful to accompany the workplan. An example gantt chart considering the key milestones of the MVA is included in Annex 2.
2. **Define tasks and responsibilities** for team members and key stakeholders engaged in the MVA. Clearly state the deliverables expected from each task and communicate these with the relevant parties. Tools like a Responsible, Accountable, Consulted and Informed (RACI) matrix can assist delivery teams define tasks and responsibilities within a workflow or workplan.
3. **Share with Steering Committee** for review and feedback and to ensure agreement on any specific roles or responsibilities related to key MVA steps and activities.

Objectives

Development MVA Work Plan, including a schedule of all key steps and activities and the intended timelines allocated to each step.

Outputs

MVA Work Plan

Develop assessment plan

Step 1.3 Activity B (continued)

Develop Work Plan and schedule of activities

Suggested resources

Human

- The Delivery Team should work collaboratively to develop the workplan and schedule of activities. The output should consider the various expertise on the Delivery Team as well as the available resource hours.

Technical and operational

- All previous outputs
- Suggested project Work Plan and timelines template
- RACI matrix template

Considerations

1. Ensure that appropriate resources (e.g. human, financial or technological) are allocated to the activities detailed in the Work Plan.
2. The Work Plan is the key resource for project management and coordination of all activities involved in the MVA among the Delivery Team and Steering Committee.
3. The Work Plan is a live, iterative document that will be updated as the MVA is undertaken. It should be continuously reviewed and updated to account for any changes experienced during the MVA lifecycle.
4. The Work Plan should be understood as a framework that allows for any potential challenges to progress or deviations from the agreed outputs or deadlines to be identified, communicated and coordinated so that corrective measures and risk mitigation efforts can be undertaken.
5. Work Plans and their corresponding timelines may differ across cities and countries. Timelines for Stages, Steps and Activities may differ (e.g. take shorter or longer to complete) due to a range of context-specific factors. The progress bar indicating the weighting of this activity as part of the full MVA process provided in this Handbook are intended as guidance only, but should be followed as far as possible.

Objectives

Development MVA Work Plan, including a schedule of all key steps and activities and the intended timelines allocated to each step.

Outputs

MVA Work Plan

Stage 1 Checklist: Preparation

Step 1.1. Set up Delivery Team and Steering Committee

Activity A: Establish and mobilize Delivery Team

- ☐ Delivery Team established and mobilized

Activity B: Set up MVA Steering Committee

- ☐ Steering Committee established and mobilized

Activity C: Map and snalyze stakeholders

- ☐ Stakeholder List
- ☐ Stakeholder Influence-Interest Matrix
- ☐ Stakeholder Profiles

Activity D: Prepare stakeholder engagement plan

- ☐ Stakeholder Engagement Plan

Step 1.2. Conduct rapid diagnostic of the city or urban area

Activity A: Assess city capacities and resources

- ☐ Capacity and Resource Needs Assessment
- ☐ Capacity Building Plan

Activity B: Conduct City Context Analysis

- ☐ A high-level summary analysis of the city context

Step 1.3. Develop assessment plan

Activity A: Define geographic scope

- ☐ An agreed geographic boundary for the MVA.

Activity B: Develop work plan and schedule of activities

- ☐ Work Plan and schedule of activities

Mapping and analysis

Stage 02

The ongoing consternation of the bridge at the Nairobi river in Mathare slum, Kenya 2016, © UN-Habitat_Julius Mwelu

Stage 2
Mapping and analysis

Stage overview

Summary: The Mapping and analysis stage involves both sourcing and applying data to provide a detailed analysis of vulnerability hotspots within urban areas using the lenses of climate change, biodiversity, and urban growth. The maps created in this stage represent a key output of the MVA. It is through the overlaying of these outputs that areas of intersecting and interconnected vulnerabilities and vulnerability hotspots are identified and analyzed.

This stage involves considering the current state of the climate, biodiversity, and urban dimensions. It relies on GIS to map known vulnerabilities or vulnerability indicators in each of the three dimensions and combine said data into maps that identify locations where multiple vulnerabilities compound to create vulnerability hotspots. Steps 1 and 2 focus on collecting and preparing the necessary quantitative and qualitative data that are required to complete the mapping activities. Steps 3, 4 and 5 focus on organising and mapping the data into dimensional vulnerability hotspots, identifying competing and multilayered vulnerabilities, and completing the supporting analysis. The supporting analysis intends to identify the sensitivities, exposures, and (lack of) adaptive capacity that contribute to the vulnerability hotspots. An optional extension includes replicating the MVA mapping and analysis for future scenarios, using projected future climate, biodiversity, and urban development data.

Objective: To generate comprehensive data and analysis on the interconnected and compounding vulnerabilities that make people, infrastructure, and the environment susceptible to various adverse climate change impacts, urbanization trends, socioeconomic conditions, and other challenges.

Outputs: The key outputs of this stage are realized through five separate steps, where each builds on the output of the last. Each step generates an output that is essential to thecreation of the MVA:

1. Data requirements prepared for the assessment
2. Quantitative and qualitative data acquired
3. Historic, current and predicted vulnerabilities mapped and analyzed
4. Intersecting and interconnected vulnerabilities mapped and analyzed
5. Multilayered Vulnerability Profiles developed

Activities conducted under each step are shown below and described in detailed step-by-step guidance in the following sections.

Stage Two

Step 2.1

Mapping assessment preparation

Activity A
Establish data requirements

Activity B
Identify data sources and availability

Activity C
Develop Geospatial Workflow

Step 2.2

Data acquisition and collection

Activity A
Prepare Data Collection Plan

Activity B
Gather qualitative data

Activity C
Gather quantitative data

Activity D
Data cleaning and pre-processing

Step 2.3

Map historic, current and future vulnerabilities

Activity A
Map historic and existing climate change, urban and biodiversity vulnerabilities

Activity B
Analyze historic and existing climate change, urban and biodiversity vulnerabilities

Activity C
[optional extension]
Map future climate change, urban and biodiversity vulnerabilities

Activity D
[optional extension]
Analyze future climate change, urban and biodiversity vulnerabilities

Step 2.4

Map multilayered vulnerability hotspots

Activity A
Map intersecting and interconnected vulnerabilities

Activity B
Analyze intersecting and interconnected vulnerabilities

Step 2.5

Develop Multilayered Vulnerability Profile

Activity A
Document the Multilayered Vulnerability Profile

Activity B
Validate the Multilayered Vulnerability Profile

Activity C
[optional extension]
Visualize Multilayered Vulnerability Profile

Mapping assessment preparation

Step 2.1 Activity A

Establish data requirements

Activity description

Summary

The first task in preparing for the MVA mapping and analysis is to establish the assessment's data needs and requirements. Establishing data requirements for the MVA involves a systematic process to ensure that the analysis is comprehensive, relevant, and tailored to the study's specific needs. It is the first step of the assessment that seeks information explicitly tailored to the geographic area defined in **Stage 1**.

Data needs and requirements are informed by the outputs of **Stage 1**, Step 1.2 Activities A and B. This activity should also consider the guidance of the Steering Committee.

The steps below will help to establish data requirements for the MVA.

Tasks

1. **Review the MVA scope and objectives** to understand the geographic focus, extent, timeframe, and specific vulnerabilities or risks to be assessed (e.g. climate change **hazards).**
2. **Conduct a literature review** to identify existing studies, reports, and available data related to the study area and the initially identified climate risks, urban and spatial trends and conditions, and biodiversity. This helps to identify data sources and data gaps, avoid duplicating efforts, and ensures the use of the latest information. This Activity will build on those completed in Steps 1.2A and 1.2B, wherein a rapid analysis was undertaken to understand the city context.

   Refer to the indicators specified in the *Data collection and analysis technical brief* for a cursory understanding of potential data needs. The brief describes the suggested indicators for each of the 3 MVA dimensions. The brief includes 10 indicators for the climate dimension, 3 cluster indicators for the biodiversity dimension and 7 indicators for the urban dimension. The document also contains details on the key and most relevant data, information, and documentation to be used in the MVA. This resource should be consulted for an understanding of the type of GIS data that will be needed to complete the MVA. While selection does not occur until Step 2.2 Activity A, Delivery Teams should be aware that it is suggested that at least 3 and no more than 6 indicators are used for each dimension. Indicators should be selected based on local context and data availability.
3. **Determine the temporal resolutions** required for the assessment. This involves deciding on the time period that the MVA will consider. It is suggested that the MVA consider the current period in its analysis of the three key thematic vulnerability topics: climate change, urban and spatial, and biodiversity. Where indicators are presented as a change value, it is suggested that this is presented as the current time period's departure from the historic baseline.

   Definitions of "historic" and "current" are flexible and subject to data availability. Where possible, historic baselines should be built from datasets covering 30 years (i.e., 1950-1980, 1970-2000, 1980-2010). The current period should be defined by at least 5 years of recent data (i.e., 2017-2022, 2010-2015). Additional discussion is provided in the Technical Brief.

   An optional extension includes analysis of future (projected) scenarios of climate change, urbanization, and biodiversity. Climate models and projections from trusted sources (i.e., IPCC, UKCP, CSIRO) may be used to obtain future climate scenarios and socio-economic pathways.
4. **Determine the spatial resolutions** required for the assessment to confirm the level of detail needed in spatial data. As it is suggested to conduct the MVA at city-level and community-level, data at these subnational levels is preferential. A Data Requirements Sheet provides guidance on the spatial resolutions for GIS data for each indicator and layer. Note that it is possible that the preferred resolution will change as the MVA progresses and new information is gleaned. In some cases, existing data may need to be resampled at higher or

Objectives

Determine which data and documentation is required to undertake the MVA

Outputs

Completed Data Requirements Sheet

Establish data requirements

Activity description

lower resolutions.

Tasks

5. **Consider data integration** and plan for the use and integration of different types of data at different scales, considering the interdisciplinary and multidisciplinary nature of the MVA. Ensure that data from various sources can be effectively combined for a holistic analysis of multilayered and interconnected vulnerabilities and risks.
6. **Customize and tailor the data requirements** to the specific needs of the assessment. Consider the unique characteristics of the city or community, as well as the priorities of the study area, the specific resources and capabilities available, and the vulnerable communities present. Adjust data identification and collection efforts accordingly.
7. **Compile the 4A. Data Requirements Sheet** template – summary which summarizes the specific data needs and specifications for the MVA. The Data Requirements Sheet is a tool to identify and organize geospatial data used in the MVA. It is intended to streamline the process of identifying and organizing data held by the Delivery Team and data to be requested from auxiliary sources. The Data Requirements Sheet can be considered a living document, to be updated as progress is made in the preparatory steps of the MVA.

After these tasks are completed, the Delivery Team will be able to determine exactly what data is required for the MVA, which will help to prepare the Geospatial Workflow (Step 2.1 Activity C) and Data Collection Plan (Step 2.2 Activity A).

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.1 Activity A should be co-led by the Team Lead.

Technical and operational

- *Data collection and analysis technical brief*
- Data Requirements Sheet template

Considerations

It is important to review and update the Data Requirements Sheet throughout the MVA. For example, during the Data acquisition and collection step, additional data requirements may be identified. Similarly, data that was previously included may be identified as unhelpful and removed. For example, as data is collected for different dimensions and indicators from different sources, it may become apparent that some data does not meet or align with the established requirements and cannot be used.

Completing this step may reveal a need to engage additional stakeholders.

Objectives

Determine which data and documentation is required to undertake the MVA

Outputs

Completed Data Requirements Sheet

Identify data sources and availability

Activity description

Summary

Using the completed Data Requirements Sheet, the Delivery Team can now begin to identify and locate potential sources for GIS data, information, and documentation required for the MVA. The completed Data Requirements Sheet may also help the Delivery Team to identify data that must be created newly or procured prior to use in the GIS analysis.

For the MVA, the main data requirements pertain to the GIS data for selected indicators corresponding to the three dimensions of the assessment methodology (urban, climate change and biodiversity).

Since GIS data is occasionally tied to project work, it is also essential for other relevant quantitative and qualitative data (i.e., project reports, censuses, surveys) to be identified, accessed, and collected for the MVA to be as comprehensive as possible.

Tasks

1. **Review the** *Data collection and analysis technical brief***,** including recommended datasets and sources, to confirm whether the geospatial data for selected city or urban area is available in the required resolution, quality, standard and format.
2. **Identify local and national government agencies** who are responsible for data collection and management in relevant MVA aspects (e.g. such as climate adaptation, spatial planning, environmental protection) and obtain data.
3. **Identify all other potential sources** for acquiring the required spatial data, which may include online data portals, utility companies, meteorological institutions, United Nations agencies, international and local development organizations, NGOs and CSOs, research institutions and academia, and the private sector.
4. **Assess data availability and accessibility** of the identified data sources and confirm that complete, accurate, high-resolution, recent, reliable, compatible data can be obtained for the MVA.
5. **Document data availability and accessibility limitations,** such as poor data quality, reliability, coverage, resolution, etc., which need to be addressed.
6. **Consider any potential data challenges** such as data discrepancies, incurred costs, licensing, copyright or usage restrictions, data privacy, security and confidentiality constraints, and data format technical compatibility issues.
7. **Coordinate with data owners** (e.g. public sector, academia, utilities authorities) to formally request data and acquire data. In some cases, this may require establishing institutional arrangements, drafting of formal data requests, or signing of data sharing agreements.
8. **Set up the initial Data Inventory** which will be used to list and catalogue the available data that will be used in the MVA.

The supplementary *Data collection and analysis technical brief* provides detailed information on what type of data is required for the MVA, as well as data sources and resources that should be used.

Objectives

To identify and confirm the availability of required data for the MVA

Outputs

A completed Data Inventory

Identify data sources and availability

Suggested resources

Human

- Step 2.1 Activity B should be co-led by all members of the Delivery Team. The Delivery Team should also consider collaborating with the Steering Committee to identify additional data potential data sources and contributors.

Technical and operational

- Data *collection and analysis technical brief*
- Data Requirements Sheet template
- Data Inventory template

Considerations

The Data Inventory requires updating through each of the following steps and activities in Stage 2. It will be further developed in Step 2.2 Data acquisition and collection when qualitative and quantitative data is collected.

It is recommended that Delivery Teams take a standardized approach to organizing, updating, storing and maintaining the Data Inventory, including all datasets and documentation, to ensure transparency, accountability, and efficiency in managing the MVA data assets.

Data management protocol should be established among the Delivery Team. This should cover aspects such as filing and naming conventions, data usage, data formats, access and permissions, version control, and folder organization. Consider using a shared cloud storage (SharePoint, Google Drive) to organize and distribute files for the duration of the MVA.

Objectives

To identify and confirm the availability of required data for the MVA

Outputs

A completed Data Inventory

Mapping assessment preparation

Step 2.1 Activity C

Develop Geospatial Workflow

Activity description

Summary

The Geospatial Workflow now needs to be documented to guide the sequencing steps and processes involved in performing spatial analysis, data manipulation, and visualization for the MVA. The Geospatial Workflow will help unify knowledge throughout the Delivery Team, as well as establish organizational and administrative metrics for the handling of GIS data.

Geospatial workflows are designed to guide users through the entire process of working with spatial data, from setting the scope and establishing data requirements, to data acquisition and collection, to data cleaning, organizing and pre-processing, to analysis, interpretation, and presentation of results. It ensures quality, reproducibility, and usefulness throughout the process and, most importantly, of the MVA results. In this way, this Handbook and the accompanying Data Collection and Analysis Technical Brief act as a guideline from which the Geospatial Workflow can be built.

It is important to acknowledge that there is no single best way to approach a Geospatial Workflow, and that each workflow may differ between Delivery Teams.

The Geospatial Workflow considers the output of all of previous steps and activities. The Rapid City Diagnostic, MVA Assessment Plan, Data Requirements and Data Inventory all help to shape the Geospatial Workflow. It also considers future outputs and how they will be addressed. The additional tasks to help prepare the output are listed below.

Tasks

1. **Identify stakeholders and resources:** Determine the stakeholders involved in the MVA, including end-users (e.g. local government practitioners), decision-makers (e.g. local government policymakers), and technical experts (e.g. project GIS specialist). Assess available resources such as personnel, software, hardware, and spatial data.
2. **Select tools and software:** Choose the appropriate GIS software and tools (such as QGIS, Google Earth Engine, Survey123) based on the project requirements, budget, technical expertise and local capacities. Consider factors such as data compatibility, analysis capabilities, scalability, and user interface.
3. **Data acquisition and collection:** Determine the approach to acquiring and collecting data, considering the data requirements and sources already defined. This should include which team member is responsible for contacting data custodians and which is responsible for executing Data Quality Assurance (QA) and Quality Control (QC), if enumerators will be required for any part of the data collection, and how updates are communicated throughout the team. Some or all of these responsibilities may have already been specified in the RACI matrix completed in Step 1.3 Activity B. Note that this sub-output will also inform the Data Collection Plan.

   The approach to collecting and acquiring data need not be finalized in this Activity. Instead, this Activity is intended to introduce the Delivery Teams to the Activities required before executing the GIS Analysis. At this point, it may be helpful to read through the remainder of Stage 2 so that it is understood what is required.
4. **Establish data management protocols:** Tools like naming conventions for documents and geospatial data, and establishing a dedicated file storage structure and location will assist the Delivery Team to keep data and information organized. Additional choices, like rules for altering data sets and versioning, and how frequently and where to backup data are also a part of the Geospatial Workflow and help safeguard against accidental data loss and setbacks.
5. **Develop Standard Operating Procedures (SOPs):** Define standardized procedures and protocols for data collection, processing, analysis, and reporting. Document SOPs to ensure consistency, repeatability, and transparency in the workflow.

Objectives

To provide the overarching structure and approach for undertaking the GIS and data mapping and analysis component of the MVA

Outputs

Detailed Geospatial Workflow

Develop Geospatial Workflow

Activity description

Tasks

6. **Establish Data Quality Assurance (QA) and Quality Control (QC) measures:** Implement QA/QC measures to ensure the accuracy, completeness, and reliability of spatial data. Define data validation procedures, error-checking mechanisms, and data reconciliation processes.
7. **Design workflow architecture:** Develop a workflow architecture that outlines the sequence of tasks, dependencies, and inputs/outputs of the geospatial workflow. Break down the workflow into manageable stages or modules, each with specific objectives and deliverables.
8. **Document the geospatial workflow:** As an integral part of the MVA process that ultimately defines how and where GIS data will be handled, the Geospatial Workflow should be documented and distributed across all members of the team who will interact with geospatial data. The workflow should be considered a living document, with updates likely as the MVA progresses and Delivery Teams learn what works best for them.
9. **Implementation and deployment:** Execute the MVA Geospatial Workflow according to the established procedures and timelines. It is critical to monitor progress, track milestones, and adjust resources as needed to ensure successful implementation.

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.1 Activity C should be co-led by the Team Lead.

Technical and operational

- All previous outputs
- *Data collection and analysis technical brief*
- Data Requirements Sheet template
- Data Inventory template

Considerations

Capacity building on geospatial data management may be required to assist the Delivery Team undertake this Activity. It is critical that personnel (such as Delivery Team GIS specialists and or local government data management units) have the necessary skills and knowledge to execute the GIS techniques required to complete the MVA effectively. This may include training on GIS software, data management techniques, spatial analysis methods, and best practices in geospatial analysis and data visualization.

Objectives

To provide the overarching structure and approach for undertaking the GIS and data mapping and analysis component of the MVA

Outputs

Detailed Geospatial Workflow

Data acquisition and collection

Step 2.2 Activity A

Prepare Data Collection Plan

Activity description

Summary

Following the Rapid city diagnostic completed in Step 1.2 and the Mapping assessment preparation completed in Step 2.1, the Delivery Team should next prepare a detailed Data Collection Plan to guide all data collection activities undertaking during the MVA.

The Data Collection Plan builds on previous outputs, including the Data Requirements Sheet and the Data Inventory. If not yet completed, the Data collection and analysis technical brief should be consulted prior to initiating this Step of the MVA.

The Data Collection Plan should consider: chain of command; naming conventions; data storage, access, and versioning; and how individual responsibilities are distributed across members of the Delivery Team.

Tasks

1. **Select areas to assess:** Confirm the geographic boundaries in which to undertake the MVA. It is recommended to assess multilayered vulnerabilities at the city and community level and to select potentially vulnerable communities or neighbourhoods. This selection should be based on the findings of the rapid city diagnostic and with the considerations of the Steering Committee. The chosen area(s) should be selected based on the likelihood of current and future climate change, urban, and biodiversity vulnerabilities. This may include low-income communities, informal settlements, elderly populations, critical infrastructure, coastal areas, etc.
2. **Select indicators:** Using the outputs of the Rapid City Diagnostic, the Data Requirements Sheet and the Data Collection and Analysis Technical Brief's GIS Indicator Factsheets, identify and prioritize the indicators within each of the MVA dimensions (climate change, urban and biodiversity) that are most relevant to the area being assessed. Delivery teams are asked to select between 3 and 6 indicators for each dimension. The selected indicators from each dimension will be combined in subsequent Steps to form three raster layers that will be used in the GIS mapping and analysis to identify and analyze vulnerability hotspots. Multilayered vulnerabilities are identified through the combination and overlay of the individual dimension layers. It is important that the selected indicators reflect the most prevalent and pressing climate change hazards affecting the urban area being assessed, within the boundary of the available data. The process for compiling the layers is described in the *Data collection and analysis technical brief* and is elaborated in Step 2.3.
3. **Select data collection instruments:** Choose the most appropriate methods for gathering the required data. This should include methods for collecting both primary and secondary data, and qualitative and quantitative data. Guidance on data collection methods for qualitative and quantitative data is provided in the *Data collection and analysis technical brief* and in Step 2.2 Activities B and C.
4. **Plan for data acquisition and collection:** Using the outputs of the appraisal of data availability, and the areas selected for assessment, determine how data will be acquired and collected. This may include accessing open-source datasets, obtaining data from governments, NGOs or CSOs, designing surveys, or conducting data collection activities with key stakeholders. Specific approaches are detailed in the following activity guidance and in the *Data collection and analysis technical brief*.
5. **Plan for data analysis:** The MVA uses a normalized overlay analysis to identify, map, and assess vulnerability hotspots and multilayered vulnerabilities. It is critical that the GIS analysis is supplemented by literature, validation and ground-truthing, scenario planning, and other means of data analysis. Specific approaches are detailed in the following activity guidance and in the *Data collection and analysis technical brief*.
6. **Plan for interpretation and reporting:** It is important to understand the requirements for interpreting and reporting the MVA output, specifically for the development of the Multilayered Vulnerability Profile. Guidance is provided in the *Data collection and analysis technical brief*.

Objectives

Develop a Data Collection Plan to guide Step 2.2 Activities B and C

Outputs

A Data Collection Plan. Continue to update the Geospatial Workflow accordingly

Prepare Data Collection Plan

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.2 Activity A should be co-led by the Team Lead and other members who have significant data collection responsibilities. The RACI Matrix completed in Step 1.3 Activity B can help identify the relevant team members.

Technical and operational

- Data Requirements Sheet template
- Data Collection Plan template
- *Data collection and analysis technical brief*

Considerations

The Data Collection Plan may need to be updated during the MVA process. It should be reviewed and iterated as the data collection is undertaken to address any issues, gaps, or limitations that arise.

When preparing the Data Collection Plan, consider how quality assurance measures (i.e., the accuracy, reliability, and validity of the collected data) can be applied throughout the process. This may involve training data collectors, conducting pilot tests, and implementing data validation checks.

The Data Collection Plan should also detail how stakeholders will be engaged, and refer to the Stakeholder Engagement Strategy. Engaging relevant stakeholders throughout the data collection and analysis process is pivotal to ensuring that their perspectives and concerns are incorporated into the assessment.

Objectives

Develop a Data Collection Plan to guide Step 2.2 Activities B and C

Outputs

A Data Collection Plan. Continue to update the Geospatial Workflow accordingly

Data acquisition and collection

Step 2.2 Activity B

Gather qualitative data

Activity description

Summary

Collecting and analyzing qualitative data is essential for completing a comprehensive MVA. It complements the GIS and quantitative data that is used in the MVA by providing localized, contextual and nuanced understanding, capturing lived experiences, identifying vulnerable populations, infrastructure and environments, validating spatial findings, fostering stakeholder engagement, and enhancing the relevance and depth of assessment findings for informed adaptation and resilience decision-making and action. Further elaboration on the use of qualitative data for the MVA is provided in the supplementary *Data collection and analysis technical brief.*

Tasks

The Delivery Team should gather the qualitative data that has been detailed in their Data Requirements List, utilizing the sources they have identified, and the qualitative data collection methods stated in the Data Collection Plan. The main activities to be undertaken are:

1. **Review *Data collection and analysis technical brief*** to understand how qualitative data can be used to complement, deepen and strengthen the assessment analysis in each city.
2. **Review data collection plan** to determine which types of qualitative data are required to support the MVA, specifically addressing data, knowledge and understanding gaps.
3. **Gather available qualitative data** such as project documents, local or national assessments, report and policy documents, academic literature, case studies and research publications related to urban planning, environmental assessments, disaster management, and climate adaptation in project cities and countries.
4. **Undertake qualitative data collection** methods, such as key informant interviews, focus group discussions, community surveys, observations and site visits, multistakeholder and targeted consultations, participatory GIS mapping and community vulnerability mapping, to obtain required data.
5. **Document and organize data** by ensuring all collected data is recorded, documented, categorized and stored so it can be easily found and utilized for the forthcoming analysis tasks. This should result in updates to the Data Inventory prepared in Step 2.1 Activity B.

Considerations

The collection of qualitative data will be a continuous process that starts before the Mapping and Analysis tasks and continues through the full lifecycle of the project.

Qualitative data collection is one of the main activities that will be used to facilitate meaningful stakeholder engagement through the project. As such, it is important that the qualitative data collection activities outlined in the Data Collection Plan align with the Stakeholder Engagement Plan and overall MVA Work Plan.

The timeline for this data collection step is contingent on the availability and accessibility of data, which will differ in different city or country contexts. If significant data gaps exist and data collection challenges persist, the duration of this activity may be considerably increase.

Robust data management protocols are as necessary for qualitative data as they are for quantitative data. Organization is also paramount.

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS specialist. Step 2.2 Activity B should be co-led by the Team Lead and other members who have significant data collection responsibilities. The RACI matrix completed in Step 1.3 Activity B can help identify the relevant team members.

Technical and operational

- Data Requirements Sheet template
- Data Collection Plan template
- *Data collection and analysis technical brief*
- Data Inventory template
- Preferred GIS Software (e.g. QGIS, ArcGIS)

Objectives

To collect and analyze key qualitative data relevant to the MVA

Outputs

Compilation of qualitative data in the Data Inventory

Data acquisition and collection

Step 2.2 Activity C

Gather quantitative data

Activity description

Summary

The MVA makes use of quantitative data, primarily through the analysis of GIS data for each of the layers and their corresponding indicators. The Delivery Team is encouraged to make use of national and local GIS datasets. Where gaps or temporal inconsistencies occur, Delivery Teams are invited to utilize global open-source, accessible geospatial datasets. Ultimately, the focus should be on creating and/or obtaining as high-quality and accurate data sets as are permitted by time, financial, and personnel constraints. The MVA methodology aims to be replicable so that results can be updated by country teams in the future if new/more accurate datasets become available. In this way, the MVA should be considered a living output.

For the MVA, the main GIS data requirements pertain to the selected indicators corresponding to the three dimensions of the assessment methodology (urban, climate change, and biodiversity) as defined and selected in the Data Collection Plan (specifically Task 2).

A set of open-source, free and suitable GIS datasets have been identified and prepared for the MVA and can be found in GIS Data Indicators Factsheets in the *Data collection and analysis technical brief*. In the absence of available local data, these are the first datasets that should be consulted by the Delivery Team. Other potential quantitative data and relevant sources are also provided in these documents.

Tasks

1. **Review *Data collection and analysis technical brief*** to understand how qualitative data can be used to complement, deepen and strengthen the assessment analysis in each city.
2. **Review Data Collection Plan** to determine which types of quantitative data are required to build indicators and support the MVA, specifically focusing on GIS and spatial data.
3. **Gather available local data:** Obtain geospatial data for all three dimensions and the prioritized indicators from the available local sources identified in Step 2.1.
4. **Gather open-source quantitative data:** Obtain geospatial data for all three dimensions and the prioritized indicators from the open-source datasets provided in the GIS Data Indicator Factsheets. Digital datasets in formats, such as shapefiles, GeoJSON, KML, or raster formats, should be acquired.
5. **Appraise data:** It is important to check whether the data for the urban areas to be studied from these sources meet the data requirements set out in earlier steps. This task should also verify and update any quantitative data against qualitative data obtained in the previous Activity. If gaps or limitations exist, the Delivery Team should identify other potential sources for data or consider using proxy or estimated data.

   Using proxy data is the practice of replacing missing or compromised data with a related or comparable data source, or with a reliable estimate. Some common examples include using census values from a neighbouring country, province or region with similar characteristics, or estimating climate extremes based on region of similar size, latitude, and geography. Owing to the challenges involved with assessing the representativeness or suitability of proxy data, this option should be reserved for country teams who have experience using data substitutions and/or who are confident in the choice of proxy.

   If there is little confidence in choices available for proxy or estimated data, Delivery Teams are encouraged to consider selecting a different indicator for which representative data is available.
6. **Organize quantitative data:** Once the GIS data is collected, the Delivery Team should build and organize the datasets for each layer and indicator. GIS layers should be categorized, comparable in temporal and spatial resolution, and fit-for-use. Layers should have metadata that indicates methodologies used to collect the data, or which global dataset the information has come from.

Objectives

Identify and organize quantitative geospatial data for use in the MVA

Outputs

Compilation of quantitative geospatial data in the Data Inventory

Gather quantitative data

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.2 Activity C should be co-led by the Team Lead and other members who have significant data collection responsibilities. The RACI Matrix completed in Step 1.3 Activity B can help identify the

Technical and operational

- Data Requirements Sheet template
- Data Collection Plan template
- *Data collection and analysis technical brief*
- Data Inventory template
- GIS indicator factsheets
- Preferred GIS software (e.g. QGIS, ArcGIS)

Considerations

It is important to note that while open-source datasets are available are useful for the MVA, utilizing local data that can be more recent, accurate and of higher resolution is recommended, if it exists and is accessible. It is recommended that Delivery Teams coordinate closely with key stakeholders and partners to request and acquire suitable local data for the study.

Local datasets also tend to provide more local contextualized, up-to-date and validated information that is specific to the study area, such as climate change hazard susceptibility, infrastructure conditions and socio-economic characteristics. Global, open-source datasets may not capture these aspects accurately which could lead to inaccurate analysis and interpretation. Using these datasets in combination with open-source data allows for a more comprehensive and accurate MVA.

Quantitative data to be used in the MVA does not only focus on GIS data. Consider whether other types of quantitative data, such as survey data, census data, earth observation, remote and satellite imagery, and statistical data, could add value to the MVA. Using this data in conjunction with GIS data can help address gaps in datasets for sites and regions where open-source data is less accurate or scarce. These datasets can also be combined with the existing open-source datasets through GIS software to create more nuanced and detailed MVA spatial layers or indicators for GIS analysis. This may involve data conversion, digitization, standardization and integration.

Acquiring data may involve formally requesting data and establishing and signing data sharing agreements with different parties. For example, to access and use government data, it may be necessary to first request data through formal correspondence with the government and then sign a memorandum of agreement or a data sharing agreement which dictates the terms and conditions of using the data for the MVA. The Steering Committee, particularly members involved in government, should assist in this process.

The specific approaches to acquiring and collecting data in each city/country may present challenges to the Delivery Team. For example, data acquisition in some countries may take longer than others. It is important that the Delivery Team anticipate and plan for issues such as delays, usage and sharing restrictions, and time needed for approval of sharing agreements.

As in the previous step, the timeline for this data collection is contingent on the availability and accessibility of data, which will differ in different city or country contexts. If significant data gaps exist and data collection challenges persist, the duration of this activity may significantly increase.

Objectives

Identify and organize quantitative geospatial data for use in the MVA

Outputs

Compilation of quantitative geospatial data in the Data Inventory

Data acquisition and collection

Step 2.2
Activity D

Data cleaning and pre-processing

Activity description

Summary

Data cleaning and pre-processing goes hand-in-hand with data collection and creation, and is an integral part of any geospatial workflow. Spatial data is often distributed across multiple systems and conforming to various standards and formats. This is especially true in cases such as this where the data informing the analysis is collected from various sources.

