Myanmar Climate Change Alliance

Mainstreaming Climate Change in Town Planning in Myanmar

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Mainstreaming Climate Change in Town Planning in Myanmar

Developed by:

Institute for Housing and urban development Studies (IHS)

and

Myanmar Climate Change Alliance (MCCA)

In Collaboration with

Ministry of Construction

Department of Urban and Housing Development

Department of Building

Ministry of Natural Resources and Environmental Conservation:

Environmental Conservation Department

Mainstreaming Climate Change in Town Planning in Myanmar

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Acronyms

DOB	Department of Building
DUHD	Department of Urban and Housing Development
ECD	Environmental Conservation Department
GAD	General Administration Department
IHS	Institute for Housing and urban development Studies
MCCA	Myanmar Climate Change Alliance
MOC	Ministry of Construction
MONREC	Ministry of Natural Resources and Environmental Conservation
UN-Habitat	United Nations Human Settlements Programme
UN Environment	United Nations Environment Programme

Research team

The Guidelines were developed according to inputs and contributions provided in different phases of the project “Mainstreaming Climate Change in Town planning in Myanmar”.

Phase 1: inception workshop in Nay Pyi Taw

In the inception workshop that was held in March 2018, the selected trainees from MOC and MONREC provided a first overview of the urban planning system in the country and highlighted specific challenges that should be addressed, especially with regards to climate issues. A capacity needs survey was conducted in order to identify the strengths and weaknesses of the group in terms of their skills.

Phase 2: one-week training in Bangkok

In April 2018 a one-week training on “Mainstreaming Climate Change in Town planning in Myanmar” was conducted in Bangkok, Thailand. The curriculum included lectures by IHS, MCCA and guest lecturers, daily workshops for the application on tools and methods on case studies in Myanmar, and field visits.

Phase 3: on-the-job training in Myanmar

During 20 days in June 2018, the trainees with the guidance of IHS and MCCA applied the learnings of the training in Bangkok on their daily work in Nay Pyi Taw, with the aim of reviewing the Town Plans of Pakokku and Taunggyi, and incorporating climate change considerations. The on-the-job training included field trips to Pakokku and Taunggyi where, with the support and cooperation of the local governments and stakeholders, participatory mapping workshops were conducted to collect primary data for past climate hazards and ecosystems in the area.

Phase 4: development of the Guidelines

These Guidelines were developed based on the methodology that was co-designed with the trainees during the on-the-job training, therefore reflecting the needs and context of Myanmar’s institutional structure and planning system. They aim at organizing the developed methodology in clear phases and steps while providing additional sources and references, relating each step to the learning material from the training in Bangkok and referring to policies, studies and reports that have been developed by Myanmar’s government and other organizations.

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Photo credits: Alexandra Tsatsou (IHS)

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1

Introduction

1.1 Cities and Climate Change

Climate change poses a big challenge for many cities around the world. The confluence of rapid urbanization and climate change impacts intensifies the vulnerability of the urban population. While cities experience climate change impacts differently (e.g. higher temperature for one city, lower temperature for another), increases in extreme weather events and human-induced disasters have serious consequences for public health, economic growth, and social security, especially among the urban poor (UN-Habitat, 2014, p. 5).

Cities located along coastlines and river deltas, for example, may be more susceptible to coastal erosion, sea-level rise, and increased flooding. These, in turn, damage infrastructure, displace households and disrupt livelihoods. Among vulnerable groups, such impacts may overstretch their coping strategies as well as magnify already existing inequalities. Moreover, incremental impacts from climate change, such as on water sufficiency and food productivity may not be immediately visible in the short-term (UN-Habitat, 2014, pp. 14–16).

The current and future catastrophic risks are enough reasons for cities to act. If these climate change impacts are not addressed, these will exacerbate already existing challenges and will hasten social and economic development. Building resilience to climate change and adapting to its impacts should be at the forefront. However, climate change planning does not come easy for many local governments, especially in low income countries that are faced with resource constraints (UN-Habitat, 2014, pp. 17–18).

The choices that cities make, in the short and long term, in sectors such as land use planning, infrastructure development, human settlements and disaster risk management, among others, have an influence on the ability to adapt to climatic changes (UN-Habitat, 2014, pp. 23). What land policy instruments and concrete climate resilient actions should cities undertake? How can a city have a well-balanced climate change agenda and at the same time generate additional sustainability benefits?

The most successful climate change initiatives balance development goals and climate change responses (“co-benefits” or “synergies”) as well as multi-scalar (national, regional, local) and multi-sectoral (e.g. energy, transport) actions. Technical and land policy-related solutions are within reach of many cities and local governments. Urban practitioners and planners can use tools and methodologies for responsible decision making and planning and for implementing suitable land use strategies (UN-Habitat, 2014, pp. 23–25).

IHS-MCCA Bangkok sessions	Grafakos, Stelios. (2018). ***Introduction to Cities and Climate Change***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/xh3VzJizPjNmjL (Accessed: 20 July 2018)

1.2 Land Policy Instruments

Land policy instruments or tools can play a decisive role in the implementation of urban development

strategies. There are several different kinds of categories of land policy tools. Each category plays a different role in managing land resources and in helping to manage disaster risk:

- **Planning and regulatory tools** use government planning powers to enforce desired land development patterns, based on the town vision and plan.
- **Administrative instruments** are actions based on the legal power of local governments to restrict or promote/incentivize certain kinds of land development.
- **Taxation instruments** include taxes and special duties and charges based on land use, transfers and land ownership
- **Market instruments** use the land market to influence market actors including households and private firms.
- **Engineering tools** are hardware measures to protect buildings or areas from natural disasters. These kinds of tools are integrated with the local land use plan and can be used in conjunction with planning/regulatory and administrative instruments.
- **Natural protection tools** use natural features that are present in the landscape to reduce disaster risk. As with engineering tools, natural protection tools are part of a land use plan and can be used in conjunction with planning/regulatory and administrative instruments.

1.3 Participatory GIS Approach

Including participation in planning processes is a powerful way of inducing the active support of stakeholders and the ownership for collective decisions. Engaging people in planning and decision-making processes can strengthen social cohesion and also function in an educational way, building active citizens and creating awareness of environmental, social, economic and institutional issues and multiple perspectives. Moreover, participation incorporates a higher level of transparency in decisions and planning processes. Nevertheless, the methods and outcomes of participatory approaches should be dealt with careful attention so as to have processes that rank at the higher degrees of the Arnstein's ladder of participation.

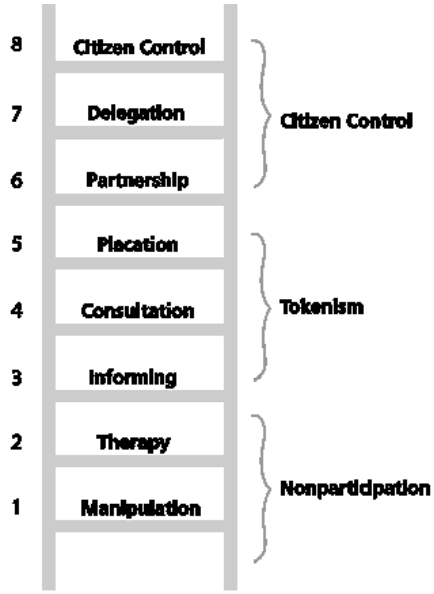


Figure a: The degrees of citizen participation. Source: Arnstein, 1969)

Participatory mapping, one of the many participatory approaches, is a widespread and very informative approach through which planners can collect valuable information, including their spatial dimension. Mapping is any method where people are encouraged to use maps in order to communicate their knowledge and ideas spatially and more clearly. Among the different types of knowledge, such as sectoral or expert specialized knowledge, "community knowledge" has the characteristic of being context specific, community-based and spread by social networks. The

combination of community knowledge and mapping leads to participatory mapping methodologies. Participatory mapping is the open and inclusive process of creating maps with the input of the community, and is fundamental when we want to collect the views of larger groups of people, including the spatial dimension. Maps created through participatory processes represent, apart from the community's knowledge, also the community's values. They represent local knowledge systems such as place names, symbols, events that belong to a community and would be impossible to identify or explore without communication with the local population.

Participatory mapping, apart from a way to access collective community knowledge, is also a tool for community empowerment. Through participatory mapping processes, communities can articulate and communicate spatial knowledge, which is then recorded and archived. Moreover, through expressing and mapping their views, communities can advocate for change, or indicate and address internal problems and conflicts. Overall, through the participation of communities to collective events like participatory mapping workshops they improve their capacities through learning, knowledge exchange and community building.

Land use planning and natural resources management are some of the processes that can benefit from participatory mapping processes as well, especially when it is combined with technology, for example with GIS software. Participatory GIS (P-GIS) is a form of participatory mapping that allows the local population to participate in Town planning processes. The difference between community mapping and P-GIS is what happens to the data *after* it is collected. In P-GIS, the data and information collected through methods such as interviews, questionnaires or focus groups (which use paper or maps to allow participants to record spatial details) is then digitized so that it can be georeferenced and analyzed using the power of GIS software. One of the biggest advantages of this approach, apart from the analytical part, is the possibility to easily visualize the outputs, a powerful means of communication. In these Guidelines we have combined the use of participatory mapping with P-GIS for mapping the results of the Vulnerability Assessment and the Ecosystem Services Assessment.

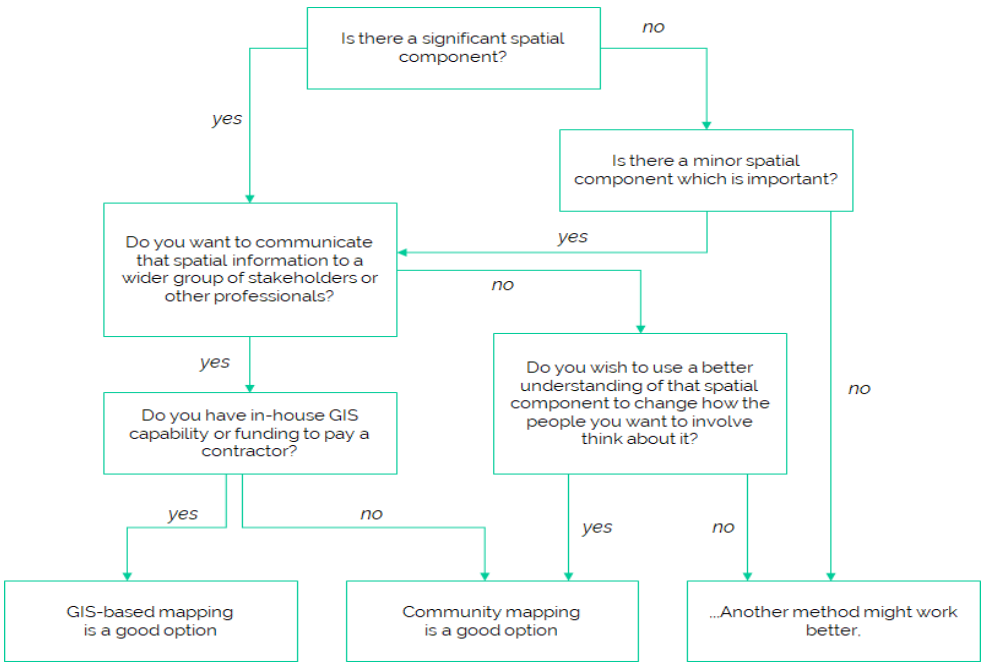


Figure b: Selecting a mapping method/ Source: Adapted from Forrester & Cinderby (2013)

Myanmar policies, studies and reports	Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017a). *Building a resilient Myanmar society through education, science and technology: Policy Guidance Brief 6*.

2

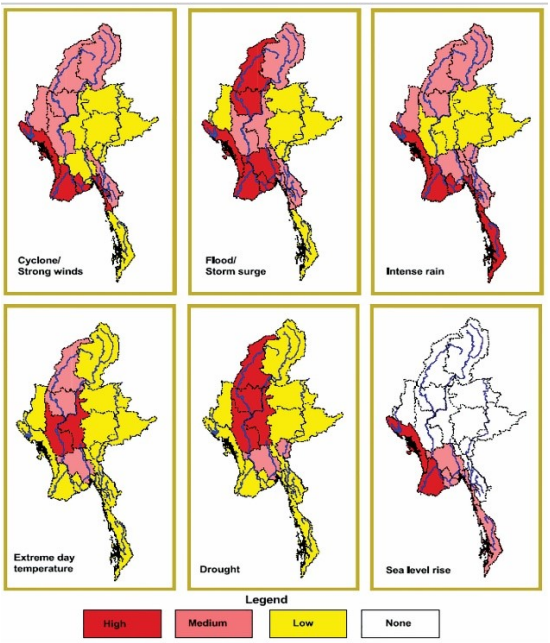
Climate Change and Town planning in Myanmar

2.1 Climate Change Impacts in Myanmar

Predicting climate change impacts at a local level in Myanmar is still challenging and uncertain, mainly due to the lack of data and information. The Myanmar Climate Change Strategy and Master Plan 2018-2030 (MCCMP) also highlights that Myanmar is presently at comparatively early stages of urbanization, which is expected to deliver socioeconomic growth and development but also bring with it potential heightened risk (Department of Urban and Housing Development, n.d., p. 4). For example, as urbanization increases, demand for energy, services, and resources will increase, which in turn may result in increased GHG emissions and degradation of the natural environment. Furthermore, Myanmar's towns and cities will be exposed to additional risk due to the negative effects of climate change: people and assets will suffer from more rapid-onset disasters (floods, cyclones, heat waves etc.) and the slow-onset effects of climate change. These include increasing temperatures, more extreme heat days, more rain but shorter rainy seasons (bringing more intense rainfall and storms), and rising sea levels. The poor, particularly those living in substandard housing and informal settlements, have the lowest capacity to adapt and will be more vulnerable to the impacts of climate change. Fortunately, given its early stage of urbanization, Myanmar has an opportunity to pre-emptively integrate land use planning and climate-change adaptive measures and steer the urbanization process to shape towns and cities that are sustainable, inclusive, low-carbon, and climate-resilient (MCCA/UN-Habitat, 2017, pp. 3–6).

However, climate change has already had an observable impact in Myanmar. Observations made between 1981 and 2010 place average temperature increases at 0.25°C. During this time period, rainfall has increased slightly in Myanmar, and this increase was higher in coastal areas than inland areas. As per Department of Meterology and Hydology(DMH), The monsoon season has been shortened by approximately two weeks (141 days to 121 days) over a period of 30 years 1981-2010. In terms of predictions for climate change effects in Myanmar, temperatures are expected to increase by 1.3°C–2.7°C by mid-century. However warning varies by both season and region, with the cool (Novermber –February) and hot (March-May) seasons projected to see the most warming. In parallel, rainfall is also projected to increase during the monsoon season, with other increases and decreases spread throughout the year. In terms of geographic location, the hilly regions located in the east and the north, are expected to see the most dramatic warming with an average of 3°C increases in the hot season. In the initial observation period outlined above, Myanmar experienced one day of extreme heat a year on average. In future projections, this number is expected to go up to a range of four to seventeen extreme heat days a month. For the coastal areas, projections expect increases in sea level rise between 20cm and 41cm by mid-century. These flooding projections are separate from cyclone activity as they are projected to take place independently of changes in cyclone severity (Horton et al., 2017, pp. 20–28; MONREC (Ministry of Natural Resources and Environmental Conservation), n.d., pp. 24–28).

In this context, the Myanmar Climate Change Alliance (MCCA) has developed a Climate Change Vulnerability Assessment methodology specifically for the context of Myanmar, and has conducted three Vulnerability Assessments at the township level, for the townships of Pakokku , Labutta and Hakha (with ICIMOD). The two locations were selected because they represent different climatic zones of Myanmar, and face different climate change challenges.



Vulnerability of area and Regions/States in intensity and severity of extreme weather events. Source: DMH.

PROJECTED CONSEQUENCES OF CLIMATE CHANGE	
CLIMATE HAZARD	VULNERABLE REGION
Increasing temperatures	All regions
Heatwaves/ extreme high temperature	• Arid and semi-arid central belt • Central Dry Zone
Drought/water insecurity	• Rain-shadow (arid and semi-arid) central belt • Central Dry Zone
More erratic rainy seasons; intense rain and downpours	• Northern Hilly Region • Mountainous and hilly areas in Kayin, Kachin, Shan, Mon and Chin • Ayeyarwady river basin • Central Dry Zone • Coastal areas
Floods	• Catchment areas in Hilly Regions • Low-lying areas along major river systems (such as the Ayeyarwady Delta) • Coastal areas
Cyclones	• Coastal areas, mainly: - Rakhine - Ayeyarwady Delta - Mon
Sea level rise and storm surge	• Coastal areas, particularly Rakhine and Ayeyarwady

Figure 1 Vulnerability of areas and Regions/States in intensity and severity of extreme weather events.

Figure 2 The Irrawaddy (Ayeyarwady) river, more than 5 km wide, and its extended floodplain at the area of Pakokku/Bagan.

