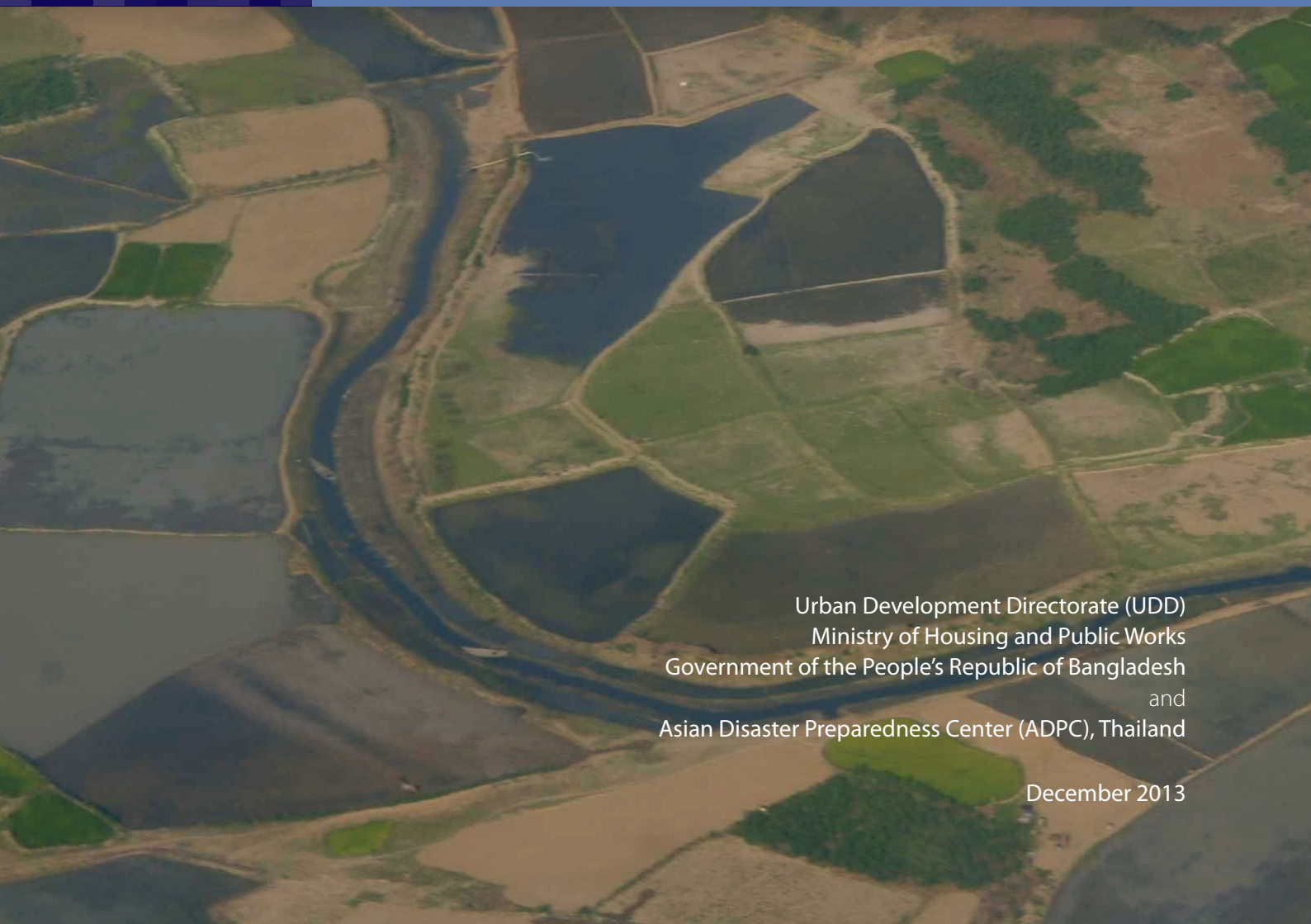
Guidelines for Mainstreaming Disaster Risk Reduction into **Land Use Planning** for Upazilas and Municipalities in Bangladesh



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Cover photo
Ulric Johannesen

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ACRONYMS

ADPC	Asian Disaster Preparedness Center
CCA	Climate Change Adaptation
DRR	Disaster Risk Reduction
EM-DAT	Emergency Events Database
FAO	Food and Agriculture Organization of the United Nations
GDP	Gross Domestic Product
GIS	Geographic Information System
LUP	Land Use Plan/Planning
MDG	Millennium Development Goal
UDD	Urban Development Directorate
UDC	Urban Development Council
UNEP	United Nations Environment Programme

GLOSSARY

Disaster A serious disruption of the functioning of a community or society involving widespread human, material, economic or environmental losses exceeding the ability of the affected community or society to cope using its own resources.

Disaster risk The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Disaster risk reduction The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Exposure People, property, systems, or other elements present in hazard zones that are thereby subject to potential losses.

Land use The spatial location of functions and activities.

Land use plan A document or set of documents which provide clear policy and strategic instruction for achieving sustainable, effective spatial development for a given area.

Land use planning Systematic and iterative procedure carried out in order to create an enabling environment for sustainable development of land resources which meets people's needs and demands. It assesses the physical, socio-economic, institutional and legal potentials and constraints with respect to an optimal and sustainable use of land resources, and empowers people to make decisions about how to allocate those resources.