Data cleaning and pre-processing allows the Delivery Team the opportunity to thoroughly examine the data before using it in the analysis. This involves various operations performed on spatial datasets before the analysis can take place. These operations are crucial to ensure the data is in a suitable format, quality, and structure for further analysis, visualization and decision-making. Critically, it enables the team to address any errors before conducting the analysis. This improves the accuracy, consistency, and reliability of spatial data that will be used in the MVA.

Data cleaning is the process of reviewing data and removing or fixing any incorrect, outdated, duplicate, unnecessary, NaN, or missing fields or values. In spatial data, this applies to both the geometry and attributes. Pre-processing involves integrating, adding or combining data from multiple sources, transforming, reorganizing or normalizing data.

This activity is undertaken as the Delivery Team collect the required data. It is therefore a continuous and iterative process to be completed concurrently with Step 2.2 Activities B and C.

Multiple software's and data packages exist to automate data cleaning. Delivery Teams are welcome to use these tools but should note that they are not necessary.

Tasks

1. **Confirm permissions:** Check the schema and ensure administrative rights (ability to edit)
2. **Review data and identify errors:** Review the data to understand its content, format, and quality. Assess the data for completeness, correctness, consistency, and currency. Identify any potential errors, anomalies, or inconsistencies. Attribute errors can include missing or null values, inconsistent units and spelling and other typological errors, and data types that do not match the field. Geometry errors can include overlaps, gaps, duplicates, over- and undershoots. Sorting attributes is a useful first step in identifying attribute errors. ArcGIS has a Topology Toolset while QGIS has a Topology Plugin that can assist the Delivery Team to check for geometry errors.
3. **Correct errors:** Correct any errors, inconsistencies and inaccuracies identified in the dataset. This may require consulting sources or revisiting the literature analysis. This task may also include creating new or deleting unnecessary attribute fields and updating data types. Validate cleaned data against predefined quality criteria.
4. **Data conversion:** Convert vector data into a common format if necessary (i.e., .shp vector files, .tif or .img rasters). Data should also be transformed or projected into a common CRS. There is no preferred format for data. Delivery Teams are advised to work in a data format that is most comfortable to them given their experience and expertise.
5. **Data reduction:** Large datasets can sometimes be cumbersome for analysis. Data pre-processing may involve reducing the datasets size while preserving essential information through techniques such as spatial or attribute sampling, aggregation, or generalization. The team may also find it beneficial to clip regional datasets to the MVA analysis area.
6. **Data integration:** Integrate cleaned GIS data with other datasets if necessary. Ensure seamless integration by aligning schemas and spatial references. On reviewing the data, the team may conclude that normalizing the data would provide better results in analysis.
7. **Metadata creation:** Metadata provides essential information about the dataset, including its source, quality, and characteristics. An essential part of data pre-processing involves creating or updating metadata to document the datasets properties, qualities, and processing steps.

Objectives

To prepare and process the GIS and other required datasets for the MVA

Outputs

Cleaned, organized, and processed datasets

Data cleaning and pre-processing

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist.

Technical and operational

- Preferred GIS Software (e.g. QGIS, ArcGIS)
- GIS datasets from Data Inventory
- Johnston, Michelle, and Mary Mozigno. 2019. 'Esri Best Practices: QA/QC for Your GIS Data'. Presented at the Esri User Conference. https://www.esri.com/content/dam/esrisites/en-us/about/events/media/UC-2019/technical-workshops/tw-6391-1016.pdf

Considerations

Some attribute errors within the data may be irremediable within the available time period. The Delivery Team and GIS Specialist must then decide if the errors present render the dataset unreliable, or if the errors can be overlooked for the purpose of the MVA.

Delivery Teams may find that they wish to perform cleaning and pre-processing at an earlier timepoint in Stage 2. Some teams may also decide to break up the tasks within the cleaning and pre-processing activity and disperse them to different Team Members All approaches are valid as long as the activities are completed prior to beginning Step 2.3.

Objectives

To prepare and process the GIS and other required datasets for the MVA

Outputs

Cleaned, organized, and processed datasets

Map historic, current and future vulnerabilities

Step 2.3
Activity A

Map historic and existing climate change, urban and biodiversity vulnerabilities

Activity description

Summary

By combining multiple indicators as spatial data layers, the MVA intends to integrate data from various disciplines such as climatology, urban planning, ecology, and social sciences. This interdisciplinary approach allows for a holistic understanding of vulnerabilities, considering both natural and human-induced factors, and their impacts on ecosystems and communities. Visualizing vulnerabilities helps stakeholders and policymakers to better understand the extent and severity of challenges.

Understanding where vulnerabilities are concentrated is the first step toward prioritizing mitigation and adaptation efforts, allocating resources effectively, and implementing targeted interventions. The use of historical data combined with current observations enables the identification of trends, patterns, and potential future scenarios, aiding in long-term planning and risk management.

It must be noted here that the MVA aims to visualize vulnerabilities, without consideration for exposure, adaptive capacity, or sensitivity. These additional elements are considered in the subsequent hotspot analysis.

This activity is to be repeated thrice; once for each of the three dimensions:

- once to combine all selected urban indicators into a single urban vulnerability hotspot raster,
- once to combine all selected biodiversity indicators into a single biodiversity vulnerability hotspot raster,
- and once to combine all selected climate change indicators into a single climate change vulnerability hotspot raster.

Overview

This Activity utilizes raster overlay analysis without weighting. It is intended to be a simple and replicable process. To achieve this, the process avoids assigning values of importance to vulnerability indicators, and instead bases its determination of high vulnerability by way of overlap – vulnerability hotspots are identified as areas where multiple vulnerabilities (as indicators) are acting.

For this analysis it is helpful if the input datasets have a common grid and cell size. The resolution should be determined by expert judgement and based on the resolution of the available indicator data. Similarly, all input datasets should be transformed into a common projected coordinate system following the local data. All input datasets need to have the same boundaries.

Process

1. Prior to commencing the overlay analysis, any vector indicator data needs to be transformed into raster data. There are a number of ways this could be achieved, and it is ultimately at the discretion of the Delivery Team and GIS expert to choose an appropriate methodology.

   Direct conversion from point or line features to raster is possible, and the Delivery Teams must decide if a direct conversion is an appropriate approach for their indicator data. It may be required that buffers, feature clusters, envelopes or other analysis are used prior to raster conversion. Alternatively, teams may choose to apply a distance mapping technique like Euclidean distance to achieve the polygon to raster conversion.

   Delivery teams must also decide if proximity and/or overlap in polypoint or polyline features should indicate compound or increased vulnerabilities. In point or line conversion to raster data, limitations like boundary rules may apply if the vector data lay on or across a cell boundary.

   There are also multiple ways to approach rasterizing polygon data. If the polygons are small enough, Delivery Teams should consider approaching the rasterization as they have with point data. If the polygons are of considerable size, Delivery Teams might consider a direct conversion with raster cells assigned based on cell centre, maximum area, or maximum combined area.

   Delivery Teams may also decide that a conversion applied to one indicator dataset is not appropriate for another and opt to follow multiple methodologies to

Objectives

Combine data relating to climate hazard indicators to reveal locations of vulnerability hotspots.

Outputs

3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions.

Map historic and existing climate change, urban and biodiversity vulnerabilities

Activity description

Process

convert vector data to raster data. In all cases, decisions made while executing the MVA analysis should be recorded.

2. Once indicator data are in raster format, represent vulnerable and/or exposed areas with "1" and exposure/vulnerability free areas with "0". This simplistic representation will ensure the MVA does not become overcomplicated. Indicators with continuous or ranging values should be normalized, with 0 representing vulnerability-free areas and 1 representing the areas with the highest vulnerability, as defined by that indicator's value.

   The process of statistical normalisation transforms a dataset so that all of its variations fall between 0 and 1. This process is useful when there is a need to compare multiple datasets that are all measured on different scales. The transformation to a common scale allows data from different sources to be compared against one another without losing the characteristics of the individual datasets.

   new value → original value

$$X' = \frac{x - \min(x)}{\max(x) - \min(x)}$$

   Taking population density as an example of a dataset with large ranging values, a statistical normalisation would transform a population density dataset to have the highest population densities represented by values close to 1, while the lowest population densities are represented by values closest to 0.

   Categorical data, in contrast, will need to have numerical values between 0 and 1 assigned to represent the relative vulnerability of that category. Applying a land use classification as an example of categorical data, natural and undisturbed landscapes with the lowest vulnerabilities should receive low scores (e.g., 0 or 0.1), moderately disturbed landscapes that retain some but not all of their native qualities (like agricultural land) should receive moderate scores (e.g., 0.3 to 0.6). Scoring of additional categories like urban and residential, and minerals and landfill are subjective and to be determined based on the specific context and opinion of local experts.

   Additional guidance on building indicators is available in the *Data collection and analysis technical brief* and accompanying GIS indicator factsheets.

3. Using raster math (addition) combine all thematic indicators into a single vulnerability hotspot raster (i.e., Combine all urban dimension indicators into a single urban vulnerability hotspot raster. Combine all biodiversity dimension indicators into a single biodiversity vulnerability hotspot raster. Combine all climate change dimension indicators into a single climate change vulnerability hotspot raster). In the resulting output rasters, higher values will indicate locations of increased vulnerability, also referred to as "vulnerability hotspots."

   Noting that for each dimension the maximum number of indicators to use is 6, the highest value at any vulnerability hotspot in any of the output rasters should be 6.

4. Normalize each of the output vulnerability hotspot rasters.

   Step 2.3 Activity A should result in three distinct raster outputs, one for each of the three dimensions (urban, climate change, and biodiversity) and indicating (through higher values) the locations where multiple vulnerabilities exist within that dimension.

Objectives

Combine data relating to climate hazard indicators to reveal locations of vulnerability hotspots.

Outputs

3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions.

Map historic, current and future vulnerabilities

Step 2.3 Activity A (continued)

Map historic and existing climate change, urban and biodiversity vulnerabilities

Suggested resources

Human and Technical

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist

Technical and operational

- Collected data in support of selected climate change, urban, and biodiversity indicators.
- Preferred GIS software (e.g. QGIS, ArcGIS)
- GIS indicator factsheets
- 'Understanding Euclidean Distance Analysis — ArcMap | Documentation'. https://desktop.arcgis.com/en/arcmap/latest/tools/spatial-analyst-toolbox/understanding-euclidean-distance-analysis.htm.
- 'Understanding Overlay Analysis — ArcGIS Pro | Documentation'.https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/understanding-overlay-analysis.htm.
- 'Multi Criteria Overlay Analysis (QGIS3) — QGIS Tutorials and Tips'.https://www.qgistutorials.com/en/docs/3/multi_criteria_overlay.html

Considerations

Data from different sources may have varying resolutions, accuracies, and precisions. It is essential to ensure consistency and compatibility among datasets to avoid inaccuracies or distortions in the analysis. To achieve this, it may be helpful to define or assign a "base raster" with the target resolution that all other data will be adjusted (resampled) to match. There will likely be a need to interpolate or generalize one or more datasets to achieve a consistent resolution across the analysis.

Higher resolution data will require greater computational resources and likely require greater storage space and processing time. Consider the capabilities of the hardware in use. This must also be balanced against the boundary of the area being assessed and the resolution of the available data. For smaller communities, the area being assessed may be smaller than the highest resolution available from global datasets. In these cases, the analysis should rely on locally available data at an appropriate resolution, or adjust (expand) the study area.

Proxy data is used as a substitute for direct measurements or observations when the required data is unavailable. Delivery Teams are advised to only use proxy data when they are confident in its quality, spatial and temporal resolution, consistency, validity, and relevance. Lapses in any one of these considerations can introduce unknown or unexpected errors into the analysis. Uncertainties associated with proxy data in the analysis should therefore be documented and communicated in the results. To increase the robustness of the analysis, proxy data should be combined with country-specific data.

Objectives

Combine data relating to climate hazard indicators to reveal locations of vulnerability hotspots.

Outputs

3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions.

Map historic, current and future vulnerabilities

Step 2.3 Activity B

Analyze historic and existing climate change, urban, and biodiversity vulnerabilities

Activity description

Summary

A detailed and structured analysis of the 3 thematic vulnerability hotspot rasters produced in Step 2.3 Activity A should be undertaken by the Delivery Team. Analyzing current and historic vulnerabilities is essential for building a comprehensive understanding of vulnerabilities, understanding trends and patterns, learning from past events, identifying priority areas for action, and developing effective adaptation and resilience strategies to address the challenges posed by climate change, urbanization and biodiversity loss.

Following the IPCC definition, vulnerabilities occur as a result of overlapping degrees of exposure, sensitivity, and (reduced) adaptive capacity. It is the combined impact of these components that determines the level and extent of vulnerability present at any location. Using the output rasters from the previous step which highlight vulnerability hotspots in each of the 3 dimensions (climate change, urban, and biodiversity), this step aims to explore and identify specific exposures, sensitivities, and adaptive capacities that are present in each hotspot and contribute to the overall vulnerability.

Like Step 2.3 Activity A, this activity should be completed thrice, once for each of the dimensions considered in the MVA.

Exposure

The degree to which a system, community, infrastructure or region is subjected to specific hazards or stressors. It represents the physical, social, economic, and environmental characteristics that make a particular entity susceptible to the impacts of climate change. Exposure is a fundamental component of the MVA as it helps identify areas, assets, or populations that are at risk of experiencing adverse effects from climate hazards, urbanization or biodiversity loss. For the MVA, the Delivery Team need to assess physical, social, economic, ecological and infrastructural exposure to each MVA layer for the city and selected urban areas.

Sensitivity

The degree to which urban systems, assets, populations, and ecosystems are susceptible to the impacts of climate change, urbanization and biodiversity loss. Sensitivity assessment helps identify vulnerabilities within the urban environment and understand how various elements may be affected by different hazards, shocks and stresses. Sensitivity is a key component of the MVA because it helps to determine the potential magnitude of impacts and prioritize adaptation strategies. For the MVA, the Delivery Team need to assess physical, social, economic, ecological and infrastructural sensitivities to each MVA layer for the city and selected urban areas.

Adaptive capacity

The ability of urban systems, communities, and individuals to cope with and respond to the impacts of climate change and climate-related hazards, urbanization and biodiversity loss. Adaptive capacity is a crucial aspect of the MVA, as it determines how effectively a city or community can adapt to and recover from climate-related challenges. For the MVA, the Delivery Team need to assess the adaptive capacities related to critical infrastructure, basic services, institutions and governance, community preparedness and resilience, economic resources, and knowledge and information.

When performing the analysis in this task, the Delivery Team should assess exposure, sensitivity and adaptive capacity for each of the vulnerability hotspot rasters.

Process

1. **Review the map:** A preliminary review of the raster outputs of the previous Activity should be undertaken to ensure the results of each dimension are credible. The raster output of each dimension should indicate vulnerability hotspots that broadly align with known vulnerabilities of the same dimension within the area. It may be beneficial to elicit expert opinion while validating the output.
2. **Assess vulnerabilities:** Assessing vulnerability involves identifying and analyzing factors that contribute to the susceptibility of a system, population, or environment to harm, risks, or adverse impacts. The raster output of Step 2.3 Activity A is used to help create a visualization of vulnerabilities and should be used to guide this exercise.

Objectives

Analyze the historic and existing climate change, urban and biodiversity vulnerabilities present in the city and selected urban areas.

Outputs

Comprehensive written analysis of current climate change, urban and biodiversity vulnerabilities in city and selected urban areas.

Map historic, current and future vulnerabilities

Step 2.3
Activity C

Map future climate change, urban and biodiversity vulnerabilities

Activity description [OPTIONAL EXTENSION]

Summary

Mapping future vulnerabilities is intended to simulate the potential impacts of climate change, urbanization, and biodiversity loss on ecosystems and communities. Decision-makers can use the spatial outcomes to formulate policies that promote sustainable development, biodiversity conservation, and climate resilience. These capabilities contribute to informed decision-making, resilient planning, and sustainable management of natural resources and human habitats.

Mapping future climate change, urban, and biodiversity vulnerabilities closely mirrors Step 2.3 Activity A wherein historical and current climate change, urban, and biodiversity vulnerabilities are mapped.

It is suggested that, to complete this Activity, teams repeat the procedure outlined in Step 2.3 Activity A with updated data.

Determining future projections:

Delivery Teams are encouraged to use future projection datasets matched with initially chosen indicators to map future vulnerabilities. Where these are not immediately available, Teams should consult approved national and/or city development plans for indication on future development plans including land use change, biodiversity loss, and urbanization projections.

The IPCC Interactive Atlas and reports are a good first resource for determining future climate change vulnerabilities, while IPBES, the IUCN Red List, and the Monitoring Framework for the Kunming-Montreal Global Biodiversity Framework are good first resources for determining future biodiversity vulnerabilities. The sources of some open-source GIS datasets for projected vulnerabilities for the three layers are included in the Data Collection and Analysis Brief.

Translating future projections into geospatial data may require close collaboration with stakeholders. It is essential that Delivery Teams recognize that projections are estimates, not an exact science, and this Activity should be a best guess based on government policy, international commitments, current science, extrapolated historical changes, and expert knowledge.

For example, a current forest or shrubland that has been earmarked by the development authorities for future housing or commercial development, can be represented as future biodiversity loss (a vulnerability) in GIS. Similarly, population growth projections can indicate expanding urban sprawl or areas of increasing population density and informal settlement. These can also be represented in GIS.

With this Activity there is much flexibility assigned to the Delivery Teams and GIS specialists. Indicator data for use in this Activity can be updated from indicator datasets, from the outputs of Step 2.3 Activity A or created anew.

Mapping process (Repeated from Step 2.3 Activity A):

1. Prior to commencing the overlay analysis, any vector indicator data needs to be transformed into raster data. There are a number of ways this could be achieved, and it is ultimately at the discretion of the Delivery Team and GIS expert to choose an appropriate methodology.

   Direct conversion from point or line features to raster is possible, and the Delivery Teams must decide if a direct conversion is an appropriate approach for their indicator data. It may be required that buffers, feature clusters, envelopes or other analysis are used prior to raster conversion. Alternatively, teams may choose to apply a distance mapping technique like Euclidean distance to achieve the polygon to raster conversion.

   Delivery teams must also decide if proximity and/or overlap in polypoint or polyline features should indicate compound or increased vulnerabilities. In point or line conversion to raster data, limitations like boundary rules may apply if the vector data lay on or across a cell boundary.

   There are also multiple ways to approach rasterizing polygon data. If the polygons are small enough, Delivery Teams should consider approaching the rasterization as they have with point data. If the polygons are of considerable size, Delivery Teams

Objectives

Combine data relating to climate hazard indicators to reveal locations of climate hazard hotspots.

Outputs

3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions.

Map future climate change, urban and biodiversity vulnerabilities

Activity description [OPTIONAL EXTENSION]

might consider a direct conversion with raster cells assigned based on cell centre, maximum area, or maximum combined area.

Delivery Teams may also decide that a conversion applied to one indicator dataset is not appropriate for another and opt to follow multiple methodologies to convert vector data to raster data. In all cases, decisions made while executing the MVA analysis should be recorded.

2. Once indicator data are in raster format, represent vulnerable and/or exposed areas with "1" and exposure/vulnerability free areas with "0". This simplistic representation will ensure the MVA does not become overcomplicated. Indicators with continuous values should be normalized, with 0 representing vulnerability free areas and 1 representing the areas with the highest value, as defined by that indicator. For example, using a population density dataset, raster pixels assigned to areas with no population would be zero while those assigned to the highest population density would be one. In some cases, it may be required to invert or reclassify the dataset before constructing the indicator.

   Additional guidance on building indicators is available in *Data collection and analysis technical brief*, and accompanying GIS indicator factsheets.

3. Using raster math (addition) combine all thematic indicators into a single vulnerability raster. In the resulting output taster, higher values will indicate locations of increased vulnerability, also referred to as "vulnerability hotspots."

4. Normalize the output vulnerability rasters.

   Step 2.3 Activity C should result in three distinct raster outputs, one for each of the three dimensions (urban, climate change, and biodiversity) and indicating (through higher values) the locations where multiple vulnerabilities exist within that dimension.

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist

Technical and operational

- Collected data in support of selected climate change, urban, and biodiversity indicators.
- Preferred GIS software (e.g. QGIS, ArcGIS)
- GIS Indicator Factsheets
- 'Understanding Euclidean Distance Analysis — ArcMap | Documentation'. https://desktop.arcgis.com/en/arcmap/latest/tools/spatial-analyst-toolbox/understanding-euclidean-distance-analysis.htm.
- 'Understanding Overlay Analysis — ArcGIS Pro | Documentation'.https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/understanding-overlay-analysis.htm.
- 'Multi Criteria Overlay Analysis (QGIS3) — QGIS Tutorials and Tips'.https://www.qgistutorials.com/en/docs/3/multi_criteria_overlay.html

Considerations

This activity is optional and is recommended to be undertaken if the Delivery Team have access to high-quality, reliable projection or modelled data for the dimensions and corresponding indicators.

Not all indicators will have available future projections. Delivery Teams should be open to using proxy or estimated data where future projections are not available. It should also be noted that successful completion of this Activity does not require that all indicators are future projections, and it can be completed with a combination of current and future data.

Where possible. future projections should be consistent in the time period and future scenario (i.e., try not to mix AR4 SRES A2 in 2060 scenarios with AR6 SSP1 in 2100).

Future projections are an estimate and uncertainty is inherent.

Objectives

Combine data relating to climate hazard indicators to reveal locations of climate hazard hotspots.

Outputs

3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions.

Map historic, current and future vulnerabilities

Step 2.3
Activity D

Analyze future climate change, urban and biodiversity vulnerabilities

Activity description [OPTIONAL EXTENSION]

Summary

Analyzing future climate change, urban, and biodiversity vulnerabilities closely mirrors Step 2.3 Activity B wherein historical and current climate change, urban, and biodiversity vulnerabilities are analyzed, and ultimately the steps are the same.

It must be noted that the analysis of future vulnerabilities represents a single possible outcome. The predictions used are inherently uncertain and these results should be interpreted only as a theory. This fact must be stressed to stakeholders during the stakeholder engagement.

Tasks

1. **Review the map:** The data used in the assessment of future vulnerabilities are projections, making an evaluation of the validity of the result incredibly challenging. The map should instead be reviewed to ensure the projections used are representative of the same future time period and climate forcing scenarios. Any results that appear overly widespread or intense should be manually altered.
2. **Assess vulnerabilities:** Assessing vulnerability involves identifying and analyzing factors that contribute to the susceptibility of a system, population, or environment to harm, risks, or adverse impacts. The raster output from Step 2.3 Activity C help create a visualization of vulnerabilities and should be used to guide this exercise.

   Some questions to consider while assessing vulnerabilities include: In each of the three dimensions are there consistent or repeated characteristics in the areas that have identified high vulnerability? Across the three maps are, there areas that consistently show high vulnerability? What is their relationship to the 3 components of vulnerability, namely exposure, sensitivity, and adaptive capacity? Can these three components be mapped or identified, independent of the dimension being assessed?
3. **Compare with other data:** In the case of future climate projections, the mapped future vulnerabilities should be compared to sources like the IPCC.
4. **Engage stakeholders:** Stakeholder engagement is essential to ensure the success, effectiveness, and sustainability of the MVA. Following the mapping of vulnerabilities, stakeholders should be given the opportunity to validate the outputs. Delivery Teams should consider hosting a workshop or advertising an extended period where stakeholders can submit recommendations, concerns, and other feedback.

   Stakeholder engagement and validation is an iterative process that may require multiple rounds of revision and consultation. Ensure that feedback received is well-documented and absorbed into the output. Revised maps should be communicated so that stakeholders are aware that their concerns have been addressed.

   If possible, voices from affected communities should be prioritized.
5. **Document results:** Synthesize the findings of the vulnerability assessment to identify key vulnerabilities, hotspots, and priority areas, including any patterns identified in the data. This is the first step to developing adaptation plans and strategies that address the root causes of vulnerability and build adaptive capacity.

   Document the stakeholder validation process, including the feedback received, revisions made, and decisions taken based on stakeholder input. Maintain records of stakeholder communications, meetings, agreements, and approvals for transparency, accountability, and reference purposes.

Objectives

Analyze the future climate change, urban and biodiversity vulnerabilities present in the city and selected urban areas

Outputs

Comprehensive written analysis of future climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Analyze future climate change, urban and biodiversity vulnerabilities

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS specialist. Step 2.3 Activity B should be co-led by the Delivery Team's urban development, climate change, and urban resilience specialists

Technical and operational

- Maps and datasets from Step 2.3 Activity C

Considerations

This activity is optional and can be undertaken if the suitable datasets for projected data across the climate change, urban and biodiversity dimensions and indicators are available, accessible, and at the right scale and resolution for the city or study area. It may be the case that only projected climate change hazard datasets are available and therefore all three dimensions cannot be projected, mapped and assessed. In this instance, is recommended to consider how projected scenario planning (using climate models, urban expansion models, or biodiversity loss models from various sources) can be integrated into the action planning activities to be undertaken in Stage 3 of the MVA process.

It is important to consider whether a round of stakeholder engagement is required to address any data gaps, provide additional insight, perspectives and feedback, and to enhance the overall analysis process. If this is required and is feasible for the Delivery Teams, it is recommended that mission is organized to the city and appropriate stakeholder data collection activities and consultations are undertaken.

Objectives

Analyze the future climate change, urban and biodiversity vulnerabilities present in the city and selected urban areas

Outputs

Comprehensive written analysis of future climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Map multilayered vulnerability hotspots

Step 2.4 Activity A

Map intersecting and interconnected vulnerabilities

Activity description

Summary

Vulnerability hotspots in the MVA refer to locations in which vulnerabilities across the three dimensions (urban, climate change, biodiversity) intersect or overlap with vulnerability hotspots in other dimensions. These are specific areas in which the populace, infrastructure and environment face high exposure, sensitivity, and vulnerability to various interconnected impacts and challenges related to climate change, urbanization and biodiversity loss.

The MVA geospatial analysis explores and appraises locations, and the communities, infrastructure and ecosystems, in which there is overlap and concentration of vulnerabilities across all of the three dimensions. This means mapping the intersections and interrelations between:

- urban and climate change vulnerabilities,
- climate change and biodiversity vulnerabilities,
- biodiversity and urban vulnerabilities,
- and finally, between the urban, climate change, and biodiversity vulnerabilities.

There are numerous potential intersections and interrelations across each combination of dimensions, reflecting the diverse and unique contexts and local climatic, ecological, spatial, urban, social, and economic characteristics and dynamics in cities. Mapping the intersections and interrelations of these vulnerabilities is imperative to understanding how compounding exposures, sensitivities and the absence of adaptive capacity can negatively affect a population and ecosystem.

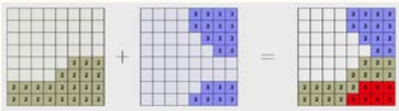
Overlapping vulnerabilities in the MVA refers to situations where multiple vulnerabilities coexist within the same system or community, often amplifying the overall risk and complexity of managing climate impacts, urbanization and biodiversity loss. These overlapping vulnerabilities can occur due to various interconnected factors and can exacerbate each other's effects. Detailed information on intersecting and interconnected vulnerabilities can be found in the Data Collection and Analysis Technical Brief.

To keep the MVA simple and replicable, each input layer is assigned the same weighting. In doing so, compounding vulnerabilities are identified solely by location, and the MVA avoids assigning subjective weighting or value schemes. The supporting analysis identifies and explores sources of sensitivity, exposure, and adaptive capacity, expanding on the hotspot analysis and identifying priority or high value contributors.

FIGURE 5

Overlay spatial data polygon-on-polygon

Source: http://www.gitta.info/Suitability/en/html/BoolOverlay_learningObject1.html



This Activity is to be repeated once for each of the combinations of dimension, i.e.,

- Once to map and evaluate potential intersections and interconnectedness between the urban and climate change dimensions (2 dimensions),
- Once to map and evaluate potential intersections and interconnectedness between the climate change and biodiversity dimensions (2 dimensions),
- Once to map and evaluate potential intersections and interconnectedness between the biodiversity and urban dimensions (2 dimensions), and
- Once to map and evaluate potential intersections and interconnectedness between the urban, climate change, and biodiversity dimensions (all 3 dimensions).

This Activity is based on raster overlay analysis and uses the output vulnerability rasters from Step 2.3 Activity A.

Process for 2 overlapping dimensions:

1. Review the input data to ensure values are logical (i.e., higher values correlating with higher vulnerabilities) and in broad alignment with the understood vulnerabilities.
2. Using overlay analysis (raster math), assign equal weights (50 per cent) to each of the input raster datasets.

Objectives

Map the intersecting and interconnected vulnerabilities in the MVA study area

Outputs

3 raster datasets and maps with intersecting and interconnected vulnerabilities

Map intersecting and interconnected vulnerabilities

Activity description

Summary

Combine the datasets into a single raster of combined indicators.

Weighted overlay analysis can be achieved using the Spatial Analysis Toolset in ArcGIS, in the QGIS GDAL Toolset, or using the raster calculator.

Process for 3 overlapping dimensions:

1. Review the data to ensure values are logical (i.e., higher values correlating with higher vulnerabilities) and in broad alignment with the understood vulnerabilities.
2. Using overlay (raster math), assign equal weights (33 per cent) to each of the input raster datasets. Combine the datasets into a single raster of combined indicators. It will be necessary to assign one raster a 34 per cent weighting to achieve the required 100 per cent sum. This should have a minimal effect on the analysis and output.

Overlay analysis can be achieved using the Spatial Analysis Toolset in ArcGIS, in the QGIS GDAL Toolset, or using the raster calculator.

Some Delivery Teams may choose to apply a scheme similar to those used in quantitative bivariate mapping. Supporting documentation is provided in the resources section of this activity.

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.3 Activity B should be co-led by the Delivery Team's urban development, climate change, and urban resilience specialists.

Technical and operational

- Preferred GIS software (e.g. QGIS, ArcGIS)
- Maps and datasets from Step 2.3 Activity A
- *Data collection and analysis technical brief*
- 'Understanding Overlay Analysis — ArcGIS Pro | Documentation'. https://pro.arcgis.com/en/pro-app/latest/tool-reference/spatial-analyst/understanding-overlay-analysis.htm.
- 'Multi Criteria Overlay Analysis (QGIS3) — QGIS Tutorials and Tips'. https://www.qgistutorials.com/en/docs/3/multi_criteria_overlay.html.
- 'How To: Create a Quantitative Bivariate Map in ArcGIS Pro'.https://support.esri.com/en-us/knowledge-base/how-to-create-a-quantitative-bivariate-map-in-arcgis-pr-000027489.
- 'Bivariate Choropleth Maps: A How-to Guide'. https://www.joshuastevens.net/cartography/make-a-bivariate-choropleth-map/

Considerations

Input datasets in overlay analysis must have comparable scales and/or units.

Input datasets in overlay analysis must have the same boundaries.

Objectives

Map the intersecting and interconnected vulnerabilities in the MVA study area

Outputs

3 raster datasets and maps with intersecting and interconnected vulnerabilities

Map multilayered vulnerability hotspots

Step 2.4 Activity B

Analyze intersecting and interconnected vulnerabilities

Activity description

Summary

Interpreting the intersecting and interconnected vulnerabilities from the GIS maps produced in the earlier steps allows for the assessment of the locations, interrelations and impacts of multilayered vulnerabilities on people, infrastructure and ecosystems. In undertaking the overlay of the 3 main layers, their combinations, and the final integration of vulnerabilities across each dimension will produce a hotspot map. This systematic approach, utilizing both GIS analysis techniques, technical interpretation, ground truthing and validation, comprehensively visualizes overlapping climate, urban, and biodiversity vulnerabilities.

Tasks

1. Understand the layers:

- **Climate vulnerability layer:** This might include areas prone to flooding, drought, heatwaves, or sea level rise. Identify the regions where these climate-related risks are highest.
- **Urban vulnerability layer:** This could represent population density, infrastructure stress, or areas lacking essential services. Look for densely populated or rapidly urbanizing areas that are exposed to climate risks.
- **Biodiversity vulnerability layer:** Focus on ecosystems or biodiversity hotspots at risk of degradation due to urban expansion or climate impacts.