Myanmar policies, studies and reports	Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2018a). Better Integrating Social Sustainability in Labutta Township: Building Climate Change Resilience through Rapid Analysis and Potential Actions. Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2018b). Better Integrating Social Sustainability in Wards 13 and 14 Pakokku Township: Building Climate Change Resilience through Rapid Analysis and Potential Actions. United Nations Human Settlements Programme. (2016a). Scenarios for Building Resilience in Pakokku Township: Climate Change Vulnerability Assessment (2016-2050). United Nations Human Settlements Programme. (2016b). Scenarios for Building Resilience in Pakokku Township: Climate Change Vulnerability Assessment (2016-2050) Executive Summary.
IHS-MCCA Bangkok sessions	Cain, Felicity. (2018). ***Introduction to Climate Change in Myanmar***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/9cYzQzzDi3o1bu (Accessed: 20 July 2018) Raasakka, Nina. (2018). ***Introduction to Ecosystem-Based Adaptation and***

	Ecosystem Services. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/6pZMojMcxuJxy7

2.2 Climate Change Policy in Myanmar

Under Myanmar Climate Change Alliance, a fladship programme of MoNREC, Government of Myanmar, Myanmar has developed several specific policy documents in relation to climate change. These include a Myanmar Climate Change Policy, Myanmar Climate Change Strategy and Master Plan 2018-2030 (MCCMP), and sectoral action plans including the action plan for Building Resilience and Sustainable & Inclusive Towns and Cities (MCCA/UN-Habitat, 2017; MONREC (Ministry of Natural Resources and Environmental Conservation), 2016, 2017).

Furthermore, the country has taken international actions that signal its commitment to addressing climate change, such as ratifying the Paris Agreement and adopting the (Intended) National Determined Contributions - (I)NDC.

Myanmar has set the below milestones as goals to its 2030 targets:

- Include climate change in spatial and land-use frameworks, laws & policies which are part of the National Urban Policy, Planning Law, and township by-laws at the national and local levels
- Retrofit, adapt, and/or maintain public service buildings to be resilient to climate change
- Adapt housing and create capacities for self-construction
- Educate town planners, engineers, and architects to include climate resilient design in towns/townships
- Create climate resilience plans for townships and cities
- Ensure real-estate developers and industries design and build while taking climate change into account

Myanmar policies, studies and reports	Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017c). *Climate-smart agriculture, fisheries and livestock for food security: Policy Guidance Brief 1*. Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017e). *Resilient and low-carbon energy, transport and industrial systems for sustainable growth: Policy Guidance Brief 3*. MONREC (Ministry of Natural Resources and Environmental Conservation). (n.d.-a). *Building Local Level Resilience to Climate Change in Myanmar*. MONREC (Ministry of Natural Resources and Environmental Conservation). (n.d.-b). *Building Local Level Resilience to Climate Change in Myanmar: Presentation Training Modules*. United Nations Human Settlements Programme. (2017). Scenarios for Building Resilience in Pakokku Township : Climate Change Vulnerability Assessment (2016-2050) Policy Summary. UN Environment, & UN Habitat. (n.d.). *Building Local Level Resilience to Climate Change and Hazards in Myanmar: A Handbook for Practitioners*.
IHS-MCCA Bangkok sessions	Cain, Felicity. (2018). ***Introduction to the Myanmar Climate Change Alliance and the Policy Context***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/gbVcpUpNChOmlU (Accessed: 20 July 2018)

2.3 Town Planning Process in Myanmar

Myanmar's vision for 2040 is to develop an urban system that contributes to the balanced, sustainable and comprehensive urban and regional development. At the city level, the aim is to establish green cities that provide adequate housing and infrastructure, to upgrade the living standards of all Myanmar citizens. A development concept for "concentrated decentralization and balanced development" has been adopted with Yangon and Mandalay as the main centers. Based on the national plan, cities and towns in Myanmar are classified (classes A, B, C, D, E) based on their characteristics such as being capital cities, major cities of state and region, and also by other attributes like population size.

Figure 3 The hierarchy of the planning system in Myanmar

For the 4th level of the **"City/Town Development Plan"**, where these Guidelines focus, there is a list of 193 towns for planning until 2021, while towns plans have been implemented for around 100 towns. The prioritization of the towns is done by DUHD, who select the town and request the planning permission from the State and Regional government. In special cases, such as disaster affected towns or for new industrial zone projects, the State and Regional government may request to prioritize an urgent Town planning process.

The administrative divisions of Myanmar (and also the common levels at which data, studies and reports are available), are:

1) First level: *Region, State, Nay Pyi Taw Union Territory* (21 sub-divisions)
2) Second level: *District* (67 sub-divisions)
3) Third level: *Township* (330 sub-divisions)
4) Fourth level: *Ward* (urban, 3183 sub-divisions) *Village tract* (rural, 13602 sub-divisions)
5) Fifth level: *Village* (70838 sub-divisions)

The City/Town Development Plan is conducted at the urban scale, which is between the third and fourth levels of the administrative division scale. In the case of Pakokku, the Town Development Plan focuses on the urban area of Pakokku Town. However, in the case of Taunggyi the Town Development Plan regards the town of Taunggyi and also the neighboring towns of Ayetharyar and Shwe Nyaung. Although there is no common structure for the Town Development Plans in Myanmar, they mainly include general conceptual development ideas and proposals, as well as specific

Guidelines for development at the block or the building level. Regarding the land uses, a Town Development Plan will usually indicate the town borders and special areas, not a land use or zoning map.

The planning process is managed differently at the different urban levels. The Figure below presents the structure of the responsible departments in the two urban groups of the country: (one) Yangon-Mandalay-Nay Pyi Taw and (two) all other towns and townships in Myanmar (ADPC, 2014).

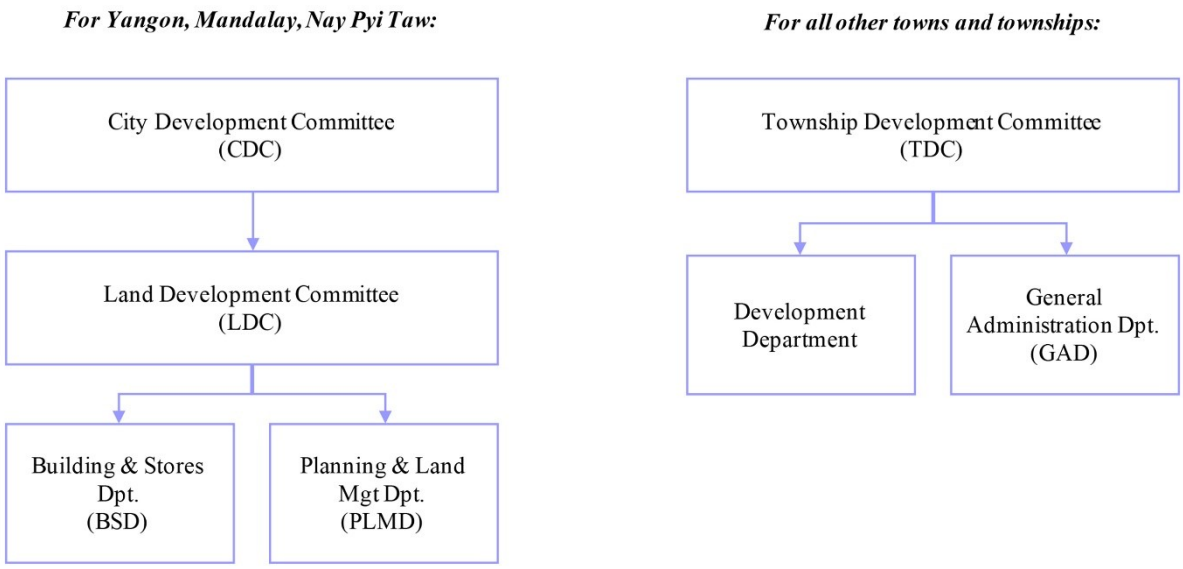


Figure 4 Management of the planning process for different urban centers in Myanmar. Source: Developed with information from (ADPC, 2014)

Myanmar policies, studies and reports	Department of Urban and Housing Development, Ministry of Construction (n.d.-a). *Housing Policy and Strategy*. Department of Urban and Housing Development, Ministry of Construction. (n.d.-b). *Myanmar National Housing Policy White Paper*. Department of Urban and Housing Development, Ministry of Construction. (n.d.-c). *Myanmar National Urban Policy Framework*. Department of Urban and Housing Development, Ministry of Construction. (n.d.-d). *Myanmar Rapid Urban Diagnostic Report*. Ministry of Construction. (2014). *Town planning Summary Report*. Ministry of Construction Urban and Housing Development Department. (2015). *Summary of Taunggyi Urban Structural Planning Report*.
IHS-MCCA Bangkok sessions	Ministry of Construction, Department of Urban and Housing Development. (2018). ***Myanmar Town planning Process***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/26IWMC2FMv4JH1 (Accessed: 20 July 2018) Ministry of Construction, Department of Urban and Housing Development. (2018). ***Conceptual Plan of Pakokku***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/6JYYnUrZHvrkun (Accessed: 20 July 2018) Ministry of Construction, Department of Urban and Housing Development. (2018). ***Conceptual Plan of Taunggyi***. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/lnqnNJgDdrBM4x (Accessed: 20 July 2018)

3

Mainstreaming Climate Change in Town planning

3.1 Conceptual Framework

Mainstreaming climate change considerations in the planning process is crucial, especially considering that Myanmar ranks second in list of most affected countries by climate extreme events between 1996-2015 (Global Climate Risk Index 2017). Adaptation to climate-related hazards will require Town planning that involves governmental institutions, academia, private sector as well as a high level of community participation. Town planning should generally cover the following aspects: it must be efficient (economically viable and with productive use of land) as well as socially acceptable, it should facilitate land use changes or improvements that reduce inequality and land conflicts, it should be sustainable therefore meeting the needs of current and future generations.

Land use planning is the vehicle through which the most important climate change, disaster risk reduction, sustainability and resilience considerations can be mainstreamed in Town Development Plans. The urban development and climate change policies and action plans in Myanmar already identify the need for an integrated approach for climate resilient development. The Land Use Policy of Myanmar (Myanmar, 2016), highlights the importance of land use planning for mitigating the environmental impacts of development and calls for the collaboration of environmental institutions with urban planners. In addition, the Vulnerability Assessments that are being developed by MCCA highlight **ecosystems** as one of the main variables that contribute to the vulnerability (or resilience) of settlements and communities.

Strengthening land use planning in the urbanization process of Myanmar is essential for the selection and adoption of the best land utilization for potential and alternative environmental, social and economic development in cities. Land uses must meet the needs of the local people while preserving natural resources and improving the management of **Ecosystem Services** for current and future generations. Therefore, land use planning could be used as an instrument to authorize land use changes or avert unwanted changes to adapt cities to climate related hazards and mitigate risks.

In this context, the methodology presented in these Guidelines merges three-layered approach in order to mainstream climate change into Town planning that combines:

1. the Town planning process in Myanmar,
2. a Vulnerability Assessment at the town level and
3. an Ecosystem Services assessment.

The main concepts included in the framework are: climate hazards and projections, climate change impacts, current and future Vulnerability Assessment, green and blue infrastructure, Ecosystem Services, co-benefits, ecosystem-based adaptation, nature-based solutions, land use maps, land policy instruments.

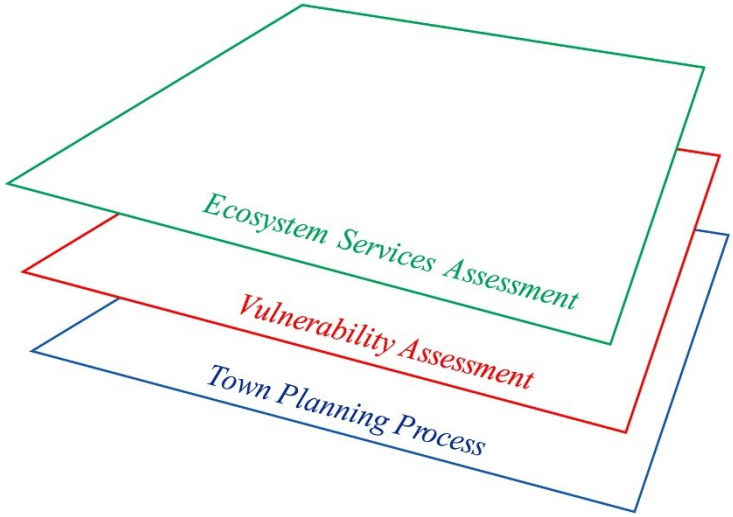


Figure 5 The three-layered approach for mainstreaming climate change in the Town Development Plan.

The three-layered methodology merges the three approaches by combining their steps as shown in the image below:

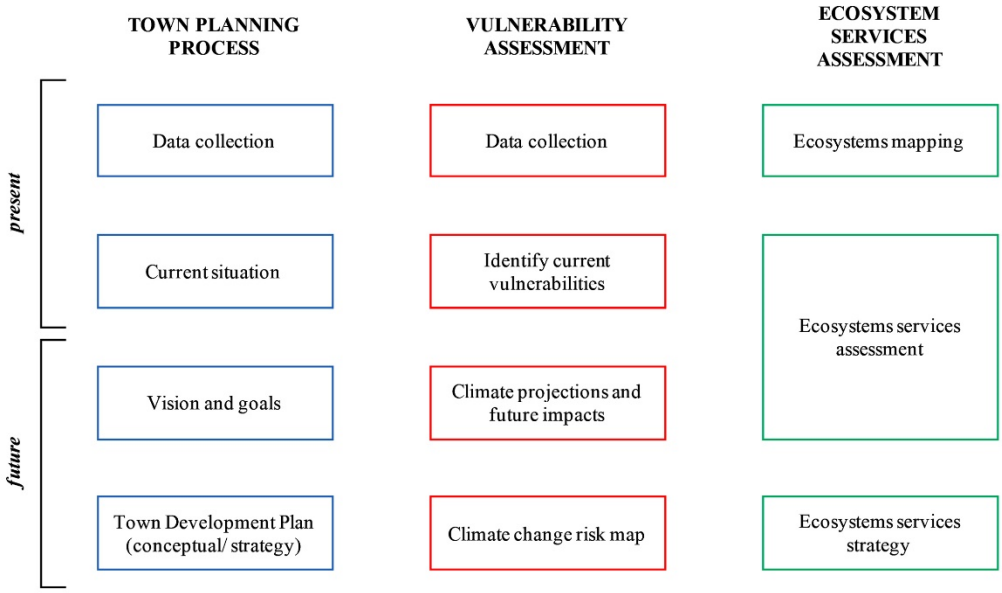


Figure 6 Merging the steps of the three different approaches to a new process of Town planning in Myanmar.

Myanmar policies, studies and reports	Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017f). *Sustainable Management of Natural Resources for Healthy Ecosystems: Policy Guidance Brief 2*. https://doi.org/10.1002/047147844X.wr146 Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017b). Building resilient, inclusive, and sustainable cities and towns in Myanmar: Policy Guidance Brief 4, (October). Retrieved from http://www.burmalibrary.org/docs24/Brief-4_web.pdf Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance. (2017d). *Managing climate risks for people's health and well-being: Policy Guidance Brief 5*.

3.2 Revised Town Planning Process

Mainstreaming climate change in the Town planning process of Myanmar can be organized in **five phases** and each phase is further detailed in **three steps** and various **activities**, as shown in the Figure below.

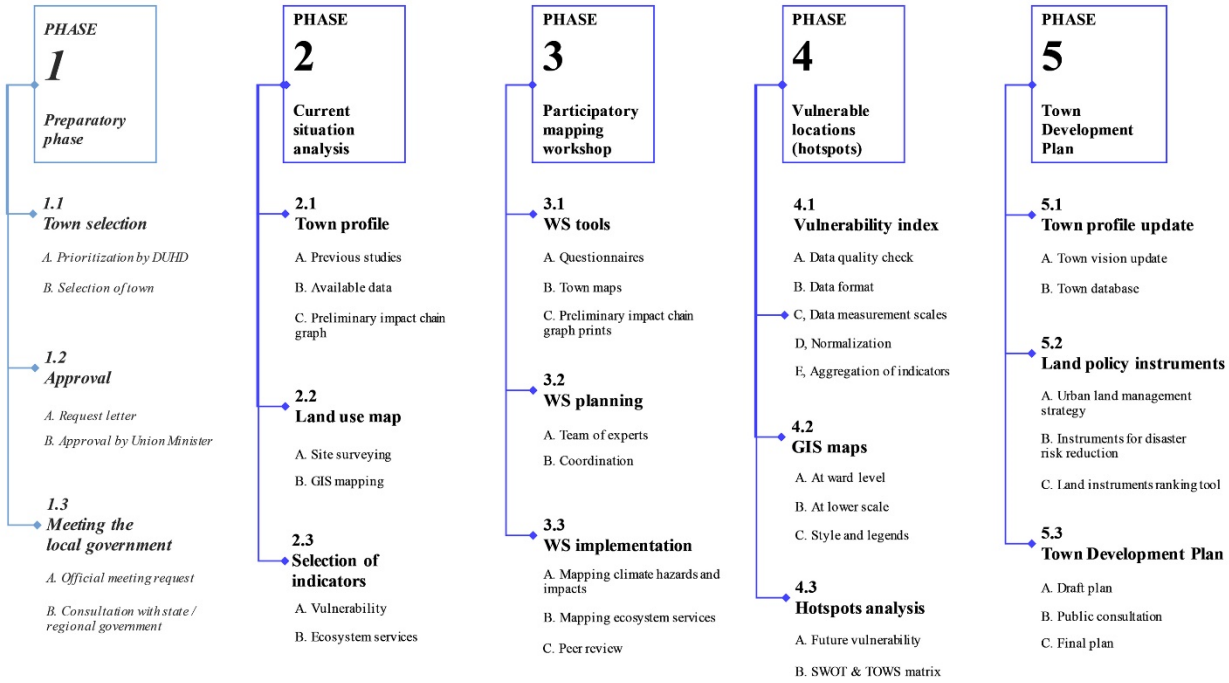


Figure 7 The reviewed town planning process in Myanmar, organized in five phases.