Mahallah Smallest identifiable area in a municipality with a settlement of a homogenous group of people. For operational convenience, statistically mahallas are delineated within wards.

Mouza Definite area demarcated and identified by the revenue department with a jurisdiction list number. It may be populated or unpopulated.

Natural hazard A dangerous natural phenomenon (such as a flood, storm or earthquake) that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.

Parishad A local level council charged with governing a specific area.

Pourashava A municipality at local level.

Rural Rural refers to an area which is not an urban area or is not included within a municipality or cantonment.

Shahar Smaller urbanized area or secondary town.

Urban Urban refers to those areas where three-fourth of the adult male population of the area is employed in pursuits other than agriculture, and such area contains not less than fifteen thousand population and an average number of people not less than two thousand inhabitants per square mile.

Union Smallest local administrative (local government) unit of rural areas. A union is composed of mouzas and villages. A union has a union parishad.

Upazila Sub-district administrative area.

Village Smallest geographic unit of rural areas. A village may be a single mouza, or there may be more than one village in a mouza. It is always populated.

Vulnerability The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard.

Ward Smallest local administrative (local government) unit of urban areas. For operational convenience, a municipality's area is divided into three or more wards. The ward boundaries are specified by gazette. A ward has a ward parishad (council).

Zila District administrative area.

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PART 1

INTRODUCTION

Dhaka is expanding rapidly due to new construction on the periphery
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Background

It is the policy of the Republic of Bangladesh, that the state shall provide the basic necessities of life, including food, clothing, shelter, education and medical care (Constitution of Bangladesh, Art. 15). The sustainable provision of such goods and services, especially in a densely populated and rapidly developing country like Bangladesh, requires sound economic, social and environmental planning. Within this framework, sustainable urbanization is a recognized national goal (cf. the Bangladesh Perspective Plan 2010-2021). Meaningful, effective urban and land use planning are key mechanisms of the state achieving sustainable urban development.

As a planning and decision-making tool, the essential purpose of land use planning is to 'create an enabling environment for sustainable development of land resources which meets people's needs and demands' (FAO and UNEP, 1999). However, conventional land use planning does not include natural hazards as a factor when determining appropriate allocation of land uses and related policy for the management of land resources. Approximately 80 per cent of the country consists of flood plains and wetlands which are subject to regular flooding, intense cyclonic activity along the coasts, heavy rainfall during the monsoon periods and seismic activity, Bangladesh experiences regular disasters related to diverse natural hazards. Considering the disastrous effects of these hazards, it is essential that land use planning accounts for natural hazards and becomes 'risk-sensitive'. Such a goal is supported by the Bangladesh Sixth Five Year Plan (2011-2015) which emphasizes the need for disaster preparedness, the usefulness of vulnerability and risk assessments, including hazard and risk mapping, and the effectiveness of reducing disaster risk through risk-based land use planning.

The Urban Development Directorate (UDD) is the primary government agency responsible for the preparation of land use plans (LUP). The UDD prepares LUPs for all zila and upazila across the national territory, with the exception of the four largest cities (Dhaka, Chittagong, Khulna and Rajshahi) where City Development Authorities are charged with this duty. UDD was established in 1965, and its land use planning process has developed since then. However, to date, there is no designated guideline outlining the prescribed land use planning process. Therefore, there is a strong need for a rational set of land use planning guidelines, which, given the disaster context of Bangladesh, make prescriptive and strategic provision for disaster risk reduction (DRR).

Objectives

These Guidelines for Mainstreaming Disaster Risk Reduction into Land Use Planning for Upazilas and Municipalities in Bangladesh are intended to promote the establishment of a common land use planning process at local level, as well as promote the use of disaster risk information and disaster risk reduction strategies at planning level. This is a concise document: a more in-depth manual for mainstreaming DRR into LUP preparation will also be developed.

Specifically, the objectives of the guidelines are:

- to provide an enhanced, systematic and standardized procedure for LUP preparation;
- to provide guidance to planners on integrating DRR into LUP preparation; and
- to raise the awareness of planners to incorporate DRR into LUP.

Planners in Dhaka prepare for a planning session
© ADPC

Target Readers

These guidelines are intended to be read and utilized by a diverse range of readers, namely:

- planners, including town planners, urban and regional planners, and physical planning consultants at national and local government levels;
- building professionals such as architects and civil engineers;
- natural resource specialists, such geographers, geologists, hydrologists and environmentalists;
- disaster risk management professionals, including risk assessment experts,
- academicians, research professionals, students of planning and development discipline;
- international development partners and donor agencies.

In this way, it is hoped that these guidelines, and the associated manual for mainstreaming DRR into land use planning, will be of use to a broad range of planning professionals. Similarly, it is hoped that planners will provide feedback based on field experience using these guidelines so that UDD might review and revise them on a biannual basis.

PART 2

LAND USE AND DISASTERS IN BANGLADESH

Cyclone Mahasen causes extensive flooding in May 2013
© Maf Uk

Land Use and Land Use Planning in Bangladesh

Land Use in Bangladesh

The spatial location of functions and activities is called land use. It may take various forms. Land use may be intensive such as human settlements, commercial and industrial areas, and urban agriculture, or it may be less intensive such as livestock production, forestry and nature reserves. The major development activities which take place on land are residing, working, recreating, and moving. Land use not only considers productive processes (e.g. industry, commerce, agriculture) but also deals with functions such as environmental conservation, recreation, physical and technical infrastructure (i.e. roads, building, water supply facilities, waste disposal sites etc.).