2. Identify vulnerability hotspots

- **Hotspots:** These are areas where the different vulnerabilities (climate, urban, biodiversity) overlap. Areas with multiple high-risk factors are the hotspots that require urgent attention.
- **Spatial patterns:** Look for patterns in the distribution of vulnerabilities. Are certain vulnerabilities clustered around specific types of landscapes, such as coastal zones, urban fringes, or mountainous areas?
- **Interactions:** Understand how different layers interact. For example:

i. Urban and climate: A densely populated area in a flood zone signals heightened vulnerability.

ii. Urban and biodiversity: Rapid urbanization near biodiversity hotspots can lead to significant environmental degradation.

iii. Climate and biodiversity: Climate-sensitive ecosystems located in areas at risk of extreme weather events could face long-term damage.

3. Assess vulnerability intensity:

- **Colour coding and symbology:** most maps will use a colour gradient to represent intensity levels. Darker or more intense colours often indicate areas of higher vulnerability. Focus on these regions to understand the magnitude of risk.
- **Vulnerability appraisal:** Deepen the analysis by completing further qualitative analysis to validate the maps hotspots intensity. Assess whether the map allows for a user to understand the exposure, sensitivities and adaptive capacities of specific communities, infrastructure and ecosystems located within the identified hotspots. It is important to note that the GIS maps help to pinpoint high probability areas of vulnerabilities but should be the only resource used to determine the overall vulnerability of a specific site or area.

4. Analyze prioritization needs:

- **High-overlapping areas:** These are areas where multiple vulnerabilities converge (e.g., a densely populated, low-income area in a flood-prone region that is also home to critical ecosystems). These hotspots often require priority interventions such as infrastructure upgrades or conservation efforts.
- **Low-overlapping Areas:** Regions where one or two vulnerabilities are present but not as intense. These areas may still need interventions but might be lower priority compared to high-overlapping areas.

5. Examine critical zones

- **Urban growth areas:** Look for zones where urban expansion overlaps with biodiversity hotspots or climate-sensitive zones. These could be potential hotspot areas where urbanization needs to be managed carefully to avoid ecological damage.

Objectives

Analyze the intersecting and interconnected climate change, urban and biodiversity vulnerabilities present in the city and selected urban areas

Outputs

Comprehensive written analysis of the intersecting and interconnected climate change, urban and biodiversity vulnerabilities in the city and selected urban areas

Map multilayered vulnerability hotspots

Step 2.4 Activity B (continued)

Analyze intersecting and interconnected vulnerabilities

Activity description

Tasks

- **Vulnerable populations:** Identify which communities or neighbourhoods are located in these hotspots. Are they underserved areas? Are they particularly at risk due to socioeconomic factors like poverty, lack of infrastructure, or limited access to services?
- **Protected areas:** Check if critical biodiversity areas, such as forests, wetlands, or wildlife reserves, are at risk due to urban or climate pressures. This can inform conservation priorities.

6. Consider temporal implications

- **Current vs. future:** If your map includes future climate projections or urban growth scenarios, consider how vulnerability hotspots might shift over time. Some areas may become more vulnerable as urbanization or climate impacts increase.
- **Planning horizon:** Use the map to identify which regions need immediate action versus those that require long-term planning. For example, regions currently facing severe urban-climate pressure should be addressed sooner, while future urban growth areas near biodiversity zones may need zoning regulations or conservation planning.

7. Document the vulnerabilities, including any revision of maps to account for and incorporate additional analysis provided by the qualitative data collection and verification process.

Suggested resources

Human

- Activities in Stage 2 should be led by the Delivery Team's GIS Specialist. Step 2.3 Activity B should be co-led by the Delivery Team's urban development, climate change, and urban resilience specialists.

Technical and operational

- Maps and datasets from Step 2.4. Activity A
- 'How To: Create a Quantitative Bivariate Map in ArcGIS Pro'.https://support.esri.com/en-us/knowledge-base/how-to-create-a-quantitative-bivariate-map-in-arcgis-pr-000027489
- 'Bivariate Choropleth Maps: A How-to Guide'. https://www.joshuastevens.net/cartography/make-a-bivariate-choropleth-map/

Considerations

It is important to consider whether a round of stakeholder engagement is required to address any data gaps, provide additional insight, perspectives and feedback, and to enhance the overall analysis process. If this is required, and is feasible for the Delivery Teams, it is recommended that mission is organized to the city and appropriate stakeholder data collection activities and consultations are undertaken.

Objectives

Analyze the intersecting and interconnected climate change, urban and biodiversity vulnerabilities present in the city and selected urban areas

Outputs

Comprehensive written analysis of the intersecting and interconnected climate change, urban and biodiversity vulnerabilities in the city and selected urban areas

Develop Multilayered Vulnerability Profile

Step 2.5 Activity A

Document the Multilayered Vulnerability Profile

Activity description

Summary

Validating the Multilayered Vulnerability Profile involves ensuring that the MVA process and final output is thorough, accurate, and comprehensive. This activity is crucial as helps to ensures that assessment adequately captures the multilayered vulnerabilities present in the city or urban areas, allowing policymakers and planners to prioritize resources effectively.

Validating the Multilayered Vulnerability Profile enhances its credibility, value and usefulness among stakeholders, including local government officials, community members, and funding agencies. A validated assessment is more likely to be trusted and accepted, increasing the likelihood of its recommendations being implemented. By ground-truthing the findings of the MVA with key stakeholders, the Multilayered Vulnerability Profile can more accurately reflect the diverse needs and concerns of all communities within the city, including those that are most vulnerable to climate change, urbanization and biodiversity loss impacts. By validating the assessment findings, cities can address equity considerations. Finally, in validating the Profile, the Delivery Team will have the evidence-base that is required to inform tailored, prioritized and long-term adaptation strategies resilience action planning that will take place in MVA Stage 3.

Components of the Multilayered Vulnerability Profile report include

1. **Introduction:** Provide background information on the purpose, objectives and scope of the MVA. Explain the importance of understanding multilayered vulnerabilities in the assessment city or urban areas for urban planning, climate change adaptation, disaster preparedness, biodiversity conversation, and resilience building.
2. **Methodology:** Describe the MVA methodology used to assess multilayered vulnerabilities. This should include the summary of all key steps and activities. Provide details on any specific, unique or innovative approaches applied in the MVA of the city or urban area, such as data sources, tools, and data collection and analysis techniques employed. Outline any stakeholder engagement activities, such as consultations, expert interviews, or community engagements that were conducted during the assessment process.
3. **City profile:** Present a summary of the City Context Analysis. This should provide an overview of the city, including its geographical location, population demographics, economic activities, infrastructure, and environmental features, as well as institutional and policy frameworks.
4. **Multilayered Vulnerability Assessment:** This section is the bulk of the Vulnerability Profile and should contain the comprehensive and structured analysis of (i) historic and current climate change, urban and biodiversity vulnerabilities; (ii) future climate change, urban and biodiversity vulnerabilities, if completed; (iii) intersecting and interconnected climate current climate change, urban and biodiversity vulnerabilities; and (iv) multilayered vulnerability hotspots. The assessment findings will be presented with a combination of the written narrative, annotated maps and graphics and written analysis.

The Multilayered Vulnerability Profile report guides the third Stage of the MVA and marks a milestone output. The analysis and narrative provided in the Multilayered Vulnerability Profile report will steer intervention planning to inform recommended adaptation and resilience actions needed to address the multilayered vulnerabilities identified and assessed in the study.

Objectives

To develop the Vulnerability Profile using the outputs of all previous Steps and Activities

Outputs

Comprehensive Multilayered Vulnerability Profile report

Document the Multilayered Vulnerability Profile

Suggested resources

Human

- This activity will require the inputs of all technical specialists on the delivery team. It is critical that Vulnerability Report undergoes several rounds of review and iteration before it is shared to the Steering Committee for review and before it undergoes the wider validation and finalization process.

Technical and operational

- MVA Work Plan
- Stakeholder Engagement Plan
- Rapid city diagnostic
- Data Collection Plan
- Analysis of historic and existing climate change, urban and biodiversity vulnerabilities (Step 2.3 Activity B)
- Analysis of multilayered vulnerability hotspots (Step 2.4 Activity B)
- Multilayered Vulnerability Profile report template

Considerations

The consolidation of the Multilayered Vulnerability Profile will bring together all prior components and outputs of the MVA process. It is recommended that the Report accurately captures and communicates these in an attractive, accessible and visual manner.

Objectives

To develop the Vulnerability Profile using the outputs of all previous Steps and Activities

Outputs

Comprehensive Multilayered Vulnerability Profile report

Develop Multilayered Vulnerability Profile

Step 2.5 Activity B

Validate the Multilayered Vulnerability Profile

Activity description

Summary

Following the comprehensive data analysis process, the Delivery Team should prepare written documentation on the outputs of the MVA study. This will then be compiled in the Vulnerability Profile Report for the city or urban areas.

The Vulnerability Profile Report should provide a comprehensive analysis of various aspects of vulnerability within the city, providing information relating to vulnerabilities in each of the three dimensions, their intersections and interconnectedness, and the concentration of multilayered vulnerabilities in specific hotspots. The report serves as a valuable resource for informing decision-making, guiding urban planning and climate adaptation, biodiversity conservation efforts, and fostering resilience-building initiatives.

Tasks

1. **Stakeholder validation exercises:** Using the Vulnerability Profile as a reference point, involve key stakeholders such as local government officials, community leaders, and representatives from vulnerable populations in the validation process. Engage with local communities and stakeholders who are directly impacted by the vulnerabilities identified in MVA in validation exercises such as vulnerability mapping review, ground-truthing and revision. Gather feedback from community members regarding the accuracy and relevance of the vulnerabilities identified and assessed to their lived experiences and local knowledge. Their input can help ensure that the assessment is accurate reflects the diverse perspectives and priorities of the city's residents.
2. **Comparative analysis:** Compare the Multilayered Vulnerability Profile with other available data sources, such as historical records, previous vulnerability assessments, or independent studies that have been identified earlier in the MVA process. Look for consistency and alignment between the MVA outputs and the other sources of information to validate its findings.
3. **Expert peer review:** Seek input from the various subject matter experts in the Delivery Team, Steering Committee and other key partners (such as other UN-Habitat experts, academic institutions or CSOs. Peer review by different experts can provide valuable insights, help validate the accuracy of the assessment and identify areas for improvements.
4. **Compile and integrate validated findings:** Capture all out the outputs of the validation process and update the Vulnerability Profile Report to ensures all additional information, considerations and analysis is included in development of the final multilayered vulnerability profile report.

Suggested resources

Human

- Delivery Team experts responsible for leading stakeholder engagement and critical technical elements of the MVA as facilitators to present the MVA and solicit inputs, feedback, validation and enhancement of the Multilayered Vulnerability Profile report.

Technical and operational

- Multilayered Vulnerability Profile report

Considerations

It is important to ensure that a comprehensive, diverse and representative cohort of stakeholders are engaged in the validation process. Local, traditional and indigenous knowledge is invaluable to deepening and validating the vulnerability profile.

If possible, ensuring peer review and expert consultation with local and international specialists, is recommended. Cross-sectoral validation of experts from diverse sectors (e.g. urban planning, environmental conservation, public health, etc.) can ensure all dimensions of vulnerability have been appropriately captured and assessed.

This process will require iterative refinement and may need several rounds of validation, including several workshops or consultations, in order to arrive to the final, validated output. This process will improve its practical utility as well as its accuracy.

Objectives

Conduct validation and ground-truthing stakeholder engagement activities with identified stakeholders to verify and validate vulnerabilities

Outputs

Updated Multilayered Vulnerability Profile Report

Develop Multilayered Vulnerability Profile

Step 2.5 Activity C

Visualize Multilayered Vulnerability Profile

Activity description [OPTIONAL EXTENSION]

Summary

The visual presentation of the Multilayered Vulnerability Profile is crucial for conveying the MVA in a clear and understandable manner. Strong visual representations of multilayered vulnerabilities in cities and urban areas make the complex MVA more accessible to a wider audience, including policymakers, urban planners, community members, and other stakeholders who may not have expertise in technical or scientific fields. By presenting the data and analysis virtually and visually and not only in text-based reports, information becomes more digestible and easier to understand and interpret, leading to more informed decision-making.

The complex relationships and spatial patterns of multilayered vulnerabilities can be conveyed more effectively through maps, charts, graphs, and infographics, allowing stakeholders to grasp the key vulnerabilities facing the city and their implications. This can also facilitate enhance engagement on the MVA outputs with key stakeholders by stimulate dialogue, encourage participation, and mobilize collective action to address vulnerabilities and build resilience.

Digitizing and visualizing the Vulnerability Profiles also helps local leaders and decision-makers communicate the urgency of addressing specific vulnerabilities and risks within the city and then prioritize actions and allocate resources effectively. By visually mapping vulnerable areas, populations, and critical infrastructure, cities can identify priority areas for intervention and investment, ensuring that limited resources are directed towards the most pressing needs.

Tasks

1. **Prepare Maps:** Using the GIS methods explained in Steps 2.3 and 2.4, prepare detailed, maps which spatially demonstrate vulnerabilities, including conflicting and overlapping vulnerabilities, and the location of vulnerability hotspots. The maps should be annotated to provide narrative relating to vulnerabilities, such as drivers, impacts, implications, relationships, and risks. They should highlight the vulnerabilities faced by different systems, such as people, infrastructure and environment.
2. **Prepare infographics:** Design infographics that visually summarize key findings, recommendations, and strategies for building resilience. Use icons, symbols, and illustrations to communicate complex concepts in a simplified and engaging manner. Arrange information guide the viewer's attention and facilitate comprehension.
3. **Prepare flowcharts and diagrams:** Develop flowcharts or process diagrams to illustrate the interactions between different factors contributing to vulnerability across the dimensions and their combinations. Present any causal relationships, feedback loops, and dependencies among various elements within the city's socio-ecological system. Highlight intervention points or decision nodes where targeted actions can reduce multilayered vulnerabilities.
4. **Use photographs and images:** Incorporate photographs and images to provide visual context and enhance understanding of on-the-ground realities. These can be used to capture aspects such as climate change hazards, infrastructure vulnerabilities, or environmental degradation.
5. **Create StoryMaps:** ArcGIS StoryMap is a web-based tool provided by ESRI that allows users to combine maps, text, images, and multimedia content to create interactive and engaging narratives that convey information, tell stories, and communicate spatial data effectively. It is recommended that StoryMaps are created for each city and urban area assessed to leverage the power of the MVA spatial data and visualization.

Objectives

To visualize the outputs of the MVA for diverse audience

Outputs

Attractive visual and graphical outputs of the MVA

Visualize Multilayered Vulnerability Profile

Suggested resources

Human

- The digitization and visualization of the Vulnerability Profile will require strong technical proficiency in GIS software, data visualization, and design and communication skills. A GIS expert with expertise in preparing interactive web-maps and data dashboards, could deliver this output.

Technical and operational

- Maps and analysis from Steps 2.3 and 2.4

Considerations

This activity is optional and, due to the potential complexity and difficulty in certain contexts, is only recommended if the Delivery Team has the suitable data, capacities, resources, and enabling environment required.

Digitization of the Vulnerability Profile may require specific data security and privacy laws to be adhered to, and as such, this output may not be considered open-source and accessible. Data ownership, storage, maintenance and updating all need to be considered if undertaking this step too.

Visual communication promotes transparency by making vulnerability data and assessment processes more transparent and accessible to the public. Transparent visualizations enable stakeholders to scrutinize the evidence, understand the basis for decision-making, and hold authorities accountable for their actions or inaction in addressing vulnerabilities.

Objectives

To visualize the outputs of the MVA for diverse audience

Outputs

Attractive visual and graphical outputs of the MVA

Stage 2 Checklist: Mapping and analysis

Step 2.1 Mapping assessment preparation

Activity A: Establish data requirements

- ☐ Completed Data Requirements Sheet

Activity B: Identify data sources and availability

- ☐ Data Inventory

Activity C: Develop Geospatial Workflow

- ☐ Detailed Geospatial Workflow

Step 2.2 Data acquisition and collection

Activity A: Prepare Data Collection Plan

- ☐ Data Collection plan for each city/country

Activity B: Gather qualitative data

- ☐ Compilation of qualitative data in the Data Inventory

Activity C: Gather quantitative data

- ☐ Compilation of quantitative data in the Data Inventory

Activity D: Data cleaning and pre-processing

- ☐ GIS layers that are organised, comparable in temporal and spatial resolution, and fit-for-use.,
- ☐ Clean, organized, and processed datasets

Step 2.3 Map historic, current and future vulnerabilities

Activity A: Map historic and existing climate change, urban and biodiversity vulnerabilities

- ☐ Historic and existing: 3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions
- ☐ Comprehensive written analysis of current climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Activity B: Analyze historic and existing climate change, urban, and biodiversity vulnerabilities

- ☐ Future: 3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban and climate change dimensions
- ☐ Comprehensive written analysis of future climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Activity C: Map future climate change, urban and biodiversity vulnerabilities [Optional Extension]

- ☐ Future: 3 raster vulnerability datasets of combined indicators, one for each biodiversity, urban, and climate change dimensions

Activity D: Analyze future climate change, urban and biodiversity vulnerabilities [Optional Extension]

- ☐ Comprehensive written analysis of future climate change, urban and biodiversity vulnerabilities in city and selected urban areas
- ☐ Comprehensive written analysis of future climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Stage 2 Checklist: Mapping and analysis

Step 2.4 Map multilayered vulnerability hotspots

Activity A: Map intersecting and interconnected vulnerabilities

- ☐ 3 raster datasets and maps with intersecting and interconnected vulnerabilities

Activity B: Analyze intersecting and interconnected vulnerabilities

- ☐ Comprehensive written analysis of current climate change, urban and biodiversity vulnerabilities in city and selected urban areas

Step 2.5 Develop Multilayered Vulnerability Profile

Activity A: Document the Multilayered Vulnerability Profile

- ☐ Comprehensive Multilayered Vulnerability Profile report

Activity B: Validate the Multilayered Vulnerability Profile

- ☐ Updated Multilayered Vulnerability Profile report

Activity C: Visualize Multilayered Vulnerability Profile [Optional extension]

- ☐ Attractive visual and graphical outputs of the MVA

Intervention planning

Stage 03

Community members in Mathare slum, Nairobi, Kenya during COVID19- - May 2020. @UN-HabitatKirsten Milhahn

Stage 3
Intervention planning

▸Stage overview

Summary: The purpose of the Stage is to transform the findings of Stage 2 into bankable projects which will build resilience to current and future climate, urban and biodiversity shocks and stresses. The output of Stage 2 – the MVA and Multilayered Vulnerability Profile report – is a critical input to a resilience action plan. One key output of Stage 3 – the Resilience Action Plan – is a critical input to development of the pipeline of bankable urban climate resilience projects [30].

Working with a diverse range of stakeholders, the steps involved in this stage will result in the development of 10-12 resilience building actions that are financially and technically feasible and tackle the intersecting vulnerabilities identified in the MVA.

Objective: To develop, disseminate and implement an impactful ***Resilience Action Plan*** which will reduce vulnerabilities related to climate change, urbanization and biodiversity loss in hotspots.

Outputs: The three steps each result in specific outputs which combined will lead to a robust action plan and 3 follow-on steps towards dissemination and implementation:

1. An overarching vision and strategic objectives to guide the resilience action plan;
2. A draft resilience action plan including a shortlist of 10-12 actions with full action sheets; and
3. An ongoing communication strategy for dissemination.

The activities conducted under each step are shown below and described in detailed step-by-step guidance in the following section.

30 It important to clarify here that not all MVAs may automatically lead to the development of an action plan, and not all action plans will automatically lead to the development of a pipeline of bankable urban climate resilience projects. There are many variables and factors which will determine whether the process outlined in this Handbook can be implemented as it is intended in different city and country contexts.

Stage three

Step 3.1

Visioning and objective setting for action plan

Activity A
Define vision and objectives

Activity B
Validate resilience vision and objectives with stakeholders

Step 3.2

Develop Resilience Action Plan

Activity A
Longlist resilience actions

Activity B
Prioritize and shortlist resilience actions

Activity C
Codesign actions with stakeholders

Activity D
Identify funding mechanisms

Activity E
Prepare Action Sheets

Activity F
Assemble and validate Resilience Action Plan with stakeholders

Activity G
Obtain political approval

Step 3.3

Disseminate, campaign and scale

Activity A
Develop action plan Communication Strategy

Activity B
Disseminate Resilience Action Plan

Activity C
Develop approach to integrate action plan into strategic documents

Visioning and objective setting for action plan

Step 3.1
Activity A

Define vision and objectives

Activity description

Summary

Developing a comprehensive vision for a city action plan requires a thorough and collaborative process. Resilience Plans are designed to enhance a city's ability to withstand, adapt to, and recover from shocks and stresses. The visioning process entails defining a future vision for a resilient city and formulating strategic objectives before identifying actions to realize that vision.

The overarching vision for a Resilience Action Plan must confront the multilayered vulnerabilities identified in Stage 2, ensuring that the city's key challenges, shocks and stresses related to climate, biodiversity and urban vulnerabilities are addressed. This will provide guidance and direction to steer the development of the action plan.

As the project team formulates the vision and strategic objectives, it should reflect on the findings of the MVAs to ensure the city's key vulnerabilities and vulnerable hotspots are fully integrated into its future ambitions. Emphasis should be placed on developing a forward looking, inclusive and ambitious vision tailored to the unique to context of the city.

Tasks

1. **Plan a visioning workshop:** Prepare an interactive and engaging structure with supplementary materials to support the development of an overarching vision and strategic objectives for the action plan. Prepare a suitable workshop approach, fitting to the context and pitched towards the Steering Committee. Broadly the workshop should include these steps:

a. **Review** of MVA results and key findings to fully understand the areas, sectors, infrastructure, and people/communities that that are most vulnerable to and at risk from the various hazards, shocks and stresses. This may also include reviewing additional materials such as the rapid city diagnostic and City Context Analysis.

b. **Identify** key themes to structure the strategic objectives and the action plan. These could be structured in a number of ways, for example by sector (i.e. water resources, transport etc), by hazard or vulnerability type (i.e. sea level rise, socioeconomic vulnerability), or by areas of responsibility (i.e. department for environment, department of public works) etc.

c. **Build** a collaborative future vision for the action plan. The vision should be long term, up to 10-15 years (or to an appropriate timescale for the context). The vision should capture the city's long-term resilience ambition and direction. The project team can direct the discussion on the vision by suggesting questions that participants should strive to answer (i.e. What words of phrases describe your ideal city? How would you like your city to be for future generations?) The Steering Committee should work together to create a compelling and concise Vision Statement that encapsulates the desired future state of the city in terms of resilience.

d. **Identify** a set of medium-term strategic objectives linked to the vision and themes. These would typically be for the period of 5-10 years and should be aligned to the pre-determined themes and may be crosscutting in nature. Using the agreed vision, the Steering Committee should work together to identify 3-5 cross-cutting strategic objectives which will help to bridge where the city is currently and the future vision.

2. **Deliver visioning workshop:** The visioning workshop should take a maximum of 2.5 hours and conclude with an agreed overarching vision, key themes, and strategic objectives for the action plan. In delivering the workshop, it is critical to enable a range of diverse perspectives to inform decisions.

Objectives

To develop an overarching strategic Vision Statement to build resilience in the city

Outputs

A clear and articulate Vision Statement for strengthening resilience; A set of strategic objectives for the Resilience Action Plan

Define vision and objectives

Suggested resources

Human

- Delivery Team members with expertise and experience in stakeholder engagement and participatory urban and climate action planning, can lead the visioning workshop.
- Delivery Team members with expertise in governance and policy, and with strong understanding of the local context, can co-lead the visioning workshop.
- Community representatives, government-community liaison officers, or civil society organizations with direct connections to and relationships with local communities and vulnerable populations, should be engaged to facilitate expanded and enhanced stakeholder participation.

Technical and operational

- City Context Analysis
- MVA for city and selected communities
- Multilayered Vulnerability Profiles
- Vulnerability hotspot maps
- 'City Resilience Profiling Tool'. 2021. Guide. UN-Habitat Urban Resilience Hub.[31] https://unhabitat.org/sites/default/files/2021/01/crpt-guide.pdf

31 The City Resilience Profiling Tool serves as a valuable resource for developing a comprehensive vision for a city›s action plan. By providing a systematic approach to understanding and addressing the city›s vulnerabilities, the CRPT helps identify gaps and opportunities for resilience-building initiatives. This baseline assessment lays the groundwork for future actions aimed at enhancing the city›s resilience to various challenges, including those related to climate, biodiversity, and urban development. Integrated into the visioning process, the insights from the CRPT ensure that the vision and strategic objectives are forward-looking, inclusive, and tailored to the city›s unique context.

Considerations

The city may already have a strategic vision. If so, there is the option to review and update or amend this vision to include the specific strategic direction and objectives related to resilience.

The formulation of the Vision and Strategic Objectives should take into account relevant strategies, policies and agendas at national and subnational levels to allow for the Resilience Action Plan to be aligned with key development priorities and policies.

Objectives

To develop an overarching strategic vision statement to build resilience in the city

Outputs

A clear and articulate Vision Statement for strengthening resilience; A set of strategic objectives for the Resilience Action Plan

Visioning and objective setting for action plan

Step 3.1 Activity B

Validate resilience vision and objectives with stakeholders

Activity description

Summary

It is critical to obtain inputs from a range of stakeholders on the Vision Statement and Strategic Objectives to ensure that the ambitions of the Resilience Action Plan are representative of all key stakeholders that it will affect. The Validation workshop should provide an overview of the key findings of the MVAs and the City Context Analysis as well as an explanation of the decision-making process of the Steering Committee. After which, stakeholders must be able to provide comments and discuss any strengths or limitations of the Vision Statement and Strategic Objectives.

Tasks

1. Prepare validation workshop agenda and materials: The workshop should be scheduled over a period of 1 hour – 1.5 hours dependent on the context. It can be held in person or virtually, ensuring the communication approach is fitting to a diverse range of stakeholders. The workshop should include an overview of the process for developing the Vision and Strategic Objectives, followed by interactive exercises or discussion with the purpose of collecting stakeholder inputs into the Vision and Strategic Objectives.
2. Invite key stakeholders: Invite key stakeholders to the in-person or virtual validation workshop, these should have been identified in the stakeholder engagement plan and previously been involved in other stakeholder engagement events. Utilize the IAP2 Spectrum of Participation Table to ensure appropriate representation and meaningful participation, particularly from stakeholders categorized in the "Consult" and "Empower" clusters of engagement.
3. Deliver validation workshop.
4. Collect final stakeholder inputs: Provide a period of 1 week for stakeholders to provide any additional comments on the Vision and Strategic Objectives. This allows any absentees or individuals unable to openly communicate during the workshop to provide thoughts on the future Vision and Strategic Objectives.

Suggested resources

Human

- Delivery Team members with expertise and experience in stakeholder engagement and participatory urban and climate action planning should lead the validation of the Vision Statement and list of Strategic Objectives.

Technical and operational

- City Context Analysis (Step 1.2 Activity B)
- Rapid city diagnostic
- MVA for city and selected communities
- Multilayered Vulnerability Profile (Step 2.5 Activity A)
- Vulnerability hotspot maps (Step 2.4 Activity A)
- Draft themes, vision and strategic objectives (Step 3.1 Activity A)
- IAP2 Spectrum of Participation table (Step 1.1 Activity C)
- 'Our City Plans: An Incremental and Participatory Toolbox for Urban Planning'. 2022. Global Toolbox. UN-Habitat [32]. https://unhabitat.org/sites/default/

Considerations

The purpose of the workshop is to obtain approval and validation from stakeholders on the Vision Statement and Strategic Objectives. Therefore, stakeholders are able to provide critical comments however, the finalization process should not extend beyond 1 week.

32 The Our City Plans Toolbox supports local governments and urban actors in small and intermediate cities to better understand, customize and develop inclusive and integrated urban planning processes, using a step-by-step methodology.

Objectives

To engage stakeholders in defining and finalizing the Vision Statement and Strategic Objectives for strengthening the resilience of their city and to co-create and validate the Vision Statement and list of Strategic Objectives for strengthening resilience of the city with key

Outputs

Finalized Vision Statement and set of Strategic Objectives

Develop Resilience Action Plan

Step 3.2 Activity A

Longlist resilience actions

Activity description

Summary

The initial drafting and longlist of measures should be a background task throughout Stage 2, building on emerging measures from stakeholders, the Delivery Team, Steering Committee, any technical experts, and findings of the MVAs. By this activity, early actions should be ready to supplement with a longlist. The tasks described below should build on this existing list. The longlisting process aims to find a broad longlist of potential actions that address the key vulnerabilities identified through the MVA and which align with the Strategic Objectives and Vision. Through the tasks below a longlist should be identified encompassing a range of actions including different action types (soft and hard), classifications (i.e. policy, capacity development, infrastructure, behavioural etc.), costs (high, medium, low) and timescales (short or long term).

Tasks

1. **Refine measures** which might have evolved through engagements with stakeholders or interactions with technical experts and the Steering Committee.
2. **Review existing, ongoing or planned resilience projects** from different departments or other levels of government. E.g. Projects or initiatives aligned with the NAP or NDC.
3. **Review other action plans and resilience strategies** from other contexts (I.e. other cities or countries) to identify additional measures that may be relevant to the city.
4. **Identify any additional measures** with the support of the Steering Committee and technical experts to fill outstanding gaps related to the strategic objectives and key vulnerabilities identified in the MVA.

It is critical that each of the measures longlisted is directly aligned to the overarching vision and strategic objectives although this will be reconfirmed during the prioritization activity (Step 3.2 Activity B).

Suggested resources

Human

- Delivery Team experts with experience in action planning and project preparation are recommended to lead this activity. It is recommended that team members with expertise in climate change, urban development, biodiversity conservation, urban and climate finance, and institutions, policy and governance facilitate the longlisting process.

Technical and operational

- City Context Analysis (Step 1.2 Activity B)
- MVA for city and selected communities
- Multilayered Vulnerability Profile (Step 2.5 Activity A)
- Vulnerability hotspot maps (Step 2.4 Activity A)

Considerations

Selected measures should seek to compliment other national and sub-national strategies.

Occasionally measures intended to build resilience and reduce vulnerability can result in maladaptation. It is critical in the selection of measures that the project team is cognizant of these risks and avoid any unintended outcomes.

Look for opportunities to optimize co-benefits, for example socio-economic development opportunities, carbon reduction, nature restoration benefits.

Ensure that selected measures cover the full scope of the geographic area, address a full range of vulnerabilities and encompass the needs of the most vulnerable.

Objectives

To develop a longlist of potential resilience actions

Outputs

A longlist of potential resilience actions across a range of sectors, activity types and short and long-term actions

Prioritize and shortlist resilience actions

Activity description

Summary

The longlist of actions will be refined into a final shortlist of actions that will be part of the final action plan. This filtering process will be conducted using a Multicriteria Analysis (MCA). Key criteria will be determined by the project team through which the longlist of actions will be sorted. This process will culminate in a shortlist of 10-12 actions that will be developed into full action sheets. Of these, project teams should aim to have 70 per cent technical resilience building measures ("hard" actions) and 30 per cent supporting actions ("soft" actions).

Tasks

1. **Develop criteria for the MCA in collaboration with the Steering Committee:** The project team and Steering Committee must identify key criteria through which the longlist of actions will be reviewed and prioritized. These criteria should be closely associated with the vision and strategic objectives, allowing the project team to shortlist synchronized actions under common goals. The criteria could be organized under categories, with up to 3 criteria per category. The MCA could become a time-consuming activity and, as such, it is recommended that no more than 3-5 criteria are included within each category. The structure and nature of these criteria should be determined by the project team and Steering Committee and tailored to the local context. Some typical criteria categories might include:
   a. Resilience benefit: Criteria that assess the actions based on their ability to reduce key vulnerabilities.
   b. Technical and financial feasibility: Criteria that assess the ability of the city to implement the action (for example, funding availability, opportunity for revenue generation or cost saving, alignment with existing policy/ regulatory framework, timeline feasibility etc.).
   c. Alignment with strategic objectives: Criteria that assesses the alignment of the action with the medium-term Strategic Objectives.
   d. Gender and social inclusion: Criteria which assess the action's potential to reduce inequalities and improve livelihoods of marginalized and vulnerable people.
   e. Co-benefits: Criteria which assess the potential environmental, social and economic co-benefits that the action may lead to.
2. **Optional:** develop a weighting for each criteria category, that reflects the priorities of the stakeholders, which will impact the overall scoring of the MCA. This can be done in a participatory manner (as part of step 2 below) or can be done in agreement with the Steering Committee.
3. **Optional:** Share criteria with stakeholders in an online survey: If resources available, the project team may choose to share the criteria with key stakeholders in an online survey. The survey can be used to capture any additions or modifications that stakeholders suggest.
4. **Conduct MCA on the longlist of actions:** Choose a simple scoring approach to utilize, the scoring will be used to assess the applicability of the action to the criteria. A 1-3 scoring scale is recommended, simple to apply and will provide differentiation between the actions (where '1' = low applicability and '3' = high applicability). Aggregate and normalize the scores under each criteria category. With the total scores for each action, the project team should generate a preliminary ranking of the actions.
5. **Compile final shortlist of actions:** Gather the draft shortlist by selecting the 10-12 highest ranked actions after the MCA. The shortlist is preliminary until stakeholders have consulted on the rankings in Step 3.2 Activity C.