3.3 The Guidelines

Although mainstreaming climate change into town and land use planning has been emphasized by practitioners and scholars as one of the main climate policy responses, in practice, particularly for low and middle income countries, there are very few examples of a systematic approach of mainstreaming climate change in town and land use planning. In addition to that, low income countries suffer from lack of resources and capacity in order to develop and apply a comprehensive approach for mainstreaming climate change issues into town and land use planning. Although there are some of guidelines and handbooks that have been developed on urban climate change adaptation planning, there is a lack of guidance and support to low income countries both at the national and local level on how to mainstream climate change into town and land use planning. Against this background, this Guidelines report aims at bridging this gap and contributing to the capacity development of local and national officials working on town and land use planning.

The objectives of the Guidelines are:

- To provide an overview of the steps where climate change can be mainstreamed in Town planning process in Myanmar,
- To provide step-by-step guidance on applying the suggested methodology for mainstreaming climate change in the Town planning process in Myanmar.

The Guidelines provide step-by-step guidance for mainstreaming climate change in Town planning in Myanmar. An overview of the complete Town planning process is given in order to provide the context in which the analyzed, climate change related activities are developed. However, the focus is on how to collect, analyze and compile the necessary information to include climate change in the land use planning process and eventually the Town Development Plan document. Therefore, the

Guidelines focus on the steps where climate change considerations can be included, through which the suggested methods and activities are presented in an analytical but simple manner.

The methods suggested in these Guidelines are not exclusive and can be altered or replaced by similar methodologies depending on the needs and available resources of each town. The overall method as it is presented in this document is based on the procedure that was developed by IHS, MCCA and professionals of DUHD, ECD, GAD and DOB in Myanmar in June 2018. Pakokku and Taunggyi are the two towns in Myanmar that participated in the development of these Guidelines, and the towns where the Guidelines were applied for the first time.

The expected users of these Guidelines are the governmental staff who are involved in the Town planning process in Myanmar. This includes the town planners and GIS experts of DUHD, along with environmental sciences and built environment or engineering experts from other governmental departments (such as the ECD, DOB, etc), as well as the local government and administration officers (GAD) of towns in Myanmar.

Although some of the concepts that are included in the methodology are defined in the Guidelines, it is assumed that the users have a good understanding of town and land use planning, as well as climate change issues.

The Guidelines were developed as part of the Capacity Building Activity on Land Use Planning and Climate Change which started in March with an inception workshop in Myanmar, and continued in April, 2018 in Bangkok, with the training of eleven government staff from DUHD, DOB, and ECD on Climate Change and Land Use Planning theory and applications. The capacity building activity continued in Myanmar in May 2018 with an “on the job training,” in which participants from MOC in Nay Pyi Taw traveled to the towns of Pakokku and Taunggyi. Along with the local government departments, the participants organized sessions to discuss, develop, and test the method for mainstreaming climate change in the town plans, with the guidance of IHS staff and the support of MCCA. Previous studies and Guidelines developed for Myanmar were considered to achieve synergies with work that was already done. Links and references to these documents are provided at the end of each section.

The Guidelines can be used during Town planning processes in Myanmar in cases, for example, when developing a new Town Development Plan or when revising an existing Town Plan -in which climate change was not initially included.

To ensure alignment with national development goals and priorities, several key documents were considered when preparing this methodology and are mentioned at the end of each section.

The Guidelines are structured as follows. The first section introduced climate change and cities; focusing on Myanmar, the climate change projections and the climate change policy in the country. The second section presented the Town planning process in Myanmar by organizing it in phases, simple steps, and activities. The third section outlined the steps where climate change can be mainstreamed. The conceptual framework for mainstreaming climate change in the process (introducing a Vulnerability Assessment and an Ecosystem Services mapping, conducted through participatory methods and GIS analysis) guides the organization of the steps and activities. The fourth section analyses in detail the steps of the process where climate change can be mainstreamed, following the conceptual framework. For each step the objectives, activities, outcomes, required data and material, as well as additional sources and references are provided.


Existing Land Use & Flood Hazard Map

4

Stepwise Methodology (phases 2-5)

This chapter presents the developed methodology of the Guidelines, which is organized in 5 phases. Each phase consists of 3 steps, and various activities under each step. As climate change can be mainstreamed in the steps and activities of phases 2-5, only the steps of these phases are presented in detail. Specifically, the following aspects for each step are analyzed in this chapter:

- **Objective**: this section presents the specific objective of each step, as part of the overall methodology of the Guidelines.
- **Activities**: each step consists of various activities, which are listed and analyzed one by one, in the section "activities".
- **Outputs**: the outputs section enlists the expected outputs of the step's activities.
- **Data requirements**: this section refers to the data, information and material that is needed in order to complete the activities of each step successfully.
- **Key considerations**: important aspects that require special attention, as well as tips for the implementation of the activities of each step, can be found in this section.
- **Other sources and references**: in the last section, "other sources and references", references and links to academic papers, open access publications, reports and online resources are provided.

IHS-MCCA Bangkok sessions: at the end of each step, there is a grey table with the caption "IHS-MCCA Bangkok sessions". In this table, the reader can have direct access to the relevant presentations from the training in Bangkok that was organized as part of this project. The links provide direct access to the presentations, with one click.

PHASE 1

Preparatory phase

1.1
Town selection

A. Prioritization by DUHD

B. Selection of town

1.2
Approval

A. Request letter

B. Approval by Union Minister

1.3
Meeting the local government

A. Official meeting request

B. Consultation with state / regional government

PHASE
2

Current situation analysis

2.1
Town profile

A. Previous studies

B. Available data

C. Preliminary impact chain graph

2.2
Land use map

A. Site surveying

B. GIS mapping

2.3
Selection of indicators

A. Vulnerability

B. Ecosystem services

PHASE
3

Participatory mapping workshop

3.1
WS tools

A. Questionnaires

B. Town maps

C. Preliminary impact chain graph prints

3.2
WS planning

A. Team of experts

B. Coordination

3.3
WS implementation

A. Mapping climate hazards and impacts

B. Mapping ecosystem services

C. Peer review

PHASE
4

Vulnerable locations (hotspots)

4.1
Vulnerability index

A. Data quality check

B. Data format

C, Data measurement scales

D, Normalization

E, Aggregation of indicators

4.2
GIS maps

A. At ward level

B. At lower scale

C. Style and legends

4.3
Hotspots analysis

A. Future vulnerability

B. SWOT & TOWS matrix

PHASE
5

Town Plan

5.1
Town profile update

A. Town vision update

B. Town database

5.2
Land policy instruments

A. Urban land management strategy

B. Instruments for disaster risk reduction

C. Land instruments ranking tool

5.3
Town Development Plan

A. Draft plan

B. Public consultation

C. Final plan

Phase 2: Current Situation Analysis

Step 2.1 Developing the Town Profile

Objective The objective of this step is to understand the current situation of the town by exploring previous studies, collecting existing data and consulting with the local government and stakeholders. The output is the Town Profile document, which presents an overview of the current situation of the town.

Activities The activities of step 2.1 are conducted in consultation with all the concerned local government departments and parliament representatives, at a meeting organized during the first visit of the planners' team to the city. The (indicative) departments to be invited and consulted are the following:

- General Administration Department
- Township Development Committee
- Survey and Land Record Department
- Department of Meteorology and Hydrology
- Department of Fire Fighting
- Department of Immigration
- Department of Health
- Department of Agriculture
- Department of Forestry
- Department of Environmental Conservation
- Department of Education
- Department of Electricity Distribution
- Department of Irrigation
- Department of Planning
- Department of Rural Development
- Local Communities

A. Previous studies

Knowing what studies have been already conducted for the town and having access to the final reports, collected data, and contacts of the people involved is very helpful for understanding how the town functions, at the beginning of the planning process. The local stakeholders have very good knowledge of the studies conducted previously at their town, or studies conducted at different levels (for example a regional study), which include important background information for the local level as well.

B. Available data

The consultation meeting is also an opportunity to request the required secondary data (historical, social, economic, spatial, environmental and climate data of the last decades and future climate projections, etc.) from the responsible departments. The data should be requested at the lowest possible spatial division level, in order to be able to conduct the most detailed analysis later. For example, having data per building, per neighborhood or per ward is much more helpful than having information for the town as one unit.

C. Preliminary impact chain graph

During the local stakeholder's consultation, the planners' team can structure a first version of the

climate change impact chain graph, based on the current situation of the climate and reflecting on past climate hazards. The impact chain graph, as well as the discussion through which it is constructed, are valuable as they help the team understand the town in the context of climate change and the challenges it has faced in the past.

The **Impact Chain Graph** is an organizational tool which helps in the understanding of the different factors which affect the vulnerability of a system. These can be useful in developing adaptation options. Furthermore, impact chains can be edited throughout their creation process as new information is gathered and assimilated.

Box 1 About the impact chain graph

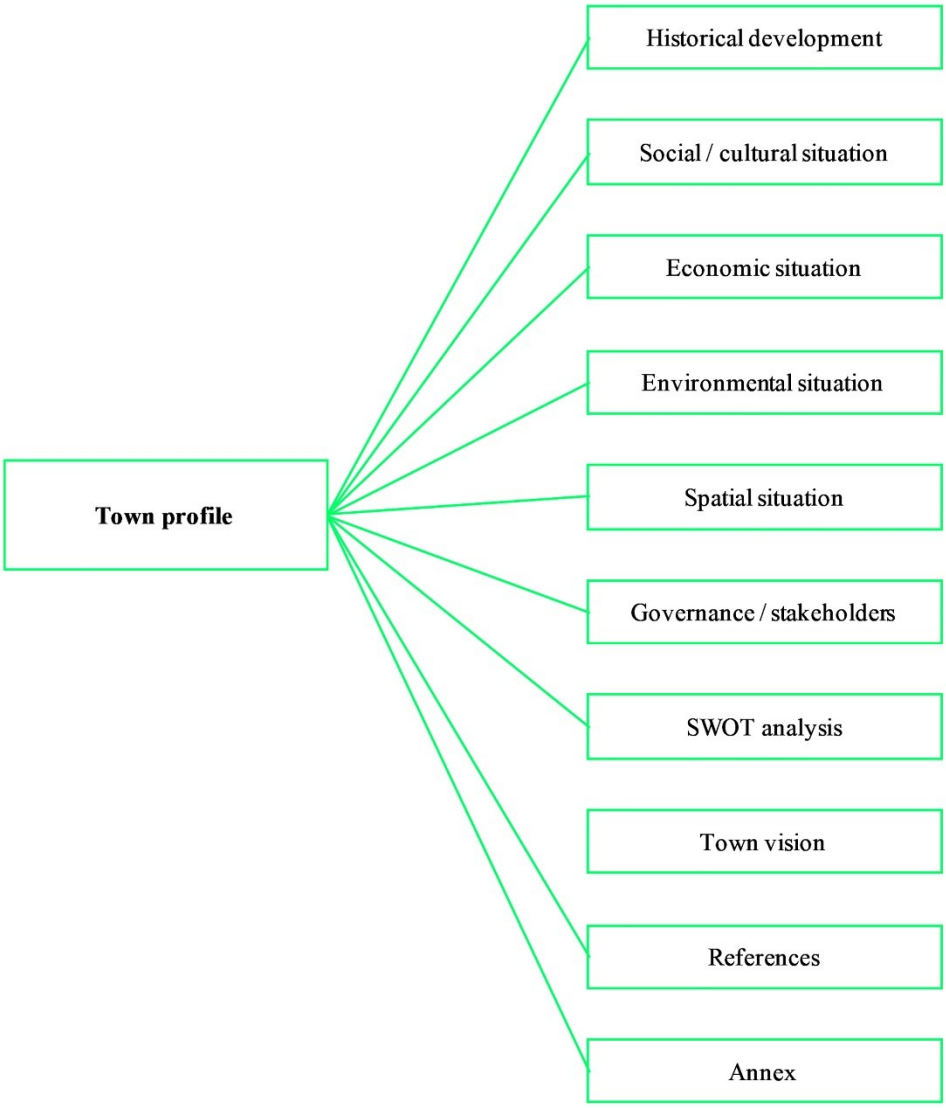


Figure 8 Updates in the structure of the Town Profile, to include climate change considerations. See Annex 7 for the more detailed indicative outline.

Step 2.2 Developing the Land Use Map

Objective

The objective of this step is to develop (or update) the land use map of the town, so that it reflects the current situation as it is in reality, or "on the ground". Having an accurate and updated land use map is crucial, as it acts as the basis for conducting

the vulnerability and Ecosystem Services Assessments, as well as for developing the Town Development Plan.

Activities

A. Site surveying

The main activity required for creating an updated and accurate land use map is the site surveying of the urban area by using appropriate software, tools and methods, such as GPS tracking.

A first (or alternative) step for this process is mapping the land uses of the town only in GIS using satellite images (WMS - Web Map Service).

B. GIS mapping

After the site surveying, the collected data can be imported in GIS and refined in order to have the land use map of the town. Organized per town block, the land use map should indicate the use of each block (e.g. housing, commercial, education, mixed use, green space, forest, water, etc.) and at the same time visualize the street network and important infrastructure through land uses (e.g. port, airport, etc.).

Apart from the land uses, the map should also indicate the town boundary, ward boundaries and (if available) the outlines of planned extensions.

Outputs

- Current land use map of the town in GIS

Data requirements

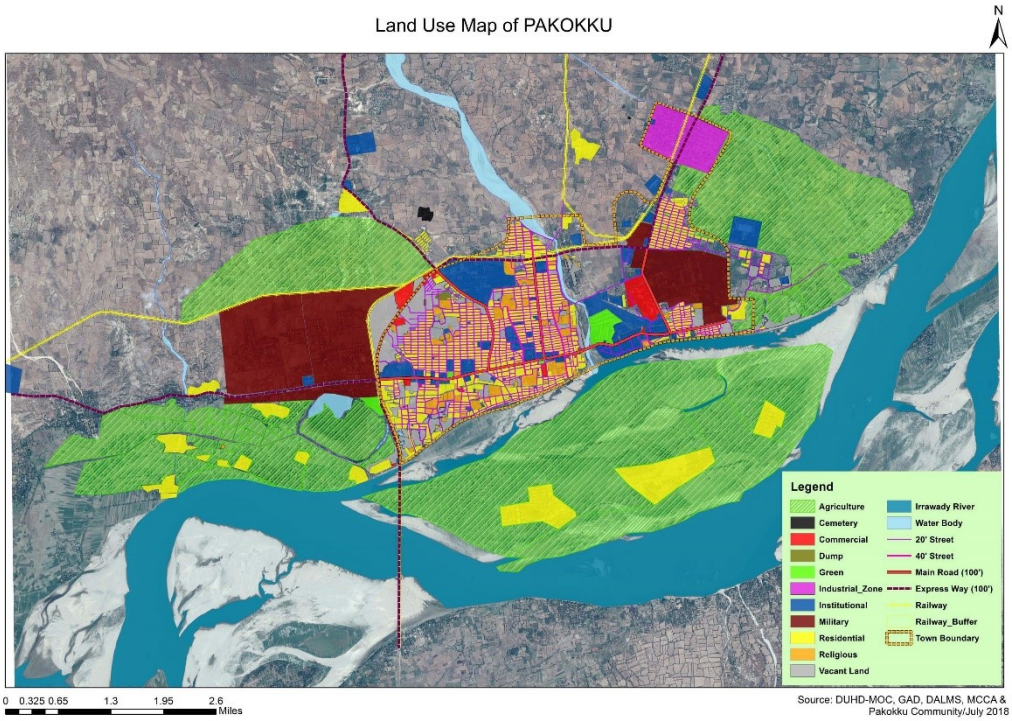
- Town plan
- Current land uses

Key considerations

Depending on the city size, the difficulty and complexity of this step increases. The average timeframe to complete this step is one to three weeks, depending on the town size, the number of available GPS devices and GIS experts involved.