There are many factors which determine the way human societies use land. These include:

- physical factors such as the topography of the land, soil quality, sub-surface soil condition, the micro-climate situation (rainfall, wind and sunshine hours) at different locations and climate change factors;
- economic factors such as the cost of land and the cost of using it for different activities, proximity to markets, economic development objectives;
- social factors such as land tenure rights and regulations, inheritance practices, tradition, labor patterns and costs, governmental systems, and cultural perspectives and views towards land and nature.

These factors combine in unique and often competing ways, and result in certain activities and functions taking place in certain locations. The distribution of different land uses in Bangladesh is determined mainly by the monsoon and associated seasonal flooding (Table-1). These physical factors are reinforced by high population density and increasingly by alterations to the natural environment for flood protection, drainage and irrigation. The four primary and competing land uses in Bangladesh are agriculture, forestry, human settlements and water bodies.

For economic reasons, rural, small-scale agriculture land is often converted to other forms of land use with higher economic returns – such as industry, mining and commercial agriculture. This creates considerable pressure on rural lands, and often leads to an imbalance between urban and rural areas, both in terms of relative economic wealth and quality of life of the people. Land use planning has become a necessary prerequisite for spatial development that aims at social, ecological and economic sustainability. A LUP creates the preconditions required to achieve a type of land use that is environmentally sustainable, socially just and economically sound. At the core of land use planning, there are primary tasks of balancing competing land uses by stakeholders and the joint identification of those uses for which the highest consensus can be achieved- ideally for the purpose of sustainability.

Table 1 Area distribution of different land use categories in Bangladesh		
Land Use Category	Area (million hectare)	Percentage (%)
Agriculture	9.57	64.9
State Forest		
Classified	1.52	10.3
Unclassified	0.73	5
Private Forest		
Homestead	0.27	1.8
Tea/Rubber Garden	0.07	0.5
Urban	1.16	7.9
Water	0.94	6.4
Other	0.49	3.2
Total	14.75	100

Source: Dey (2012)

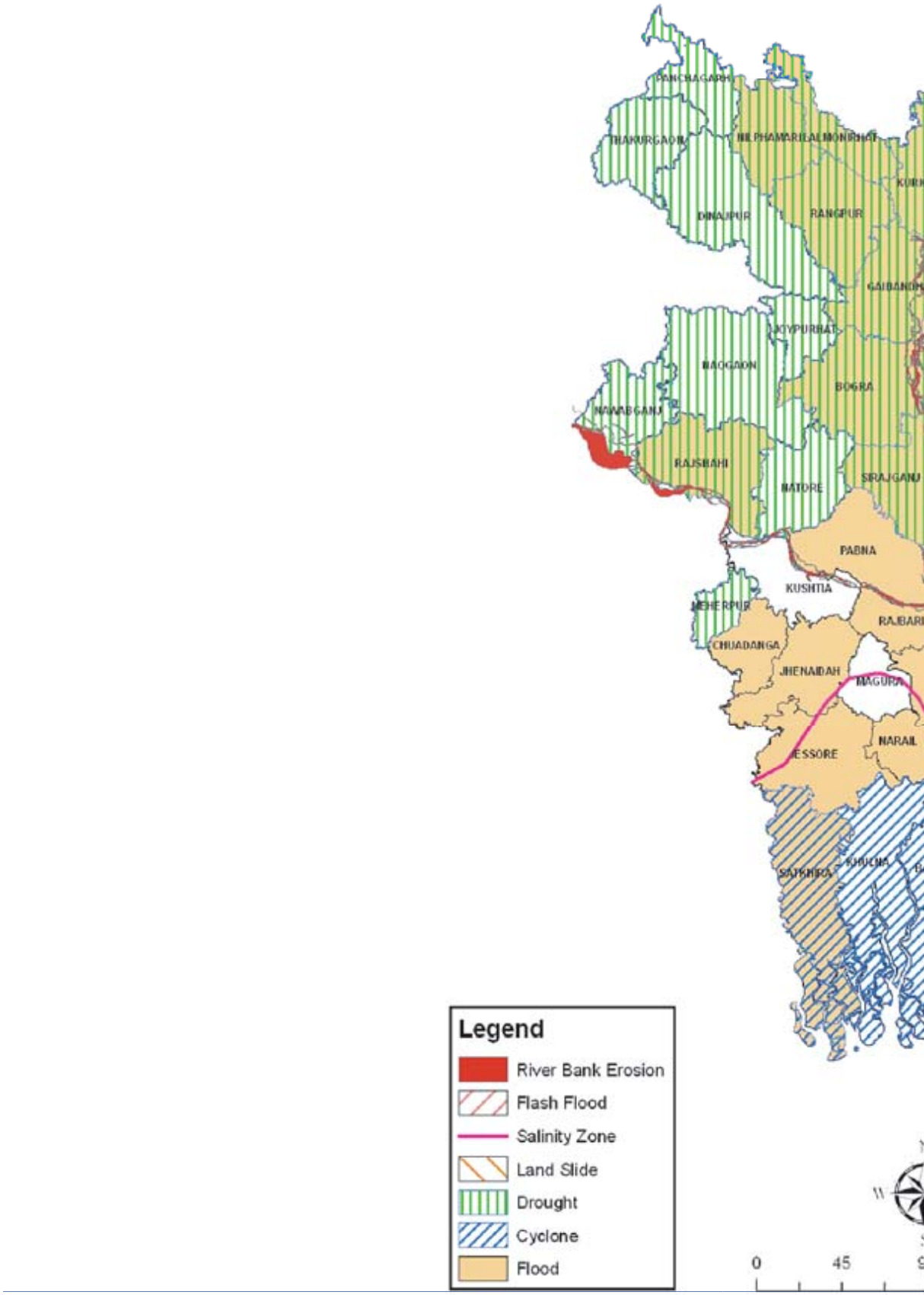
In Bangladesh, mounting population pressure increased flooding and rapid urbanization is causing competition over the use of land. Agricultural land is being bought from farmers and converted to industrial or urban use in order to accommodate hospitals and health centers, schools, colleges, universities and government offices, roads, power stations and communications projects. In this way, the amount of good quality arable land under agricultural production is decreasing at about 3 per cent per annum and has been doing so since the 1980s (Jaim and Begum, 2003). This has lead to the broad recognition in Bangladesh that the State should intervene in an effective manner to protect agricultural land. This calls for the formulation of a national land use policy which is essential for achieving balanced development and improved implementation and enforcement of LUPs. However, while land use planning is recognized as an essential activity, it has hardly been subject to serious discussion within government.