Objectives

To prioritize and identify a draft shortlist of actions

Outputs

Agreed MCA criteria and a draft shortlist of prioritized actions

Prioritize and shortlist resilience actions

Suggested resources

Human

- This activity requires collaboration and coordination between all Delivery Team members, the Steering Committee, and engaged local stakeholders. Members with strong experience in project prioritization should lead this task.

Technical and operational

- Longlist of actions (Step 3.2 Activity A)
- Vision Statement and Strategic Objectives (Step 3.1 Activity A)
- Multilayered Vulnerability Profile (Step 2.5 Activity A)

Considerations

If resources allow, this stage could be conducted in a workshop format with key stakeholders to efficiently and unanimously agree on the scoring of actions across various criteria.

Objectives

To prioritize and identify a draft shortlist of actions

Outputs

Agreed MCA criteria and a draft shortlist of prioritized actions

Develop Resilience Action Plan

Step 3.2 Activity C

Codesign actions with stakeholders

Activity description

Summary

After a shortlist has been agreed using the MCA, it should be shared with stakeholders in a 1-day prioritization and action design workshop (in two stages). The purpose of the workshops will be to i) validate the scoring of the actions and confirm the final shortlist with stakeholders but also to ii) obtain stakeholders' inputs into the design of actions, including opportunities to strengthen actions, (e.g. by improving alignment with roles and responsibilities, existing strategies or funders) or by identifying limitations or weaknesses in the actions (e.g. financially unfeasible or potential for unintended consequences). It is critical to capture the rationale behind any stakeholder agreement or disagreement with the preliminary scoring, so appropriate actions can be taken by the project team.

Optional

If resources do not allow time for a workshop approach. Inputs from stakeholders could be gathered using an online survey. This could be conducted by providing a survey with the vision and strategic objectives and ask stakeholders to identify actions from the longlist which best align with the vision from their perspective. Other questions could ask stakeholders to rate actions in relation to their gender and social inclusion effectiveness, potential for vulnerability reduction etc. A free text option should be provided to allow stakeholders to provide any other comments on the shortlisted actions.

Tasks

1. **Prepare the 1-day prioritization and action design workshop agenda and materials:** The workshops should be scheduled over a period of 1 day in 2 separate sessions. The project team should decide whether multiple workshops are required (for example, it may be beneficial to have separate workshops with communities and NGOs to government entities). The workshop can be held in person or virtually, ensuring the communication approach is fitting to a diverse range of stakeholders (an in-person workshop is recommended). The first session of the workshop should broadly follow these steps:
   a. Overview of completed tasks
   b. Methodology for action prioritization
   c. Overview of the vision statement and strategic objectives
   d. Presentation of action longlist and shortlist
   e. Stakeholder input into prioritization
2. The second session will immediately follow the first session. Therefore, it should focus on an interactive discussion on each of the shortlisted actions in turn. The presenters should aid the discussion by asking specific questions on the design of the action. These might include:
   a. Where could this action be located in the city?
   b. Are there any specific assessments or approvals that are required for the action?
   c. Do you have any concerns about possible risks of this action?
   d. Who do you envisage being responsible for the implementation and operation of the action? Etc.
3. **Invite key stakeholders:** Invite key stakeholders to the in-person or virtual prioritization and action design workshop, these should have been identified in the stakeholder engagement plan and previously been involved in other stakeholder engagement events.
4. **Deliver prioritization and action design workshop**.
5. **Collect final stakeholder inputs:** Provide a period of 1 week for stakeholders to provide any additional comments on the final action shortlist and design of actions. This allows any absentees or individuals unable to openly communicate during the workshop to provide thoughts on the actions.

Objectives

To validate and finalize shortlist of actions and to obtain stakeholder input into the design of final actions

Outputs

A final shortlist of actions

Codesign actions with stakeholders

Activity description

Tasks

6. **Finalize action shortlist:** Outputs of the workshop and any online surveys or other consultations should be taken into account, this may entail updating scores within criteria based on new knowledge or technical inputs from stakeholders or adapting shortlist rankings according to stakeholder inputs. Stakeholders may also provide inputs which require the reformulation of actions, in which case the project teams should revise the criteria scoring for the actions.
7. **Record stakeholder opinions on action design:** Note any stakeholder inputs into the design of actions from the workshop or any other engagement approaches. These will be integrated into the final action sheets.
8. **Validate shortlist with the Steering Committee:** Share the final shortlist virtually with the Steering Committee. Collect any final comments and their approval over a 1-week period. It is at the discretion of the project team how these comments are collected, an online survey is recommended to enable ease of processing.

Suggested resources

Human

- This activity requires collaboration and coordination between all Delivery Team members, the Steering Committee, and engaged local stakeholders. Members with strong experience in project prioritization should lead this task.

Technical and operational

- MCA shortlist of actions (Step 3.2 Activity C)
- Vision Statement and Strategic Objectives (Step 3.1 Activity A)
- Stakeholder Engagement Plan (Step 1.1 Activity D)

Considerations

If there are time and budget constraints consider utilizing online surveys and other low-resource intensive opportunities to collect stakeholder opinions.

If the Delivery Team have been able to map and assess future vulnerabilities, it is recommended that the action planning process includes a scenario planning exercise whereby actions are identified, appraised and prioritized based on business-as-usual or worst-case scenario futures. This foresight approach to action planning can help select and design interventions that are most urgent and required in the face of increasing and worsening climate change impacts.

Objectives

To validate and finalize shortlist of actions and to obtain stakeholder input into the design of final actions

Outputs

A final shortlist of actions

Identify funding mechanisms

Activity description

Summary

Identifying funding mechanisms is a crucial step in the development of the resilience action plan. This activity will involve researching and evaluating various sources of funding that can support the implementation of resilience-building measures identified through the MVA and action shortlisting process. By identifying suitable funding and financing for the actions, the city can ensure the availability of financial resources necessary to implement the actions.

Prior to this stage a preliminary assessment of the financial feasibility of each action should have been considered in Step 3.2 Activity B, therefore the actions brought to this activity should be financially feasible.

Tasks

1. **Estimate capital expenditure (CapEx) and operational expenditure (OpEx) costs of actions:** Conduct a very high level financial assessment to find the estimated CapEx and OpEx costs for each shortlisted action.
2. **Map potential financing and funding approaches:** Conduct a comprehensive mapping exercise of all potential funding sources available at local, national, regional and international levels. This might include sources such as government grants, public-private partnerships and revenue generation.
3. **Assess eligibility:** Analyze eligibility criteria as well as application process and timelines associated with each funding source to determine their suitability for financing the actions.
4. **Evaluate the feasibility and sustainability of funding mechanisms:** Considering factors such as the alignment with strategic objectives, flexibility etc. assess the medium and long term suitability of possible funding sources.
5. **Prepare an early prioritized list of funding mechanisms:** Based on the feasibility and sustainability evaluation, develop a list of prioritized funding mechanism, considering the potential of each to generate sufficient resources and support the implementation of actions.

Suggested resources

Human

- This activity requires a collective effort of the Delivery Team to identify and appraise potential funding mechanisms and possible financial instruments from a range of different donors and partners. Experts with experience in resource mobilization, climate finance and project preparation are recommended to lead this activity.

Technical

- Action Shortlist (Step 3.2 Activity C)

Considerations

The activity should not involve a full financial assessment but should use a high-level financial assessment to estimate the potential costs of the actions to inform the following assessment of potential funding mechanisms.

Objectives

To find a list of suitable funding mechanisms for the shortlisted actions

Outputs

A prioritized list of funding mechanisms

Develop Resilience Action Plan

Step 3.2 Activity E

Prepare Action Sheets

Activity description

Summary

With the final shortlist of actions, the Resilience Action Plan can be developed. This task will involve framing and providing detail to the shortlisted actions which outline specific implementation steps, responsibilities, timelines and content of the action. These action sheets serve as comprehensive roadmaps for execution and implementation and provide guidance for preparing bankable projects. Action Sheets should be prepared by the project team with the involvement of the Steering Committee and tailored to the local context.

At a minimum, the Action Sheets should include the following:

I. Action title. Provide a short and clear action title which reflects the essence of the action. It should capture the primary focus and purpose of the action.

II. Action rationale (i.e. vulnerabilities addressed from the MVA). Present a clear justification for the action, outlining the specific vulnerabilities addressed from the MVA. Reference the spatial analysis to strengthen the rationale, connecting the action to identified needs.

III. Brief description. Summarize the content of the action, including an overview of intended outputs, outcomes, and impact. Provide a brief yet comprehensive description to give the reader a clear understanding of the action›s purpose and expected results.

IV. Strategic objective alignment. Identify how the action aligns with the vision and objectives. This ensures that the action is in line with the broader goals and aims of the plan.

V. Alignment with policies, plans and frameworks. List any relevant policies, plans and frameworks that the action supports or aligns with. Include local, national and international policies, plans and frameworks with a particular focus on National Adaptation Plan (NAP) and Nationally Determined Contributions (NDCs) alignment.

VI. Co-benefits. Describe potential co-benefits which may arise with the implementation of the action. These should be categorized into; i) environmental, ii) economic and iii) social co-benefits.

VII. Key Performance Indicators (KPI). Specify the most relevant KPIs for monitoring and evaluating the action›s impact and success. Identify these indicators from the list used in Stage 2.

VIII. Action owner. Identify a suitable individual, team or department that will take ownership of the action moving forwards. If multiple individuals or departments should co-own the action, make note of these here.

IX. Implementation steps. Summarize up to 10 key steps of the action implementation.

X. Action timeframe. Present a realistic timeline for the implementation of the action. Define key milestones and deadlines.

XI. Indicative cost and funding mechanism. Include the high-level estimate of the Capital Expenditure (CapEx) and Operational Expenditure (OpEx) costs required for the implementation of the action as identified in Step 3.2 Activity D. Include a summary table identifying potential financing and funding sources to support planning and budgeting.

XII. Risks (i.e. financial, political, technical, social and environmental). Provide an overview of any potential risks to the action. These should be detailed under the headings of; i) financial, ii) political, iii) technical iv) social and, v) environmental.

Tasks

1. **Draft template of Action Sheets:** The project team should collaboratively prepare a suitable action sheet template.
2. **Share Action Sheet template with Steering Committee for approval:** Virtually obtain comments and approval from the Steering Committee on the action sheet template.
3. **Drafts Action Sheets for shortlisted actions:** After approval, the project team should complete the action sheet template for all actions in the shortlist.

Objectives

To develop detailed action sheets for each of the shortlisted actions

Outputs

Complete and detailed Action Sheet for each shortlisted action

Prepare Action Sheets

Activity description

Tasks

4. **Obtain any additional inputs and expertise:** Complete any final sections which require inputs or review from external experts, for example financial expertise, gender and social inclusion specialists or others.
5. **Finalize Action Sheets:** Integrate all final inputs and finalize all actions sheets.
6. **Obtain Steering Committee approval:** Share final action sheets with the Steering Committee to obtain approval.

Suggested resources

Human

- It is imperative that a Delivery Team member with experience in developing project proposals leads this activity. The preparation of action sheets requires knowledge and understanding of the requirements of project finance and funding. Ensuring that experts with previous experience in preparing and implementing projects with international financing institutions, national governments, and the private sector, are engaged in this activity is highly recommended.

Technical and operational

- MCA shortlist of actions (Step 3.2 Activity C)
- Stakeholder inputs from the prioritization and action design workshop (Step 3.2 Activity C)
- Vision Statement and Strategic Objectives (Step 3.1 Activity A)
- Stakeholder Engagement Plan (Step 1.1 Activity D)
- Prioritized list of funding mechanisms (Step 3.2 Activity D)
- Multilayered Vulnerability Profile (Step 2.5 Activity A)
- Online survey results (if used)

Considerations

Recommendations for preparing attractive bankable projects include:

- Financial feasibility: Conduct thorough feasibility studies to ensure projects are viable and have a clear return on investment.
- Clear objectives and outcomes: Define clear, measurable objectives and outcomes for each project to attract funders' confidence.
- Leverage partnerships: Partner with international organizations, NGOs, and the private sector to leverage expertise, resources, and co-financing opportunities.
- Engage with networks: Join networks such as the Cities Climate Finance Leadership Alliance (CCFLA), Local Governments for Sustainability (ICLEI), Global Covenant of Mayors for Climate and Energy (GCoM) and Sustainable Urban Resilience for the Next Generation (SURGe) Initiative, to access resources, best practices, and potential funding opportunities.
- Tailor proposals: Tailor project proposals to meet the specific requirements and strategic goals of the targeted funding sources.
- Highlight multiple benefits: Emphasize the co-benefits of climate projects, such as job creation, public health improvements, and enhanced social equity, to make a stronger case for funding.
- Resilience and sustainability: Showcase how projects will enhance urban resilience and sustainability, providing long-term benefits beyond immediate climate impacts.
- Robust financial systems: Ensure the city has strong financial management systems to handle and report on climate finance transparently.
- Accountability mechanisms: Implement mechanisms for tracking and reporting on the use of funds to build trust with donors and stakeholders.
- Innovative finance: Explore innovative finance models that combine public, private, and philanthropic funding to de-risk projects and attract larger investments.
- National policy alignment: Align city climate plans with national policies and priorities to access national climate funds and gain government support.

Objectives

To develop detailed Action Sheets for each of the shortlisted actions

Outputs

Complete and detailed Action Sheet for each shortlisted action

Develop Resilience Action Plan

Step 3.2 Activity F

Assemble and validate Resilience Action Plan with stakeholders

Activity description

Summary

The action plan assembly is the final step in the preparation of the action plan. The main component of the action plan will be the action sheets developed in Step 2.3 - Activity E. However, the action plan should also be considered as a strategic document. Therefore, the final action plan should also include the following elements:

I. **Purpose of the Resilience Action Plan:** Summarizing the main purpose of the action plan and the journey taken to develop it.

II. **Overview of the MVA findings:** Summarizing overview of the main MVA findings and vulnerability profiles which informed the basis of the action development.

III. **Vision Statement and Strategic Objectives:** Description of the overarching vision and strategic objectives which underlay the Resilience Action Plan.

IV. **Action Sheets:** Priority actions including all the information detailed in the action sheets.

V. **Implementation and monitoring:** Information on the proposed implementation and monitoring plan going forward including clear roles and responsibilities, a brief monitoring, evaluation and learning (MEL) plan and the indicators for monitoring progress and impact.

Tasks

1. **Prepare validation workshop agenda and materials:** Before the action plan is finalized, it must be presented to and validated with key stakeholders. Plan to conduct the workshop in a collaborative manner. The approach should be tailored to the context but it is recommended that the following steps are included
   a. A walk through of the action plan step-by-step including highlighting key components such as the vision and strategic objectives and encourage clarification questions from the participants.
   b. Facilitate a discussion allowing stakeholders and to share their perspectives, encourage feedback on the feasibility of the actions, their timeline and financing and any potential challenges. This could be facilitated using a SWOT analysis session where participants can collectively identify strengths, weaknesses, opportunities, and threats related to the action plan. This helps in refining the plan and addressing potential obstacles.
   c. Gather consensus by the end of the workshop from participants on the final version of the action plan including any documented changes that will be integrated.
2. **Invite key stakeholders:** Invite key stakeholders to the in-person or virtual Validation Workshop, these should have been identified in the stakeholder engagement plan and previously been involved in other stakeholder engagement events.
3. **Share final Resilience Action Plan with key stakeholders:** Ensure that all key stakeholders have access to the final action plan at least a week in advance of the workshop. If necessary, provide any background information and instruct attendees on the objectives of the workshop.
4. **Deliver validation workshop.**
5. **Finalize Action Plan:** Integrate any changes which were agreed in the workshop and finalize the action plan.

Objectives

To develop the final validated action plan document

Outputs

Final validated Resilience Action Plan document

Assemble and validate Resilience Action Plan with stakeholders

Suggested resources

Human

- Delivery Team members with expertise and experience in facilitating stakeholder engagement and participatory planning and decision-making are required to undertake the validation process to finalize Action Plan.

Technical

- Vision Statement and Strategic Objectives (Step 3.1 Activity A)
- Multilayered Vulnerability Profile (Step 2.5 Activity A)

Considerations

The validation of the Action Plan may require several rounds of activities, engaging different stakeholders. The finalization process may require several updates or iterations of the Action Plan to allow it to be fully validated and endorsed.

Objectives

To develop the final validated Resilience Action Plan document

Outputs

Final validated Resilience Action Plan document

Develop Resilience Action Plan

Step 3.2 Activity G

Obtain political approval

Activity description

Summary

All approval requirements will be unique to each individual country/city, and these should be pre-emptively identified by the project team, this includes all formal legal procedures and any necessary public consultation, if required. Appropriate steps should have been taken throughout the action plan development in preparation for any approval processes.

The Steering Committee should consider if the Resilience Action Plan must be approved as a statutory document. Documentation should be submitted for approval with consideration to any relevant local, regional and/or national government or political bodies.

As part of the approval process, the relevant governing body's budget cycle should also be considered to ensure alignment with the investments proposed in the Action Plan.

Tasks

1. **Prepare documentation for approval:** Prepare the Resilience Action Plan and any supporting documentation for approval. Ensure any additional requirements are completed and accounted for, such as prior approval from the Ministry of Finance or any government agencies involved in budgeting, statutory requirements for approval, or public consultation timelines.
2. **Share documentation with relevant parties:** It is recommended that the Action Plan and other documents are prepared and shared with relevant parties in advance to ensure that any additional requirements are understood and met ahead of formal approval. The Steering Committee should finalize the Action Plan document with a view to seeking approval of the document from relevant authorities.
3. **Amend Resilience Action Plan.**
4. **Acting on any feedback** received, make amendments to the already Action Plan, before submission.
5. **Submit action plan and obtain approval:** Including any additional documentation, submit final action plan and await approval.

Suggested resources

Human

- The final Resilience Action Plan is a collective deliverable and output that requires the participation of all Delivery Team members.

Technical

- Full Resilience Action Plan document
- Any supporting documentation for approval

Considerations

Governing bodies' budget cycles may influence when the Resilience Action Plan is approved, endorsed and published.

Ensure all necessary governmental bodies' approval is achievable.

Objectives

Finalized Resilience Action Plan with all relevant governmental approvals which is ready to begin scaling, campaigning and disseminating.

Outputs

An approved final Resilience Action Plan

Disseminate, campaign and scale

Step 3.3 Activity A

Develop Resilience Action Plan Communication Strategy

Activity description

Summary

This activity will communicate and promote the work in developing and promoting the Resilience Action Plan (outlined in Step 3.2) to relevant stakeholders. This activity will determine the scale and reach of the Resilience Action Plan and is essential to the project's widescale success. It is necessary to involve stakeholders in the communication strategy's development as they will be essential to its implementation. This will involve stakeholders who have been engaged throughout the MVA and action plan development.

The Communications Strategy will apply across multiple time scales ensuring long-term success of the action plan. It will also include communicating to internal audiences. It should also include the following:

- Audiences and key stakeholders and groups to target communications to, including their preferred method of communication (e.g. face-to-face, radio, newspaper, social media).
- Key outputs, including communication goals.
- Resources including human resources and mediums/platforms available to communicate on.
- Timeline, including key dates relating to the development of the project and also related events where the project/Resilience Action Plan can be communicated.
- Communication style and approach.
- Activity owner.
- Mechanism for review of activities.

The strategy should provide clear information on the dissemination plans of

Tasks

1. **Project background:** understanding of the timelines of the project, outputs and the key moments which need to be communicated; and who key people are working on the project, including the project coordinator(s).
2. **Audience identification:** Ensure that the stakeholders identified are relevant to the project/Resilience Action Plan. The audiences may change and or develop as the project/Resilience Action Plan develops.
3. **Communication Strategy:** development of a communication strategy documenting outlining key audiences, timeline with key moments and activities, and communication approach.
4. **Review:** To ensure the strategic plan is cohesive and consistent with previous related approaches by stakeholders, key people to the development of the project should review the document and give their feedback which should be

Suggested resources

Human

A dedicated communications and stakeholder engagement specialist is required to lead this activity. The specialist should be well versed in preparing high-quality, context-specific and localized communications and engagement with the diverse set of stakeholders that typically exist in a city or urban context.

Technical and operational

- Final Resilience Action Plan
- Information about the development of the Resilience Action Plan
- Time from key stakeholders to review and support with providing further information about the project

Considerations

During the launch event and as a part of thinking in the years after the event, attempt to reach bipartisan political support where possible. Particularly if using government officials at events or in marketing/delivery.

Objectives

To deliver a clear and concise Communication Strategy which ensures that the Resilience Action Plan and the desired impact are widely

Outputs

A detailed Communication Strategy which includes the final strategy including delivery and post-delivery stages to ensure the Resilience Action Plan is widely communicated and understood

Disseminate, campaign and scale

Step 3.3 Activity B

Disseminate Resilience Action Plan

Activity description

Summary

Dissemination of the Resilience Action Plan for each country will manifest differently but should follow the Communication Strategy developed in Step 3.6 - Activity A. Each office should determine between a public facing dissemination strategy or a more limited dissemination approach. However, public dissemination should align with the communication strategy document to keep clear messaging. Involvement of stakeholders is essential in the dissemination and delivery of a launch event which shares the Resilience Action Plan and its objectives with local communities and the wider stakeholders.

The public launch event, if used, should demonstrate leadership support, and be led by a high-ranking local government official with the support of national, provincial and local government stakeholders, if feasible. Speakers should follow high level dialogue on the general need and advantages of the strategy. Other relevant stakeholders, including representatives from the private sector, international development sector, civil society, academia and local communities should be invited. It should involve media outlets with the goal of maximising visibility for the event.

Tasks

1. **Organize and deliver a public facing launch event** if suitable for the dissemination of the Resilience Action Plan. If pursuing an external launch event, it is important to demonstrate leadership support (for example, the attendance of a mayor, Governor or other senior leadership is recommended). Key stakeholders should be involved in the preparation and delivery of the event to broaden the audience and help deliver a clear message on the Resilience Action Plan and its intended impact over short, medium and long terms.
2. **Publish the final Resilience Action Plan online**: It is recommended that the Action Plan becomes publicly available online, included translated versions in the major languages of the country.

Suggested resources

- Final Resilience Action Plan
- Communication Strategy document

Considerations

The dissemination of Resilience Action Plans differs from country to country. There is no one-size-fits-all approach, however, it is recommended that Action Plans are made publicly available digitally in local languages and that outreach efforts are made to raise awareness about the plans to all potential beneficiaries and affected persons.

Objectives

To disseminate and widely share the City Resilience Action Plan

Outputs

Delivery of a public launch event, and Resilience Action Plan published online

Develop approach to integrate Resilience Action Plan into strategic documents

Activity description

Summary

This activity aims to outline a systematic approach for integrating the Resilience Action Plan into existing strategic documents of relevant stakeholders. By aligning the Resilience Action Plan with strategic documents, such as city development plans or climate resilience strategies, the impact and implementation of the Resilience Action Plan can be maximized and sustained over the long

Tasks

1. **Identify and review strategic documents:** collaborate with relevant departments to identify national, regional, and local strategic documents that align with the Action Plan's goals, including city development plans, climate resilience strategies, and other relevant documents. Compile relevant strategic documents into a List of Strategic Documents.
2. **Mapping and integration:** Review and analyze each strategic document to identify opportunities to integrate the Resilience Action Plan's objectives, activities, and budget allocations. Determine specific points within the existing strategic documents where the objectives of the Resilience Action Plan can be integrated. Based on the review and identification process, develop a structured approach for integrating the Resilience Action Plan into strategic documents, outlining opportunities and approach steps, responsibilities, timelines, and potential barriers for implementation.
3. **Stakeholder consultation:** Engage with relevant stakeholders, including government agencies, local communities, businesses, and other key actors, to gather input and feedback on the proposed integration approach. Discuss the Resilience Action Plan and its proposed integration, ensuring ownership, alignment, and buy-in from key decision-makers, identified in line with the IAP2 Spectrum of Participation Table.
4. **Review and finalize integration plan:** Incorporate feedback from stakeholders and finalize the integration plan, ensuring that it aligns with the objectives and priorities of all stakeholders involved. Work with relevant authorities to revise strategic documents, incorporating the Resilience Action Plan's elements.

Suggested resources

Human

- The Delivery Team's expert on policy, governance and institutions should lead this task, supported by other key technical specialists. It is critical that the Resilience Action Plan aligns with a city's climate and development ambitions and commitments, as well as the national and international adaptation and climate action policies, strategies and agendas.

Technical and operational

- Resilience Action Plan document
- IAP2 Spectrum of Participation table

Considerations

Verify that the proposed integration complies with relevant laws, regulations, and policies at each level of governance. Ensure harmony between the Resilience Action Plan's objectives and legal frameworks.

Communicate transparently with stakeholders about the integration process, its objectives, and expected outcomes. Be prepared to adjust the plan in response to changing priorities, stakeholder feedback, or external environmental factors.

Objectives

Secure long-term commitment to the Resilience Action Plan by integrating it into relevant strategic documents

Ensure consistency and alignment between the Resilience Action Plan and broader development goals

Facilitate resource allocation and budget planning for Resilience Action Plan implementation

Outputs

List of Strategic Documents, Strategic Document Integration Plan

Stage 3 Checklist: Intervention planning

Step 3.1 Visioning and objective setting for action plan

Activity A: Define vision and objectives

- ☐ Clear and articulate Vision Statement for strengthening resilience
- ☐ A set of Strategic Objectives for the Resilience Action Plan

Activity B: Validate Resilience Vision Statement and Objectives with stakeholders

- ☐ Finalized vision statement and set of strategic objectives

Step 3.2 Develop Resilience Action Plan

Activity A: Longlist resilience actions

- ☐ A longlist of potential resilience actions across a range of sectors, activity types and short and long-term actions

Activity B: Prioritize and shortlist resilience actions

- ☐ Agreed MCA criteria (and agree weighting if it is decided to include weighting)
- ☐ A draft shortlist of prioritized actions

Activity C: Codesign actions with stakeholders

- ☐ A final shortlist of actions

Activity D: Identify funding mechanisms

- ☐ A prioritized list of funding mechanisms

Activity E: Prepare Action Sheets

- ☐ Complete and detailed Action Sheet for each shortlisted action

Activity F: Assemble and validate Resilience Action Plan with stakeholders

- ☐ Final validated Resilience Action Plan document

Activity G: Obtain political approval

- ☐ An approved final Resilience Action Plan

Step 3.3 Disseminate, campaign and scale

Activity A: Develop Resilience Action Plan communication strategy

- ☐ A detailed communication strategy which includes the final strategy including delivery and post-delivery stages

Activity B: Disseminate Resilience Action Plan

- ☐ Delivery of a public launch event involving local stakeholders
- ☐ Resilience Action Plan published online

Activity C: Develop approach to integrate action plan into strategic documents

- ☐ List of Strategic Documents
- ☐ Strategic Document Integration Plan

Accessible, solar-powered hillside public escalators in Medellin, Colombia
2024 © UN-Habitat_Lee Michael Lambert

Annexes

Youths from the Ibura community in Recife, Brazil, present the model built as a result of the Public Spaces Design workshop held by UN-HABITAT within the Pernambuco Cooperation project, © UN-Habitat_Renatto Mendonça

Stage 1
Annexes

Hillside indigenous communities of Lake Atitlan, Guatemala
2024 © UN-Habitat_Lee Michael Lambert

Stage 1 Annexes

1. Stakeholder tools

1A. Stakeholder List

A **Stakeholder List** is a comprehensive inventory of individuals, groups, organizations, or institutions that have an interest in, influence over, or are affected by a particular project, initiative, or decision-making process. This list helps identify key actors whose involvement is critical for the success of the project, ensuring that their needs, concerns, and inputs are considered throughout the project lifecycle.

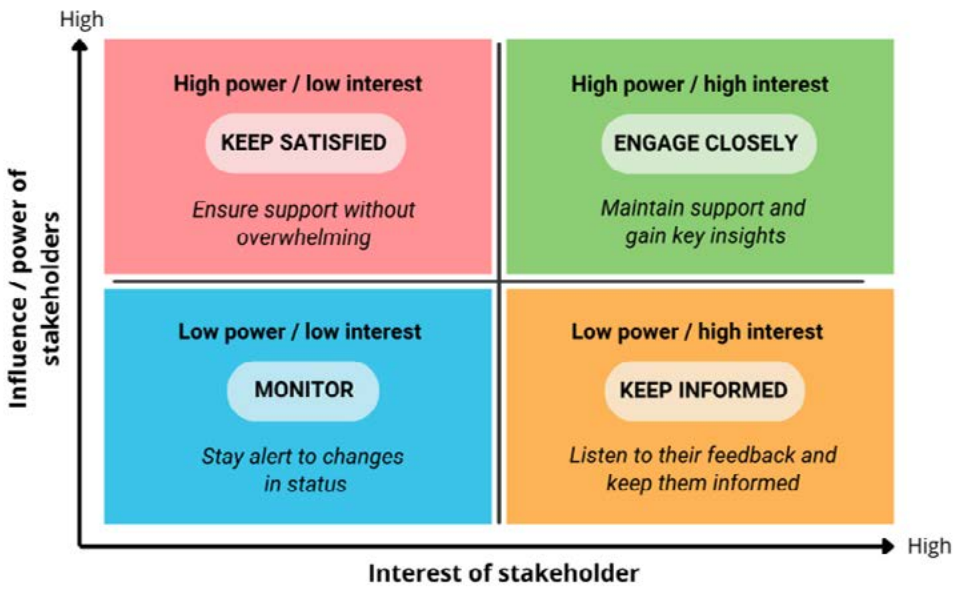
In the context of the MVA, for example, the stakeholder list would typically include entities involved in urban planning, climate adaptation, and social welfare, as well as local communities and businesses that are directly or indirectly affected by climate risks. An example completed stakeholder list is provided here.

Stakeholder	Main Role on Project	Key Engagement Activities (Phase I)
Regional/ State government	General stakeholder coordination and resource mobilization	Selection of cities; Coordination with local government;
Local administration	Co-leader and direct beneficiaries of the project; Counterpart to jointly execute several activities of the project	Local communities' identification and selection; Community-level data collection and acquisition; Multilayered vulnerability assessment support; Development of City-wide Resilience Strategy development; Capacity development
Selected districts	Local partner and counterpart to support project activities	Community-level data collection and acquisition; Multilayered vulnerability assessment support; Development of City-wide Resilience Strategy development; Capacity development
Local communities	Participation in vulnerability profiling, identification of key challenges, needs and priorities	Community-level data collection and acquisition; Multilayered vulnerability assessment support; City-wide Resilience Strategy development
Local university	Potential partner for capacity building exercise of local administrations and knowledge sharing dissemination	Community-level data collection and acquisition; Multilayered vulnerability assessment support; City-wide Resilience Strategy development

1B. Stakeholder Influence-Interest Matrix

A Stakeholder Influence-Interest Matrix is a tool used in project management to categorize and analyze stakeholders based on their level of influence over the project and their interest in the project's outcomes. This matrix helps project teams prioritize stakeholders for engagement and tailor strategies to manage relationships effectively.

For the MVA, this matrix is used to organize stakeholders into four categories depending on the degree of influence they have and the extent of their interest in the MVA. It's a critical tool for managing stakeholder engagement throughout the MVA process, ensuring that key actors are involved appropriately and at the right level



1C. IAP2 Spectrum of Participation table

The **IAP2 Spectrum of Public Participation** is a widely recognized framework developed by the International Association for Public Participation (IAP2) that outlines different levels of public involvement in decision-making processes. The spectrum is designed to help organizations identify the most appropriate level of public engagement based on the objectives of the project and the extent to which the public can influence decisions. It ranges from simply informing the public to empowering them to make decisions.

For the MVA, this spectrum includes five key levels of participation, each with a corresponding goal and promise to the public. These levels are Inform, Consult, Involve, Collaborate, and Empower. An example of a completed IAP2 participation table is shown below for use in Stage 1 of the MVA.