Other sources and references

Uddir, Kabin. (2013). *Image classification and land cover mapping*. Presentation, Kathmandu. Available at: https://www.slideshare.net/kabiruddin/image-classification-land-cover-mapping (Accessed: 13 July 2018)



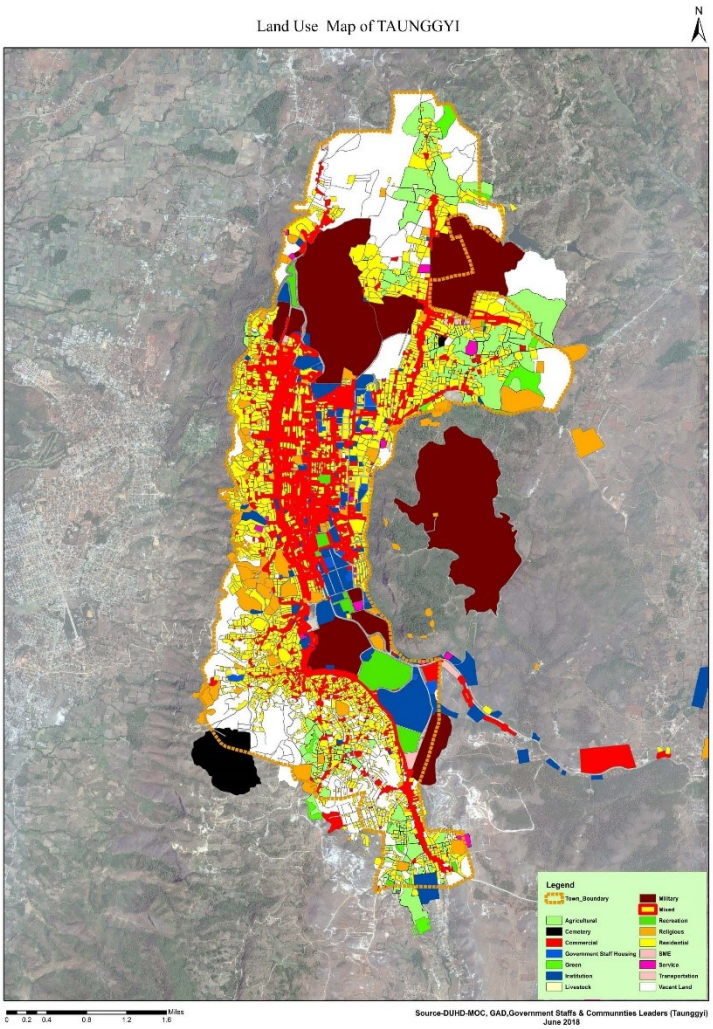


Figure 9 : Land use maps of Pakokku and Taunggyi. Source: DUHD-IHS-MCC

Step 2.3 Selecting Indicators

Objective

The goal of this step is to have a comprehensive overview of vulnerability and its components, as well as of ecosystems and Ecosystem Services in the town, without trying to be exhaustive. Various and advanced methods to conduct these assessments exist, and they can be very technical and complicated while there is no standardized way to conduct them.

Based on the Town Profile and the developed land use map, the objective of this step is to conduct a first screening for indicators of vulnerability and Ecosystem Services that are relevant to the current situation in the town. These indicators will later be used during the participatory mapping workshop as a basis for collecting data per ward and also as a guideline for the group discussions.

Activities

A. Selecting Vulnerability indicators

For the Vulnerability Assessment, indicators should be identified for the components of vulnerability: *exposure*, *sensitivity,* and *adaptive capacity*. An indicator is an observable and measurable entity that serves to define a concept in a practical way. The selection of indicators is a very important step in every analytical process. In order to have reliable results, indicators should be based on SMART criteria and be Specific, Measurable, Attainable, Relevant and Time-bound. (See also: GIZ, 2014, pp. 76, 79, 81)

Vulnerability refers to the extent to which a natural or man-made system is susceptible to the effects of climate change be they climatological changes or extreme hazard occurrences (Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance, 2017, p. 5). This is in reference to the predisposition of these systems and refers to concepts that deal with the nature of the system in its relation to its preparedness and its adaptation potential.

Exposure refers to the instances when human (people, infrastructure, assets, etc.) and environmental (ecosystems) systems are in positions which make them vulnerable to climate change and hazards. Some of these systems could include water resources, structures such as houses and businesses, livestock, crops, electric services, etc. (VA Assessment Manual, p. 4). Exposure factors such as temperature, precipitation, and climatic water balance are climate parameters contributing to vulnerability (GIZ, 2014, pp. 21, 63).

Sensitivity is the susceptibility of a human or natural system to negative impacts of climate change and/or hazards. Or in other words, how fragile are human constructions, such as houses or crops, and ecosystems, such as forests or streams, in the face of climate-change induced effects such as rising temperatures or floods/droughts? (VA Assessment Manual, p. 8). Sensitivity can refer to both the negative and positive effects of climate change on a system, and is usually in reference to the natural characteristics as well as the human-made characteristics of the system and how climate change affects these. Social aspects of a system such as population density only factor into sensitivity if they go hand in hand with a particular climate change impact (GIZ, 2014, pp. 21, 64).

(GIZ, 2014, pp. 76, 79, 81)

Adaptive capacity is the ability to change in order to continue to live in a stable manner in the face of the effects of climate change and its impacts. This also includes the ability to take advantage of changes caused by climate change. For example, growing more

crops in response to a longer growing season. Adaptive capacity is highly limited by knowledge and resources (Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance, 2017, p. 5).

The selection of relevant indicators for a town should be based on the analysis of the current situation, and also the climate change projections for the future. A list of possible indicators for the vulnerability components is provided in Annex 4.

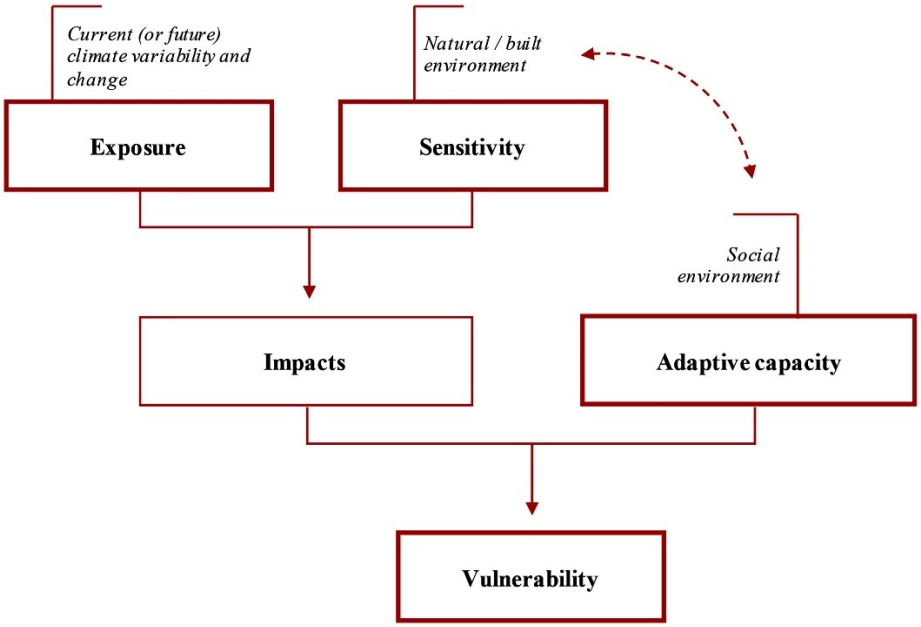


Figure 10 Components of Vulnerability. Source: Adapted from GIZ, 2014.

B. Selecting Ecosystem Services indicators

Indicators should also be identified for the Ecosystem Services: provisioning, regulating, and cultural. This process helps the team of urban planners to understand the value of the ecosystems through the services they provide, and to be able to effectively communicate the importance of preserving the ecosystems (or the impacts and cost of destroying them) to the stakeholders and community.

An **ecosystem** is defined as a dynamic complex of plant, animal, and micro-organism communities and their non-living environment (e.g. air, water, soil) interacting as a functional unit (UN Environment, 1993).

Ecosystem Services are defined as “the direct and indirect contributions of ecosystems to human well-being” (TEEB, 2011) and further described as “flows of value to human societies, as a result of the state and quantity of natural capital” (TEEB, 2010). The Millennium Ecosystem Assessment (2005) defined four categories of Ecosystem Services:

- **Provisioning services**: the goods or products obtained from ecosystems such as food, freshwater, timber, and fiber.
- **Regulating services**: The benefits obtained from an ecosystem‘s control of natural processes such as climate, disease, erosion, water flows, and pollination, as well as protection from natural hazards.
- **Cultural services**: the non-material benefits obtained from ecosystems such as recreation, spiritual values, and aesthetic enjoyment.
- **Supporting services**: the natural processes such as nutrient cycling and

primary production that maintain the other services.

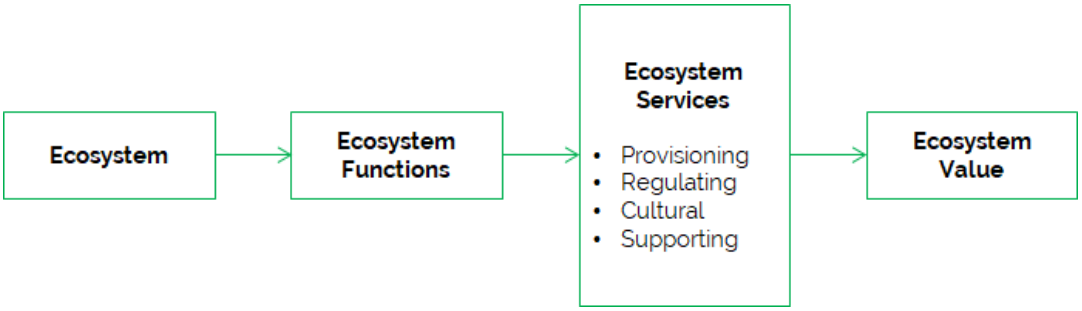


Figure 11 Simplified version of the cascade model for ecosystems and Ecosystem Services. Source: Adapted from Haines-Young and Potschin (2010)

A list of possible indicators for Ecosystem Services is provided in Annex 5. The selection of the indicators should be done based on the ecosystems that currently exist within the town boundaries or close to the town, and provide their services to the urban area population. The expected future changes to these ecosystems also plays a role to the selection of indicators and should be considered.

Outputs

- List of selected indicators of vulnerability (separated in exposure, sensitivity, adaptive capacity)
- List of ecosystems and Ecosystem Services deriving from each of them
- Measurement units for each indicator
- Possible sources for collecting the required data

Data requirements

- Climate change projections
- Mapped ecosystems (form land use map)
- All information and data from the Town Profile

Key considerations

The list of selected indicators should not be too long or too complex and detailed, but it should include the most important and critical aspects related to the current and expected future situation of the town. By attempting to create a model that is too complex and detailed there is the risk of wasting time and resources, while losing focus and being distracted from the most important issues.

Other sources and references

UN Habitat. (n.d.). Climate Change Vulnerability Assessment Manual: Methodological Framework for Townships of Myanmar

GIZ (2014). The Vulnerability Sourcebook: Concept and Guidelines for standardized Vulnerability Assessments. Deutsche Gesellschaft für Internationale Zusammenarbeit - GIZ.

Scarano, F., & Ceotto, P. (2015). Brazilian Atlantic forest: impact, vulnerability, and adaptation to climate change. Biodiversity and Conservation, 24(9), 2319-2331. doi: 10.1007/s10531-015-0972-y

WCCD. 2018. *World Council on City Open Data Portal*. Available at: http://open.dataforcities.org/ (Accessed: 13 July 2018)

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PHASE 1

Preparatory phase

1.1
Town selection

A. Prioritization by DUHD

B. Selection of town

1.2
Approval

A. Request letter

B. Approval by Union Minister

1.3
Meeting the local government

A. Official meeting request

B. Consultation with state / regional government

PHASE 2

Current situation analysis

2.1
Town profile

A. Previous studies

B. Available data

C. Preliminary impact chain graph

2.2
Land use map

A. Site surveying

B. GIS mapping

2.3
Selection of indicators

A. Vulnerability

B. Ecosystem services

PHASE 3

Participatory mapping workshop

3.1
WS tools

A. Questionnaires

B. Town maps

C. Preliminary impact chain graph prints

3.2
WS planning

A. Team of experts

B. Coordination

3.3
WS implementation

A. Mapping climate hazards and impacts

B. Mapping ecosystem services

C. Peer review

PHASE 4

Vulnerable locations (hotspots)

4.1
Vulnerability index

A. Data quality check

B. Data format

C, Data measurement scales

D, Normalization

E, Aggregation of indicators

4.2
GIS maps

A. At ward level

B. At lower scale

C. Style and legends

4.3
Hotspots analysis

A. Future vulnerability

B. SWOT & TOWS matrix

PHASE 5

Town Plan

5.1
Town profile update

A. Town vision update

B. Town database

5.2
Land policy instruments

A. Urban land management strategy

B. Instruments for disaster risk reduction

C. Land instruments ranking tool

5.3
Town Development Plan

A. Draft plan

B. Public consultation

C. Final plan

Phase 3: Participatory Mapping Workshop

Step 3.1 Preparing the Workshop Tools

Objectives

The main aim of this step is to build on the understanding of the town that was achieved during the previous phase, in order to create simple tools (questionnaires, maps, diagrams) for collecting additional needed data, from the ward administrators and the community, in a participatory manner.

Activities

A. Questionnaires

At this step of the process, crucial data for developing the Town Development Plan may be missing. The participatory mapping workshop is a good opportunity for the urban planners to collect the missing information in details from the people who have the best empirical knowledge and also direct access to it, the ward administrators. The following types of data can be **requested per ward**, from the ward administrators:

1. Data for completing and detailing the Town Profile
2. Data useful for conducting the Vulnerability Assessment
3. Data for ecosystems and Ecosystem Services

The data can be requested in the form of a questionnaire that is compiled using the indicators that have been selected in step 2.3. One printed questionnaire is needed for each ward.

Figure 12 The ward administrators and community members fill in questionnaires and keep notes during the participatory mapping workshop at Pakokku on 10th June 2018, with the support of the GAD officer.

B. Town maps

It is suggested to print **a set of maps for each group**, so that participants are able to cluster around the table and participate with indicating locations and adding notes on their group's map. For facilitating this process, the size of the map should be approximately paper size A0 (841 x 1189 mm), or printed at a

scale between 1:50,000-1:25,000. The required maps are: a **land use map** with a legend located at a visible point and a **satellite Figure** printed at the same scale. Based on the experience at Pakokku and Taunggyi, it is recommended to use the land use map for mapping hazards and their impacts and the satellite Figure in combination with the land use map for the discussion on Ecosystem Services, as participants may need to refer again to the land use map and to the information they previously added on it.

Additional material that is needed along the prints of the town maps are small sticky papers, in different colours (red-yellow-green, or other colours that can indicate scale from low to high). They can be used to indicate locations on the map and also allow writing a small explanation on the paper. Their size should be related to the size of the map, so that it is possible to indicate a satisfactory level of detail.

Figure 13 The ward administrators and community members in Taunggyi around a satellite image of Taunggyi, where the ward and town boundaries are also indicated. Participatory mapping workshop in Taunggyi, 13th June 2018.

C. Preliminary impact chain graph prints

Additionally, a print of the climate change impact chain graph per table is needed so that the workshop participants can discuss it, draw on the paper and update it.

Figure 14 A member of the experts team from DUHD draws the impact chain graph of Taunggyi during the participatory mapping workshop conducted as part of the IHS-MCCA on the job training, on 13th June 2018.

Outputs

- Questionnaire for the collection of additional needed data for Town Profile, Vulnerability Assessment and Ecosystem Services
- Prints of the land use map of the town (at a suitable size and scale)
- Prints of satellite Figures of the town (at a suitable size and scale)
- Prints of the climate change impact chain graph diagram

Data requirements

- All data and information collected during the previous steps of the process

Key considerations

The proposed tools are indicative and based on the experience of the workshops in Pakokku and Taunggyi. The workshop tools can also be of different formats, like for example game cards, posters, checklists or semi-structured interview / group discussion guides. This depends on the format of the participatory mapping workshop and the material that different types of workshops or events require.

Other sources and references

Reilly, K., Adamowski, J. and John, K., (2018). Participatory mapping of Ecosystem Services to understand stakeholders' perceptions of the future of the Mactaquac Dam, Canada. Ecosystem Services, 30, pp.107-123. Under a creative commons licence. Open access at: https://doi.org/10.1016/j.ecoser.2018.01.002

GIZ (2014). The Vulnerability Sourcebook: Concept and Guidelines for standardised Vulnerability Assessments. Deutsche Gesellschaft für Internationale Zusammenarbeit - GIZ.

UN-Habitat. (n.d.-b). Climate Change Vulnerability Assessment Manual: Methodological Framework for Townships of Myanmar.

IHS-MCCA Bangkok sessions	Tsatsou, Alexandra. (2018). **Participatory Mapping of Ecosystem Services**. Presentation, Bangkok. Available at: https://www.slideshare.net/secret/6JbHhTTxnesXk (Accessed 20 July 2018)

Step 3.2 Workshop Planning

Objectives

The objective of this step is to plan all aspects for the implementation of the participatory mapping workshop, so that the team of experts will be able to work in a coordinated way to lead the process and collect all the necessary data and information from the participants, in the limited available time.

Activities

A. Setting up a team of experts

The team of experts who will plan, coordinate and run the participatory mapping workshop could consist of the DUHD urban planners' team, joined by the local MOC, ECD and GAD officers and other available or interested local government staff.

In order to plan and implement the workshop efficiently, clear roles and responsibilities should be assigned to each member of the experts team, one or two days before the workshop day. The experts team should identify (at least) an event coordinator, a logistics manager, the facilitators and an assistant facilitator that will collect the notes at each table. The responsibilities connected to each role are as follows.

Experts' roles during the participatory mapping workshop

Event coordinator: introduction, presentation of process and concepts, timekeeping, overseeing the discussions at the different tables, providing additional explanations, facilitating the plenary discussion, closing the event

Logistics manager: coordinating the preparation of the venue, tables, chairs, projector (if needed), getting the graphic material, printing the maps, etc.

Facilitators: facilitating the discussions at the tables, guiding participants through the process in order to collect and map the necessary information. The facilitators should be able to keep a balance between guiding and fully controlling the discussion: a fully controlled discussion may prevent participants from expressing themselves freely which may lead them at keeping thoughts and information to themselves. A more flexible discussion allows participants to express themselves more openly, and the facilitators to have access to more (or new) information and better understanding of the area. The ability of the facilitators is always relevant; therefore, a particular attention should be placed on the facilitators' selection.