Land Use Planning in Bangladesh

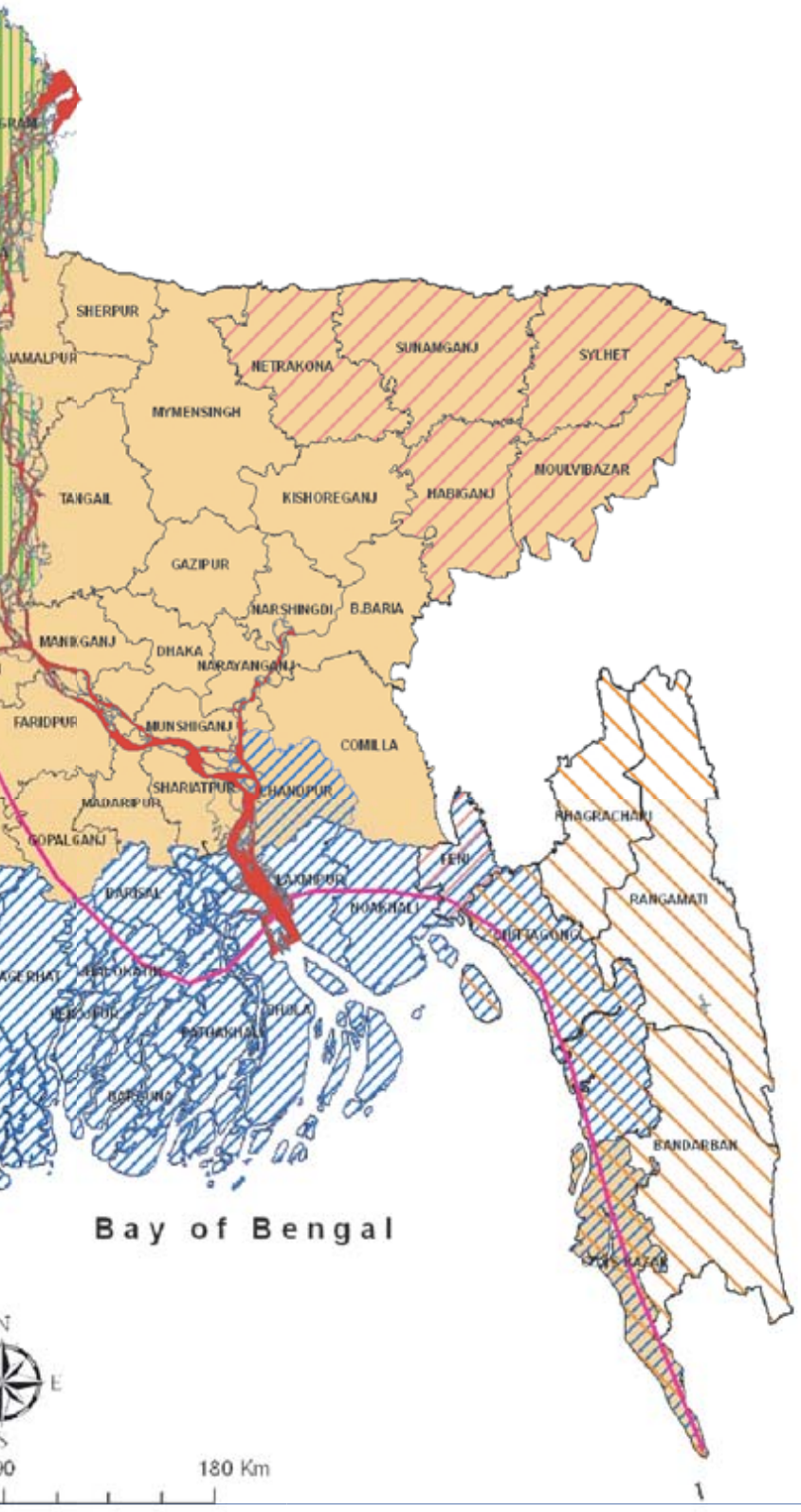
The urban population of Bangladesh is growing twice as fast at the total population. This is due to both natural population growth in towns and cities, and high rates of rural-to-urban migration. By 2025, it is estimated that 50 per cent of the total population will be living in urban areas. Within this content, towns and cities in Bangladesh need to improve their capacity to plan and manage current growth in order to ensure adequate living standards for urban residents as well as to facilitate longer-term growth. However, many urban areas in Bangladesh do not have land use plans in place, leading to activities being uncontrolled, unplanned and uncoordinated. As a result, urban development in these areas is largely unsustainable and characterized by inadequate provision of municipal services, expanding informal settlements, fragmentation of peri-urban areas, inefficient land use and poorly functioning land markets.