	Inform	Consult	Involve	Collaborate	Empower
Participation goal	To provide the public with balanced and objective information to assist them m understanding the problem, alternatives, opportunities and/ or solutions.	To obtain public feedback on analysis, alternatives and/or decisions.	To work directly with the public throughout the process to ensure that public concerns and aspirations are consistently understood and considered.	To partner with the public in each aspect of the decision including the development of alternatives and the identification of the preferred solution	To place final decision-making in the hands of the public.
Promise	We will keep you informed.	We will keep you informed, listen to and acknowledge concerns and aspirations, and provide feedback on how public input influenced the decision.	We will work with you to ensure that your concerns and aspirations are directly reflected in the alternatives developed and provide feedback on how public input influenced the decision.	We will look to you for advice and innovation in formulating solutions and incorporate your advice and recommendations into the decisions to the maximum extent possible.	We will implement what you decide.
(example) Techniques	Newsletter, website, lectures, media coverage, videos.	Focus groups, surveys/polls, public meetings.	Workshops, interactive websites, interactive meetings.	Participatory decision-making, advisory committees, citizen committees.	Participatory budgeting, citizen juries, citizen decision committees.
(example) Usage	To inform re: project launch, to provide project updates, to deliver project background information.	To collect local context information, to collect opinion on issues of concern, to gather feedback on a plan proposal.	To develop planning element options and alternatives, to explore ideas and proposals, to debate merits of plan elements.	To host democratic processes (e.g. consensus-building, voting) that help decide policy inclusion.	To host democratic processes through which citizens decide on the plan policies and their implementation parameters.
Allocated stakeholders					

2. Suggested project work plan and timelines

MVA ROADMAP	
STAGE 1 - PREPARATION	
Step 1.1 - Set up the Delivery Team and Steering Committee	
Activity A	Establish and mobilize the Delivery Team
Activity B	Set up MVA Steering Committee
Activity C	Map and analyze stakeholders
Activity D	Prepare Stakeholder Engagement Plan
Step 1.2 - Conduct rapid diagnostic of the city or urban area	
Activity A	Assess city capacities and resources
Activity B	Conduct City Context Analysis
Step 1.3 - Develop assessment plan	
Activity A	Define geographic scope
Activity B	Develop MVA Work Plan and schedule of activities
STAGE 2 - MAPPING AND ANALYSIS	
Step 2.1 - Mapping assessment preparation	
Activity A	Establish data requirements
Activity B	Identify data sources and availability
Activity C	Develop Geospatial Workflow
Step 2.2 - Data acquisition and collection	
Activity A	Prepare Data Collection Plan
Activity B	Gather qualitative data
Activity C	Gather quantitative data
Activity D	Data cleaning and pre-processing
Step 2.3 - Map historic, current and future vulnerabilities	
Activity A	Map historic and existing climate change, urban and biodiversity vulnerabilities
Activity B	Analyze historic and existing climate change, urban and biodiversity vulnerabilities
Activity C	Map future climate change, urban and biodiversity vulnerabilities
Activity D	Analyze future climate change, urban and biodiversity vulnerabilities
Step 2.4 - Map multilayered vulnerability hotspots	
Activity A	Map intersecting and interconnected vulnerabilities
Activity B	Analyze intersecting and interconnected vulnerabilities
Step 2.5 - Develop Multilayered Vulnerability Profile	
Activity A	Document the Multilayered Vulnerability Profile
Activity B	Validate the Multilayered Vulnerability Profile
Activity C	Digitize the Multilayered Vulnerability Profile
STAGE 3 - INTERVENTION PLANNING	
Step 3.1 - Visioning and objective setting for action plan	
Activity A	Define Vision and Objectives
Activity B	Validate Resilience Vision and Objectives with stakeholders
Step 3.2 - Develop resilience action plans	
Activity A	Longlist resilience actions
Activity B	Prioritize and shortlist resilience actions
Activity C	Codesign actions with stakeholders
Activity D	Identify funding mechanisms
Activity E	Prepare Action Sheets
Activity F	Assemble and validate action plan with stakeholders
Activity G	Obtain political approval
Step 3.3 - Disseminate, campaign and scale	
Activity A	Develop action plan Communication Strategy
Activity B	Disseminate Resilience Action Plan
Activity C	Develop approach to integrate action plan into strategic documents

Activity will start only if the previous supporting activity is complete

3. RACI matrix template

A RACI matrix (also known as a Responsibility Assignment Matrix) is a project management tool used to clarify roles and responsibilities across various tasks, activities, or deliverables within a project. The RACI framework is especially useful for defining who is responsible for what, ensuring accountability, and avoiding confusion or overlap of responsibilities.

For the MVA, the RACI matrix is helpful in guiding the development of the Work Plan for the MVA, and should be used by Delivery Teams in this step during Stage 1.

RACI Matrix

[Project Title]

Roles and Responsibilities

Responsible, Accountable, Consulted, Informed

Deliverable or Task	Status	Sponsor	Name or Role	Name or Role	Name or Role	Name or Role	Project Manager	Technical Lead	Name or Role	Name or Role	Name or Role	Consultant	Name or Role	Name or Role	Name or Role	Name or Role
		Sponsor / Leadership					Project Team					Other Resources				
Phase 1																
Deliverable/Task 1		A	R				I									
Deliverable/Task 2		A		R			I									
Phase 2																
Deliverable/Task 1		C	I				A	R								
Deliverable/Task 2			I				A		R							
Phase 3																
Deliverable/Task 1			I				A	I		R		C				
Deliverable/Task 2			I				A	I	R			C				
Phase 4																
Deliverable/Task 1				I			A	R					C			
Deliverable/Task 2				I			A		R							
Insert new rows above this one																

D	Driver	Assists those who are responsible for a task.
R	Responsible	Assigned to complete the task or deliverable.
A	Accountable	Has final decision-making authority and accountability for completion. Only 1 per task.
S	Support	Provides support during implementation.
C	Consulted	An adviser, stakeholder, or subject matter expert who is consulted before a decision or action.
I	Informed	Must be informed after a decision or action.

Stage 2
Annexes

Market area in El Potrerillo, Pasto, Colombia, highly vulnerable to climate impacts, 2024. © UN-Habitat_Lucia Gasser Hidalgo.

Stage 2 Annexes

4. Data Requirements Sheet template

4A. Data Requirements Sheet template – summary

Step 2.1. Activity A. Establish data requirements:

Summary: The first task in preparing for the MVA mapping and analysis is to establish the assessment's data needs and requirements. Data needs and requirements are informed by the outputs of Step 1, including the guidance of the Steering Committee and selection of geographic areas in which to conduct the MVA. Establishing data requirements for the MVA involves a systematic process to ensure that the analysis is comprehensive, relevant, and tailored to the study's specific needs.

The steps on the next sheet will help to establish data requirements for the MVA:

Objective: Determine which data and documentation is required to undertake the MVA

Output: Completed Data Requirements Sheet

Activity Owner: Project Delivery Team

Required Resources:

1. *Data collection and analysis technical brief*
2. Data Requirements Sheet Template

Considerations:

1. It is important to review and update the Data Requirements Sheet through the MVA. For example, during the Data Acquisition and Collection step, additional data requirements may be identified.
2. Completing this step may reveal a need to engage additional stakeholders.

No.	Inform	Complete (yes/no)	Notes / Information
1	**Review the MVA scope and objectives** to understand the geographic focus and extent, time frame, and specific vulnerabilities or risks to be assessed (e.g. climate change hazards). *Ensure that the Delivery Team are comfortable with the various steps and activities. As each situation is unique, it may be in the best interest of the Delivery Team to alter the order of some steps. At the start of Stage 2.1, the Delivery Teams should have a broad idea of the areas to be assessed. The data and information compiled in the following steps should help define the specific, street level boundaries of the neighbourhood or community to be assessed.*		
2	**Conduct a literature review and appraisal of existing and available data** to identify existing studies, reports, and available data related to the study area and the initially identified climate risks, urban and spatial trends and conditions, and biodiversity. This helps to identify data sources and data gaps, avoid duplicating efforts, and ensures the use of the latest information. This Activity will build on those completed in Steps 1.2A and 1.2B, wherein a rapid analysis was undertaken to understand the city context. *The literature review should focus on the broad areas identified for the MVA, however it should not overlook larger regional or national data sources. The literature review should cover a broad range of sources, including but not limited to: government reports and plans, briefs and documents from aid agencies, project reports and assessments, research papers, and national archives. Use the table in the «Literature Review» sheet of this document to help organise available information.*		

No.	Inform	Complete (yes/no)	Notes / Information
3	**Refer to the *Data collection and analysis technical brief*** which contains all the information on the key and most relevant data, information and documentation to be used in the MVA.		
4	**Determine the temporal resolution** required for the assessment. This involves deciding on the time intervals for data collection and analysis. The MVA requires analysis of historic, current and future scenarios relating to the three key thematic vulnerability topics: climate change, urban and spatial, and biodiversity. Climate models and projections may be used to obtain future climate scenarios and socio-economic pathways. *The literature review should aim to consider current and historic information. During the literature review, keep track of the time periods that documents reference, and begin to build a timeline for the areas of interest. Temporal resolution of the assessment will be finalised as data is collected and the Delivery Team assesses what is available.*		
5	**Determine the spatial resolution** required for the assessment to confirm the level of detail needed in spatial data. As the MVA is typically conducted at city-level and community-level, data at these subnational levels is preferential. A Data Requirements Sheet provides guidance on the spatial resolutions for GIS data for each indicator and layer. *Similar to temporal resolution, the spatial resolution at which the MVA is conducted will ultimately depend on available data. Still, the literature review should investigate multiple data sources and scales. It may be worth conducting in-person interviews with various data-oriented agencies to understand the various GIS data they have and its applicability to the MVA.*		
6	**Consider data integration** and plan for the use and integration of different types of data, considering the interdisciplinary and multidisciplinary nature of the MVA. Ensure that data from various sources can be effectively combined for a holistic analysis of multilayered and interconnected vulnerabilities and risks. *Establish a preferred coordinate reference system and data formats. If data are not readily available in the preferred schemas, engage a software that is capable of performing the necessary conversions.* *Note that there are many free and open-source software available to support the MVA, and licenced software is not a necessary expenditure.*		
7	**Customize and tailor the data requirements** to the specific needs for the assessment. Consider the unique characteristics of the city or community, as well as the priorities of the study area, and adjust data identification and collection efforts accordingly.		
8	**Compile the Data Requirements Sheet** which summarizes the specific data needs and specifications for the MVA. *This is the Data Requirements Sheet. It is intended to be used as a guidance tool in combination with the Handbook and the Data Collection and Analysis Brief.*		

4B. Data Requirements Sheet template – literature and data review

	Document or Report Title	Report Type	Author or Custodian	Availability	Was there pre-existing data used in the genesis of this report or document?	Is this data potentially informative for the MVA?	Is that data in the possession of the Delivery Team?	Was there data created or procured in or for this report or document?	Is this data potentially informative for the MVA?	Is that data in the possession of the Delivery Team?	Comments / Additional Information
INSTRUCTION	In this field, enter the title of the report or document	In this field, indicate what kind of a report or document it is. Common types might include "Research Report," "Project Document," "Finance Report," or "External Audit."	In this field enter who is responsible for producing the report. This might include the person, group, or department who authored the report, the agency, group or department who commissioned the report, or the consultancy that put the report together.	In this field indicate where the report or document can be found and if there are any sharing or access restrictions to be mindful of. Include any relevant web links, internal storage locations, or DOI/ISSN/etc. information	In this field indicate if the report or document used any pre-existing data. Comment on the type of data used (i.e., old maps, GIS data from the national planning office). If known, also comment on data ownership and any use restrictions.	This field offers a drop-down yes or no option.	This field offers a drop-down yes or no option.	In this field indicate if any new data was created or procured to support this report/document or as an outcome of this report/document. Provide details on the type of data and comments on ownership and any use restrictions.	This field offers a drop-down yes or no option.	This field offers a drop-down yes or no option.	In this field provide any comments or additional information that is helpful to inform the data requirements
EXAMPLE	Nairobi Integrated Urban Development Master Plan (2014)	Planning and Policy Document	Nairobi City County (NCC Municipal Government) and Japan International Cooperation Agency (JICA)	Publicly available here	GIS data and maps from 2014 and earlier are used. Data is not open-source or available online. Data is owned by NCC and JICA.	Yes	No	Data was procured and developed by JICA and NCC.	Yes	No	It may be possible to formally request the GIS datasets used for this report (or any more recent and updated datasets) from JICA or NCC.

5. Data Inventory template

A data inventory is a systematic catalogue of an organization's data assets. It gives a complete picture of an organization's data resources, including information about how they are collected, stored, accessed, and used.

This data inventory is intended to support the Delivery Team organize their geospatial indicators for the MVA.

The data inventory is organised into three sheets, one for each of the three dimensions considered in the MVA (climate change, urban and biodiversity). As data is collected by the Delivery Team it should be documented into its appropriate dimension within the data inventory, and all details should be filled in. The data inventory should be shared in a communal and accessible location where all team members have access to up-to-date information.

In the columns below, the same headings used in the data inventory are replicated, and a description of the information that should be included in each heading is provided. Within the sheets marked "Climate Change", "Urban", and "Biodiversity", a sample dataset has been included as guidance. Note that this document is a guideline and teams are welcome to make changes to adapt the document to their needs.

File Path: *Storage location of the dataset.*

File Extension: *The three- or four-letter code appearing at the end of a file name and indicating what type of file it is.*

File Name: *The name that appears in the folder structure.*

Data Description: *A brief summary of the data within the dataset and how it is organised.*

Dataset Name: *The internal name of a GIS dataset. Note this may not be present.*

Data Source: *A brief description of where the data informing the dataset originated from. This might include "digitised from a map," "field data collection," "*

Date of Creation: *When the dataset was created.*

Date of Last Update: *When the dataset was last updated.*

Extent: *A brief overview of the spatial extent of the dataset.*

Data Owner or Steward: *The person or agency responsible for creating, commissioning, or curating the dataset.*

Data Custodian: *Person within the Delivery Team with responsibility over the dataset for the duration of the project.*

Restrictions for Use: *Any restrictions for use of the dataset as outlined by the owner or steward in the data collection process.*

Metadata: *An indication of the presence and status of metadata within the geospatial dataset.*

Supporting Documents: *An indication of the presence and location of any documents that support the information contained within the dataset.*

QA/QC: *An indication of the status of QA/QC and data cleaning executed on the dataset.*

	Location		Details				Resolution			Responsibility			Status		
	File path	File Extension	File Name	Dataset Description	Dataset Name	Data Source	Date of Creation	Date of Last Update	Extent	Data Owner or Steward	Data Custodian	Restrictions for Use	Metadata	Supporting Documents	QA/QC
Climate change	~Library/ CloudStorage/ OneDrive - UN Habitat/RISE UP/Phase I/ Data	.shp	AB_AvgTemp	Average daily temperatures, calculated at each of the country›s 13 AWS›. Averages taken over 30 year record from 1980 to 2010. Point data.	Average Daily Temperatures	Observational Data	2012	--	Country Wide	National Meteorological Service	JJ	None	None	None	Not started
	~Library/ CloudStorage/ OneDrive - UN Habitat/RISE UP/Phase I/ Data	.shp	2012_stats_la-bor_FS_final_v2	Results of 2012 labour force survey completed in Capital city. Polygon dataset of districts making up the city. Includes employment status by age and gender.	2012 Labour Force Survey	Field Data Collection (National Statistics Office)	2013	--	Capital city borders only	National Statistics Office	JJ	Yes. Do not share beyond project. See Data Sharing Agreement.	Incomplete	Yes, see report on National Statistics website.	In progress
	~Library/ CloudStorage/ OneDrive - UN Habitat/RISE UP/Phase I/ Data	.img	AB_ProtectedAreas	Grid representation of protected areas, used to calculate connectivity. Raster Data, 2km grid	Protected Area Connectivity	Digitized from National Parks Act 2007 update	2010	2020	Country wide	Environment Division	JJ	Yes. Do not share beyond project. See MOU.	Yes	None	Completed 01/06 by JJ.
Urban	~Library/ CloudStorage/ OneDrive - UN Habitat/RISE UP/Phase I/ Data	.shp	2012_stats_la-bor_FS_final_v2	Results of 2012 labour force survey completed in Capital city. Polygon dataset of districts making up the city. Includes employment status by age and gender.	2012 Labour Force Survey	Field Data Collection (National Statistics Office)	2013	--	Capital city borders only	National Statistics Office	Janeil	Yes. Do not share beyond project. See Data Sharing Agreement.	Incomplete	Yes, see report on website.	Completed
Biodiversity	~Library/ CloudStorage/ OneDrive - UN Habitat/RISE UP/Phase I/ Data	.img	AB_ProtectedAreas	Grid representation of protected areas, used to calculate connectivity. Raster Data, 2km grid	Protected Area Connectivity	Digitized from National Parks Act 2007 update	2010	2020	Country wide	Environment Division	Janeil	Yes. Do not share beyond project. See MOU.	No	None	Completed 01/06 by JJ.

6. Data Collection Plan template

Guidance Notes: Please delete and fill in any text which is written in *Orange Italics*

Data Acquisition and Collection Plan

Objectives

Provide 1-2 objectives of the data collection plan, for example:

To develop a methodology and plan for data collection in *XXX* as part of the Multi-layered Vulnerability Assessment.

Outputs

Provide a list of expected outputs of the data collection plan.

1. *E.g. collection of relevant MVA data for selected assessment areas – e.g. 3 urban poor and vulnerable communities*
2. *E.g. GIS or qualitative data collected for 3-6 key indicators for each of the three key dimensions (climate change, urbanization and biodiversity)*
3. *Add more outputs as required*

Background

Provide a short paragraph or two on what steps have been undertaken so far, the background of your project and the context, as well as the purpose of the plan.

Data collection approach

Outline the methodology of your data collection process for the MVA, the points below are some examples of data collection approaches. Please elaborate, edit or delete as required for your data collection plan. When adding points try to ensure a concise but useful amount of information is shared, usually around one or two sentences for each.

1. *E.g. Selection of spatial areas in the city/ community for assessment – i.e. what criteria was used to determine the geographic scope?*
2. *E.g. Selection of 3-6 indicators for the dimensions of climate change, urban and biodiversity – what indicators were selected and why?*
3. *E.g. Selection of Data Collection Instruments – why were certain data collection methods (e.g. surveys or community mapping) selected?*
4. *Add more steps as required*

Data requirements

Insert each of your predicted requirements for data, with a one-sentence justification. Information to help complete this section can be found in Step 1 of the Handbook. Data requirements established in Step 2.1 – Activity A will also help to complete your data requirements.

DATA REQUIREMENT	JUSTIFICATION FOR REQUIREMENT
Data requirement one …	*Reason for requirement of this data type*
Add more rows as required	

Data inventory

Complete the table below with the type of data you expect to access, alongside some additional information on it. This will be expanded in the more detailed 'Inventory of Data' Excel document in Step 2.1 Activity B.

DATA SET	DATA TYPE	DATA SOURCE	DATA FORMAT	DATA OWNER	UPDATE FREQUENCY
E.G.SOUTHWARK_ URB_ DEN_ MAP_2	*e.g. Urban density map*	*e.g. Local Government office*	*e.g. .GPKG file*	*e.g. Public access digital file found on www. ...*	*e.g. 2 years old, next survey expected next year*
Add more rows as required					

Data collection

Complete the table below with the data collection methods that you are using in your data collection. These should be practical and feasible within the city context. The list of data collection methods can be updated through the project.

DATA COLLECTION METHODS	DESCRIPTION OF THE COLLECTION METHOD
ENTER TITLE OF DATA COLLECTION METHOD	**Provide more information on the method. Including information on stakeholder engagement.**
e.g. local survey	
e.g. questionnaires	
add more rows as required	

Workplan and timeline

Create a workplan with specific timelines for your data collection. An example is provided below. Refer to your data collection approach and methodology for additional tasks. Edit all aspects of the table to fit your data collection plan.

Task	January				February			
	1	2	3	4	1	2	3	4
Enter the steps of your data collection plan	Highlight the cell Blue for when it is set to be completed (as shown below)							
1. E.g. Assemble data collection team								
2. E.g. Identify suitable spatial areas for assessment								
3. E.g. Collect open-source GIS datasets								
4. E.g. Design survey questionnaire								
5. E.g. Mobilize data collectors/enumerators								
Add more rows as required								

Communities of Chacha, a flood prone area within Debre Birhan, Ethiopia, 2024

Other considerations

This section should include a list of any limitations of the plan or any considerations which should be highlighted. Some examples can be found below. The list should be expanded and adapted to the context.

- *E.g. The Data Collection Plan may need to be updated during the MVA process to reflect new data sets or types, or to reflect any new knowledge or information.*
- *E.g. Quality assurance such as accuracy, reliability and validity need to be considered during data collection and analysis to ensure data is suitable for the MVA.*
- *E.g. Logistical arrangements and costs associated with data collection activities.*
- *E.g. Any foreseen risks or barriers to data collection and any mitigation strategies.*
- *Add more considerations as required*

7. Multilayered Vulnerability Profile template

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Multilayered Vulnerability Hotspots **00**

Introduction

Background and context

Climate change, urbanization and biodiversity

Introduction to Climate Change, Urbanization and Biodiversity and interdependencies and connections.

Assessing multilayered vulnerabilities in cities and urban areas

Introduction to assessing Multilayered Vulnerabilities.

Multilayered vulnerability assessment tool

Introduction to the MVA Tool and purpose.

Climate change, urbanization and biodiversity in [Location, Country]

Introduction to location context in relation to climate change, urbanization and biodiversity.

Context analysis

Summary of city context analysis here. Please note that the following headings are suggestions of the pertinent topics to include in this section. They can be changed/updated as needed.

Location and geography

Subtitle

History of city development and growth

Subtitle

Demographics

Subtitle

Key economic sectors

Subtitle

Environment, biodiversity and climate

Subtitle

Urbanization trends

Subtitle

Physical and social infrastructure assets

Subtitle

Institutional and policy frameworks

Subtitle

Methodology

Approach and methodology

Standard approach and methodology. Provide any commentary on how the methodology was adapted for your assessment.

Geographic scope

Provide a description of the geographic scope of the assessment and why this area was selected. Suggested to provide a base GIS map highlighting any key infrastructure that influenced the selection of assessment area.

Vulnerability dimensions

Urban dimension

Insert urban vulnerability hotspot map

Provide an introduction to this dimension. Consider including a brief summary of relevant laws, regulations, or policy that contribute to this dimension and any significant successes or challenges that have been realized.

Indicators

Indicator 1….

Provide a narrative for the first indicator selected for the urban dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail.

Indicator 2….

Provide a narrative for the first indicator selected for the urban dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail. [Copy this format for all indicators used within the urban dimension.]

Urban dimension analysis

Provide an analysis of the findings within the urban dimension. Focus on a targeted and concise assessment of how the elements contribute to vulnerability hotspots shown in the map. Where possible, reflect on the changes through historic, current and future for this dimension. Some questions to consider while assessing vulnerabilities include: In the hotspot map, and within the indicators are there consistent or repeated characteristics in the areas that have identified high vulnerability? Across the maps, are there areas that consistently show high vulnerability? What is their relationship to the 3 components of vulnerability, namely exposure, sensitivity, and adaptive capacity? Can these three components be mapped or identified, independent of the dimension being assessed?

Urban future vulnerabilities

In at least ½ page comment on future vulnerability trends in urbanization, how these may change in the coming years, specifically reflecting on vulnerability hotspots identified in the urban dimension and whether these are expected to become more/ less vulnerable. Draw on additional resources as needed.

Climate change dimension

Insert climate change vulnerability hotspot map

Provide an introduction to this dimension. Consider including a brief summary of relevant laws, regulations, or policy that contribute to this dimension and any significant successes or challenges that have been realized.

Indicators

Indicator 1....

Provide a narrative for the first indicator selected for the climate change dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail.

Indicator 2....

Provide a narrative for the first indicator selected for the climate change dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail. [Copy this format for all indicators used within the urban dimension.]

Climate change dimension analysis

Provide an analysis of the findings within the climate change dimension. Focus on a targeted and concise assessment of how the elements contribute to vulnerability hotspots shown in the map. Where possible, reflect on the changes through historic, current and future for this dimension. Some questions to consider while assessing vulnerabilities include: In the hotspot map, and within the indicators are there consistent or repeated characteristics in the areas that have identified high vulnerability? Across the maps, are there areas that consistently show high vulnerability? What is their relationship to the 3 components of vulnerability, namely exposure, sensitivity, and adaptive capacity? Can these three components be mapped or identified, independent of the dimension being assessed?

Climate change future vulnerabilities

In at least ½ page comment on future vulnerability trends in climate change, how these may change in the coming years, specifically reflecting on vulnerability hotspots identified in the climate change dimension and whether these are expected to become more/ less vulnerable. Draw on additional resources as needed, in particular, IPCC reports and The World Bank Climate Knowledge Portal.

Biodiversity dimension

Insert biodiversity vulnerability hotspot map

Provide an introduction to this dimension, Consider including a brief summary of relevant laws, regulations, or policy that contribute to this dimension and any significant successes or challenges that have been realized.

Indicators

Indicator 1....

Provide a narrative for the first indicator selected for the biodiversity dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail.

Indicator 2....

Provide a narrative for the first indicator selected for the biodiversity dimension including i) Why the indicator was selected, ii) Any limitations to the indicator, changes or proxy data that were used to assemble the indicator. Provide comments to set up the analysis but avoid analyzing each indicator map in detail. [Copy this format for all indicators used within the urban dimension.

Biodiversity Dimension Analysis

Provide an analysis of the findings within the biodiversity dimension. Focus on a targeted and concise assessment of how the elements contribute to vulnerability hotspots shown in the map. Where possible, reflect on the changes through historic, current and future for this dimension. Some questions to consider while assessing vulnerabilities include: In the hotspot map, and within the indicators are there consistent or repeated characteristics in the areas that have identified high vulnerability? Across the maps, are there areas that consistently show high vulnerability? What is their relationship to the 3 components of vulnerability, namely exposure, sensitivity, and adaptive capacity? Can these three components be mapped or identified, independent of the dimension being assessed?

Biodiversity Future Vulnerabilities

In at least ½ a page comment on future vulnerability trends in biodiversity, how these may change in the coming years, specifically reflecting on vulnerability hotspots identified in the biodiversity dimension and whether these are expected to become more/ less vulnerable. Draw on additional resources as needed.

Overlapping vulnerabilities

Urban and climate change vulnerabilities

Insert urban vulnerability hotspot map

Provide an analysis of intersecting and interconnected vulnerabilities between urban and climate. Highlight key hotspots within the city and why these are occurring. Note any critical infrastructure or important land use areas with overlapping hotspots. Refer to the MVA data collection and analysis brief for examples of hotspots. E.g. population density, infrastructure intensity and heat stress or extreme weather events and vulnerable infrastructure.

Climate change and biodiversity vulnerabilities

Insert climate x biodiversity vulnerability hotspot map

Provide an analysis of intersecting and interconnected vulnerabilities between climate and biodiversity. Highlight key hotspots within the city and why these are occurring. Note any critical infrastructure or important land use areas with overlapping hotspots. Refer to the MVA data collection and analysis brief for examples of hotspots. E.g. Sea level rise and vulnerable coastal ecosystems, Extreme weather events and habitat degradation.

Biodiversity and urban vulnerabilities

Insert biodiversity x urban vulnerability hotspot map

Provide an analysis of intersecting and interconnected vulnerabilities between biodiversity and urban. Highlight key hotspots within the city and why these are occurring. Note any critical infrastructure or important land use areas with overlapping hotspots. Refer to the MVA data collection and analysis brief for examples of hotspots. E.g. Urban growth and habitat degradation and fragmentation, Urbanization and reduced ecosystem resilience

Multilayered vulnerability hotspots

Insert vulnerability hotspot map (overlay of 3 dimensions)

Provide an analysis of overlapping vulnerabilities between the three dimensions considered. Note and comment on the three contributions to vulnerability: exposure, sensitivity, adaptive capacity. Comment on how vulnerabilities in different areas (i.e., social, economic, physical, environmental) can compound and exacerbate each other. Discuss the importance of and any challenges in developments in governance and planning. Consider topics such as urban planning and design, governance and public services, economic development, social infrastructure, environmental development, social infrastructure and housing, and environmental sustainability.

Data collection and analysis technical brief

View of Ciudad Bolivar in south Bogota, Colombia, November 2021 © UN-Habitat_Hector Bayona

Overview

A practical, step-by-step practitioners' guide – ***Multilayered Vulnerability Assessments Handbook: Planning for urban, biodiversity and climate action*** – has been developed in order to assist UN-Habitat and partners in the implementation of the project. This ***Data collection and analysis technical brief*** is a supplementary material to the Handbook and should be used to help guide practitioners through the MVA process.

It should be used by the multidisciplinary MVA Delivery Teams. In particular, the geographic information systems (GIS), data management, climate change, biodiversity and urban resilience specialists in the team will utilize this Brief in their implementation of the key steps and activities relating to MVA data collection and analysis.

How to use the brief

The Brief should be used as a resource to support Delivery Team members in understanding and undertaking the MVA in selected cities in their countries. It outlines the methodology to be used, specifically relating to data collection for and geospatial analysis of multilayered vulnerabilities across urban, climate change and biodiversity dimensions in cities and vulnerable urban poor communities.

Structure

The first section provides an introduction to multilayered vulnerabilities in cities and describes the MVA approach and methodology, including details on the MVA layers and indicators, vulnerability intersections and interconnectedness and hotspots concepts, and vulnerability profiles.

The second section provides an overview of the MVA data collection and analysis process, steps and activities. It lays out the data requirements for the three layers and their corresponding indicators, and presents the data collection methods to be deployed. It also includes GIS indicator factsheets which can be used to better understand the data requirements for the project.

The third section provides information on the data analysis and interpretation tasks to be undertaken in the MVA. This includes technical information, geospatial analysis methods and the methods for interpreting and reporting the analysis.

Aerial view of people of Saaba, Burkina Faso during the visit of UN-Habitat Executive Director © UN-Habitat_Jonas Yameogo

Considerations

The brief focuses on the quantitative data collection and analysis component of the MVA methodology. It does not provide detailed guidance on the qualitative data collection and analysis methods (i.e. stakeholder engagement activities to validate, ground-truth and strengthen data collection and analysis) that will support the Mapping and analysis. This is elaborated in the Handbook.

The Multilayered Vulnerability Assessment tool

The MVA Mapping and analysis methodology has been designed to be replicable, usable, and adaptable to different users and contexts. It can be implemented with open-source, global datasets and free-to-use GIS software (such as QGIS) which allows for (i) increased access to wider audience of users; (ii) zero to minimal cost implications or burden to users; (iii) highly collaborative assessments engaging wide range of stakeholders; (iv) strong interoperability and compatibility of data and information; (v) customization and integration with other databases, software and tools; and (vi) enhanced reproducibility and scalability.

An informal settlement on the Picacho hill in Medellin, Colombia. 2012 © UN-Habitat_A.Padrós

MVA Layers

Climate risk, biodiversity loss, and rapid urbanization are intrinsically linked. However, in both policy and praxis, the integrated analysis of the interrelations of these challenges is limited. There is a lack of evidenced approaches to mapping multidimensional, multilevel and multi-scalar vulnerabilities relating to climate change, urbanization and biodiversity. The MVA methodology addresses this gap by utilizing an innovative approach to geospatial analysis of multilayered vulnerabilities in cities and communities.

The MVA focuses on mapping and analysis of three key layers or dimensions:

- **Climate change:** The extent, occurrence, frequency and severity of climate change hazards that can adversely impact society, infrastructure and the environment
- **Urban:** Urban, spatial and socioeconomic trends, conditions and challenges that make communities and cities more susceptible to the adverse impacts of climate change and development pressures
- Biodiversity: The abundance and conditions of ecosystems and habitats, richness and intactness of different species, and the threats to these

Each layer and its corresponding indicators are described in detail in the following sections. The MVA methodology requires that input data are raster data, and comments are provided oh how best to achieve this.

Base layers

For the MVA mapping process, a base layer – the foundational layer of geographic data that serves as the background onto which other thematic layers are overlaid – is loaded into GIS software, such as QGIS. The base layer provides essential context and spatial reference for the MVA layers and indicators being mapped and analyzed. It forms the backdrop against which other geographic features, such as roads, land use, building footprints, demographics, or environmental data, can be visualized and analyzed.