Assistant facilitators: supporting the facilitator in guiding the discussion and taking notes of everything that is being discussed. This information can be later used to complete any missing information from the maps and post-its, when they are transferred in GIS. Moreover, any additional qualitative information can be used to update the Town Profile.

Box 2 The roles of the experts' team at the participatory mapping workshop

B. Coordination

After collaborating with the local government departments to arrange the date, time and venue of the workshop, invitations should be sent to the participants. The invitations should be sent at least two days before the planned workshop date, and should include the agenda of the day along with an explanation of the background (why is the workshop taking place, how participants can prepare

themselves before attending the event, is any expertise or specialized knowledge needed, what will the outcome of the workshop be, how will the results be used, etc.).

The **participants to invite** are the ward administrators, representing all wards of the town, as well as community representatives. In addition, social groups that should be invited are women (probably through women's organizations), older people and young people, in order to raise awareness, be educated about the issues, and get familiar with participatory processes. Young people can be invited through schools or other youth organizations.

The **number of participants** can vary depending on the size of the town, as it is based on the number or wards.

For conducting the workshop, It is suggested to **divide the participants in groups of ten**. The decision on how to select the composition of each group is important because it can affect the discussions and, as a result, the outcomes of the participatory mapping workshop. Some possible ways of splitting the groups are:

- randomly (e.g. by asking them to join a table of their choice, or assigning them randomly to a table),
- geographically (e.g. east, west, north, south areas of the town),
- based on the exposure to hazards (e.g. risky/less risky areas),
- based on their proximity to important ecosystems, etc.

The team should decide on the best option before the workshop, by reflecting on the advantages and disadvantages of each of them and keeping in mind the context of each town (Town Profile).

The **venue** of the workshop, can be a meeting or events room at the premises of the municipality or with a public character (for example, in Pakokku the workshop was held at the Flood Shelter). The number of groups and therefore, number of tables, can determine the selection of a venue of adequate size to host the workshop.

As already mentioned, the **agenda** of the day along with a brief explanation for the scope and objectives of the workshop should be attached to the invitation. The provision of a description of the participatory mapping process and the concepts that will be mapped will help the participants understand the context better and be more prepared for the mapping activity. Based on previous experiences in Myanmar, providing a meal (lunch or dinner, depending on the workshop timing) to the participants is suggested, as they skip their daily activities in order to support the

Box 3 Participatory mapping workshop: venue and agenda

An indicative agenda for a participatory mapping activity, based on workshops run in Pakokku and Taunggyi, is provided in Annex 3.

Outputs

- Division of roles of the Experts team: roles and responsibilities for each member for the implementation of the workshop
- List of invited participants
- Finalized venue arrangements

- Workshop agenda (for an indicative agenda see Annex 3)

Key considerations

A successful mapping workshop requires careful and detailed preparation by the experts' team. Before running the workshop all team members, no matter their role, should be aware of the city profile, what the climate change projections and threats for the town are, and what data needs to be collected. Based on this information, the team can prepare the questionnaires with the data needed per ward, decide how to split the groups, prepare the maps and work in a coordinated way to collect as much information as possible in the few hours of the workshop duration.

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Step 3.3 Workshop Implementation

Objectives

The overall objective of this step is promoting community engagement in Town planning process, by implementing the participatory mapping workshop and getting the local knowledge and collective perspective on vulnerability and Ecosystem Services, in addition to any other relevant issues that come up. More specifically, through this step the aim is to collect specialized data for vulnerability and Ecosystem Services, per ward, and visualize them on a participatory map. The outcome is a concrete visualization of the local knowledge on the discussed issues.

Activities

A. Opening the workshop

At the beginning of the workshop, after a presentation of the agenda and a round of introduction from the team and the participants, the experts' team should present:

- a short overview of the Town planning process
- the participatory mapping method
- definitions of the concepts used during the mapping activity (e.g. climate change, vulnerability and its components, ecosystems and Ecosystem Services)
- a short presentation to provide more information about the concepts to the workshop participants.

A Q&A session after this introduction is useful for clarifying any issues and can function as a bridge to the discussions to be continued at the tables, after allocating the participants in their groups. After the Q&A the participants can be divided in groups and proceed to their tables with the facilitator and the assistant

facilitator.

When the participants have gathered around the tables in their groups, a few minutes should be spent for **familiarizing themselves with the land use map**, and understanding what it depicts. A usual method to do this is by asking the participants to identify the location of their home and work, as well as routes and places they visit daily. At the same time, possible inconsistencies of the map can be spotted and pointed out for updating later in GIS.

Box 4 Participatory mapping workshop: familiarizing with the maps

Figure 15 An urban planner from DUHD leads the introductory session of the participatory mapping workshop conducted as part of the IHS-MCCA on the job training at Taunggyi, on 13th June 2018.

B. Mapping of climate hazards and their impacts

The first part of the workshop regards the mapping of past climate hazards (such as *storms, floods, droughts, landslides*) and their impacts on the built and natural environment, the community, and the economy.

Using the impact chain graph and keeping in mind the list of selected indicators for exposure, sensitivity and adaptive capacity, the facilitators should guide the discussion and ask the participants to indicate on the map the **type of climate hazard** along with its **location, spatial distribution (extend), frequency and intensity**. In addition, its **impacts** can also be mapped.

For indicating the impacts of the hazards, the facilitators can guide the discussion to reflect on impacts on different **affected sectors** (e.g. agriculture, economic activities and livelihoods, infrastructure, energy, transport, water and sanitation). Additionally, the impacts on **affected groups** (such as low-income groups, women, children, the elderly, minorities, specific professions, etc.).

This process can be repeated to map multiple climate hazards that the town has experienced in the past.

The ward administrators are at the same time asked to provide additional information for the **indicators of vulnerability** per ward in written form, on the distributed **questionnaires**.

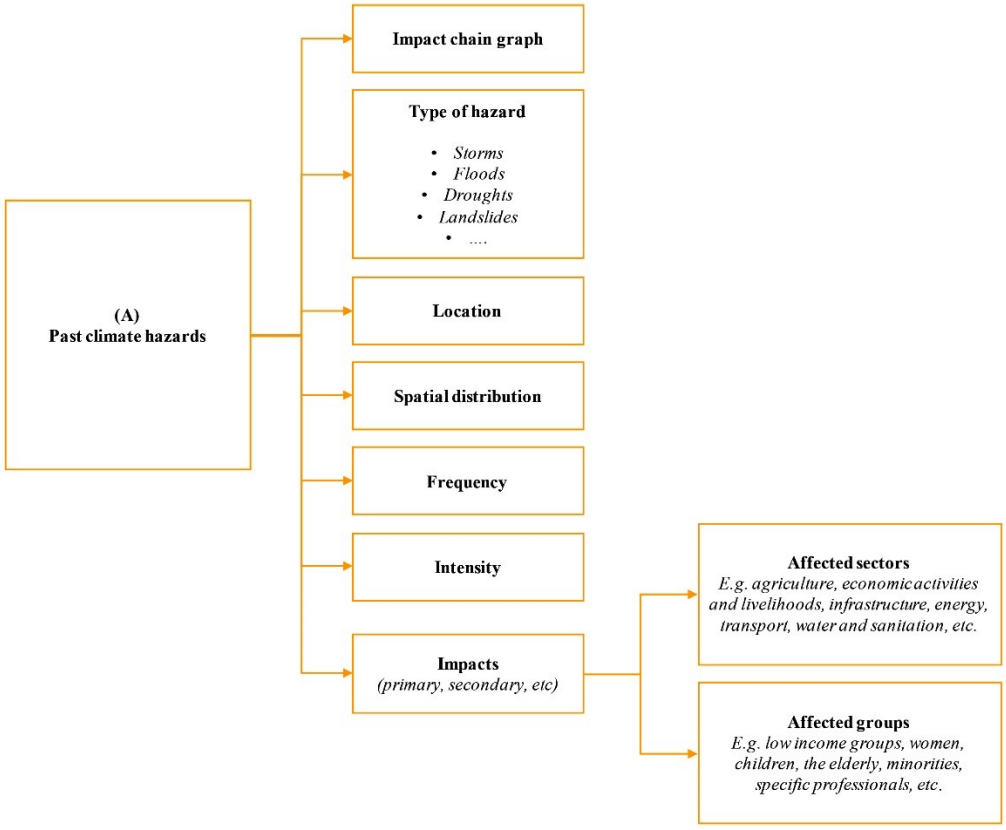

Figure 16 Aspects to consider when mapping past hazards and their impacts during the participatory mapping workshop.

After mapping the current hazards, the facilitators can guide the discussion to the topic of **future climate hazards**. Based on the discussion on past hazards and their impacts, and keeping in mind the climate change projections, the group can reflect on the primary and secondary impacts and discuss **future vulnerability** of sectors and groups.

C. Mapping of Ecosystem Services

The next part of the workshop regards the mapping of Ecosystem Services. The land use map acts as the basis for the identification of Ecosystem Services because, The ecosystems are already indicated through various land uses on the land use map such as green spaces, forests, peri-urban greenery, rivers. lakes, the sea, etc.

Firstly, the participants should agree on which are the ecosystems in the town. The facilitators can guide the discussion to explore whether there are more ecosystems that have not been mapped on the land use map and note their location. For all the identified ecosystems, the group discussion should reflect on their **conditions, the Ecosystem Services and their spatial distribution**. In addition, attention should be paid on the **social groups who benefit** from these ecosystems and services, similarly to the discussion about the affected groups in the previous activity. Who is responsible for the management and maintenance of the different ecosystems and green areas could be also an issue to address and identify.

The ward administrators are at the same time asked to provide additional information for the **indicators of Ecosystem Services** per ward in written form,

on the distributed **questionnaires**.

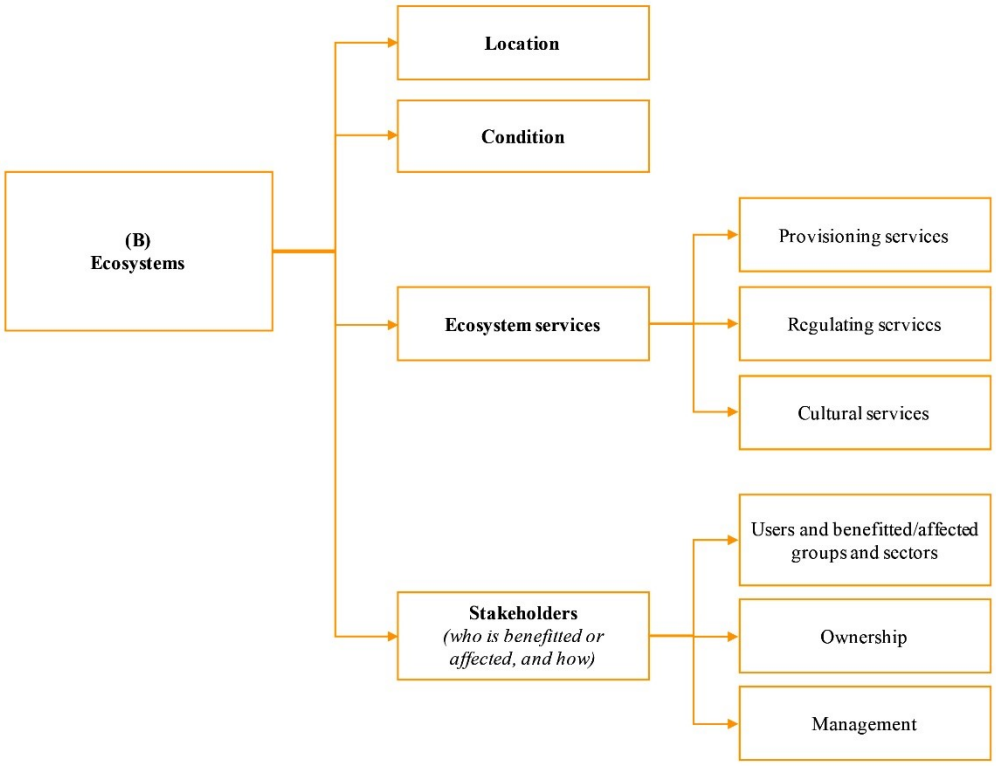

Figure 17 Aspects to consider for mapping ecosystems and Ecosystem Services during the participatory mapping workshop.

The discussions during the two mapping activities can provide valuable input for **updating the climate change impact chain graph** based on the knowledge and experience of the community. This can be done collectively by the participants and the facilitators, by drawing and writing on the impact chain graph print on the table. This graph reflects the impacts of the past hazards. If future vulnerability has been discussed already during a workshop, it is possible to also construct an impact chain graph using the climate projections as a starting point, and indicating the chain of **future impacts**.

D. Peer review

Once the two parts of the mapping are complete the groups are asked to switch tables and observe the work of another group. The process of comparing the maps is useful as validation of other groups' mapped info, and reflection on what the group had been previously discussing. The roles of the facilitator and the assistant facilitator are very important here, in order to identify, note and explore further the differences or inconsistencies, while trying to understand which information is correct, objectively. To conclude the review, each group provides a grade from 1 (worst grade - completely disagree) to 10 (best grade -completely agree) to the work done on the map.

This peer-review process ends in a **plenary session** where the groups present the given grades and justifications for them. The spotted differences between the two maps are discussed and elaborated, while the groups try to reach consensus with the support of the team.

Figure 18 Peer review of maps in Pakokku (left) and Taunggyi (right).

Outputs

- Maps of past climate hazards and their impacts
- Maps of ecosystems and understanding of their attributes and services
- Updated impact chain graph and (possibly) future climate change impacts chain graph
- Primary data at the ward level, collected through the distributed questionnaires (as described in step 3.1)

Material requirements

- Room equipped with the necessary equipment for the number of participants (tables, chairs, projector)
- Printed workshop tools (according to step 3.2) and graphic supplies

Key considerations

- Conflicting information provided by the participants should be noted and further explored by the experts' team later, or clarified during the plenary session at the end of the participatory mapping workshop. The facilitators should keep track of such conflicting information.
- Factors (like the background, mood, etc.) may affect the responses of participants, which means that the collected data needs to be cross-checked (triangulated) and validated through discussions with more people or desk research.
- The time when the mapping activity takes place is important, as if it is in the morning participants have to skip their work. Therefore, there could be some reimbursement for their participation. Organizing the workshop in the evenings, weekends and holidays would be handier as the participants would be free, but it is also challenging as it overlaps with their free time and other activities they may have arranged.

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PHASE 1

Preparatory phase

1.1
Town selection

A. Prioritization by DUHD

B. Selection of town

1.2
Approval

A. Request letter

B. Approval by Union Minister

1.3
Meeting the local government

A. Official meeting request

B. Consultation with state / regional government

PHASE 2

Current situation analysis

2.1
Town profile

A. Previous studies

B. Available data

C. Preliminary impact chain graph

2.2
Land use map

A. Site surveying

B. GIS mapping

2.3
Selection of indicators

A. Vulnerability

B. Ecosystem services

PHASE 3

Participatory mapping workshop

3.1
WS tools

A. Questionnaires

B. Town maps

C. Preliminary impact chain graph prints

3.2
WS planning

A. Team of experts

B. Coordination

3.3
WS implementation

A. Mapping climate hazards and impacts

B. Mapping ecosystem services

C. Peer review

PHASE 4

Vulnerable locations (hotspots)

4.1
Vulnerability index

A. Data quality check

B. Data format

C, Data measurement scales

D, Normalization

E, Aggregation of indicators

4.2
GIS maps

A. At ward level

B. At lower scale

C. Style and legends

4.3
Hotspots analysis

A. Future vulnerability

B. SWOT & TOWS matrix

PHASE 5

Town Plan

5.1
Town profile update

A. Town vision update

B. Town database

5.2
Land policy instruments

A. Urban land management strategy

B. Instruments for disaster risk reduction

C. Land instruments ranking tool

5.3
Town Development Plan

A. Draft plan

B. Public consultation

C. Final plan

Phase 4: Identifying Vulnerable Locations (Hotspots)

Step 4.1 Vulnerability Index

Objectives

The main objective of this step is to develop a Vulnerability Index that will allow the identification of the most vulnerable locations, the so-called "hotspots". In order to do so, special attention is needed on the management and processing of the data. There are different ways to develop a Vulnerability Index. Different researchers and practitioners depending on the local context adopt different approaches on developing a Vulnerability Index to map the most vulnerable areas. Considering the Myanmar context and the Vulnerability Assessment manual that has been developed by MCCA (MONREC and MCCA, 2017), a simple and widely used and solid method for the development of the Vulnerability Index is presented in this step.

Vulnerability hotspots

A hotspot indicates one of the most vulnerable areas of the town. Its high vulnerability usually stems from the co-existence of high exposure, high sensitivity, and at the same time low adaptive capacity. In some cases, the vulnerability results from the exposure to multiple climate risks and hazards, while in other cases it can result from the exposure to a single climate hazard. When the extends of a hotspot location are identified, the land use plan and ecosystems of the area can be analyzed, along with additional social, economic, environmental and spatial aspects, in order to develop strategies that can reduce the level of vulnerability in the future.

According to the Climate Change Assessment for Sorsogon, Philippines developed by UN-Habitat, the urban hotspots in the city are growing on the average annual rate of 1.7%

Box 5 Vulnerability hotspots

Activities

A. Data quality check

Data is vital to any Vulnerability Assessment and the quality of the results depends to a large extent on the quality of the data. Once data are gathered, a quality check needs to be conducted. It is important to keep in mind some basic quality criteria while collecting the data. For that purpose, the following criteria are important to be considered when collecting data and checking their quality, and if they are suitable for the purpose we need them.