The national government accords a high priority to the optimization of limited land resources, and land use planning is considered an important, effective instrument for local development planning and the efficient, sustainable management of land resources in Bangladesh. Land use planning is a technique to ensure the optimization

FIGURE 1 Hazard map of Bangladesh



Source: Bangladesh (20012)


SHERPUR
NETRAKONA
SUNAMGANJ
SYLHET
MYMENSINGH
MOULVIBAZAR
TANGAIL
KISHOREGANJ
HABIGANJ
GAZIPUR
NARSHINGDI
B.BARIA
MANIKGANJ
DHAKA
NARAYANGANJ
FARIDPUR
MUNSHIGANJ
COMILLA
SHARIATPUR
CHANDPUR
MADARIPUR
GOPALGANJ
FENI
LAKSHMIPUR
NOAKHALI
RANGAMATI
CHITTAGONG
BARGUNA
BANDARBAN
Bay of Bengal
180 Km

of land use. Decision-making on land management issues always involves conflicts of interest. While demand for land increases due to a growing population and increasing economic activity, the supply of land is finite, and land therefore becomes increasingly scarce. Land use planning seeks to navigate these competing interests and find consensus amongst stakeholders in regards to future land and resources use, as well as the structures which will be built. The United Nations defines land use planning as the:

Systematic and iterative procedure carried out in order to create an enabling environment for sustainable development of land resources which meets people's needs and demands. It assesses the physical, socio-economic, institutional and legal potentials and constraints with respect to an optimal and sustainable use of land resources, and empowers people to make decisions about how to allocate those resources (FAO and UNEP, 1999).

Land use planning is a public policy exercise that designates and regulates the use of land in order to improve physical, economic, and social efficiency and citizen well-being. The final outcome of land use planning is:

- the allocation and zoning of land for specific uses;
- the regulation of the intensity of such use; and
- the formulation of legal and administrative instruments that support the implementation of the plan at field level.

Land Use Planning Package

Land use planning in Bangladesh produces a package of planning outputs which includes a structure plan, an urban area plan and a detailed area plan. Each plan contributes to the provision of a common framework for overall development in the area. The purpose of the plan is to reduce uncertainty about the current conditions of the area, and to describe and manage future development. This provides a basis and a shared understanding upon which different agencies, both public and private, can proceed in their development activities.

- **The structure plan** develops broad strategies for managing and promoting efficient medium- to long-term urban development. The structure plan integrates economic, physical and environemntal planning objectives, providing a framework for development activities in the area. Compared to the other plans, the structure plan covers a larger area of land, and a longer period of time. The plan is expressed as strategic policy for key sectors, such as the economy, housing, traffic and transportion, spatial development, land development, or the environment. Attention is also given to the insitutional requirements for implementation of these strategies. Plans include an analysis of the major constraints and opportunities in the area and provides major development options and policies based on these. Usually there is also some indication of the most suitable areas for development, as well as identification of priority sectors and activities for implementing the development strategy.
- **The urban area plan** provides a medium-term (i.e. normally ten-year) strategy for the development of the urban area. It defines the geographic boundaries of the planning area over the ten-year planning period. Urban area plans consist of a range of elements, including planning rules for the urban area, multi-sectoral investment

Barisal's structure plan (1), urban area plan (2), and detailed area plan (3)

Source: Bangladesh, (2010)

programs, sectoral surveys, such as traffic, population, power, water surveys, and the location of key facilities such as health and educational facilities.

- **The detailed area plan** covers issues which require immediate attention during the early period of the structure plan (normally the first five years). Within the framework set by the structure plan, the detailed area plan closely examines and provides detailed guidance on a limited number of priority activities to be implemented over the short-term. Guidance is especially related to land use and infrastructure. The plan's formulation is highly participatory. The plan identifies potential projects and ranks these according to priority. For the prioritized projects, the plan provides guidance ranging over the location of the project, its goals and objectives, key actors and resources required, and budget implications. The detailed area plan is reviewed every five years.

Upazilas and municipalities need to begin practicing this land use planning package in order to achieve planned, effective and sustainable development.