Some organizations may prefer to utilize their own aerial photographs or topographical data as base layers. For others, GIS data for the base layer is available in standardized formats (such as shapefiles or GeoTIFFs) from different sources (such as Google Maps, OpenStreetMaps, ArGIS) and is easily integrated into GIS software for visualization, interpretation and analysis. The base layer components recommended for use in the MVA mapping process are shown in the table below.

Table 1. Base layers for the MVA

Base Layer	Details
Data requirement on	Aerial imagery, satellite imagery, LiDAR data, or other representatives that provide a high-resolution, temporally relevant, image representation of the Earth's surface
Terrain	Elevation data that represents the topography of the land, including hills, valleys, and slopes
Land Cover	Data that represents different types of land cover, such as forests, grasslands, parks, greenspaces urban areas, water bodies, and agricultural fields
Hydrography	Data on rivers, lakes, streams, and other water features, including watersheds delineation, natural and man-made water bodies, water bodies' boundaries and flow direction
Transportation networks	Data represent transportation networks providing essential information about major and minor roads, streets, highways, railways, airports, and other transportation infrastructure within an area
Building footprint	Data that represents the outlines or footprints of buildings within a specific geographic area. It provides spatial information about the location, size, shape, and footprint of individual buildings
Critical infrastructure	Data that represents spatial information about essential physical assets, systems, and facilities that are vital for the functioning of a city including transportation, energy, telecommunications, water and wastewater systems, healthcare, education, social infrastructure, emergency services, and government facilities
Administrative boundaries	Data that represents administrative boundaries such as country borders, state or province boundaries, municipal boundaries, and electoral districts

FIGURE 6 **Example satellite imagery base layer map from Honiara, Solomon Islands**
Source: UN-Habitat. 2023.

Urban dimension

FIGURE 7 **The vast urban expanse of metropolitan Mexico City at sunset**
Source: Lee Michael Lambert, 2024.

Urban related vulnerabilities in the MVA refer to the trends, characteristics and conditions of urban environments that increase susceptibility to the adverse impacts of climate change. These vulnerabilities manifest in various ways and affect different components of urban systems, infrastructure, services, and populations, particularly vulnerable and marginalized groups such as those living in informal settlements and the urban poor.

For the ***Urban dimension*** of the MVA, a number of primary indicators should be considered. GIS data pertaining to each indicator can be observed and assessed in order to better understand overall urban ***vulnerability*** of a particular city or community. By examining each of these indicators and the aggregation of them through geospatial analysis, a summary of urban vulnerability will be produced. The primary indicators included in the urban dimension of MVA and the vulnerability rationale is Table 3.

Table 2. List of urban dimension indicators

Indicator	Vulnerability rationale
Population and population density	Rapid population growth and high population density can amplify the vulnerability of cities and communities to the adverse impacts of climate change. Densely populated areas face challenges such as increased exposure to extreme weather events, stressed infrastructure systems, limited green spaces, poor air quality, heightened heat stress, concentration of marginalized communities, and resource competition for basic services. Population datasets are commonly found as raster data where each grid cell represents a count for that area, or as polygon datasets with values assigned for a defined area. To convert the polygon to raster data, use a cell centre assignment type.
Urbanization and urban growth	Urbanization, spatial expansion of cities and concentration of built-up infrastructure can exacerbate vulnerability. Rapid and extensive urbanization and growth can increase exposure to natural hazards, cause the loss and fragmentation of natural ecosystems and biodiversity, and reduce the capacity infrastructure systems to accommodate the growing populations and withstand impacts of increasing climate change hazards.

Indicator	Vulnerability rationale
Land use	Different land uses, patterns and management practices in cities influence the vulnerability of infrastructure, environment and communities to adverse climate impacts. Different land uses are associated with varying levels of exposure to climate-related hazards and land use patterns often intersect with social vulnerabilities and vulnerable infrastructure systems. Land use also affects the provision of ecosystem services and biodiversity, which play critical roles in climate resilience. Rasterize polygon datasets using a cell-centre assignment type. To use land use datasets in the MVA their values need to be reassigned as numerical representation. Since 0 in the MVA represents no vulnerability and 1 represents vulnerability, the values should be reassigned with 0 representing areas of natural vegetation, 0.3 representing agricultural areas, 0.5 representing residential areas, 0.7 representing industrial areas and 1 representing urban centres.
Socioeconomic vulnerability	Socioeconomic vulnerability is the susceptibility of communities or populations to the adverse impacts of climate change based on their social and economic characteristics. Socioeconomic vulnerability is determined by the income levels, poverty rates, employment levels, education levels, access to healthcare, race/ethnicity, age, disability, and housing tenure of certain populations.
Access to services	Access to basic urban services influences a community›s ability to prepare for, respond to, and recover from climate-related hazards, shocks and stresses. Vulnerability can be increased if communities have limited access to services such as water and sanitation, telecommunications, energy, transportation, healthcare, education, social, cultural, and emergency services.
Informal settlements	The geographical location, scale, demographics, physical conditions, and social and economic dynamics of informal settlements can exacerbate vulnerability to climate change impacts. People living in informal settlements typically have limited access to services, resources and infrastructure, no formal land tenure security, suffer increased levels of deprivation and poverty, rely on informal economies and livelihoods. Informal settlements are also often located in the most environmentally precarious areas within cities.
Building and infrastructure typologies and conditions	Building and infrastructure typologies and conditions can correlate with increased climate vulnerability. Physically vulnerable infrastructure, such as poorly constructed buildings, aging and inadequate, urban infrastructure and informal settlements, are prone to damage or failure during extreme weather events, leading to disruptions in essential services, economic losses, and risks to public safety. The size, height, design, structural features and construction materials of building and infrastructure can also increase vulnerability
Environmental quality	Environmental contaminants refer to substances in the environment that can pose harm to human health. Contaminants can enter the environment from point sources like industrial and commercial facilities, oil and chemical spills, and non-point sources like wastewater treatment and parking lots. Urban areas are at a heightened risk due to the concentration of human activities and the potential for exposure. There are many ways this indicator can be represented, including as point data representing point source pollutants, or points, lines or polygons representing area of impact.
Urban heat islands	Densely populated areas tend to experience higher temperatures than surrounding rural areas due to the urban heat island effect. Heat-trapping surfaces such as asphalt, concrete and buildings absorb and retain heat, leading to elevated temperatures and increased energy demand for cooling. Heat-related illnesses and heat stress can disproportionately affect vulnerable populations.

Understanding these urban characteristics and factors how they interact to contribute to the vulnerability of a city or community is crucial for developing effective climate adaptation strategies and policies. By identifying and addressing these vulnerabilities, cities can enhance their resilience and better prepare for the challenges posed by climate change.

Climate change dimension

FIGURE 8 **Flood-prone informal settlements in Nairobi, Kenya**
Source: © UN-Habitat_Julius Mwelu, 2024

Climate change related vulnerabilities in the MVA involve identifying the specific risks and susceptibilities that different hazards, shocks and stresses pose to a particular region, system or population. These are events or phenomena with the potential to cause harm or damage, and climate change can amplify their frequency and intensity.

For the ***climate change dimension*** of the MVA, a number of primary indicators should be considered. GIS data pertaining to each indicator can be observed and assessed in order to better understand overall ***climate vulnerability*** of a particular city or community. By examining each of these indicators and the aggregation of them through geospatial analysis, a summary of climate vulnerabilities will be produced. The primary indicators included in the climate change dimension of MVA and the vulnerability rationale is Table 4.

Table 3. List of climate change dimension indicators

Indicator	Vulnerability rationale
Temperature rise	Rising temperatures can affect precipitation patterns and evaporation and impact water resource availability and quality, increase incidence of heatwaves which endanger human health and wellbeing, disrupt ecosystems and alter biodiversity patterns, and cause heat stress and heat-related damage to critical infrastructure.
Sea level rise	Sea level rise can pose significant risks to coastal communities, such as increased coastal flooding, exacerbated impacts of extreme weather events such as hurricanes, typhoons, and coastal storms, erosion loss, fragmentation, and degradation of coastal habitats damage and disruption of coastal infrastructure and services, and compromised water quality and availability.

Indicator	Vulnerability rationale
Fluvial or riverine flooding	Fluvial flooding has a widespread reach and unpredictable nature. With the potential to inundate vast areas, cause loss of life and injury, disrupt and damage property, infrastructure systems, urban services and economies, displace people, and damage agricultural land, it poses significant risks to communities living near rivers.
Coastal flooding	With rising sea levels, storm surges, and erosion, coastal areas face increasing exposure to inundation, threatening lives, infrastructure, and livelihoods. Assessing vulnerability to coastal flooding in cities is crucial for identifying communities and ecosystems at risk, allowing for targeted strategies like infrastructure investments, evacuation plans, and ecosystem restoration.
Drought	Droughts pose a major threat due to their far-reaching and compounding impacts. Water scarcity caused by droughts affects not only access to drinking water supply and security, but also public health, agriculture, food security, ecosystems, economic activity, and resilience. Assessing vulnerability helps identify regions and communities most at risk, considering factors like dependence on rain-fed agriculture, limited water storage, and poverty levels.
Extreme heat	Urban residents and vulnerable populations, such as children, the elderly and persons with disabilities, people living in inadequate housing, and informal settlement dwellers, may face increased health risks such as exhaustion, heatstroke, and dehydration due to more frequent and intense heatwaves. Urban infrastructure can be vulnerable to stress caused by heatwaves due energy demands, leading to disruptions in services such as electricity, transportation, and water supply, which will in turn make communities more vulnerable.
Landslides	Landslides pose significant risks to public safety, as they can cause injury, loss of life, and property damage. They also can damage critical infrastructure such as roads, bridges, utilities, and buildings, disrupting transportation networks, water supply systems, and energy distribution networks. Landslides disproportionately affect disadvantaged populations such as low-income communities and people living in informal settlements, compounding their existing vulnerabilities.
Storm surge and tropical cyclones	Coastal areas are vulnerable to increased frequency and intensity of tropical storms and hurricanes, leading to storm surges. Storm surges are a leading cause of coastal flooding during hurricanes, tropical cyclones, and severe storms, and leads to the damage and disruption of critical infrastructure, poses threats to public health and safety, and causes habitat destruction, coastal erosion, and contamination of water bodies.
Coastal erosion	Coastal erosion can threaten critical infrastructure such as roads, bridges, ports, utilities, housing, and buildings located in coastal areas and have significant environmental consequences, including habitat loss, shoreline retreat, and sedimentation of water bodies. Communities living in coastal areas have increased vulnerabilities due to coastal erosion which poses risks to public safety and health, including injury, loss of life, and displacement of residents, and can threaten local livelihoods and food security.

Note that not all climate change indicators are relevant or applicable to all cities or communities. The above list is a selection of the more prevalent climate change-related hazards, shocks and stresses that can influence the overall vulnerability of a city's people, infrastructure and environment. It is not an exhaustive list and other indicators that are specific to a city's context can be considered when undertaking the MVA.

Understanding climate change vulnerabilities is essential for developing effective climate adaptation and urban resilience strategies. The thorough assessment of these aspects helps communities, governments, and development organizations identify priority areas for action to enhance resilience and reduce the potential impacts of climate change hazards.

Biodiversity dimension

FIGURE 9 **An aerial view of Mombasa's green and blue landscape, Kenya**
Source: © UN-Habitat_Blue Economy, 2018

Biodiversity related vulnerabilities the MVA refer to the susceptibilities of ecosystems, plant and animal species, and overall biodiversity to the impacts of climate change, urbanization and other development pressures. Climate change can alter temperature and precipitation patterns, disrupt habitats, and contribute to extreme weather events, affecting biodiversity on various scales. Urbanization causes habitat loss and fragmentation, altering land use patterns, contributing to pollution, exacerbating climate change impacts, and increases human-wildlife conflicts.

For the ***biodiversity dimension*** of the MVA, a number of primary indicators should be considered. GIS data pertaining to each indicator can be observed and assessed in order to better understand overall ***biodiversity vulnerability*** of a particular city or community. By examining each of these indicators and the aggregation of them through geospatial analysis, a summary of climate vulnerabilities will be produced. The primary indicators included in the biodiversity dimension of MVA and the vulnerability rationale is Table 5.

Table 4. List of biodiversity dimension indicators

Indicator	Vulnerability rationale
Mean species abundance	Mean species abundance serves as an indicator of the overall health, richness and integrity of biodiversity and ecosystems within and around urban areas. Hotspots of high biodiversity value within urban areas, such as green spaces, parks, and natural reserves, provide habitat for diverse plant and animal species and various ecosystem services for cities. However, they are largely vulnerable to climate change impacts, habitat disruption and loss, urban growth, infrastructure development, land use changes, hunting and illegal wildlife trade, and other development pressures.
Protected / conservation areas	The location, characteristics and conditions of protected and conservation areas within or near cities can influence vulnerability to climate change impacts and urbanization. Protected and conservation areas often encompass diverse ecosystems, including forests, wetlands, grasslands, and coastal habitats, which provide essential ecosystem services that enhance climate resilience. They serve as natural infrastructure for climate adaptation in cities, providing essential services such as flood protection, water purification, and erosion control.

Indicator	Vulnerability rationale
Biodiversity connectivity	Biodiversity connectivity is the degree to which habitats and landscapes allow for the movement of species and the flow of ecological processes across different areas. In and around cities the physical, structural and functional connectivity of biodiversity is enabled through green spaces and green-blue corridors, and supports healthy ecosystems, supporting species survival and resilience, and promoting sustainable land management practices that benefit both people and nature. Biodiversity connectivity is vulnerable to including habitat loss and fragmentation, land use change, urbanization, infrastructure development, and climate change.
Native vegetation	Native vegetation places a crucial role in provided ecosystem services such as carbon sequestration, soil stabilization, water infiltration and flood control. Native vegetation contributes to ecosystem resilience, offsets greenhouse gas emissions, reduces runoff, and contributes to food security.
Ratio of native species to invasive non-native species	Invasive non-native species can have significant negative impacts on ecosystems, biodiversity, and even human health and the economy. Invasive species often have competitive advantages over native species such as rapid reproduction or a lack of natural predators. Their presence can displace native species, alter ecosystem dynamics, impact agriculture and forestry, and spread disease.

Understanding biodiversity vulnerabilities through the MVA helps cities to integrate ecological and nature-positive considerations into climate adaptation and strategies, enhance the resilience of urban ecosystems and communities, and promote sustainable development that benefits both people and nature in urban landscapes.

Mathare community, new playground and public space for children and the community, June 2019, © UN-Habitat_Kirsten Milhahn

Vulnerability intersections and interconnectedness

An estimate 1.6 billion people live in regions that are in the highest categories of socio-economic and climate vulnerability, where populations are predicted to double by 2050. Vulnerability intersections and interconnectedness in the MVA refers to locations in which certain vulnerabilities across the three dimensions (urban, climate change, biodiversity) intersect or overlap. These are specific areas in which the populace, infrastructure and environment face high exposure, sensitivity and vulnerability to various interconnected impacts and challenges related to climate change, urbanization and biodiversity loss.

The MVA geospatial analysis explores and appraises overlaps and interrelations between a combination of two of the dimensions. This means intersecting and interconnected vulnerabilities between:

- Urban and climate change vulnerabilities
- Climate change and biodiversity vulnerabilities
- Biodiversity and urban vulnerabilities

There are various potential overlaps across the combination of dimensions, reflecting the diverse and unique contexts and local climatic, ecological, spatial, urban, social, and economic characteristics and dynamics in cities. Some examples of potential overlaps and interrelations between each combination of the dimensions are shown in the table below.

Table 5. List of biodiversity dimension indicators

Dimensions	Overlaps	Vulnerabilities
Urban x climate change	Population and infrastructure density and heat stress	High density urban areas experience higher temperatures compared to surrounding rural areas due to the urban heat island effect, exacerbated by factors like concrete surfaces, lack of green spaces, and heat generated by buildings and vehicles. Climate change intensifies heat events, increasing health risks for urban populations, particularly vulnerable groups such as the elderly and low-income residents.
	Extreme weather events and vulnerable infrastructure	Urban areas are increasingly vulnerable to extreme weather events such as storms, hurricanes, and heavy rainfall, which are becoming more frequent and intense due to climate change. Urban infrastructure, including transportation networks, drainage systems, energy systems, and building may not be adequately designed to withstand these events, leading to flooding, property damage, and disruptions to essential services.
	Informal settlements and flood risk	Informal settlements are often located in hazardous locations, such as low-lying areas, floodplains, or coastal zones that are prone to flooding. Communities in these areas are highly vulnerable to the adverse impacts of coastal or fluvial flooding due to overcrowding, unsafe housing conditions, lack of proper sanitation, improper sewage and drainage systems, and limited access to essential clean water, healthcare, and emergency response services.
Climate change x biodiversity	Sea level rise and vulnerable coastal ecosystems	Rising sea levels threaten coastal ecosystems such as mangroves, salt marshes, and coral reefs, which provide critical habitat for numerous species. Coastal habitats are particularly vulnerable to inundation, erosion, and saltwater intrusion, leading to habitat loss, altered nutrient dynamics, and changes in species composition. Sea-level rise can also exacerbate coastal flooding and erosion, threatening coastal communities and infrastructure.
	Biodiversity loss and reduced climate resilience	Climate-induced biodiversity loss diminishes the capacity of ecosystems to provide vital services essential for human well-being, such as clean air, fresh water, food security, and climate regulation. Degradation of ecosystems and loss of biodiversity reduce the resilience of natural systems, increasing societal vulnerability to climate impacts.
	Extreme weather events and habitat degradation	Increased frequency and intensity of extreme weather events such as hurricanes, cyclones, floods, and wildfires can cause direct mortality, habitat destruction, and population declines for many species. Extreme weather events can also lead to secondary impacts such as soil erosion, habitat fragmentation, and changes in vegetation structure, further affecting biodiversity.

Dimensions	Overlaps	Vulnerabilities
Biodiversity x urban	Urban growth and habitat degradation and fragmentation	Population growth, rural-to-urban migration, informal settlement proliferation and the expansion of cities often involves the conversion of natural habitats such as forests, wetlands, and grasslands into built-up areas, roads, and infrastructure. This direct loss and fragmentation of habitat reduces the availability of suitable habitats for native species, disrupting migration corridors, and isolating populations, which can lead to genetic isolation and reduced species diversity.
	Urbanization and reduced ecosystem resilience	Urbanization alters the provision of ecosystem services such as carbon sequestration, water purification, and climate regulation, which are essential for maintaining biodiversity and supporting human well-being. The loss or degradation of these services in urban areas can compromise ecosystem resilience and increase communities' vulnerability to environmental stressors.
	Land use changes and biodiversity loss	Urban development alters land use patterns, leading to changes in vegetation cover, soil composition, and hydrological cycles. The conversion of natural habitats into agricultural land, urban areas, and industrial zones can lead to habitat degradation, soil erosion, and loss of biodiversity, particularly in ecologically sensitive areas such as tropical rainforests, wetlands, and coastal ecosystems.

Locating where multilayered vulnerabilities intersect and overlap, and understanding how these vulnerabilities can affect the communities, infrastructure and environments in which they are located, is critical to identifying and prioritizing resilience building interventions. These hotspots of vulnerability are where the most urgent attention is needed. Addressing overlapping spatial vulnerabilities requires integrated approaches that combine climate adaptation strategies with sustainable urban planning and biodiversity conservation.

Vulnerability hotspots

Vulnerability refers to the degree to which a system, population, or environment is susceptible to harm or adverse impacts. Vulnerability is heightened when the system, population, or environment is unable to cope, adapt, or recover from the stressors or hazard. In the context of the MVA, urban vulnerability hotspots are defined are geographical areas within or near cities and urban areas that exhibit:

- Growing urbanization, population density and growth, and development pressures;
- Heightened exposure and susceptibility to the adverse impacts of climate change;
- Concentration of socioeconomic deprivation and prevalence of marginalized communities and informality; and
- Increasing biodiversity degradation and habitat loss.

The people, infrastructure and environments located within these hotspots face multiple, compounding social, economic, environmental and infrastructural factors that make them highly vulnerable. Some examples factors contributing to vulnerability hotspots in cities are listed in the table below.

Table 6. Potential vulnerability hotspots in cities and communities

Hotspot location	Vulnerability description
Low-income neighbourhoods	Residents in economically disadvantaged areas may lack resources to cope with extreme weather events, heatwaves, or flooding, leading to increased health risks and social vulnerabilities.
Coastal zones	Urban areas along coastlines are vulnerable to sea-level rise, storm surges, and saltwater intrusion, posing threats to infrastructure, housing, and transportation systems.
High-population density areas	Dense urban centres with large populations are more vulnerable to the cascading effects of climate impacts, including strain on emergency services, healthcare, and housing.
Informal settlements	Unplanned settlements or slums often lack proper infrastructure, sanitation, and drainage, making residents highly vulnerable to climate-induced disasters.
Flood-prone areas	Locations with inadequate drainage systems or situated in low-lying areas face an increased risk of flooding during heavy rainfall or storm events.
Aging infrastructure	Cities with outdated or poorly maintained infrastructure, such as water supply and sewage systems, are more susceptible to climate-related disruptions, posing risks to public health and safety.
Socially isolated communities	Neighbourhoods with limited social cohesion and community networks may struggle to effectively respond and recover from climate-related events.
Transportation hubs	Areas with critical transportation infrastructure, such as ports or airports, are vulnerable to disruptions from extreme weather events, impacting regional connectivity and trade.
Urban heat islands	Certain neighbourhoods with high-density construction, limited green spaces, and dark surfaces can experience elevated temperatures, contributing to heat-related health issues.
Water-Stressed Communities	Areas facing water scarcity exacerbated by changing precipitation patterns, droughts, and increased demand, affecting agriculture and freshwater supply.
Areas of high biodiversity	Areas with high species richness facing threats from habitat loss, changing ecosystems, and disruptions in migratory patterns due to climate change.
Urban agricultural Zones	Areas within or near cities with high agricultural productivity facing risks such as changing growing seasons, increased pests, and extreme weather events, threatening food security.

It is often the case that the vulnerability components listed in the above table are located in the same areas and their specific vulnerabilities then become layered and compounding, creating "hotspots". Vulnerability hotspots are considered to be the areas within cities that require urgent attention.

Through the MVA's layered approach to assessing interrelated and cascading vulnerabilities, maps are produced to show specific locations where all three of the MVA layers intersect, conflict and concentrate vulnerability to specific populations, infrastructure and ecosystems. An example of vulnerability hotspots across and between dimensions for Honiara, Solomon Islands, is shown in Table 6 below.

Table 7. Honiara vulnerability mapping and analysis

Hotspot location	Vulnerability description
Urban x climate change	- The population of Honiara is concentrated on the coastal plain and the majority of key infrastructure government facilities, commercial and industrial developments are located along the coast - Low-income communities and informal settlements, with poor housing conditions and limited access to basic services and infrastructure, are located in areas at high risk to flooding, storm surges and tropical cyclones which are exacerbated by climate change - 80 per cent of the urban area is located on hills, which protects the majority of urban areas from the impact of fluvial (marine) flooding - Most coastal areas along the northern edge of the city lack natural or artificial defences from storm surges and tropical cyclones, with those areas of the city likely to be impacted by a -5meter storm surge height
Climate change x biodiversity	- Coastal benthic vegetation, such as coral reefs, seagrass, and mangroves will be damaged and eroded by temperature increases and extreme weather events, such as storm surges or tropical cyclones - Logging, agricultural expansion, overfishing, deforestation and sewage-discharge has a significant impact on land and marine biodiversity, compounding existing vulnerable to climate change hazards
Biodiversity x urban	- Land use changes due to urban expansion and population growth is the primary driver of biodiversity loss in the Honiara city and the Guadalcanal Island - Solid and hazardous waste is dumped in rivers due to lack of waste management services and infrastructure, poor governance, and lack of education - Reduced or malfunctioning ecosystem services, driven by urbanization and other development pressures, will force shortages of essential resources such as water, food and fuel for city residents - Habitat degradation and fragmentation caused by urban development is likely to adversely impact local religious, economic, and tourism-based cultural services that are supported by ecosystem and biodiversity

Source: UN-Habitat, 2024. Adapted from UN-Habitat, 2022

Identifying and addressing vulnerabilities in these hotspots is crucial for effective urban climate adaptation and resilience planning. Tailoring strategies to each areas specific challenges and needs is essential for mitigating the impacts of climate change on vulnerable communities, infrastructure and ecosystems. Comprehensive action plans that consider both climatic, physical and social dimensions can enhance the adaptive capacity of these areas and reduce the negative impacts of climate change, urbanization, biodiversity degradation, and other development pressures on vulnerable urban communities.

Data acquisition and collection

To undertake the MVA, Delivery Teams should work partners in each city to collect data and information on past adverse climate impacts, socio-economic, urban and biodiversity issues, as well as urbanization and spatial expansion trends, climate change projections, and biodiversity loss. This will firstly include key preparatory steps, such as establish data requirements, identifying and confirming data availability, and developing a Geospatial Workflow.

The Delivery Teams then identify and collect national or local GIS datasets, global open-source and accessible geospatial datasets to supplement local data, and other quantitative and qualitative data from government agencies and local development partners. Finally, the collected data is cleaned, standardized and pre-processed so that it can be used for the MVA geospatial analysis. The key activities are highlighted in the table below and elaborated further in the following sections.

Data requirements and sources

The first step to start the MVA data collection process is to establish the data requirements needed for the MVA. This involves reviewing the MVA scope and objectives to understand the geographic focus of the MVA as well as the specific vulnerabilities that will be assessed, as informed by the rapid diagnostic of the city and urban areas conducted in Stage 1.

Determining the data needs and requirements comprises the following activities:

- **Defining and prioritizing the GIS data required,** specifying dimensions of vulnerability, geographic extent, spatial resolutions, temporal resolutions and attributes
- **Defining the standards for GIS data quality, format, integration and compatibility** to ensure that all data sources are compatible with the GIS system and meet MVA requirements
- **Documenting the finalized data requirements** in a data management plan or project documentation. Include details such as data sources, formats, quality standards, and any specific processing or transformation requirements

Determining the sources and availability of the required data comprises the following activities:

- **Review the MVA open-source data resources** list to confirm whether the GIS data selected city or urban area is available in the require resolution, quality, standard and format
- **Identifying local and national government agencies who are responsible for data collection and management** in relevant MVA aspects (e.g. such as climate adaptation, spatial planning, environmental protection)
- **Identifying all other potential sources for acquiring the required spatial data,** which may include utility companies, meteorological institutions, United Nations agencies, international and local development organizations, NGOs and civil society organizations, research institutions and academia, and the private sector
- **Assess data availability and accessibility of the identified data sources** and confirm that complete, accurate, high-resolution, recent, reliable, compatible data can be obtained for the MVA
- **Consider any potential data challenges** such as data gaps and discrepancies, incurred costs, licensing, copyright or usage restrictions, data privacy, security and confidentiality constraints, and data format technical compatibility issues

For the MVA, the main GIS data requirements pertain to the selected indicators corresponding to the three dimensions of the assessment methodology (urban, climate change and biodiversity). A set of open-source, free and suitable GIS datasets have been identified and prepared for the MVA.

The specific indicators for each dimension are paired in the list below with appropriate open-source GIS datasets that can be utilized. Indicators to be used in the MVA should be selected based on criteria such as availability and accessibility, while also noting that not all indicators and their corresponding measures of vulnerabilities will be relevant to each specific city or urban area. It is key for the experts to determine which indicators are considered priority for the assessment.

Available datasets may not be a direct match for the desired vulnerability indicators, and preliminary geospatial analysis might be required after data cleaning and prior to undertaking the MVA. This analysis might require path and distance analysis, generalization, and rasterization. The MVA guidance does not provide explicit instructions for these steps. Instead, Delivery Teams are advised to choose a methodology that best fits their available data, time, and human resources.

It is important to note that while open-source datasets are available are useful for the MVA, utilizing local data that can be more recent, accurate and of higher resolution is recommended, if it exists and is accessible. It is recommended that Delivery Teams coordinate closely with key stakeholders and partners to request and acquire suitable local data for the study.

Urban dimension

The main indicators and GIS datasets to be utilized for the urban dimension of the MVA are shown below. Further details on each dataset can be found in the Urban Indicator GIS Dataset factsheets in the Annexes of this Brief.

Table 8. Open-source GIS datasets for urban dimension indicators

Indicator	GIS Dataset(s)
Population and population density	- Global Human Settlements Layer - Population - UN-Habitat – Urban Population - WorldPop - Total Population - WorldPop - Population Density - Seto Lab, Yale – Historical Urban Population - UN-Habitat – Urban Population Change
Urbanization and urban growth	- WorldPop - Global Built Settlement Growth - Global Human Settlements Layer – Degree of Urbanization - Global Human Settlements Layer – Urban Centres Database - World Pop – Urban Change - NYU and UN-Habitat - Atlas of Urban Expansion - Seto Lab, Yale – Urban Land Expansion by 2050
Land use	- Google Earth and World Resources Institute – Dynamic World V1 - OpenStreetMap - Land Use / Land Cover - ESRI – Land Use /Land Cover
Socioeconomic vulnerability	- World Bank – Global Subnational Poverty Atlas - World Bank – Subnational Poverty - World Bank – Subnational Poverty and Indicators Database
Access to services	- UN-Habitat – Access to Basic Services in Cities and Urban Areas - Slum Dwellers International – Know Your City Database
Informal settlements	- UN-Habitat – Proportion of Urban Population Living in Slum Households - Slum Dwellers International – Know Your City Database
Building and infrastructure typologies and conditions	- Global Human Settlements Layer - Building Height - Global Human Settlements Layer – Settlements Characteristics - Global Human Settlements Layer – Built Up Surfaces.

Climate change dimension

The main indicators and GIS datasets to be utilized for the ***climate change dimension*** of the MVA are shown below. Further details on each dataset can be found in the ***Climate Change Indicator GIS Dataset factsheets*** in the Annexes of this Brief.

Table 9. Open-source GIS datasets for climate change dimension indicators

Indicator	GIS Dataset(s)
Temperature rise and precipitation	- IPCC – Temperature Rise - IPCC – Precipitation - NASA – Surface Temperature Analysis
Sea level rise	- Climate Central – Flood Risk Projection by 2050 - World Bank – World Sea Level Rise Dataset
Fluvial or riverine flooding	- European Commission JRC – Flood Hazard Map of World - World Resources Institute – Aqueduct Water Risk Atlas
Coastal flooding	- Copernicus EU - Coastal Dataset for the Evaluation of Climate Impact - World Bank – Global Coastal Flood Hazard
Drought	- World Bank – Global Drought Hazard Map - UNDRR – Global Drought Events - Global Drought Information System – Global Drought Index
Extreme heat	- World Bank – Global Extreme Heat Hazard Map - Seto Lab, Yale – Urban Heat Island Intensification by 2050
Landslides	- World Bank – Global Landslide Hazard Map
Storm surge / cyclones / hurricanes	- GSSR – Global Storm Surge Database - World Bank – Global Cyclone Hazard Map - World Bank – Intensification of Storm Surges
Coastal erosion	- Climate Central – Change in Coastal Wetlands
Air quality	- UN-Habitat - Mean Population Exposure to PM2.5 - European Space Agency – Global Pollution Mapping Portal

Biodiversity dimension

The main indicators and GIS datasets to be utilized for the biodiversity dimension of the MVA are shown below. Further details on each dataset can be found in the Biodiversity Indicator GIS Dataset factsheets in the Annexes of this Brief.

Table 10. Open-source GIS datasets for biodiversity dimension indicators

Indicator	GIS Dataset(s)
Mean species abundance	- GLOBIO – Mean Species Abundance Layer - UNEP-WCMC - Global Critical Habitat Layer
Protected / conservation areas	- Google Earth and World Resources Institute – Dynamic World V1 - IUCN and UNEP-WCMC – World Database on Protected Areas - The Nature Conservancy – Geospatial Conservation
Biodiversity connectivity	- ArcGIS – Biodiversity Hotspots Layer - Conservation International – Biodiversity hotspots - Global Forest Watch – Tropical tree cover - Global Forest Watch – Global mangrove forests - Global Forest Watch – Spatial Database of Planted Trees - Greenpeace and World Resources Institute – Intact Forest Landscapes

Geospatial Workflow and data pre-processing

Once the mapping preparation steps and activities have been completed, the MVA requires a Geospatial Workflow to be created. The process refers to the sequence of steps and processes involved in performing spatial analysis, data manipulation, and visualization tasks using GIS software. Geospatial workflows are designed to guide users through the entire process of working with spatial data, from setting the scope and establishing data requirements to data acquisition and collection to data cleaning, organizing and pre-processing to analysis, interpretation, and presentation of results.