Temporal and spatial coverage and timeframes may vary among different data sources, so determine whether they can be combined and compared. Ideally you need to have data at the same level of detail (e.g. at ward level) and at the same or comparable timeframe.

Data gaps are a common problem in the field of quantitative data collection (e.g. wards omitted from spatial data, time periods missing from time series data). In case data are missing or inconsistent, consider whether you can source additional data from measurements, censuses or surveys. Alternatively, *interpolation* can be applied to close the smaller data gaps, that is a technique, finding existing data nearest to the gaps (in space or time) most likely to match the missing data.

B. Data format

The format in which data is available is a very important issue to consider. Data may be provided in different formats, such as paper documents, Word or Excel files, or other more complex formats. The experts team who collect the data, should make sure that it is in an appropriate format.. If not, the data provider may need to provide additional clarifications -or additional data.

After the data quality check, the data should be structured and compiled in readable and usable formats, **per ward and per indicator**. Excel spreadsheets are commonly used to structure and store data in big data sets that can be then easily used and transferred in other workable formats (e.g. GIS datasets).

C. Data measurement scales

Every indicator aims to measure a phenomenon to be observed in a certain measurement scale depending also on how is intended to be described.

There are four main measurement scales that are normally used:

Nominal scales are used for labeling variables, without any quantitative value. Nominal scales could simply be called "**labels**". Nominal scales are mutually exclusive (there can be no overlap between the different values) and none of them have any numerical significance. Examples of nominal scales are: land use (housing/green space/industrial) names of districts, gender (male/female), hair color (brown/blonde), orientation (north/south), material (concrete/wood), etc.

Ordinal scales specify the order of the values as this is the most important and significant information they provide, **without considering the exact differences** between each value. Ordinal scales are typically measures of non-numeric concepts like education level (none to higher education), flood risk (low to very high), satisfaction (very unsatisfied, unsatisfied, neutral, satisfied, very satisfied) , happiness (very unhappy, unhappy, neutral, happy, very happy), comfort (very low to very high), etc.

Interval scales are numeric scales in which we know not only the order, but also the exact differences between the values. A very common example of an interval scale is the Celsius temperature because the difference between each value is the same. For example, the difference between 20 and 10 degrees is a measurable 10 degrees, as is the difference between 40 and 30 degrees. Time is another good example of an interval scale in which the increments are known, consistent, and measurable. "Interval" itself indicates "space in between," interval scales not only tell us about order, but also about the value (the difference) between each item. The problem with interval scales is that **they don't have a "true zero."** For example, there is no such thing as "no temperature." Without a true zero, **it is impossible to compute ratios**. Another example is the variable "years." The year 0 that it used for measuring time in different situations is arbitrary, as zero does not imply that the year did not exist but signifies just a starting point for counting. As the variable "years" is measured at an interval scale you cannot say that the 10th century is twice as long as the 5th, but you can calculate how many centuries passed from the 5th to the 10th.

Ratio scales tell us about the order, the exact value between units, and they also have an absolute zero–which allows for a wide range of statistical analysis to be applied. Everything about interval data applies to ratio scales while ratio scales have a **clear definition of zero**. Good examples of ratio variables include height, depth, volume, age, weight, sales Figures, quantity purchased, etc. Ratio scales provide a wealth of possibilities when it comes to statistical analysis. These variables **can be meaningfully added, subtracted, multiplied, divided** (ratios).

Box 6 The four most common data measurement scales

D. Normalization of indicator values

Normalization is the technique where you convert different indicators measured in different measurement units and scales (either ratio or interval) **in one common unitless scale**. There are different normalization techniques that can be applied depending on the context and the type of indicator and its associated measurement unit that needs to be normalized. Two of the most common techniques are presented below.

Min-max technique

The most common and widely applied method is the “min- max” technique. This method transforms all values to scores ranging **from zero to one (0 - 1)** by subtracting the minimum score and dividing it by the range of the indicator values (the different between the maximum and the minimum values).

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

Figure 19 The formula for normalizing values from 0 to 1.

Ordinal 5 classes scale

Another type of normalization is to convert all the measurement scales and units of the different indicators into an ordinal five classes scale, for instance **from one to five**, where, one indicates very low score or performance on the phenomenon we are measuring (e.g. sensitivity, vulnerability) and five indicates very high score or performance. This technique allows, on one hand, the conversion of all indicators in an ordinal scale one to five, and on the other, the establishment of the five classes scheme that can be also used in GIS software for developing maps for each indicator, each component of vulnerability and the Vulnerability Index (see next step). The three, four and ten classes ordinal scales are also commonly used, in the same way as the five classes scale.

The two normalization methods mentioned above can also be used in combination, as normalized scores from zero to one can be converted to the five-class ordinal scale, and the other way around.

Exposure indicator: riverine flood level

		Riverine Flood (Level of flood in feet)
very low exposure	1	0 - 2
low exposure	2	3 - 4
moderate exposure	3	5 - 6
high exposure	4	7 - 8
very high exposure	5	9 - 10

	RF - Field Data (ft)	Normalized
Ward 1	8	4
Ward 2	6	3
Ward 3	1	1
Ward 4	2	1
Ward 5	0	1
Ward 6	0	1
Ward 7	4	2
Ward 8	7	4
Ward 9	6	3
Ward 10	6	3
Ward 11	1	1
Ward 12	6	3
Ward 13	9	5
Ward 14	9	5
Ward 15	3	2
Koke Ko Hla	10	5
Kywe Tae	5	3
Chauk Kan	0	1
Pakkoku Kyun Su	10	5

Sensitivity indicator: population density

		Socio-Economic Population Density (person/acre)
very low sensitivity	1	0 - 20
low sensitivity	2	21 - 40
moderate sensitivity	3	41 - 60
high sensitivity	4	61 - 80
very high sensitivity	5	81 - 100

	Population density - Field Data	Normalized
Ward 1	11	1
Ward 2	25	2
Ward 3	90	5
Ward 4	81	5
Ward 5	20	1
Ward 6	28	2
Ward 7	58	3
Ward 8	20	1
Ward 9	52	3
Ward 10	34	2
Ward 11	88	5
Ward 12	28	2
Ward 13	73	4
Ward 14	25	2
Ward 15	25	2
Koke Ko Hla	3	1
Kywe Tae	3	1
Chauk Kan	1	1
Pakkoku Kyun Su	1	1

Adaptive capacity indicator: school coverage

	School Coverage (% - range)
very low risk	81 - 100
low risk	61 - 80
moderate risk	41 - 60
high risk	21 - 40
very high risk	0 - 20

	School coverage - Field Data	Normalized
Ward 1	75%	2
Ward 2	100%	1
Ward 3	89%	1
Ward 4	100%	1
Ward 5	39%	4
Ward 6	65%	2
Ward 7	100%	1
Ward 8	100%	1
Ward 9	100%	1
Ward 10	100%	1
Ward 11	83%	1
Ward 12	100%	1
Ward 13	100%	1
Ward 14	93%	1
Ward 15	69%	2
Koke Ko Hla	25%	4
Kywe Tae	33%	4
Chauk Kan	16%	5
Pakkoku Kyun Su	20%	5

Figure 20 Normalization of exposure, sensitivity and adaptive capacity indicators for Pakokku town, at the ward level, using data collected during the participatory mapping workshop and by applying the ordinal 5-classes scaling. Source: IHS - DUHD -MCCA.

The objective of the normalization is to convert all the different measurement units and scales in a common unitless scale in order to be able **to aggregate the different indicators to one composite index**.

For example, as each of the three components of vulnerability, namely exposure, sensitivity and adaptive capacity, consist of multiple indicators, all these indicators of each of the three vulnerability components should be normalized in order to develop **three composite sub-indices** for exposure, sensitivity and adaptive capacity. Then these three sub-indices need to be aggregated in the final composite Vulnerability Index.

E. Aggregation of vulnerability indicators

As aforementioned, after the normalization and/or the classification of data of all indicators in the five classes ordinal scale, the indicators under each component of vulnerability (Annex 4) can be aggregated to create the exposure / sensitivity / adaptive capacity indices. Then, following the same procedure the three indices of the three vulnerability components can be **aggregated**, in order to construct the **overall Vulnerability Index.**

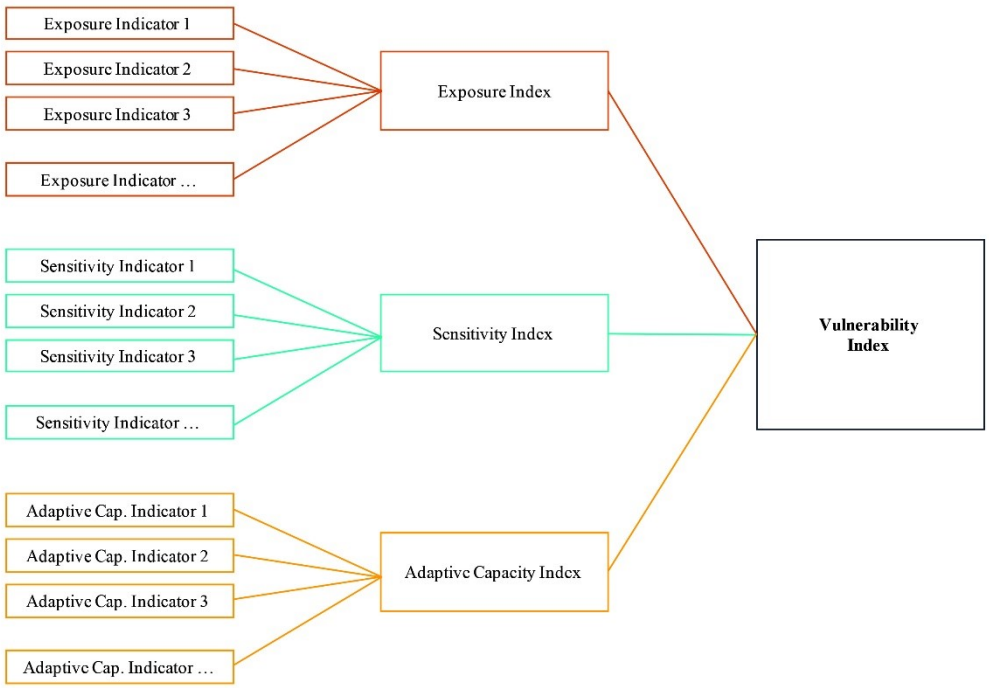

Figure 21 Aggregating normalized indicators to create the exposure / sensitivity / adaptive capacity Indices, and combining them to create the overall Vulnerability Index.

There are various methods that have been developed to construct a Vulnerability Index and assess vulnerability depending on the local context, existing capacity and available resources. The proposed method is simple, as it does not include assigning weights to specific indicators or indices, or other more advanced and complex techniques. The aggregation formula that is suggested to be applied, is the simple **"average"** of the indicators -or the three sub-indices.

After aggregating the indicators, statistical analysis can be conducted on the Vulnerability Index table, and provide valuable insights on how the wards perform in terms of the different indicators, exposure, sensitivity, adaptive capacity, or overall vulnerability. For example, the wards can be **ranked** according to their level of vulnerability. But also, by ranking the sub-indices we can identify the wards with, for example highest exposure and lowest adaptive capacity.

The vulnerability table can be then transferred to GIS and connected with a map to visualize the information spatially, as is described in the next step.

	Exposure			Sensitivity					Adaptive Capacity			Total Vulnerability Index
Wards	Riverine Flood	Flash Flood	Exposure Index	Population Density	Garbage Collection Coverage	Drains Coverage	Water Supply	Sensitivity Index	School Coverage	Mobile phone coverage	Adaptive Capacity Index	
Ward 1	4	3	4	1	5	4	5	4	2	1	2	4
Ward 2	3	3	3	1	4	3	5	4	1	1	1	3
Ward 3	1	5	3	3	2	5	5	4	1	1	1	3
Ward 4	1	1	1	3	3	3	1	3	1	1	1	2
Ward 5	1	4	3	5	4	4	1	4	1	1	1	3
Ward 6	1	1	1	3	3	3	5	4	2	1	2	3
Ward 7	2	1	2	2	3	1	5	3	1	1	1	2
Ward 8	4	1	3	1	1	3	2	2	1	1	1	2
Ward 9	3	3	3	2	1	2	5	3	1	1	1	3
Ward 10	3	1	2	1	2	3	3	3	1	1	1	2
Ward 11	1	1	1	3	1	3	4	3	1	1	1	2
Ward 12	3	1	2	1	1	1	3	2	1	1	1	2
Ward 13	5	1	3	1	1	4	5	3	1	1	1	3
Ward 14	5	1	3	1	4	5	5	4	1	1	1	3
Ward 15	2	1	2	2	5	5	2	4	2	1	2	3
Ward 16	5	1	3	1	5	5	5	4	4	1	3	4

Figure 22 The exposure/ sensitivity/ adaptive capacity indices, and total Vulnerability Index developed for Pakokku town. Source: DUHD-IHS-MCCA

Outputs

- Exposure index
- Sensitivity index
- Adaptive capacity index
- Vulnerability Index

Data requirements

Data on the different indicators of exposure, sensitivity and adaptive capacity in excel format, as they have been identified in the previous steps of the process. Possible data sources can be found in Annex 6.

Key considerations

- The selection of the *direction of preference* at the five-class ordinal scale is a step that requires special attention, as: it specifies which level of score (five-high or one-low) indicates positive or negative preference.
- Usually, **higher score indicates higher vulnerability, sensitivity and exposure** and therefore five will indicate the highest vulnerability score, whereas one will indicate the lowest vulnerability score.
- Regarding adaptive capacity, usually **the higher score indicates higher adaptive capacity** (and therefore, lower vulnerability).
- n order to be able to aggregate the exposure, sensitivity and adaptive capacity indices we need to **reverse the scale of adaptive capacity** to make sure that it has the same direction of preference with exposure and sensitivity indices. The reversal of the scale is simple and straightforward.
- Policy makers and urban planners and practitioners should always go beyond the Vulnerability Index and understand the main factors that lead to high Vulnerability (Index). They need to look specifically into all sub-indicators of exposure, sensitivity and adaptive capacity and understand which climatic, physical, environmental, socio-economic factors contribute to high levels of vulnerability.

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Step 4.2 GIS Maps

Objectives

The objective of this step is to develop GIS maps for vulnerability and Ecosystem Services, using the databases of normalized indicators that were developed in the step 4.1. The use of GIS software is aimed at visualizing the data spatially, while also providing the opportunity to conduct further geospatial analysis.

Activities

There are **two options** for creating GIS maps using the information that has been collected so far. The first option is to use the Vulnerability Index that was developed, and therefore produces maps at the ward level. The second option is to map information from the participatory mapping workshop, before aggregating them per ward.

A. GIS maps at the ward level (option one)

The first option is to produce GIS maps at the ward level, by using the Vulnerability Index and other data tables (e.g. for Ecosystem Services), where data is available **per ward**. In this case, the Vulnerability Index table (and any other data table) will be imported in GIS as the **attribute table of the *town wards* layer**. Technically, this can be achieved with the GIS command “join”, which uses a common attribute of the table and the ward boundaries GIS map (such as the ward name or ward number/code) as a connector, through which the table values can be assigned to the correct spatial unit (in this case, each ward).

In this option, the analysis for identifying the hotspots has been already conducted in Excel, as the values of the overall Vulnerability Index have been calculated and the wards with the highest vulnerability have been already identified. GIS is used to provide an easy and accurate spatial visualization of the values per ward, and therefore the locations or vulnerable wards. The visualization on maps can be very useful for understanding how vulnerability (or other indicators) are distributed spatially, and reach important conclusions.

B. GIS maps with higher level of detail (option two)

The second option is to map information in GIS directly from the participatory mapping workshop, **before aggregating them per ward** in Excel. This provides the opportunity for conducting analysis at a higher level of detail. For example, in the participatory mapping workshop the participants indicate points that were flooded, and also the level of the water at these points. The flooded area is (most probably) smaller that a whole ward. By assigning this information at the whole ward, the information about the exact extent of the flooded area is not utilized.

The GIS expert can transfer the information from the participatory mapping workshop maps directly to GIS. Using the points that have been indicated by the workshop participants, the GIS experts can create layers of polygons that show the spatial coverage of specific indicators (e.g. flood) and include their attributes (e.g. flood level per point).

In this second option, the analysis for identifying the hotspots can be conducted in GIS, and the hotspots can be identified by conducting an **"overlay analysis"**, by intersecting or clipping the involved polygons (tools intersect or clip).

C. Maps style and legends

After creating the GIS maps with either of the aforementioned options, attention should be paid to the map colours and legend. The layer values can be categorized and visualized in the same way as it was done for the normalization of the indicators: using the same value scales, units, etc. In case that a gradient colour scale from green to red or from white to solid colour is used, the choice for which colour represents the highest or lowest value should be made based on the perceived meaning of the colour in combination with whether we want to maximize or minimize this indicator. For example, if we use a colour scale from green to red, the areas with the highest flood level should be red (as this indicator should be minimized). However, the areas with the highest access to drinking water should be green (as this indicator should be maximized).