Land Use Planning Agencies

Services and programs for physical planning and urban development are undertaken by a large number of agencies working in different ministries and departments. As a result, there is significant overlap between agencies in terms of functions and responsibilities. The Ministry of Housing and Public Works through its UDD is principal national agency for physical and land use planning. The UDD provides technical planning services to the municipalities and upazilas.

Urban development planning and policy in the four largest cities in Bangladesh (i.e. Dhaka, Khulna, Chittagong and Rajshahi) are prepared by the Development Authorities for these areas (e.g. Chittagong Development Authority). The Ministry of Housing and Public Works supervises the functioning of the Development Authorities, approves their development plans and schemes, monitors progress implementing their development projects, and controls their budgets. UDD is mandated to gazette land use plans for all municipalities in Bangladesh, but not for the municipal areas under the Development Authorities.

Hazards and Disasters

The realization of local and national level development goals is regularly compromised by disasters due to a wide range of natural hazards. Natural hazards are natural phenomena which have the potentiality to cause loss of life or damage to property. Examples include floods, earthquakes, cyclones and landslides etc. When natural hazards occur, loss or damage results when communities and assets are vulnerable and exposed to the hazard, which is not always the case. Buildings, for example, can be made earthquake-proof or flood-proof, and if communities are adequately prepared to respond to natural hazard events, disaster can be avoided. Bangladesh faces a number of natural hazards (Table 2) and these regularly lead to disaster due to a variety of factors.

Table 2 Summary of different types of hazards in Bangladesh

Natural hazard type	Examples	
Geophysical hazards	• earthquakes • tsunami • land subsidence	• riverbank erosion • mass movement (dry) • coastal erosion
Hydro-meteorological hazards	• flood • cyclone • tornadoes • extreme temperature	• salinity intrusion (coastal areas) • storms and storm surge • heavy rains • drought

Source: Adapted from Bangladesh (2011)

Hydrological and Climatological Hazards and Disasters

Hydrological hazards are dominated by the country's tropical monsoon climate and the effects of the annual monsoon (July-September), with the pre-monsoon (April-May) and post-monsoon (October-November) months bringing specific meteorological activity and widespread hazard events.

Every year a vast amount of water flows through Bangladesh, carried by its three major rivers, the Ganges, the Brahmaputra and the Meghna, collectively forming the largest river delta in the world at the summit of the Bay of Bengal. Subject to rapid torrential rains during the monsoon, and being low-lying, the country is extremely vulnerable to flood. About 75 per cent of the country is less than 10 meters above sea level and 80 per cent is flood plain. Flooding normally occurs during the monsoon season from June to September. Every year, an average of 18 per cent of the country is flooded and once every three to five years, up to two-thirds of Bangladesh is flooded. Vulnerability to flood is massively exacerbated by the widespread location of villages, towns and settlements in floodplains, and flood prone areas, as well as poor quality construction. Vulnerability to flood is exacerbated by insufficient and inefficient drainage systems, and heavily silted rivers and canals.

The majority of floods are recurring and primarily due to high rainfall in the catchment areas of the rivers during the monsoon. High rainfall result in high discharge levels in the rivers which overflow their banks to flood surrounding areas. Floods regularly cause widespread damage to human settlements, infrastructure, crops and ecosystems. An overview of major hydro-meteorological hazards and their impacts in Bangladesh is illustrated in Table 3.

Table 3 Overview of hydro-meteorological hazards in Bangladesh

Hazard	Key causes	Season	Potential Impact
Flood	• excessive rainfall • excessive water from glacier melt • inadequate infrastructure • inadequate drainage • silted rivers • deforestation	Monsoon	• lose agriculture • disrupt communication systems • disrupt livelihoods • disrupt essential services • lose human lives • damage property • lose biodiversity • degrade environments • destroy cash crops • stress national economy • disrupt lifestyles • reduce fresh water fish production
Cyclone	• intense sea-surface heating (Bay of Bengal) • low moisture incursion • coastal configuration	Pre- and post-monsoon	
Drought	• reduced rainfall • non-availability of surface water • deforestation • over-farming • excessive irrigation	Dry season	

Source: Bangladesh (2011)

Cyclones, tornados and storms cause destruction of houses, infrastructure, crops and forests especially in the southern areas of the country. Over the period 1980-2010, 60 per cent or 250,000 people of the total worldwide deaths due to cyclones occurred in Bangladesh. Cyclonic activity has been increasing over recent years; however cyclone response is also improving. In addition to seasonal cyclones, seasonal droughts in Bangladesh most commonly affect the northwestern region, as it receives lower rainfall than the rest of the country. These droughts have a devastating impact on crops and thereby affect the food security of subsistence farmers.