The Geospatial Workflow for the MVA provides the overarching structure and approach for undertaking the GIS and data mapping and analysis component of the MVA and ensures quality, reproducibility, and usefulness of the MVA results. This then feeds into the preparation of a comprehensive data collection plan.

A busy street in Mathare slum Nairobi, Kenya
2016 © UN-Habitat_Julius Mwelu

Data collection sources and methods

There are several recommended data collection methods that are to be deployed in the undertaking of the MVA. In addition to using open-source GIS datasets, the Delivery Team should consider utilizing the following data collection methods and sources:

- local datasets
- earth observation (EO) tools
- field data collection

Details on how each of these methods and potential sources can be used to support the geospatial analysis of multilayered vulnerabilities in cities and urban areas are provided in the sections below.

It is likely that some data may be available as text or images rather than mapped data. The Delivery Team should budget additional human-resource hours for digitization of analogue data sources. This is also true for updating datasets that remain applicable but may be temporally inaccurate.

Local datasets

As highlighted in the data requirements section, it is crucial determine whether high-quality local datasets meeting the data requirements of the MVA are available and accessible. Local datasets often have higher spatial resolution which will allow for more granular and detailed analysis of specific vulnerabilities. Local datasets also tend to provide more local contextualized, up-to-date and validated information that is specific to the study area, such as climate change hazard susceptibility, infrastructure conditions and socio-economic characteristics. Global, open-source datasets may not capture these aspects accurately or in high resolution, which could lead to inaccurate analysis and interpretation.

Some examples of potential local datasets and sources that could be used to supplement the GIS analysis and strengthen the overall assessment of vulnerabilities are shown for the three key dimensions in the table below.

Table 11. Example local datasets and sources

Dimension	Indicator	Example local dataset and sources
Urban	Informal settlements	Informal settlements boundary maps and studies from local civil society organizations, international development organizations or City Department of Territorial Planning
	Socioeconomic vulnerability	Census data relating to socioeconomic vulnerability factors such as income, employment, education level, poverty level, gender, etc. from National Minis-try of Statistics
	Access to services	Household or district/community level data on ac-cess to basic urban services such as water supply, sanitation, housing, waste management, etc.
Climate change	Coastal flooding	Coastal flood exposure map and reports from Coastal Management Agencies or Nation-al/Provincial Meteorological Institutions
	Drought	Drought hazard datasets from National Hydrological or Water Resources Agencies
	Extreme heat	Urban heat island studies from National Public Health Agencies or local or national research institu-tions or universities
Biodiversity	Mean species abundance	Species abundance and intactness data from Mu-nicipal Department of Wildlife, Forests and Parks, Regional Environmental Protection Agencies or Na-ture Conservation NGOs
	Protected / conservation areas	Maps of protected and conservation areas and their conditions from Ministry of Environment, Depart-ment of Natural Resources or international agency networks for protected areas
	Biodiversity connectivity	Local ecological connectivity surveys from National Biodiversity Institutes, local academic institutions or biodiversity conservation agencies

Using some of these local datasets in conjunction with GIS data can help address gaps in datasets for sites and regions where open-source data is less accurate or scarce. These datasets can also be combined with the existing open-source datasets through GIS software to create more nuanced and detailed MVA spatial layers or indicators for GIS analysis. This may involve data conversion, digitization, standardization and integration.

It is important to highlight that while local data has its advantages, it's important to recognize that a combination of local and open-source data can provide a comprehensive and balanced approach to GIS analysis for the MVA. Combining the strengths of both types of data can enhance the robustness and applicability of the assessment outcomes.

Earth observation tools

Earth observation (EO) tools encompass a variety of technologies and platforms that are used to observe, monitor, and analyze the Earth's surface, atmosphere, and oceans. By leveraging EO tools and data for the MVA mapping and analysis, insights into the spatial distribution of risks and vulnerabilities can be generated. This can help to inform evidence-based decision-making and support the development of climate-resilient cities.

Some examples of earth observation tools that could be used in the MVA to support the GIS analysis includes satellite imagery (e.g. Google Earth Engine), aerial and 3D photography (e.g. Google Streetview). The table below provides some example data and sources for possible EO tools for each dimension and selected indicators.

Table 12. Example earth observation methods and sources

Dimension	Indicator	Example data and sources
Urban	Building and infrastructure typologies and conditions	Google Earth Engine
	Land use	Google Maps, land use planning documents
Climate change	Coastal erosion	Google Earth Engine, CCRVAs
	Riverine and fluvial flood	Landsat
Biodiversity	Mean species abundance	Google Earth Engine
	Biodiversity connectivity	Google Maps, reports and studies

Field data collection

Field-based data collection is also critical to the conduct of the MVA. It may be likely that some open-source or local datasets do not meet the requirements set out and required by the MVA, and so, primary data collection is needed. Field-based data collection can take many forms and can be used to obtain high-quality data across each of the MVA's dimensions and their corresponding indicators. Table 9 provides some examples of field-based data for selected MVA indicators, as well as potential datasets and sources.

Table 13. Example field data collection methods and sources

Dimension	Indicator	Example data and sources
Urban	Informal settlements	Community mapping
	Access to services	Household surveys
	Building and infrastructure typologies and conditions	Site observations
Climate change	Coastal flooding	Flood risk mapping with local communities
	Landslides	Site observations
	Storm surge / hurricanes	Participatory vulnerability mapping
Biodiversity	Means species abundance	Ecological observation surveys
	Biological connectivity	Ecosystem connectivity and corridor mapping

Data analysis and interpretation

Summary

The first step to start the MVA data collection process is to establish the data requirements needed for the MVA. This involves reviewing the MVA scope and objectives to understand the geographic focus of the MVA as well as the specific vulnerabilities that will be assessed, as informed by the rapid diagnostic of the city and urban areas conducted in Stage 1.

Analysis and interpretation of the geospatial data collected will allow to the Delivery Team understand the intersecting and interconnected vulnerabilities of people, infrastructure and ecosystems.

The vulnerability analysis process recommended by the MVA involves the comprehensive assessment of the three key components of vulnerability, as per the IPCC Framework, which are exposure, sensitivity and adaptive capacity. The joint analysis of these three components determines the level and degree of vulnerability present in a specific location to the dimensions of climate, urban and biodiversity change, as well as considering the overlapping vulnerabilities of the dimensions and the resulting hotspots in the city and selected urban areas. The result of the comprehensive data analysis process is compiled in Vulnerability Profile Report for the city or urban areas.

The following sections explain how to perform the exposure, sensitivity and adaptive capacity analysis to assess vulnerability as part of the MVA. This approach and methodology has been informed several UN-Habitat technical guidance documents, including Climate Change Vulnerability Assessment Manual, Planning for Climate Change: a strategy, values-based approach for urban planners tool, Climate Change Vulnerability and Risk: A Guide for Community Assessments, Action Planning and Implementation, City Resilience Profiling and Action Planning (RAP) Tool, and the INFORM Risk Index Tool of the European Commissions Joint Research Centre.

Vulnerability assessment analysis

Exposure analysis

identification of how your city is exposed to changes in the climate today and how it could be in the future.

The first step includes the description of climate conditions and identification of climate hazards.

- Description of current and future changes, based on a review of historic and current climate information (precipitation, temperature, extreme weather events) and projected climate scenarios for your city, region or country.
- Identification of associated climate hazards (drought, flooding, sea level rise, storms) and their biophysical manifestations (groundwater depletion, landslides, riverbank erosion, coastal erosion, etc.) and if it is possible, include their current and future magnitude.

Second step is the identification of people, places, institutions and sectors that are exposed to climate hazards. and frequency. The following table can be used to summarize identification of climate hazards and exposed features and sectors.

Table 14. Identification of climate hazards and exposed features and sectors

Climate Change Hazard	Current Weather Data	Climate Scenario Projections	Impacts	Exposed features and sectors
Drought/ flooding/ heat Waves/ sea level rise	Precipitation Temperature	IPCC projections	Description of impacts	People, places, institutions Environmental, social, infrastructure, institutional, economy

To complement the identification, use the mapping of climate change, urban and biodiversity vulnerabilities, to illustrate climate change-exposed locations in a city and their features (people, infrastructure, institutions, sectors, ecosystems, etc.). It is important to identify the places where the hazards occur and where impacts are likely to be aggravated considering projected climate change, illustrating exposed locations through the maps of climate change dimension. Furthermore, the recognition of exposed people (e.g. women, elderly, informal settlement dwellers, etc.), infrastructure (e.g., bridges, roads, schools, clinics, markets, etc.), institutions (e.g., governments, stakeholder organizations), sectors (environmental, social, infrastructure, institutional, economy) and ecosystems (e.g. wetlands, forests, coastal zones, etc.) that are impacted, is complemented by maps of the urban and biodiversity dimensions. It is important to assess the duration (how long) and frequency (how often) of hazards that the affected communities, assets, systems and environments are exposed to.

Sensitivity analysis

Its objective is to identify how these exposed people, places, infrastructure, institutions, sectors and ecosystems are impacted today and the degree to which they could be impacted in the future.

The first step includes a socio-economic sensitivity appraisal that focuses on identifying demographic, housing, welfare, and human development conditions in the city and study area. Social sensitivity considers human populations that may be negative or positive affected by climate change. In particular, this focuses on climate-related sensitivities that play an important role in understanding how exposure to climate hazards is likely to be different in different parts of the city. Some variables are related to demography, livelihoods, incomes, public health, housing and mobility. These variables provide a greater understanding of the people, places, institutions and sectors that are sensitive to climate change, tables or graphs can be used to explain this information.

Table 15. Socio-economic sensitivity variables

Consideration	Variables	Sensitive features (people, places, institutions) and sectors
Demographics	Gender Proportion of children and elderly Household literacy Education levels Proportion of economically active Household members	People, places, institution and sectors that are sensitive
Housing	Materials Condition Number of occupants	People, places, institution and sectors that are sensitive
Welfare and human development	Average income (per capita or household) Life expectancy at birth Literacy rates (as proxy measure) Poverty rates human development Index	People, places, institution and sectors that are sensitive
Production and	Land use areas residential, commercial, industrial, commercial Infrastructure Land values	People, places, institution and sectors that are sensitive

The second step is to use maps and geospatial analysis (through GIS software) to illustrate sensitivity information that can be presented spatially, for example population densities, informal settlements, vulnerable populations densities, sensitive places and sensitive ecosystems. These same maps correspond with the maps of the urban and biodiversity dimensions.

The third step is to overlay the maps of the of climate change, urban and biodiversity dimension, in such a way that the exposure component and the sensitivity component can be crossed to identify locations where exposed areas overlap with sensitive populations and places could indicate areas where vulnerability may be particularly high.

Adaptive capacity analysis

This last level of analysis comprises the identification of how well how people, places, institutions and sectors could adapt to these climate hazards and impacts. This activity evaluates a city's capacity to respond to a given climate change impact, taken into account the often overlapping and compounding urbanization pressures, socioeconomic stressors, and ecological challenges. Adaptive capacity of a city can also be understood by appraising the awareness, knowledge, resources, and skills of a city's residents and institutions.

To evaluate the adaptive capacity, the following types of adaptation must be taken into account.

- **Independent capacity:** how well individuals or families are able to respond and adapt to climate hazards without assistance from the larger community or local government.

- **Collective capacity:** how well are communities, neighbourhoods or other groups able to respond and adapt to climate hazards without assistance from government or other agencies and institutions.

- **Institutional capacity:** how well an established government is able to, or would be able to, respond and adapt to climate hazards (e.g. organizational systems, policies, regulations, human resources, technological resources)

The first step could include review on:

- City plans and policies, relevant state, provincial and national level policies.
- How individuals and households, communities and governments have traditionally responded to extreme climate events and disasters.
- Overview perspective of your adaptive capacity, or to focus your assessment of adaptive capacity on a target sector as appropriate.

The adaptive capacity to respond to a given climate change impact is based on the level of awareness of the risk or impact and the resources available to manage it. The analysis must lead to the identification of current determinants of adaptive capacity and their relation to climate change and urban planning. Table 12 outlines some of the determinants of adaptive capacity and how each type of capacity supports planning to reduce climate vulnerability in the city.

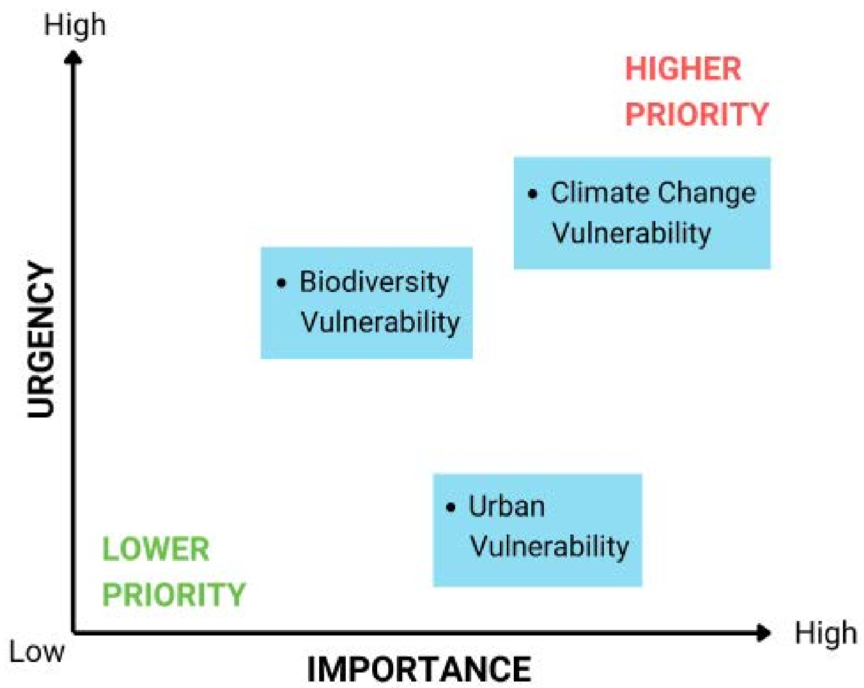
Table 16. Determinants of adaptive capacity and their relation to climate vulnerability

Consideration	Variables	Sensitive features (people, places, institutions) and sectors
Economic wealth and financial capital	Municipal financial resources, resident incomes and wealth distribution, economic marginalization, fiscal incentives for climate risk management	Climate change adaptation with internal funding or external support
Access to information and technology	Communication networks, computing tools, freedom of expression, technology transfer and data exchange	Technical data, data modelling capability, sharing and distribution information to Climate change adaptation
Material resources and infrastructure	Transport, water infrastructure, buildings, sanitation, energy supply and management	Designed, constructed, sited, and managed infrastructure and services to be more adaptable or easier to adapt to climate change impacts and risks
Human resources and capacity	Knowledge (scientific, "local", technical, political), education levels, labour.	Scientific understanding and knowledge, local knowledge, and human resources to undertake climate change planning work.
Organizational and social capital	State-civil society relations, non-governmental and community-based organizations, relationships between institutions. Modes of governance, leadership, participation, decision and management capacity.	Stakeholders (government, non-government, vulnerable groups, etc.) that work together. Functioning local government that is capable and willing to enforce municipal laws, plans and regulations.

In concluding the vulnerability analysis, the Delivery Team should utilize the findings of the previous tasks to understand the areas where urban climate adaptation and resilience building efforts may need to be focused. This includes identify the most vulnerable places and infrastructure, people and groups, institutions and sectors, and ecosystems and biodiversity, as specifically as possible. In addition to a prioritization of vulnerabilities that adaptation options should consider first.

As a result of overlay of the mapping of urban vulnerabilities, climate change and biodiversity and the analysis of exposure, sensitivity and adaptive capacity, vulnerabilities should be identified, located and fully understood. In order to validate this analysis, and to identify prioritized vulnerabilities with the stakeholders, it could be helpful to use a tool such a chart or plot based on the Eisenhower time management matrix for prioritizing actions. This tool consists of two axes: importance and urgency are the two factors on which each task must be evaluated, assigning them a value between high and low. Importance is noted on the X-axis, while the urgency is noted on the Y-axis, as shown in the following figure. This exercise can be used to assist the Delivery Team in preparing the Vulnerability Profile, as well as the identification and prioritization of interventions and actions during Stage 3.

FIGURE 10 **Prioritization of vulnerabilities**
Source: UN-Habitat, 2024



GIS indicator factsheets

Backstreet in Lamu Island, Kenya, 2024.

ANNEX TO THE MULTILAYERED VULNERABILITY ASSESSMENT DATA COLLECTION AND ANALYSIS BRIEF

GIS INDICATOR FACTSHEET: Urban dimension indicators

GIS analysis
Dimension indicator factsheet

Urban

Information

This indicator factsheet for urban areas provides a comprehensive overview of spatial indicators critical for evaluating urban vulnerability and resilience through geospatial analysis. It highlights the integration of data such as population density, urban growth trends, land use, and environmental quality into GIS frameworks to enable evidence-based decision-making. The factsheet details approaches for data collection, normalization, and rasterization, ensuring methodological consistency while accommodating local contexts. It serves as a practical guide for practitioners to effectively use geospatial tools within the Multilayered Vulnerability Assessment (MVA) framework.

Sub indicators

Population / population density
Urbanization / urban growth
Land use
Socioeconomic vulnerability
Access to services
Informal settlements
Building and infrastructure
Environmental quality
Urban heat island

Description

Population / population density. These data are commonly available from government sources like the National Statistical Offices or Census Offices.

Urbanization and/or urban growth. The representation of urbanization and/or urban growth in a GIS is not a standardized product, and it may prove challenging to find datasets directly suited to this indicator.

Land use. Land cover and land use is considered one of the 14 Global Fundamental Data Themes. It is important to note the distinctions between land cover and land use.

Socioeconomic vulnerability. These data are typically included as a part of a census or Labour Force Survey and are therefore commonly available from national statistics offices.

Access to services. The access to services indicator is a broad thematic indicator intended to summarise the overall development and quality of life within the local area.

Informal settlements. These data may be available from local or regional planning offices, public health authorities, first responders, or aid agencies.

Building and infrastructure. Datasets containing information on building typologies and/or conditions might be available from the national statistics office, first responders, local or regional planning offices, disaster response authorities, or social/community groups.

Environmental quality. The environmental quality indicator aims to represent any areas where the quality of the environment is lower resulting from the presence of contaminants and the prevailing conditions.

Urban heat island. These data might be available from meteorological offices, environmental divisions, utilities providers or even health care providers.

Indicator	Details
Population and/ or population density	These data are commonly available from government sources like the National Statistical Offices or Census Offices. Alternative sources might include agencies like those responsible for voter registration, who can indicate approximately how many adults reside in each district or neighbourhood. Local aid agencies may possess similar information. Population data can be found in a multitude of different formats. Some common formats include: • tabular format with data described by neighbourhoods, postal codes, enumeration district etc., • in GIS file types like shapefiles for a predetermined geographical boundary, or • gridded (raster) data at a given spatial resolution It is imperative to acknowledge the difference between population datasets and population density datasets. A population dataset describes the number of individuals in a population while a population density dataset describes the number of individuals per unit area or volume. Since the pattern of spacing of a population may be affected by environmental characteristics and will in turn have environmental effects of its own, the MVA prefers that any population datasets are converted to population density by dividing the population of a given location by the ground area of that location. **Processing:** To use a population or population density dataset in the MVA, the data need to be normalized, wherein the numeric values are modified to fit a common range between 0 and 1, with 0 representing the lowest contribution and 1 representing the highest. Following normalization, the data must be converted into grid formats (rasterized) using a cell-centre assignment type.
Urbanization and/ or urban growth	The representation of urbanization and/or urban growth in a GIS is not a standardised product, and it may prove challenging to find datasets directly suited to this indicator. Resultingly, the development of this indicator, and the data used to construct it, are open to various interpretations. Delivery teams should prioritise building this indicator using inputs or proxies that are most relevant to the particular circumstances of the local area. For this MVA, it is suggested that areas of urbanization and/or urban growth are identified in a GIS in one of the following ways: • Land use or land cover changes over time, based either in extent or speed • Areas of high or rapid population growth • Change in extent of built-up areas • Loss of greenspace Where satellite imagery or land use/land cover datasets are not readily available through time, Google Earth Imagery might be an asset. Where the above data is not available, other data or combinations of other data may be used to approximate this indicator: • Ratio of service infrastructure (i.e., proper drainage, waste management, stormwater management, transportation) to population. • New communities or developments on land of poor quality (i.e., known floodplains, reclaimed land or steep slopes) • Extent of night-time light pollution • Change in housing affordability • Increases in traffic congestion • Pedestrian network(s) **Processing:** It must be noted that this is a time-depended indicator and is best included as a measure of change relative to a baseline year. The choice of baseline year should be broadly agreeable with other time-dependent indicators used in the MVA to maintain harmony in temporal resolution. Once in the GIS, use the change detection toolset to identify changes in the iterated datasets. Change values can then be normalised where 0 represents no change and 1 represents the highest amount of change. These data should then be rasterized using a cell-centre assignment type and applied to the common grid size of the MVA Zonal statistics can be used to aggregate changes to a particular level (i.e., parcel) if a further level of analysis is desired. Note this is not a mandatory step.

Indicator	Details
Land use	Land cover and land use is considered one of the 14 Global Fundamental Data Themes. It is important to note the distinctions between land cover and land use. Land cover refers to the (bio-) physical cover present on the observed land surface. These categories include shrubland, bare-soil, water and can be readily determined through satellite imagery analysis. In contrast, Land use refers to the specific way that land is used by the population. These categories include agriculture, recreation, protected areas, industrial, etc. Land use therefore considers human activity and input to maintain, produce, or change the land cover and requires a deeper analysis and knowledge to produce. The MVA prefers land use as an indicator, however, will accept land cover if a suitable land use dataset is not available. It is however imperative that the dataset used does not mix the two land classification systems. These data are typically found as raster or polygon files with categorical assignments. As the MVA requires a numerical input value, the Delivery Team must reassign categories with values they deem are representative of the relative vulnerability of that land classification. This should be done in conjunction with local experts. **Processing:** Rasterize polygon datasets using a cell-centre assignment type. To use land use datasets in the MVA their values need to be reassigned as numerical representation. Since 0 in the MVA represents no vulnerability and 1 represents vulnerability, the values should be reassigned. There is flexibility in this, and it should be done with guidance of experts in mind. Delivery Teams may consider assigning "0" values to natural or undisturbed surfaces and "1" values to exploited and impervious surfaces. Delivery Teams may also consider assigning a range of values 0 through 1 to representing increasing vulnerability caused by the various land use types. If the initial data type is vector, it must be rasterized before its inclusion in the MVA.
Socioeconomic vulnerability	These data are typically included as a part of a census or Labour Force Survey and are therefore commonly available from national statistics offices. While lower income brackets are a key marker of vulnerability, it is crucial to incorporate other markers, including but not limited to, disability, education level, number of dependents, single-income households, employment and stability, age, or housing type. Note that not all markers need to be included, and teams should focus on what they deem to be most representative of the local area and circumstances. Socioeconomic vulnerability data can take a few forms: • It is commonly found as tabular data with entries linked to a predefined "district" by some type of code. In this case, it is imperative that the district boundaries are also known, either as GIS data or as a textual description that can be digitised. • In situations where the responsible authority has GIS skill, the socioeconomic data may already be available as vector or raster dataset. • It is possible that the information will exist only as a textual description and need to be digitised. These data can be prepared in a way analogous to population density. Once the socioeconomic vulnerability markers have been decided and mapped, the population meeting those markers can be divided by the ground area of that location. **Processing:** To this data in the MVA, the data need to be normalized, wherein the numeric values are modified to fit a common range between 0 and 1, with 0 representing the lowest contribution and 1 representing the highest. Following normalization, the data must be rasterized.
Access to services	The access to services indicator is a broad thematic indicator intended to summarise the overall development and quality of life within the local area. Delivery teams may choose to interpret this indicator in a few different ways, including but not limited to: • Access to clean drinking water • Water and sanitation services for the health sector • Access to Energy • Quality of sewers and/or waste disposal • Access to affordable and nutritious food (i.e., food deserts) • Quality of transportation Information on access to utilities or basic services may be included in a census. Alternatively, this information may be available in reports from utilities providers or development agencies, or in aid assessments and scoping reports. **Processing:** When building this indicator, Delivery Teams are advised to use a binary indicator when dealing with discrete datasets, and to normalise values when dealing with continuous datasets. Datasets depicting access to a certain service may choose to represent the data as number of outlets per capita within a given boundary or as distance travelled by the population to access said service. Data that are represented as the number of outlets per capita, higher values represent better access and hence, lower vulnerability. Since the MVA's scoring assigns higher values to higher vulnerabilities, the values will need to be inverted before use in the MVA. Similarly, when the indicator is calculated through distance analysis, shorter distances equate to lower vulnerabilities. The resulting distance analysis will likely need to be normalised and inverted before use in the MVA.

Indicator	Details
Informal settlements	These data may be available from local or regional planning offices, public health authorities, first responders, or aid agencies. This data may exist as: • GIS point data indicating centre points or boundary extents of informal settlements • GIS polygon or raster data indicating the sprawl or extent of an informal settlement • Aerial imagery of informal settlements • Textual descriptions of conditions and/or extents of informal settlements. Aerial imagery and textual descriptions will need to be digitised into polygons and converted to rasters. Alternatively, if data are not immediately available, boundaries of informal settlements can be digitised from openly available recent satellite imagery, in conjunction with expert local opinion. These data can also be ground-truthed if the resources are available. **Processing:** Point data may need to be buffered, or an envelope created prior to converting it to the MVA's grid size. Similar, polygon data may need to be smoothed if there are many small alleys and rough edges to the area. These data are best represented with a binary indicator, using 1 for areas which are informal settlements and 0 for areas which are not. Vector data must be rasterized before being used in the MVA.
Building and infrastructure typologies and conditions	Datasets containing information on building typologies and/or conditions might be available from the national statistics office, first responders, local or regional planning offices, disaster response authorities, or social/ community groups. GIS data that supports this indicator, or alternatively can be used as a proxy for this indicator, include: • Infrastructure age • Construction materials and/or quality • Building/Infrastructure disrepair • Building codes, guidelines, or approvals Data supporting this indicator may be classified as specialty or sensitive information and therefore difficult to obtain. Further, this type of information requires a high-resolution that may not be consistently available across the local area. **Processing:** For datasets that indicate building materials, accordance with building codes and guidelines, or a state of disrepair, the Delivery Team will need to reclassify attribute values and assign numerical values where the highest numbers coincide with the worst conditions and weakest structures. If the reassigned values are not between 0 and 1 then the values will need to be normalised. Following normalisation, the data must be rasterized prior to its inclusion in the MVA. Owning to the fine resolution of the data, it may be necessary to first aggregate the information into the grid size chosen for the MVA. This can occur as an average across the grid squares or as a sum. The choice is left to the Delivery Team to what they feel is most representative. Alternatively, the Delivery Team could choose to use one infrastructure feature as the most representative for each grid square and omit others from the analysis. For datasets indicating infrastructure age, a normalisation can be applied so that the oldest infrastructure is considered the most vulnerable.

Indicator	Details
Environmental quality	The environmental quality indicator aims to represent any areas where the quality of the environment is lower resulting from the presence of contaminants and the prevailing conditions. Common environmental contaminants include pesticides, waste, carbon monoxide, particulates and smog. Common sources of environmental contaminants include smokestacks, discharge pipes, industrial and commercial facilities and wastewater treatment. Data relating to environmental contaminants may be available from the environment or natural resource authorities. Data relating to environmental pollutants may be considered sensitive and therefore difficult to obtain. In such cases, Delivery Teams may only be able to identify known sources and locations without having access to actual measurements. It is important to note that not all industrial processes or commercial facilities will create contaminants. Delivery Teams are advised to only include those known to have poor environmental management practices in the MVA. Processing: Where the available data includes records of air or water quality measurements, Delivery Teams will need to choose the most appropriate method to include the data in the MVA. Considerations should include the measured variable and the time-period contained. It may be best to choose the most recent measurement or to calculate an average over a time-period. For regularly spaced measurements, the Delivery Team should consider creating an interpolated raster surface and normalising the values so that the highest value in the surface is 1. Alternatively, if the measurements are not evenly spaced, the Delivery team should consider applying the measured value to a representative zone of impact based on the location of the contaminant, the type of contaminant, and the medium into which it is discharged. If regular measurements are not available but sources of environmental contamination or degradation are well known, it may be more appropriate to build this indicator by applying a buffer to the suspected zone of impact of the contaminant. This application will depend on the nature of the contaminant and how/where it is being dispersed into the environment. As an example, a liquid contaminant from a discharge pipe into a stream or river can have its zone of impact represented as a buffer surrounding the river feature and extending from the point source in the direction of water flow. The width of the buffer should be dependent on river volume and speed, as well as expert opinion. In this application the data is best represented by a binary system where 1 represents contaminant zone and 0 is free from contaminants. Vector data must be rasterized prior to its inclusion in the MVA.
Urban heat islands	These data might be available from meteorological offices, environmental divisions, utilities providers or even health care providers. If available, these data may exist as polygons outlining the affected area, as points indicating the centre of the affected area, or as tabular records. Values may be represented as measured temperatures or as a percentage temperature above the surrounding area. It is also possible that this information is not readily available as GIS data and may need to be digitised based on textual descriptions or informal discussions and interviews **Processing:** Where value-based information is available, values should be normalised so that the highest affected areas are represented by a “1” and the unaffected areas are represented by a “0”. In the case of point data, a buffer tool should be applied to cover the approximate affected areas. Polygons should be converted to the common grid size for inclusion in the MVA. An alternative approach may be to infer the approximate locations and extents of urban heat islands based on the expert opinion of Climate change specialist and the presence of vegetation, infrastructure, and their respective densities. In this application, information should be conveyed using a binary, where the affected areas is represented by a “1” and the unaffected areas are represented as a “0”.

ANNEX TO THE MULTILAYERED VULNERABILITY ASSESSMENT DATA COLLECTION AND ANALYSIS BRIEF

GIS INDICATOR FACTSHEET: Climate change dimension indicators

GIS analysis
Dimension Indicator

Climate Change

Information

This indicator factsheet for climate change provides a structured overview of spatial indicators essential for analysing climate vulnerabilities and risks through geospatial methods. It includes a range of metrics such as temperature anomalies, sea level rise, flooding, droughts, landslides, and coastal erosion, each pivotal for understanding climate impacts on urban areas. The factsheet guides practitioners in sourcing, processing, normalising, and rasterising climate data to create consistent and locally adaptable inputs for the Multilayered Vulnerability Assessment (MVA). By standardising these indicators, it enables evidence-based decision-making to address climate challenges effectively.

Sub indicators

- Temperature change
- Sea level rise
- Flooding
- Drought
- Landslides

Description

Temperature change. These data are commonly available from National Meteorological Services, Environmental Divisions, or Disaster Management Offices, and will likely take the form of either a) a time-series of daily highs from a single central location, b) gridded daily averages across an area, or c) direct output (commonly csv format) from one or many all-weather stations.

Sea level rise. Localised and area-specific data may be available from a National Meteorological Service, a Natural Resource Management Office, a Fisheries division, or a Blue/Marine Economy Authority. Where localised and area-specific data are not available, there should be relatively high-quality, freely accessible global datasets

Flooding. Data and information on the areas affected by fluvial or riverine flooding may be available from the National Meteorological Service, the Environmental or Natural Resources Authority, or even Planning Offices.

Drought. These data may be available from Agricultural Offices, National Meteorological Services, Environment Authorities, or Disaster Relief Authorities.

Landslides. These data may be available from the National Environment Authority, a Natural Resources Office, Planning Offices, or Disaster Response Authorities.

Coastal erosion. Data on coastal erosion may be available from the National Environmental Authority, Fisheries Offices, Planning Offices, or a Natural Resources Authority. Measured values may be available in regions which have an established monitoring programme.