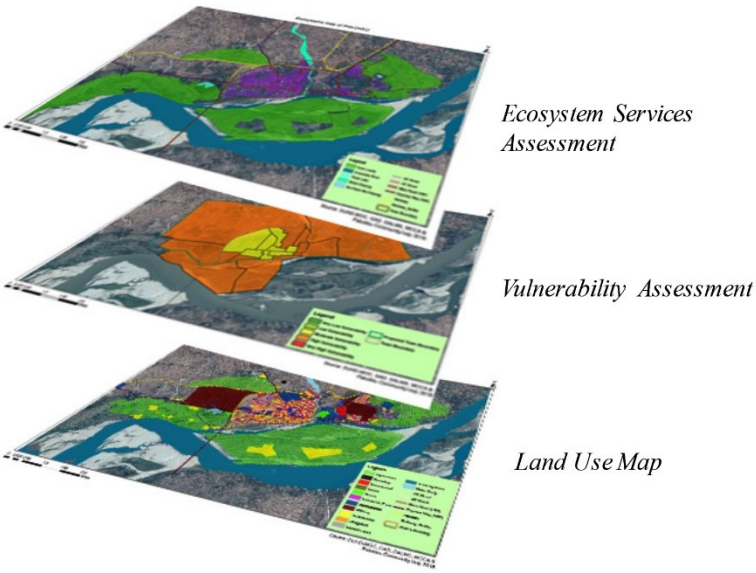

Figure 23 Illustrative representation of the three-layered approach and the concept of overlaying the three

main layers in GIS using Pakokku as an example. Source: DUHD-IHS-MCCA.

Outputs

- Maps visualizing indicators of vulnerability (ward level)
- Maps visualizing the spatial distribution of Ecosystem Services (ward level)
- Maps of exposure/sensitivity/adaptive capacity sub-indices (ward level)
- Map of Vulnerability Index (ward level)
- Hotspots at the ward level (option one)
- Spatial distribution of specific indicators' values (only in option two)
- Hotspots identified at a lower scale / in higher detail (option two)

Data requirements

- Vulnerability Index in excel format
- Exposure, sensitivity and adaptive capacity indicators in excel format
- Ward boundaries map in GIS
- Raw data (maps and notes) from participatory mapping workshop
- Data available at levels lower than ward level (e.g. specific locations of hospitals, shelters or schools instead of a generic number per ward)

Key considerations

- Check previous studies for the town and compare hazard map with other maps already developed by other departments or organizations (e.g. DMH or UN-Habitat, etc.)
- The experts' team should carefully consider whether the information that collected during the participatory mapping workshop (or from other sources) is detailed enough in order to create more detailed shapefiles in GIS, at a lower scale than the ward level, or the ward level is the lowest possible level that the analysis can be conducted.
- When identifying the hotspots additional analysis can be done for identifying the vulnerable groups, sectors etc. For doing this, the mapping of socio-economic indicators is needed.
- In GIS all data layers should have the same coordinate system, for accurate overlay analysis.
- Transparency of certain coloured symbology of base maps can be adjusted to allow for in-depth visual interpretation.
- The two options for mapping can be also combined to first have a comprehensive picture at the ward level and then conduct in depth analysis.

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Step 4.3 Hotspots Analysis

Objectives

The identified hotspots are the entry points for further analysis and prioritized interventions. The objective of this step is to formulate strategies for the development of the hotspots and suggestions for land use revision at these areas. A first activity towards these revisions is to understand the future vulnerability of the hotspots, in addition to their current vulnerability.

Activities

A. Future Vulnerability Assessment

Considering the current vulnerability of the hotspots and the climate change projections, scenarios can be developed for future vulnerability. The discussion on future vulnerability during the participatory mapping workshop, and the development of the (future) climate change impact chain graph can act as the basis for this assessment.

A **projection** is a description of the future and the pathway leading to it, based on the analysis of present trends (e.g. model-derived estimates of future climate). When a projection is considered as 'most likely' it becomes a **forecast** or prediction (deterministic or probabilistic models with level of confidence). A **scenario** is a coherent, internally consistent and plausible description of a possible future state (different scenarios as alternative Figures of how the future can unfold to reflect the range of uncertainty in projections).

Following more complex methodologies, future vulnerability scenarios can be determined by using "coefficients of change under business-as-usual scenario" (Ministry of Natural Resources and Environmental Conservation & Myanmar Climate Change Alliance, 2017). The future vulnerability can be calculated in software like Excel and GIS, while it can also be visualized on maps per ward through GIS.

However, a simple but careful and detailed development of scenarios, based on the participatory mapping, the Vulnerability Assessment and the climate projections, is enough for rapidly defining future risks and visualizing them in maps in GIS as well.

B. SWOT & TOWS matrix

After identifying the hotspots (and possibly also knowing more about future vulnerability), focused SWOT analyses can be conducted locally at the hotspots, to identify the strengths, weaknesses, opportunities and threats of the specific hotspots. These SWOT analyses should consider climate change, vulnerability, the conditions of ecosystems and Ecosystem Services as they have been identified and mapped at the previous steps.

Consequently, each SWOT analysis can be used to move further, to the synthesis of the SWOT information to produce strategies through the TOWS matrix as shown in the Figure below. The use of the TOWS matrix is suggested because it **emphasizes the external environment**, while the SWOT emphasizes the internal environment.

The TOWS matrix is compiled per hotspot area and connects the elements of the SWOT analysis in order to identify:

- Strategies that **use strengths** to **maximize opportunities**
- Strategies that **use strengths** to **minimize threats**
- Strategies that **minimize weaknesses** by taking **advantage of opportunities**
- Strategies that **minimize weaknesses** and **avoid threats**

TOWS matrix	**O** opportunities	**T** threats
S strengths	**S-O** *strategies that use strengths to maximize opportunities*	**S-T** *strategies that use strengths to minimize threats*
W weaknesses	**W-O** *strategies that minimize weaknesses by taking advantage of opportunities*	**W-T** *strategies that minimize weaknesses and avoid threats*

Figure 24 The TOWS matrix and the four types of strategies that result from it

TOWS matrix	O opportunities		T threats	
	O1	O2	T1	T2
S strengths	S-O strategies:		S-T strategies:	
S1	**SO1**	**SO2**	**ST1**	**ST2**
S2	**SO1**	**SO2**	**ST1**	**ST2**
W weaknesses	W-O strategies:		W-T strategies:	
W1	**WO1**	**WO2**	**WT1**	**WT2**
W2	**WO1**	**WO2**	**WT1**	**WT2**

Figure 25 The TOWS matrix and the strategies that result from specific TOWS elements combinations.

After identifying all the possible strategies, the ones that are **land-related** should be highlighted for consideration and revision. Blue-green solutions, that involve ecosystems and enhance Ecosystem Services should be considered for mainstreaming actions for climate change adaptation and mitigation in the town development strategy.

Land related strategies

Land Use Classification Systems (Zoning)
Hazardous Land Designations
Urban Area Plans
Land Ownership/Value Studies
Government Land Acquisition
Transfer of Development Rights
Conservation Easement
Coastal/Dune Creation, Restoration, and/or Rehabilitation

Box 7 Examples of land related strategies.

Outputs

- Knowledge and maps of the future vulnerability of the hotspots
- Strategies for the resilient development of the hotspot areas

Data requirements

- Climate projections
- Vulnerability and Ecosystem Services hotspots
- SWOT analysis

Key considerations

- The future Vulnerability Assessment is a recommended but not a mandatory activity. It is suggested to conduct it but as simply as possible.
- The hotspot SWOT and TOWS assessments can result to a high number of possible strategies / ideas for solutions. Their prioritization and selection of the final strategies should be based on clearly defined criteria such as efficiency and effectiveness (synergies between proposed strategies on spatial distribution, finance options and expected outcomes), and keeping in mind sustainability and social aspects.

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PHASE 1

Preparatory phase

1.1
Town selection

A. Prioritization by DUHD

B. Selection of town

1.2
Approval

A. Request letter

B. Approval by Union Minister

1.3
Meeting the local government

A. Official meeting request

B. Consultation with state / regional government

PHASE 2

Current situation analysis

2.1
Town profile

A. Previous studies

B. Available data

C. Preliminary impact chain graph

2.2
Land use map

A. Site surveying

B. GIS mapping

2.3
Selection of indicators

A. Vulnerability

B. Ecosystem services

PHASE 3

Participatory mapping workshop

3.1
WS tools

A. Questionnaires

B. Town maps

C. Preliminary impact chain graph prints

3.2
WS planning

A. Team of experts

B. Coordination

3.3
WS implementation

A. Mapping climate hazards and impacts

B. Mapping ecosystem services

C. Peer review

PHASE 4

Vulnerable locations (hotspots)

4.1
Vulnerability index

A. Data quality check

B. Data format

C, Data measurement scales

D, Normalization

E, Aggregation of indicators

4.2
GIS maps

A. At ward level

B. At lower scale

C. Style and legends

4.3
Hotspots analysis

A. Future vulnerability

B. SWOT & TOWS matrix

PHASE 5

Town Plan

5.1
Town profile update

A. Town vision update

B. Town database

5.2
Land policy instruments

A. Urban land management strategy

B. Instruments for disaster risk reduction

C. Land instruments ranking tool

5.3
Town Development Plan

A. Draft plan

B. Public consultation

C. Final plan

Phase 5: Town Plan

Step 5.1 Town Profile Update

Objectives

The objective of this step is to update the Town Profile that was compiled during the first stages of the Town planning process (step 2.1) and describes the current situation of the town. The information and data collected during the next steps of the process can be documented and utilized to make an updated and more informed version of the Town Profile, which will later consist an important part of the Town Development Plan.

Activities

During the participatory mapping workshop, the experts' team collected additional information for the current situation of the town in different forms: notes kept by the assistant facilitator, the questionnaires and the mapping process. All this information can be used to update the Town Profile. It can be supported visually by the GIS maps that were produced in phase four, which represent spatially the statistical information presented in the Town Profile through diagrams and graphs.

The following Figure and Annex 7 highlight the points that can be added to the Town Profile at this stage of the Town planning process. The following two activities should be given special consideration at this step.

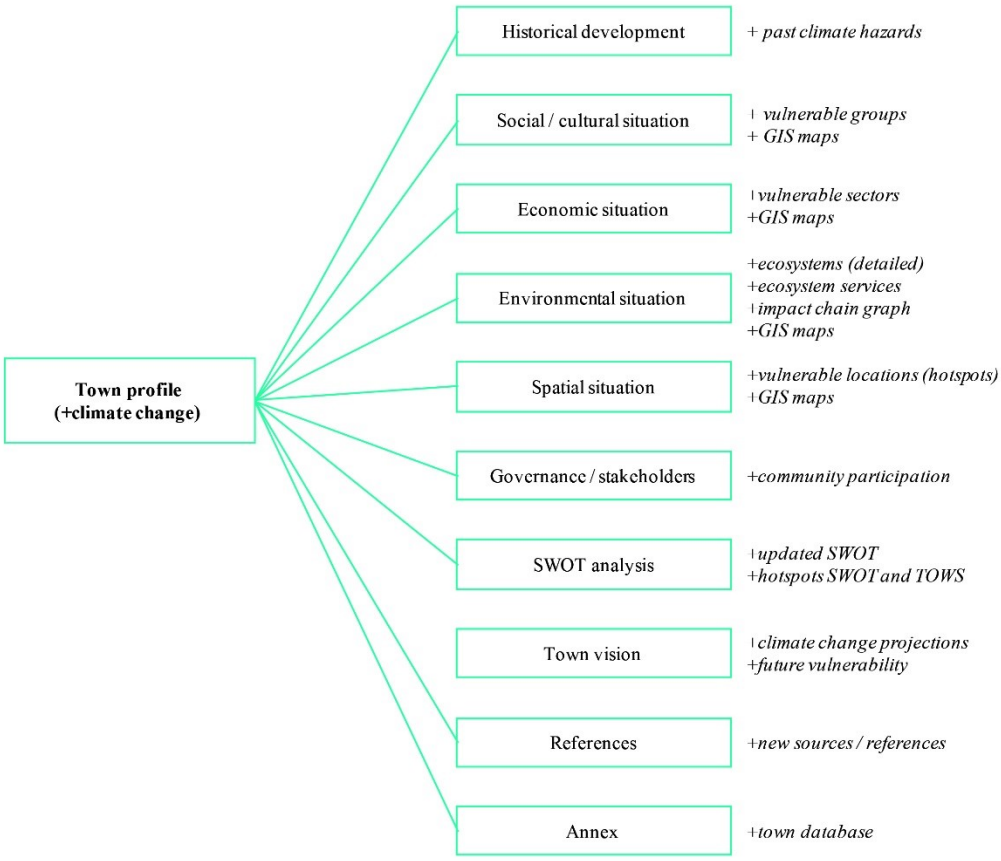

Figure 26 Updates in the structure of the Town Profile, to include climate change considerations. For more detailed description, see Annex 7.

A. Town vision update

Based on the updated SWOT analysis, and combining it with the local SWOT/TOWS analyses at the hotspots, and also with the climate change projections and information on the future vulnerability, the team can develop the town vision, for the next 30 years. The support of the local government departments, who understand the local context very well, can play an important role in this step.

B. Town database

The data that has been collected during the previous phases of the Town planning process should be organized and archived so that it is available and easily accessible for future use. The database should be organized starting at the ward level or at the lowest level for which data and information has been collected by the team. The GIS files are an indispensable part of this database, as well as the exported maps in jpeg or pdf formats.

Outputs

Draft (revised) Town Development Plan

Data requirements

All collected data (primary and secondary) of the previous phases, and the outcomes of the previous steps.

Key considerations

The Town Profile structure as it is provided in Annex 7 is indicative and can be modified to reflect the context and needs of each town.

Other sources and references

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Step 5.2 Land Policy Instruments

Objectives

The objective of this step is to develop an urban land management strategy and select the appropriate land policy instruments to be applied on vulnerable locations in different towns in Myanmar.

Activities

Land policy instruments or tools can play a decisive role in helping to implement and realize the town vision developed in step 5.1.

A. Urban land management strategy

An effective strategy involves selecting a *combination* of the different categories of tools listed below. Not all sets of tools are necessarily effective in all circumstances. Their relevance will depend on legal frameworks, market conditions and natural/landscape features present in the local context.

The following Figure illustrates an effective process by which to select the right instruments as part of an urban land management strategy to help realize a town vision. It can be used in combination with the Figure on next page. The land tool selection process involves several iterative steps, from goal setting to situation analysis to ranking and finally, proposal making.

After the selection process, the effectiveness of a land instrument must be

evaluated regularly through monitoring and evaluation procedures. If effectiveness is found to be low, then the instrument may need to be revised and/or a new instrument identified through the procedure illustrated below.

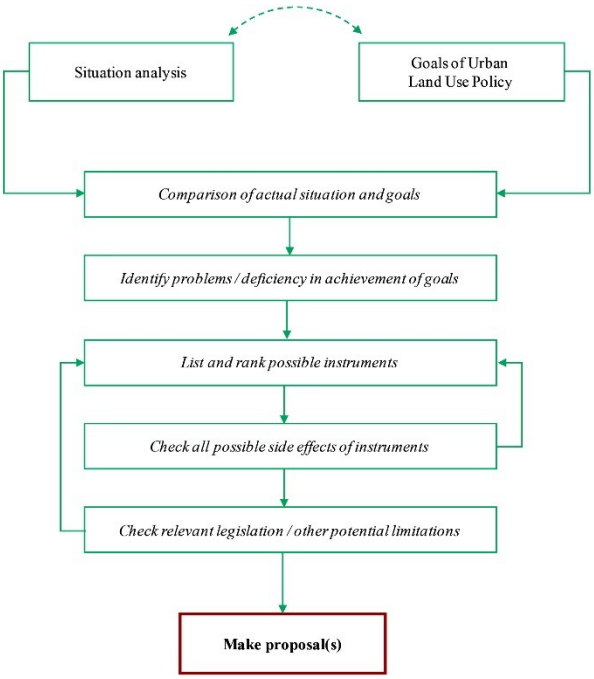

Figure 27 Land instrument selection process PS: Urban Land Management (ULM)

B. Instruments for climate induced disaster risk reduction

In the Myanmar planning and institutional context, the following tools may be suitable to help reduce disaster risk.

Planning and regulatory tools

- Comprehensive, updated land use plan
- Building code

Administrative instruments

Restrictive instruments

- Limitation of building rights in specific, well-defined areas
- Expropriation, in the case of non-compliance with the land use plan
- Laws to protect cultural or natural heritage sites
- Programs to resettle low-income and vulnerable populations away from disaster risk-prone zones and towards well-located resettlement areas in safe zones (in conjunction with administrative the instrument below)
- Incentivizing instruments
- Land sharing
- Programs to regularize land tenure of low-income and vulnerable populations in well-located safe areas
- Conservation easement

Taxation instruments

The use of taxation measures can help mitigate disaster risk in an indirect fashion, by helping to raise local revenues and by steering land development away from disaster-prone areas.

- Taxes on increments of land value
- Taxes on sales profits
- Penalty taxes on vacant lots
- Tax exemptions on land sold to public authorities
- Development charges
- Betterment charges

Market instruments

- Land exchange
- Transfer of development rights (TDR)
- Advance servicing of development land
- Public-private partnerships

Engineering tools

- Area-wide hard protection
- Design measures for disaster-prone areas

Natural protection tools

- Coastal wetland creation or restoration
- Dune building or rehabilitation
- Natural wind and/or storm surge breaks

C. Land instruments ranking tool

In the process to assess the suitability of different land tools, the following ranking tool may be utilized, in combination with Figure 29 to help urban planners to assess the proposed instruments, based on actual criteria in Myanmar Town planning law or regulations. Ranking can be based on the following ranking scale, from one=low compatibility or potential to five=full compatibility or high potential. Only those tools with the highest scores will be considered in the final assessment procedure illustrated in Figure 29.