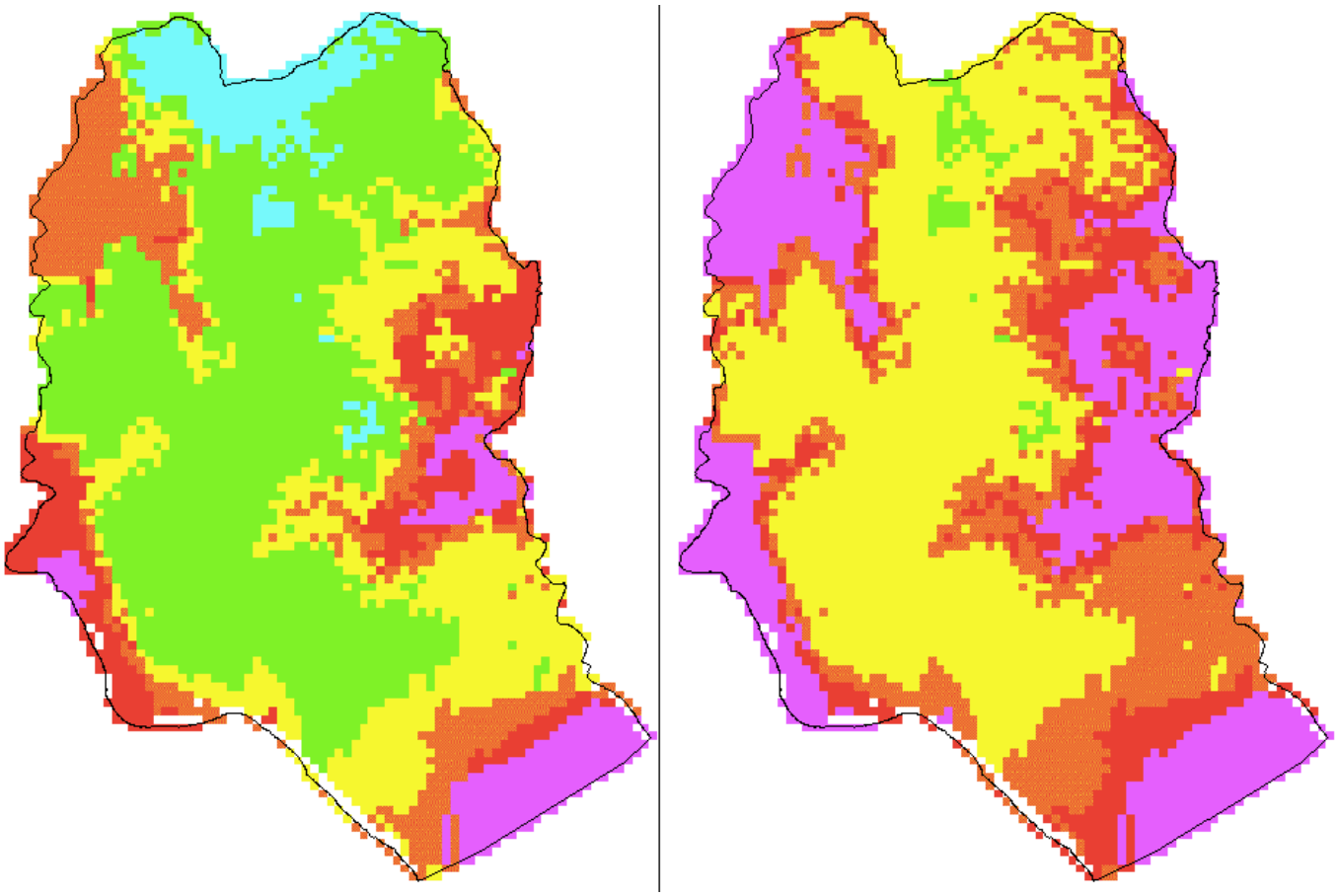
One key driver of hydro-meteorological hazards is climate change, which is expected to increase the frequency, intensity and duration of extreme events. In particular,

climate change will cause high and more intense torrential rainfall during the monsoon period (the wet months will become wet) which will place increased stress on already overworked drainage and flood management systems. At the same time, the hot, dry months are expected to become dryer which results in increased drought in many areas of the country. Climate change causes rising of mean sea level, and current rates of sea incursion and storm surges are likely to increase over the upcoming years as mean sea level continues to rise. This will threaten coastal crops and settlements. There are other drivers of hydrological hazards such as Obstruction to flood flow and natural drainage system, river bed siltation, river area reduction due to human activity.

Geophysical Hazards and Disasters

Geophysical hazards in Bangladesh are mainly seismic; however geological hazards linked to hydrological hazards are increasing (Table 4). Bangladesh is located in a seismically active and high-risk region. The northern and eastern regions of the country are particularly exposed to earthquakes. Vulnerability is increased in many towns and cities in these regions due to poorly regulated and non-engineered construction. Over the past 150 years, Bangladesh has experienced seven major earthquakes of magnitude 7 or higher.

FIGURE 2 **Earthquake microzonation maps for Dhaka..**



Source: Bangladesh (2009)

Given this seismic activity, the country is currently divided into three seismic zones (Figure 4), with zone 3 in the northeast of the country being the most vulnerable to earthquake, and zone 1 in the southwest being the least.

In addition to earthquake, landslide is emerging as a major geophysical hazard in Bangladesh. This is due to heavier rainfall during the monsoon months which loosens topsoil on hills and can cause widespread mass movements of earth, collapsing walls and causing general damage to both settlements and crops and loss of life. This is especially the case in Chittagong where the land is hilly.