Indicator	Details
Temperature change (rise)	This data is commonly available from National Meteorological Services, Environmental Divisions, or Disaster Management Offices, and will likely take the form of either a) a time-series of daily highs from a single central location, b) gridded daily averages across an area, or c) direct output (commonly csv format) from one or many all-weather stations. Depending on the nature of the output, the Delivery Team will have a series of choices in the processing of this data before it is made into an indicator for the MVA. Most important of these choices is determining the metric and historical period to base this indicator on. Temperature data is likely to include one of many variables, including but not limited to: daytime maximum, night-time minimum, daytime average, or night-time average temperature. Further, this data may be available as daily, weekly, monthly, or seasonal measurements. It is at the discretion of the Delivery Team to choose which of these variables and measurement scales to use for the MVA. The choice should broadly agree with data available and used for other indicators. A second, important decision for the Delivery Team is the choice of historical period. Once again, this choice should agree with historical periods chosen to represent other indicators. This choice will also be dependent on the length of available records and completeness of the dataset. Parallel to this, representative measurements for the current period should be selected. There should be no overlap in data used to create the historical average or the current measurement. If possible, advice should be sought from local climate or weather professionals. **Processing:** Following the establishment of a reliable historical average and current value using the agreed time series, temperature change should be presented as an anomaly value (above or below) the historical average. This can be achieved by subtracting the historical averages from the "current" value. The anomaly values should then be rasterised if they are currently present as vector (or even CSV) data. The methodological choice is left to the Delivery Team. For equally spaced point records, it is likely best to create an interpolated surface across the MVA area. Contrastingly, it may be better to apply a buffer of the approximate effective area. For single measurements from a central location, the Delivery Team can choose if it is better to apply the same value across the entirety of the area or determine a single "zone" of impact. Finally, the raster data should be normalised. Since the dataset will have negative values, the normalisation should begin by adding the absolute value of the lowest anomaly to the entire dataset, so that the lowest value is now 0. The data can then be normalised as usual.
Sea level rise	Localised and area-specific data may be available from a National Meteorological Service, a Natural Resource Management Office, a Fisheries Division, or a Blue/Marine Economy Authority. Where localised and area-specific data are not available, there should be relatively high-quality, freely accessible global datasets. It is also possible that this dataset is built through change analysis on images across a suitable time series, or from expert opinion with an elevation dataset. It is the discretion of the Delivery Team to determine the historical period to use in this indicator. Following established guidance and other indicators, the choice of historical period should broadly agree with the data available and used for other indicators **Processing:** Sea Level Rise should be presented as amount of rise, in metres (rounded to the nearest tenth). To make the data amenable to the MVA methodology it should be normalised so that the areas of highest SLR are represented by "1" and the unaffected areas are represented by "0." Vector data must be rasterised to the common grid size before inclusion in the MVA.

Indicator	Details
Flooding	Data and information on the areas affected by fluvial or riverine flooding may be available from the National Meteorological Service, the Environmental or Natural Resources Authority, or even Planning Offices. These data may take one of many forms, including historical images of high-water levels, digital flood risk zones or maps, recorded or projected flood level depth, or textual descriptions of first-hand accounts. Because of the variety in possible representation of flooding datasets, the Delivery Team may need to digitise, update, or conduct image analysis to prepare the available data for inclusion in the MVA. It is important that information used in the MVA contain as much detail about the input dataset(s) as possible. Flooding can occur as a result of one or a combination of multiple hydrological factors, each with unique characteristics and downstream effects. The strength of the MVA, and the validity of its analysis and the resulting interventions, will therefore benefit from the knowledge of which mechanism(s) is (are) represented. Some common flooding mechanisms include: • River overflow from seasonal ice/snow melt or excess rain (i.e., fluvial floods) • Blockages from vegetation, ice, or landslides • Excess overland flow (i.e., flash floods) • Prolonged, heavy rainfall and rising ground water levels • Reservoir failure In the complete absence of available information, flood zones can be inferred as flat-low-lying areas next to watercourses and with shallow water tables. **Processing:** The representation of the flood indicator will depend on the nature of the data available to build the indicator. In the case that the flood zone/are is inferred from imagery or elevation data, the indicator should be expressed as a binary where "0" represents areas with no flood risk and "1" represents areas with flood risk. If the available data indicated more than a single flood risk zone, the Delivery Team may wish to assign numerical values that increase with the level of risk. In the latter, the data must be normalised before its inclusion in the MVA. In the presence of an advanced dataset where depth of flooding is presented, values can be normalised to that the highest depths are represented by "1" and the shallowest observations or projections are presented by "0". All vector data must be rasterised along the common grid size prior to inclusion in the MVA.
Drought	These data may be available from Agricultural Offices, National Meteorological Services, Environment Authorities, or Disaster Relief Authorities. Drought information, and a subsequent indicator can be presented in many ways. The choice of representation is at the discretion of the Delivery Team and will be heavily influenced by the nature of the data available. There are four types of droughts recognised (meteorological, hydrological, agricultural, and socioeconomic), and the Delivery Team should be cautious to ensure consistency among the information used to build the indicator. Types of droughts should not be mixed. Some common representations include but are not limited to: • Extent of areas previously impacted • Magnitude or scale of impact of previous droughts across areas. • Locations deemed most likely to be impacted • Areas that will be most devastated in the event of a drought across the entirety of the MVA area The choice of representation, as well as the type of drought used to build this indicator should be recorded and noted in any analysis activities following the MVA. **Processing:** The representation of the drought indicator will depend on the nature of the data available to build the indicator. Indicators that are measured against a baseline value should be represented as an anomaly, with the baseline chosen so that it agrees with baselines or historic periods used in other indicators. Point data should be either interpolated to form a surface across the area of interest, or have their areas of impact manually digitised. All values should be normalised so that "1" indicates the areas of highest vulnerability and "0" represents areas without. As with all indicators for the MVA, these data should be rasterised to the common grid size.

Indicator	Details
Landslides	These data may be available from the National Environment Authority, a Natural Resources Office, Planning Offices, or Disaster Response Authorities. Data on landslides may take one of many forms, including but not limited to: • Past impact areas • Locations of known hills and cliffs that are unstable • Restricted access areas on popular hiking areas • Sites of past stabilization interventions • Verbal or textual accounts of past events These data may be present as LiDAR, raster, or textual descriptions. Where landslide data are not readily available, the indicator can be approximated from a combination of digital elevation and soil or geology data by isolating steep slopes with loose, unconsolidated soil, or fractured and weathered rock and drainage paths if the data are available. This analysis should be conducted with the guidance of a local geologist, engineer, or planner. **Processing:** Representation of the landslide indicator should exist as a simple binary, where "0" represents an area that is not subject to landslides and "1" represents the area that is. Delivery teams should note that the indicator is intended to represent areas potentially affected by landslides, and not just the physical landslide location itself.
Coastal erosion	Data on coastal erosion may be available from the National Environmental Authority, Fisheries Offices, Planning Offices, or a Natural Resources Authority. Measured values may be available in regions which have an established monitoring programme. Coastal erosion can also be inferred through change analysis on LiDAR, satellite, or aerial imagery. If using this approach, Delivery Teams should be cautious to ensure the images are from the same season (to remove any variability from competing accretionary or erosion seasons), and both represent the same time in the tidal cycle. In all approaches, the baseline year from which erosion is measured should be broadly consistent with what has been considered the end of the historical period or the start of the current period in other time-dependent indicators. **Processing:** Coastal erosion datasets should be presented as the reduction in coastline extent (linear), in meters and rounded to the nearest tenth. In datasets that present a measured or historical record, it may be possible to present the indicator as a rate of change calculated over the period of the available measurements. Where data are presented as geolocated measurements or records, the Delivery Team can choose to create an interpolated surface along the affected coastline, or to manually determine the area of influence for each measurement. To make the data amenable to the MVA methodology it should be normalised so that the areas of highest erosion are represented by "1" and the unaffected areas are represented by "0." Vector data must be rasterised to the common grid size before inclusion in the MVA.

ANNEX TO THE MULTILAYERED VULNERABILITY ASSESSMENT DATA COLLECTION AND ANALYSIS BRIEF

GIS INDICATOR FACTSHEET: Biodiversity dimension indicators

GIS analysis
Dimension Indicator

Biodiversity

Information

This indicator factsheet for biodiversity provides a structured overview of spatial indicators essential for analysing biodiversity-related vulnerabilities and ecosystem health through geospatial methods. It includes a range of metrics such as Mean Species Abundance (MSA), protected or conservation areas, biodiversity connectivity, and the ratio of native to invasive species, each critical for understanding biodiversity›s role in resilience and vulnerability. The factsheet guides practitioners in sourcing, processing, normalising, and rasterising biodiversity data to ensure consistent and locally adaptable inputs for the Multilayered Vulnerability Assessment (MVA). By standardising these indicators, it facilitates evidence-based decision-making to safeguard biodiversity and enhance ecosystem resilience.

Sub indicators

Mean species abundance dataset

Protected / conservation areas

Biodiversity connectivity

Ratio of native species to invasive / nonnative species

Description

Mean species abundance dataset. Species diversity is the foundation of a healthy planet. Mean species abundance (MSA) is one such measure of biodiversity. MSA measures the mean abundance of original species relative to their abundance in an undisturbed ecosystem. It can also be considered an indicator of the “naturalness” or “intactness” of biodiversity across an area.

Protected / conservation areas. Protected or conservation areas data may be available as point data indicating centre points or boundaries, or as polygons delineating boundaries. These datasets may be available from national environmental or resource management agencies. Commonly, locations and boundaries of protected or conservation areas are published by the responsible authority and available to the public.

Biodiversity connectivity. Connectivity is a measure of the relative ease with which typical species can move through the landscape between patches of habitat. Connected habitats enable unimpeded movement of species and the flow of natural processes. Fragmented habitats are oftentimes too small to sustain populations of some species and can hinder movement and access to food and other resources. Increased habitat connectivity is therefore linked to increased habitat health and longevity.

Ratio of native species to invasive / non native species. Invasive non-native species can have a negative effect on populations of native species through the spread of disease, competition for resources, or by direct consumption. When a non-native species is introduced, it can multiply swiftly because of the absence of predators in the new environment. This enables invasive non-native populations to swell, contributing to positive feedback loop.

Indicator	Details
Mean species abundance	Species diversity is the foundation of a healthy planet. Mean species abundance (MSA) is one such measure of biodiversity. MSA measures the mean abundance of original species relative to their abundance in an undisturbed ecosystem. It can also be considered an indicator of the "naturalness" or "intactness" of biodiversity across an area. MSA is a specialty biodiversity dataset. It may be available from a national biodiversity protection agency or local environmental groups. These data are commonly found as raster data. Where these data are not available from local or national sources, there are some data freely available from online sources such as GLOBIO. **Processing:** MSA ranges from 0 to 1. An MSA of 0 is indicative of a completely destructed ecosystem where no original species remain, while an MSA of 1 is indicative of a fully intact species assemblage. To represent these data as an indicator in the MVA, the values will need to be inverted so that an MSA of 1 corresponds to a vulnerability value of "0", and an MSA of 0 corresponds to a vulnerability value of "1".
Protected/ conservation areas	Protected or conservation areas data may be available as point data indicating centre points or boundaries, or as polygons delineating boundaries. These datasets may be available from national environmental or resource management agencies. Commonly, locations and boundaries of protected or conservation areas are published by the responsible authority and available to the public. Where official data is not available, there may be open-source data available from online sources like the IUCN and Protected Planet. Protected or conserved areas typically have increased regulations or limitations on types of land use and development that can occur within their boundaries. These regulations are one of many tools applied in protected or conservation areas intended to enable long-term conservation of nature with associated ecosystem services and cultural values. The MVA therefore considers the presence of a protected or conservation area (and its associated regulations) as a measure that reduces vulnerability across an area. **Processing:** Representation of the protected or conservation areas in the MVA should follow a simple 1/0 binary. Since 0 in the MVA represents no or low vulnerability, this should be assigned to the protected or conservation areas. Areas that are not protected or conserved should be assigned a "1". Vector data should be rasterised to the common grid used across the assessment.

Indicator	Details
Biodiversity connectivity	Connectivity is a measure of the relative ease with which typical species can move through the landscape between patches of habitat. Connected habitats enable unimpeded movement of species and the flow of natural processes. Fragmented habitats are oftentimes too small to sustain populations of some species and can hinder movement and access to food and other resources. Increased habitat connectivity is therefore linked to increased habitat health and longevity. These data may be available from national biodiversity protection agencies or local environmental groups. These data are commonly found as raster data although may also exist as polygon or tabular/descriptive information. There are many ways to consider the connectivity of biodiversity and ecosystems, including but not limited to: functional or structural connectivity, ecosystem type, degree of human disturbance, or scale. To simplify the application of this indicator, the MVA will consider connectivity as the fraction of natural ecosystems within the immediate surrounding area, so that a grid cell surrounded by no natural ecosystems has no connectivity, and one surrounded completely by natural ecosystems has 100 per cent connectivity. This calculation is defined in the processing section, below. As a representation of vulnerability, no or low connectivity equates to vulnerability while high or complete connectivity equates to resilience (no vulnerability). Because of the simplifications used in this indicator, it is possible to build this indicator using available land cover data or raster image data. Note however, if country teams have the data available and are comfortable using popular connectivity analysis approaches like least-cost path or resistant kernel models are welcome to apply those if preferred. **Processing:** Calculation of this indicator utilises the Focal Statistics tool. The input dataset must first be converted to a raster with the common grid size used in the MVA. Within the input dataset, binary values should be assigned so that intact or natural ecosystems are assigned a 0 (for no vulnerability) and areas that are without natural habitats or ecosystems are assigned a 1 (indicating that they are vulnerable). Note that this result is a processing step for this indicator and not yet a useful output. To calculate the connectivity indicator, a fragmentation value at each grid cell is then obtained as the sum of the grid cells in the surrounding "neighbourhood" (the 3x3 square rectangle of cells immediately surrounding the cell of interest). This can be achieved using the Focal Statistics tool in a GIS. A grid cell where half the surrounding cells are intact ecosystems or habitats, and half are degraded or destroyed ecosystems would have a fragmentation value of 4. Since natural habitats do not contribute to vulnerability, they have been assigned a 0 value and their presence is not "seen" in the calculation. The maximum possible value for a non-edge cell is 8 and obtained when the entire surrounding area is degraded or destroyed ecosystem, relating to no possible connectivity and therefore the highest vulnerabilities. The final step to calculating the biodiversity connectivity indicator is to normalise the fragmentation raster values so that the most vulnerable areas, where there is zero connectivity, are represented by a "1".
Ratio of native species to invasive non-native species	Invasive non-native species can have a negative effect on populations of native species through the spread of disease, competition for resources, or by direct consumption. When a non-native species is introduced, it can multiply swiftly because of the absence of predators in the new environment. This enables invasive non-native populations to swell, contributing to positive feedback loop. Information on invasive non-native species, and/or the ratio of native species to invasive non-native species may be considered specialised and therefore may be difficult to obtain. If available, it may be held by national biodiversity protection agencies, agricultural research groups, or local environmental groups. Where available, these data may be available as raster data, or as point data or tabular data representing field measurements across an area. **Processing:** For use as an indicator in the MVA, these data should be normalised so that areas with a high population of native species and low population of invasive non-native species are indicative of no or low vulnerability. Conversely, areas of low native species populations and high populations of invasive non-native species are highly vulnerable. In the event that data to support this indicator are represented as point or tabular information, the dataset should be interpolated across the area of interest to create a raster surface.


Public spaces in a leafy neighborhood in downtown Samarkand, Uzbekistan
2024 © UN-Habitat_Lee Michael Lambert

Glossary of terms

To enhance clarity and usability, the MVA Handbook›s Glossary is organized into several categories based on the multidisciplinary and interdisciplinary nature of the key terms and concepts used throughout the technical guidance material's stages, steps and activities. This Glossary helps users quickly locate terms relevant to specific aspects of urban planning, climate change adaptation, biodiversity conservation, socioeconomic development, and geospatial analysis and tools.

The Glossary utilizes definitions drawn from the glossaries of several highly recognized global bodies and insitutions, including IPCC, UN-Habitat, UNDP, UNDRR, UNEP-WCMC, and ESRI.

Category: Climate change	
Term	**Definition**
Adaptation	In human systems, the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities. In natural systems, the process of adjustment to actual climate and its effects; human intervention may facilitate adjustment to expected climate and its effects.
Adaptive capacity	The ability of systems, institutions, humans and other organisms to adjust to potential damage, to take advantage of opportunities or to respond to consequences.
Climate finance	The term 'climate finance' is applied to the financial resources devoted to addressing climate change by all public and private actors from global to local scales, including international financial flows to developing countries to assist them in addressing climate change. Climate finance aims to reduce net greenhouse gas emissions and/or to enhance adaptation and increase resilience to the impacts of current and projected climate change. Finance can come from private and public sources, channelled by various intermediaries, and is delivered by a range of instruments, including grants, concessional and non-concessional debt, and internal budget reallocations.
Climate projections	Simulated response of the climate system to a scenario of future emissions or concentrations of greenhouse gases (GHGs) and aerosols and changes in land use, generally derived using climate models. Climate projections are distinguished from climate predictions by their dependence on the emission/concentration/radiative forcing scenario used, which is in turn based on assumptions concerning, for example, future socio-economic and technological developments that may or may not be realised.
Ecosystem-based adaptation	The use of biodiversity and ecosystem services as part of an overall adaptation strategy to help communities cope with the adverse effects of climate change, such as restoring wetlands to manage flood risks.
Co-benefits	A positive effect that a policy or measure aimed at one objective has on another objective, thereby increasing the total benefit to society or the environment. Co-benefits are also referred to as ancillary benefits.
Exposure	The presence of people; livelihoods; species or ecosystems; environmental functions, services, and resources; infrastructure; or economic, social, or cultural assets in places and settings that could be adversely affected.
Mitigation	A human intervention to reduce emissions or enhance the sinks of greenhouse gases.

Category: Climate change	
Term	**Definition**
Multilayered vulnerabilities	Multilayered vulnerabilities in cities refer to the interconnected and overlapping risks that arise from urbanization, climate change, and biodiversity loss, affecting social, economic, and environmental systems at multiple levels and scales.
Nature-based solutions	Actions that harness the power of nature to address societal challenges, such as climate change, water security, disaster risk reduction, biodiversity loss, and human health. These solutions involve the protection, sustainable management, and restoration of natural or modified ecosystems to improve resilience, enhance biodiversity, and provide a range of environmental, social, and economic benefits.
Resilience	The capacity of interconnected social, economic and ecological systems to cope with a hazardous event, trend or disturbance, responding or reorganising in ways that maintain their essential function, identity and structure. Resilience is a positive attribute when it maintains capacity for adaptation, learning and/or transformation.
Risk	The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems. In the context of climate change, risks can arise from potential impacts of climate change as well as human responses to climate change. Relevant adverse consequences include those on lives, livelihoods, health and well-being, economic, social and cultural assets and investments, infrastructure, services (including ecosystem services), ecosystems and species.
Sensitivity	The degree to which a system or species is affected, either adversely or beneficially, by climate variability or change. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range, or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).
Vulnerability	The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts and elements, including sensitivity or susceptibility to harm and lack of capacity to cope and adapt.
Vulnerability assessment	The systematic evaluation of the exposure, sensitivity, and adaptive capacity of urban areas, communities, or systems to environmental hazards and socioeconomic stresses, often used to prioritize resilience-building efforts.
Vulnerability hotspot	A geographical area characterized by high vulnerability and exposure to climate change.

Category: Urban planning and development	
Term	**Definition**
Critical infrastructure	The physical and virtual systems and assets essential for the functioning of a society and economy. This includes transportation networks, water supply, energy grids, communications, and health systems, which are vital for urban resilience and the ability to withstand and recover from disasters or disruptions.
Financial feasibility	The evaluation of whether a project or initiative is viable from a financial perspective. It involves assessing whether the expected benefits and outcomes justify the costs, and whether adequate funding can be secured for implementation.
Financial instruments	Tools or contracts used to raise capital, manage risk, or transfer resources. In urban development and climate resilience, these can include bonds, loans, insurance, grants, and carbon credits, helping fund projects or mitigate financial risks associated with climate change or infrastructure investments.
Funding mechanisms	The structured approaches or systems for securing financial resources for projects or programs. These mechanisms can include public-private partnerships, international development funds, municipal bonds, climate funds, and other avenues to finance urban resilience and infrastructure improvements.

Category: Urban planning and development	
Term	**Definition**
Green infrastructure	Natural or semi-natural systems and networks, such as parks, green roofs, and urban forests, that provide environmental services like reducing flood risks, improving air quality, and enhancing biodiversity in urban areas.
Integrated urban planning	A planning approach that considers multiple dimensions of urban development (social, economic, environmental, and infrastructural) in a coordinated and holistic manner, aimed at creating sustainable, resilient cities.
Institutional Governance	The framework of rules, policies, and processes that guide the operations and decision-making of institutions, such as governments, public bodies, and NGOs. Effective governance ensures accountability, transparency, and coordination across sectors and levels of authority, which is critical for sustainable urban development and resilience planning.
Local government	The administrative body responsible for managing public services, infrastructure, and policies at the municipal or regional level. Local governments play a pivotal role in urban planning, disaster risk reduction, and the implementation of climate adaptation measures within cities.
Municipality	A city, town, or district that has its own local government and administrative structures. Municipalities are responsible for providing essential services, including public safety, water supply, sanitation, and urban planning, and are often at the front line of addressing climate and urbanization challenges.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs, integrating environmental, social, and economic dimensions.
Urban services	The essential public services provided to residents within an urban area, including water supply, waste management, transportation, electricity, healthcare, and education. Ensuring the equitable provision of these services is crucial for enhancing urban resilience and sustainable development.
Urban systems	The interconnected networks of infrastructure, social services, governance structures, and economic activities that support the functioning of a city or urban area. Urban systems are dynamic and complex, and their resilience depends on how well they can adapt to environmental, economic, and social changes.

Category: Biodiversity and environmental conservation	
Term	**Definition**
Biodiversity	The variety and variability of life on Earth, encompassing the diversity of species, ecosystems, and genetic resources. Biodiversity supports ecosystem services that are crucial for human well-being and urban sustainability, such as air and water purification, climate regulation, and food provision.
Biodiversity hotspot	A region that is both rich in biodiversity and under significant threat from human activities, such as urbanization or climate change. Cities located near biodiversity hotspots have a unique role to play in protecting these areas through sustainable urban planning and conservation efforts.
Blue-green infrastructure	A strategic approach to urban planning that integrates water management (blue infrastructure) and green spaces (green infrastructure) to enhance biodiversity, manage stormwater, and mitigate climate impacts. Examples include green roofs, rain gardens, and urban wetlands.
Ecological connectivity	The degree to which ecosystems and habitats are connected, allowing for the movement of species and the flow of ecosystem services. In cities, ecological connectivity can be supported through green corridors, wildlife passages, and integrated green infrastructure.
Ecosystems	Communities of living organisms (plants, animals, and microorganisms) interacting with each other and their physical environment (air, water, soil). These systems are interconnected and function as a unit, providing vital services like nutrient cycling, climate regulation, and habitat provision.
Ecosystem services	The benefits that humans derive from ecosystems. In cities, these services include air quality regulation, flood management, climate regulation through carbon sequestration, cooling effects from vegetation, and mental and physical health benefits from green spaces.

Category: Biodiversity and environmental conservation	
Term	**Definition**
Habitat fragmentation	The process by which larger, contiguous habitats are divided into smaller, isolated patches due to urban development, infrastructure expansion, or land-use changes. Fragmentation limits species movement, reduces biodiversity, and weakens ecosystem resilience to climate change.
Land use change	The alteration of the natural landscape, typically for urban development, agriculture, or infrastructure projects. Land use change is a leading driver of biodiversity loss in cities, contributing to habitat destruction and reduced ecosystem services.
Protected areas	Designated areas in or near cities that are protected by law to conserve biodiversity and natural ecosystems. Urban protected areas help preserve species, enhance ecosystem resilience, and provide recreational spaces for urban populations.
Species intactness	A measure of biodiversity that refers to the number of different species present in a given area. In urban environments, maintaining species richness is important for ecosystem health, resilience, and the continued provision of ecosystem services.
Urban biodiversity	The variety of living organisms within an urban area, including plants, animals, and microorganisms. Urban biodiversity contributes to ecosystem functioning and resilience, but it is often threatened by land use changes, pollution, and habitat fragmentation due to urbanization.

Category: Biodiversity and environmental conservation	
Term	**Definition**
Empowerment	The process of enabling individuals and communities, especially those that are marginalized, to gain control over their lives and influence the decisions that affect them. In urban climate resilience, empowerment involves increasing the capacity of vulnerable groups to adapt to and mitigate climate impacts through access to resources, knowledge, and decision-making.
Equitable development	Urban development that prioritizes the fair distribution of benefits and opportunities to all communities, especially those that are marginalized or vulnerable. In the context of climate change, equitable development ensures that infrastructure, resources, and adaptation efforts benefit all residents, particularly the most vulnerable.
Disability inclusion	The practice of ensuring that persons with disabilities are included in all aspects of urban planning, climate adaptation, and disaster risk reduction. In cities, disability inclusion in climate resilience efforts ensures that urban environments are accessible and that emergency responses are designed with the needs of persons with disabilities in mind.
Gender equity	The process of being fair to people of all genders by addressing and correcting the imbalances and disadvantages they face. In urban climate adaptation, gender equity ensures that women, men, and gender-diverse people have equal opportunities to participate in decision-making and benefit from urban services.
Gender mainstreaming	A strategy to integrate gender perspectives and considerations into policies, programs, and projects to ensure that all genders are equally considered. In climate action, gender mainstreaming aims to promote inclusivity and address the different vulnerabilities of men and women in cities.
Gender-responsive climate action	Climate initiatives that recognize and address the distinct needs, roles, and contributions of different genders. In urban planning, this includes ensuring that climate policies are sensitive to gender-based vulnerabilities, such as women's higher exposure to natural disasters or limited access to resources.
Inclusive climate action	Climate policies and measures that actively consider the needs, rights, and contributions of all segments of society, including women, marginalized communities, and vulnerable groups. Inclusive climate action in cities ensures that adaptation and mitigation efforts are accessible and beneficial to all.
Inclusive decision-making	The process of ensuring that all relevant stakeholders, especially underrepresented and marginalized groups, are included in climate and urban policy decisions. This fosters more equitable and effective climate resilience solutions that reflect the diverse needs of the urban population.

Category: Biodiversity and environmental conservation	
Term	**Definition**
Marginalized communities	Groups that experience systemic exclusion or disadvantage due to factors such as race, ethnicity, income, gender, or disability. In the context of climate change, marginalized communities often face the highest risks and have the least access to resources for adaptation and recovery.
Social equity	The fair and just distribution of resources, opportunities, and benefits within an urban area, ensuring that all residents, regardless of socioeconomic status, have access to services, housing, and resilience measures.
Social inclusion	The process of improving the ability, opportunity, and dignity of individuals and groups who are disadvantaged based on their identity to participate fully in society. In the urban context, social inclusion ensures that marginalized populations (e.g., low-income groups, persons with disabilities) are involved in and benefit from climate resilience and adaptation initiatives.
Vulnerable populations	Groups of people who are more likely to be adversely affected by climate change due to factors like poverty, age, gender, disability, or social marginalization. In cities, vulnerable populations are often disproportionately impacted by climate-related risks, such as flooding or heatwaves.

Category: Geospatial analysis and tools	
Term	**Definition**
Attribute data	Information associated with geographic features that describe their characteristics. Attribute data can include names, classifications, or numerical values related to spatial features.
Bivariate mapping	A mapping technique that displays the relationship between two variables using different colors, symbols, or shades. This method helps visualize correlations or patterns in spatial data.
Boundaries	Defined lines or borders that separate geographic areas, such as political divisions, administrative zones, or land-use categories. Boundaries are crucial for spatial analysis and the interpretation of geospatial data.
Choropleth mapping	A thematic mapping method that uses shades or colors to represent the distribution of a variable across geographic areas. This type of map is effective for visualizing data like population density, income levels, or disease prevalence.
Coordinate system	A framework for identifying locations on the Earth's surface using numerical values. Common coordinate systems include geographic coordinates (latitude and longitude) and projected coordinates (e.g., UTM).
Data inventory	A comprehensive list or catalog of available datasets, including their sources, attributes, formats, and geographic extents. A data inventory helps researchers and analysts identify relevant data for their geospatial analysis.
Digitization	The process of converting analog data, such as paper maps or photographs, into digital format for use in GIS applications. Digitization involves creating digital representations of geographic features and their attributes.
Dimension	A measurable extent of a geographic feature, typically referring to spatial (length, width, height) or temporal (time) aspects. In the MVA, dimension refers to the climate change, urban or biodiversity layers.
Earth Observation	The gathering of information about the Earth's surface through remote sensing technologies, such as satellites or aerial imagery. Earth observation data is valuable for environmental monitoring, land-use planning, and disaster response.
Geodatabase	A database specifically designed to store and manage geospatial data. Geodatabases enable efficient data organization, access, and analysis in GIS applications.
Geospatial analysis	The examination of spatial relationships, patterns, and trends within geographic data. Geospatial analysis employs various techniques and tools to extract meaningful insights from spatial data.

Category: Geospatial analysis and tools	
Term	**Definition**
Geospatial Workflow	The organized sequence of processes and steps involved in collecting, processing, analyzing, and visualizing geospatial data to achieve specific objectives or deliver outcomes in geographic information systems (GIS) and spatial analysis.
Geographic information system	A system that captures, stores, analyzes, and visualizes geographic data. GIS integrates various data types and provides tools for spatial analysis, mapping, and decision-making.
Georeferencing	The process of aligning spatial data to a known coordinate system so that it can be accurately placed in relation to other geographic data. Georeferencing is crucial for integrating various datasets.
Indicators	Quantifiable measures used to assess specific conditions or trends within a geographic context. Indicators are often used in geospatial analysis to evaluate issues like health, environment, and socioeconomic factors.
Interconnected	Describes the relationship between different geographic features or datasets that are linked or influence each other. Interconnected data is essential for understanding complex spatial phenomena.
Intersecting	Refers to the condition when two or more geographic features overlap or share a common area. Intersecting features can be analyzed to understand relationships or interactions between different datasets.
Manipulation	The process of altering, transforming, or processing geospatial data for analysis. Manipulation techniques may include filtering, aggregating, or modifying data attributes to prepare it for analysis.
Multicriteria overlay analysis	A method that combines multiple layers of spatial data to evaluate alternatives based on various criteria. This technique helps in decision-making processes, such as site selection or land-use planning.
Overlapping	A situation where two or more geographic features cover the same area. Overlapping features can be analyzed to determine relationships or impacts among different datasets.
Overlay analysis	A geospatial analysis technique that combines multiple data layers to identify spatial relationships and patterns. Overlay analysis is used to analyze how different geographic features interact or influence each other.
Polygon	A closed geometric figure defined by multiple points (vertices) connected by straight lines, representing areas on a map, such as land parcels, administrative boundaries, or natural features.
Polyline	A continuous line composed of multiple connected segments that represent linear features on a map, such as roads, rivers, or trails.
Polypoint	A collection of multiple individual points representing discrete locations on a map, such as trees, buildings, or monitoring stations.
Qualitative data	Non-numeric information that describes characteristics or attributes, often collected through interviews, surveys, or observations. Qualitative data can provide context and insights into spatial phenomena.
Quality assurance	Processes and procedures aimed at ensuring that geospatial data meets specified standards and requirements for accuracy and reliability. Quality assurance helps maintain the integrity of spatial analyses.
Quality control	Systematic measures and evaluations implemented to monitor and verify the quality of geospatial data. Quality control helps identify errors or inconsistencies in data collection and processing.
Quantitative data	Numeric information that can be measured and analyzed statistically. In geospatial analysis, quantitative data is used to perform calculations and assess relationships between variables.
Raster	A grid-based data model used to represent continuous surfaces, such as elevation or temperature. Each cell in a raster dataset has a specific value representing a characteristic of that location.
Raster math	The application of mathematical operations to raster datasets to derive new information or create new layers. Raster math can be used for calculations like sum, average, or conditional statements.

Category: Geospatial analysis and tools	
Term	**Definition**
Remote sensing	The acquisition of data about the Earth's surface from a distance, typically using satellites or aerial imagery. Remote sensing is used for monitoring land use, vegetation, and environmental changes.
Spatial resolution	The level of detail represented in a spatial dataset, often determined by the size of the smallest unit (e.g., pixel size in raster data). Higher spatial resolution provides more detail, while lower resolution may provide a broader overview.
Standard operating procedure	A set of established guidelines and protocols for conducting specific tasks or analyses in geospatial projects. SOPs ensure consistency, accuracy, and efficiency in data handling and analysis.
Temporal scale	The time frame over which data is collected, analyzed, or represented. Temporal scale is crucial in understanding trends and changes in spatial phenomena over time.
Vector	A data model that represents geographic features as points, lines, or polygons. Vector data is often used to represent discrete features such as roads, boundaries, and land use.

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