Land instrument	Legal compatibility	Compatibility with planning regulations	Institutional capacity to implement	Climate induced disaster mitigation potential	**Final score**

Figure 28 Land instruments ranking tool

Outputs

- Urban land management strategy
- Selected land policy instruments

Data requirements

- Identified hot spots??
- Town vision
- Possible identified urban strategies
- Regulatory framework of Myanmar

Key considerations

- The ADPC (2014) report (pages 58-61) provides detailed information about the use of land policy instruments for disaster risk reduction in Myanmar

Other sources and references

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Step 5.3 Town Development Plan

Objectives

The objective of this step is to develop the Town Development Plan for the next 30 years -taking into account the previous phases.

Activities

A. Draft plan

The draft Town Development Plan can be compiled starting from the updated Town Profile and current situation analysis. Then, moving further to the proposed strategies for the future development of the town, keeping climate change, vulnerability and ecosystems related information in consideration. The main parts to be added to the document are:

- The **town development concept**, which includes the new or updated town vision, the proposed town extensions in chronological phases, and the town/regional infrastructural concept regarding connections, major hubs and any radical changes.
- The **town development strategy**, which presents in detail the prioritized strategies for town-wide development through the land use plan and also through proposed or planned actions in social, environmental and economic sectors. The town development strategy should give special mention to the hotspots and analyze the focal strategies for these areas, as well as explain how they are fully embedded and efficiently integrated in the town-wide strategy.
- Finally, the **land management strategy**, and especially the land policy

instruments for climate induced disaster risk reduction, that lead to the implementation of the plans and strategies.

B. Public consultation

According to the Town planning process in Myanmar, the draft Town Development Plan should be presented to the community of the town, in a public event, for commenting, further consultation and refinement. This event is organized by the team of experts who run the participatory mapping workshop.

C. Final plan

After the remarks and comments from the public consultation have been incorporated, the Town Development Plan including climate change considerations, is complete.

Outputs

Town Development Plan document

Key considerations

The public consultation can be organized as an event similar to the participatory mapping workshop presented in phase 3. The references and additional sources for public consultations and participatory processes present various methodologies and tools for the organization of a public consultation.

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Annex 7: Town Development Plan indicative structure

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Annex 1: IHS-MCCA Bangkok Sessions

Session	Lecturer	URL
Introduction to Cities and Climate Change	Dr. Stelios Grafakos (IHS)	https://www.slideshare.net/secret/xh3VzJizPjNmjL
Capacity Building Activity on Climate Change and Land Use Planning in Myanmar	Dr. Stelios Grafakos (IHS)	https://www.slideshare.net/secret/t0ceoaoMYxX40n
Introduction to the Myanmar Climate Change Alliance and the Policy Context	Ms. Felicity Cain (UN Habitat)	https://www.slideshare.net/secret/gbVcpUpNChOmlU
Introduction to Climate Change in Myanmar. Presentation, Bangkok	Ms. Felicity Cain (UN Habitat)	https://www.slideshare.net/secret/9cYzQzzDi3o1bu
Myanmar Town planning Process	DUHD (MOC)	https://www.slideshare.net/secret/26lWMC2FMv4JH1
Conceptual Plan of Pakokku	DUHD (MOC)	https://www.slideshare.net/secret/6JYYnUrZHvrkun
Conceptual Plan of Taunggyi	DUHD (MOC)	https://www.slideshare.net/secret/lnqnNJgDdrBM4x
Vulnerability Assessment Workshop	Dr. Stelios Grafakos (IHS)	https://www.slideshare.net/secret/DgcK4QESLd8y45
Future Vulnerability Assessment	Dr. Alberto Gianoli (IHS)	https://www.slideshare.net/secret/nouzDUYr4KqkFC
Mainstreaming Climate change in Town planning: The case of Sorsogon	Dr. Stelios Grafakos (IHS)	https://www.slideshare.net/secret/rk5vyP8miymk6b
Introduction to Ecosystem-Based Adaptation and Ecosystem Services	Ms. Nina Raasakka (UN Environment)	https://www.slideshare.net/secret/6pZMojMcxuJxy7
Land and its Linkages with Blue-Green Infrastructure and Resilience Planning at the Community Level	Dr. Paul Rabe (IHS)	https://www.slideshare.net/secret/94hxTJjlMv08q2
Participatory Mapping of Ecosystem Services	Ms. Alexandra Tsatsou (IHS)	https://www.slideshare.net/secret/6JbHhTTxnesXk
Flood Management and Integrated Water-Land Use Planning in Bangkok Metropolitan Region	Dr. Sohee Kim (AIT)	https://www.slideshare.net/secret/r3SP0lDU0qqMgm
Bangkok Flood Control Center	Drainage and Sewerage Department (BMA)	https://www.slideshare.net/secret/aRAIylqXxaLAOF

Annex 2: Town Profile Indicative Outline

Town Profile (indicative outline)
1. Introduction 2. Historical development 3. Social/cultural situation: a. Demographic characteristics (using aggregated population data) b. Education c. Employment opportunities d. Leisure options e. Religion f. Other 4. Economic situation: a. The role of the city in the country and how it fulfils that role b. Formal/informal economy c. Types of businesses d. Other 5. Environmental situation: a. Geography b. Climate c. Ecosystems (condition, management, etc.) d. Impact chain graph (current situation based on past events/changes in climate) e. Pollution f. Other 6. Spatial situation: a. Geographical features b. Location of the city (in the country/region/with regard to neighboring cities) c. Spatial distribution (density; mixed/single use; planned/unplanned…) d. Access to services e. Accessibility/proximity f. Other 7. Governance/stakeholders: a. How does the city function? b. Government Structures c. Transparency d. Citizens' participation e. Map of main stakeholders in the city (NGOs, other civic organizations) f. Other 8. Town vision (if there is one already) 9. SWOT analysis 10. Conclusions 11. References to previous studies (at the town or township level), policies, national/regional/local reports, etc. 12. Annex List and description of available data

Annex 3: Participatory Mapping Workshop Agenda

Time	Activity
09.30 - 10.00	Introduction, agenda of the day
	Round of introduction
	Presentation of processes, procedures, and definitions/concepts to be used
	Q&A session
10.00 - 11.00	Familiarization with land use map ❑ Participatory mapping activity ❑ Introductory activity of mapping past climate hazards and impacts ❑ Discussion of future climate hazards and future vulnerability
Coffee Break (11.00-11.15)	
11.15 - 12.30	Participatory mapping activity ❑ Mapping ecosystems and Ecosystem Services
Lunch Break (12.30-13.30)	
13.30 - 14.30	Updating impact chain graph
14.30 - 15.00	Peer-review of maps
	Plenary discussion
Coffee Break (15.00 - 15.30)	

Annex 4: Vulnerability Indicators Examples*

CURRENT EXPOSURE (climate and past events) *"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") Source: IPCC WGIIAR5 Glossary*	Yearly precipitation data for the last decades	
	Average temperature data monthly and yearly for the last decades (average temp; minimum temp; maximum temp)	
	Rainy days/non rainy days data for the last decades	
	Average sunlight hours for the last years	
	Wind speed data for the last years	
	Hazards that occured in the last years or decades (floods, droughts, strong winds, storm surges, cyclones, etc)	
FUTURE EXPOSURE (climate projections)	Temperature projections (average temp; minimum temp; maximum temp) (annual and monthly)	
	Precipitation projections (annual and monthly)	
	Slow-onset projections	
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". Source: IPCC WGIIAR5 Glossary*	**ECONOMIC**	Economic losses due to past hazards
		Expenses for accessing water
		Value of key local industries (fishing, trade, agriculture, etc)
		Information about formal vs informal economy
	SOCIAL	Rates of water borne disease
		Dengue/malaria infection rates
		Income per capita
		Income dependency on agriculture/fisheries/etc
		Population density
		Gender
		Age

	INFRASTRUCTURE	Access to transportation
		Access to cyclone shelters
		Access to improved sanitation
		Access to solid waste collection
		Local assets (road network, water supply, sanitation infrastructure)
		Housing material/construction type
		Land ownership
		Energy infrastructure / diversification of sources of energy
		Water infrastructure / diversification of sources of drinking water
		Drainage system capacity (m3/sec)
	ECOSYSTEMS	Water source/supply data
		Rainwater harvesting
		Permeability of area (%)
		Quality of forest
		Deforestation rate
		Access to drinking water
		Access to irrigation (in agricultural areas)
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." Source: IPCC WGIIAR5 Glossary*	Local income/poverty data	
	Mobile phone penetration	
	Literacy rate	
	Level of education completed	
	Number of schools/school enrolment	

*See the below sources for more indicators

GIZ. (2014). The Vulnerability Sourcebook: Concept and Guidelines for standardised Vulnerability Assessments. Deutsche Gesellschaft für Internationale Zusammenarbeit - GIZ.. pp. 72-84

UN-Habitat. (2014). Planning for climate change: Guide – A strategic, values-based approach for urban planners. Pp. 45-82

Annex 5: Ecosystem Services Examples

Provisioning services *"the goods or products obtained from ecosystems"*	raw materials (water, timber, fiber, etc)
	Freshwater
	Food
	medicinal resources
	habitats for species
Regulating services *"the benefits obtained from an ecosystem's control of natural processes"*	local climate and air quality
	carbon sequestration and storage
	moderation of extreme events
	wastewater treatment
	Erosion
	Water flows
	Pollination
Cultural services *"the nonmaterial benefits obtained from ecosystems such as recreation, spiritual values, and aesthetic enjoyment"*	Recreation
	physical and mental health
	Tourism
	aesthetic appreciation and inspiration
	spiritual experience and sense of place

Sources/References

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Annex 6: Data Sources in Myanmar

Vulnerability Assessment

Data	Data Sources
• Population • Demographics • Key sectors/economic data • Location • Governance structure (key focal agencies, key community groups and local leaders) • Geographical profile (topography)	• GAD • Census • Dept. of planning • Google maps • Department of Forestry

• 50-year rainfall data yearly (annual and monthly)
• 50-year temperature data
  ○ average temp; minimum temp; maximum temp
  ○ annual and monthly
• 50-year rainy days/non rainy day data
• Average sunlight hours
• Wind speed data
• Hazards maps (landslides, floods etc)
	• DMH
	• GAD
	• Myanmar Earthquake Committee

• Temperature projections
  ○ average temp; minimum temp; maximum temp
  ○ annual and monthly
• Precipitation projections (annual and monthly)
• Slow-onset projections
	• GAD
	• DMH
	• MCCA-DMH “Assessing Climate Change in Myanmar”

• Data and maps of losses due to past hazards/landslides • Data and maps of deforestation • Any $ damage Figures/ Expenses to access water • Value of key local industries (fishing, trade, agriculture, etc) • Information about formal vs informal economy	• Dept. of forestry • Dept. of agriculture • Census • Dept. of planning • SURVEY • GAD
• Dengue/malaria infection rates • Rates of water borne disease • Number of schools/school enrolment	• Census • GAD
• Local assets (road network, water supply, sanitation infrastructure) • Housing data (material/construction type) • Land ownership • Energy connectivity • Drainage system capacity (m3/sec)	• CDC • GAD • Census • Dept. of land record • Dept. of electricity

• Type of ecosystem • Water source/supply data • Rainwater harvesting • Permeability of area (%) • Deforestation rate	• Forestry department • Geological department • Census • CDC • Maps
• Local income/poverty data • Mobile phone penetration • Literacy rate • Access to drinking water/'improved' water supply' piped water in their homes • Access to irrigation (in agricultural areas) • Access to 'improved sanitation' • Access to solid waste collection (solid waste collection)	• Census • GAD • MCCA • Dept. of irrigation • CDC

Ecosystem Services

Ecosystem	Ecosystem services	Indicators	Source of data
Agricultural land	Cultivated crops	Production of food (ton ha-1 year-1) Surface area of organic crops (ha)	Municipality
Forest	Provisioning services	Harvested production of textile crops (ton year-1) Total timber removal (m3 year-1) Timber growing stock (m3)	Municipality
Forest / Urban Green	Air quality regulation	Pollutants removed by vegetation (in leaves, stems and roots) (kg ha-1 year-1) Dry deposition velocity (mm s-1)	
Urban Green	Noise mitigation	Leaf Area Index + distance to roads (m) Noise reduction rates applied to UGI within a defined road buffer dB(A) m-2 vegetation unit (Derkzen et al.2015)	
Forest / Urban Green	Water retention capacity / runoff mitigation	Soil water storage capacity (mm) Soil water infiltration capacity (cm) Water retention capacity by vegetation and soil (ton km-2) Intercepted rainfall (m3 year-1) Surface runoff (mm)	Land Cover DEM Soil type Climatic data
Forest / Urban Green	Flood protection	Share of green areas in zones in danger of floods (%)	
Retaining plants along Up and down the hill	Reduction of landslide risk / Erosion protection	Vegetation cover Root-matrix Capacity of ecosystems to avoid soil erosion (dimensionless between 0-1) Soil retention (ton ha-1 year-1)	
Forest / Urban Green	Climate regulation by reduction of CO2	Carbon storage in soil (ton C ha-1) Carbon sequestration (ton ha-1 year-1)	
Forest / Urban Green	Cooling effect	Leaf Area Index Temperature decrease by tree cover (°C m-2) Cooling capacity by shading and evapotranspiration (Zardo et al. 2017)	
Forest / Urban Green	Recreation	Accessibility15 to public parks, gardens and play-grounds (more than 50 ha) - (inhabitants within 10 km from a park) Accessibility to public parks gardens and play-grounds (between 10 ha and 50 ha) - (inhabitants within 1 km from a park) Accessibility to public parks gardens and play-grounds (between 2.5 ha and 10 ha) - (inhabitants within 500 m	

		from a park) Accessibility to public parks gardens and play-ground (between 0.75 ha and 2.5 ha or smaller but important green spaces) - (inhabitants within 250 m from a park). Number/area of landscape & wildlife features with stated recreational value Proximity of green infrastructure to green travel routes (km)	
Forest / Urban Green	Nature-based education	Accessibility of parks from schools (number of public parks and gardens within a defined distance from a school)	
	Heritage, cultural	Cultural and natural heritage sites (e.g., UNESCO world heritage sites) (number per unit area, % per unit area)	

Annex 7: Incorporating Climate Change in the Structure of the Town Development Plan

Town Development Plan (indicative outline)
1. Introduction **(A) TOWN PROFILE SECTION** 2. Historical development **(update: past climate hazards)** 3. Social/cultural situation: a. Demographic characteristics (using aggregated population data) b. Education c. Employment opportunities d. Leisure options e. Religion f. Other **g. Update: vulnerable groups** **h. Update: GIS maps of demographic data** 4. Economic situation: a. The role of the city in the country and how it fulfils that role b. Formal/informal economy c. Types of businesses d. Other **e. Update: vulnerable sectors** **f. Update: GIS maps of economic data** 5. Environmental situation: a. Geography b. Climate c. Ecosystems (condition, management, etc) **(update with participatory mapping data)** **d. Ecosystem Services** e. Impact chain graph (current situation based on past events/changes in climate) **(update with participatory mapping workshop data)** f. Pollution g. Other h. **Update: GIS maps of ecosystems, Ecosystem Services, environmental data** 6. Spatial situation: a. Geographical features b. Location of the city (in the country/region/with regard to neighboring cities) c. Spatial distribution (density; mixed/single use; planned/unplanned…) d. Access to services e. Accessibility/proximity f. Other g. **Update: vulnerable locations (hotspots)** h. **Update: GIS maps of land use, accessibility to services such as schools etc., vulnerability indicators, vulnerability sub-indices, Vulnerability Assessment, hotspots** 7. Governance/stakeholders: a. How does the city function? b. Government structures c. Transparency d. Citizens' participation **(update with information from the participatory mapping workshop)** e. Map of main stakeholders in the city (NGOs, other civic organizations)

f. Other

(B) CURRENT SITUATION ASSESSMENT

8. SWOT analysis for the whole town **(updated)**
9. **SWOT analyses for vulnerable locations (hotspots)**
10. **TOWS analyses for vulnerable locations (hotspots)**
11. **Synthesis / Assessment conclusions**

(C) FUTURE PROJECTIONS

12. **Climate change projections**
13. **Impact chain graph(s)**
14. **Future Vulnerability Assessment: vulnerable ecosystems, locations, economic sectors, groups, etc.)**

(D) TOWN DEVELOPMENT CONCEPT

15. **Town vision (new or updated)**
16. **Town extensions (in phases)**
17. **Town and regional infrastructure concept**

(E) TOWN DEVELOPMENT STRATEGY

18. **Strategies for town-wide development**
    a. **Land use plan**
    b. **Social considerations**
    c. **Environmental considerations**
    d. **Economic considerations**
19. **Focal strategies for the development of the hotspots (embedded in the town-wide strategy)**

(F) LAND MANAGEMENT STRATEGY

20. **Land policy instruments for disaster risk reduction**

(G) REFERENCES

References to previous studies (at the town or township level), policies, national/regional/local reports, etc. **(updated)**

(H) ANNEX

Town database (list, description, sources, links of available data) (updated)