Table 4 Overview of geological hazards in Bangladesh

Hazard	Key causes	Season	Potential Impact
Earthquake	• major fault lines • moderate fault lines	All seasons	• destroy settlements • destroy infrastructure • lose human life • disrupt basic services and utilities • reduce area of arable land
Landslide	• heavy rains • unstable slopes • hill cutting • deforestation of slopes	Monsoon	
Erosion (river banks)	• high river discharge rates • deforestation of banks • sediment deposition on river bed • storm surge and sea current	All seasons	

Source: Bangladesh (2011)

The Impact of Disasters on Development

The cumulative impact of disasters due to natural hazards is considerable. Disasters adversely affect Bangladesh in three main ways:

- Destroying current gains and progress in development, including housing, infrastructure, human development and capital investment projects;
- Delaying current development projects by diverting government funding for development projects into emergency disaster relief;
- Setting back future development potential by disruption human and economic development and capital accumulation, as well as disrupting environmental assets vital for long term growth.

Due to increasing development such as rapid urbanization, and the concentration of human populations and assets in vulnerable cities, as well as increasingly natural hazards (especially hydrological), annual losses in human, economic, financial and environmental resources are increasing. Over the 30-year period between 1980 and 2010, Bangladesh suffered losses as per Table 5.

Table 5 Overview of losses from natural disasters from1980 to 2010	
Total number of disaster events	234
Human losses	
Total people killed	191, 836
Average killed per year	6,188
Total people affected	323 million
Average affected per year	10.4 million
Economic damage (USD)	
Total damages	17 billion
Average damage per year	0.5 billion

Source: EM-DAT (2013)

With a gross domestic product (GDP) in 2010 of USD 100.4 billion, economic losses due to natural disasters account for an average of 0.5 per cent of annual GDP. However, this is an annual average measured over 30 years and should not obscure the incredible stress placed on the national economy by particularly high impact disasters. One such was cyclone Sidr of November 2007, which had a total damage of USD 3 billion against the 2007 GDP of USD 68.4 billion, some 4.4 per cent of GDP (Table 6). 2010, Bangladesh suffered losses as per Table 6.

Table 6 Damages caused by cyclone Sidr in 2007	
Human damages	
Population affected	6.9 million
Total number of households affected	1.6 million
Total people killed	3199
Total people missing	1180
Agricultural damages	
Total crop land damaged (hectare)	1.61 million
Total livestock perished	0.46 million
Infrastructural damages	
Number of education institutions damaged	9,248
Length of embankment damaged (km)	614
Length of roads (both earthen and brick-built) damaged (km)	89,428
Total economic loss (USD)	3 billion

Source: Bangladesh (2008)

While cyclone Sidr was a particularly damaging disaster, it was not the first to cause such widespread damages in Bangladesh. An estimated USD 2.4-4 billion worth damages occurred during 1991 cyclone; which was 7.8–13.0 per cent of the year's GDP (USD 30.96 billion). An estimated 1 million homes were completely destroyed and a further 1 million homes damaged. Up to 60 per cent of the country's cattle and 80 per cent of poultry stocks were destroyed. Further, 113,300 hectares of crops were destroyed; 740 kilometers of flood embankments were destroyed or badly damaged which exposed 72,000 hectares or rice paddy to salt water intrusion (Shamsuddoha and Chowdhury, 2007). Similarly, both in 2004 and 2007, over half the country were flooded during the

monsoon. The flood of 2004 affected 25 per cent of the population and caused a total damage of USD 7 million (3.4 per cent of GDP 2004). 34 per cent of this cost was due to damaged infrastructure, with the damage to the agricultural sector accounting for 26 per cent. Both public and private holdings were severely affected: 38 per cent of the total damage was to public assets and 62 per cent was private (CPD-IRBD, 2004). In addition to primary losses, secondary losses from disasters must also be considered. For example, the flood of 1988 caused widespread damages: affecting 45 million people and killing 1600 in the flood waters. However, a further 735 people died in subsequent diarrheal diseases linked to the stagnant flood water and contamination of drinking water systems.

In addition, damages due to disasters only account for a portion of the total impact of disasters when considered holistically. Measuring economic damage does not take into consideration the long-tem losses in overall development: losses due to lost trading options, losses in health due to food insecurity, losses in education and human development due to damaged schools and health clinics etc.

The Need for Mainstreaming DRR into Land Use Planning

Given these recurring heavy losses, Bangladesh needs to systematically strengthen its tools and instruments for reducing the potentiality of such losses in future. The reduction and management of disaster risk involves reducing the exposure or vulnerability of communities and assets to hazards using policies, structural measures and planning

The Sundarbans delta region is the largest in the world
© Ignacio Benvenuty Cabral

tools, such as LUPs. However, disaster risk cannot be completely eliminated - there is always some degree of risk. Therefore, DRR also includes strategies and measures for reducing the remaining or residual risk.

A LUP is an essential planning tool for successful and systematic DRR. By regulating the location of land uses and activities (including housing, infrastructure, nature conservation and natural resource management) as well as stipulating conditions for these uses and activities (building safety conditions, urban design conditions) land use plans provide policy makers and planners with a tool whereby both exposure and vulnerability of assets and communities can be reduced. In order to do this, disaster risk information and treatment measures must be considered and deployed as part of the land use planning process.

However, current land use planning practice in Bangladesh does not systematically consider natural hazards or disaster risk. While there is some consideration given to flood management issues in master plans and land use plans, this tends to be reactionary and sporadic. What is required is a systematic, purposeful incorporation of DRR into land use planning.

Such effort will allow land use planners, when preparing a land use plan, to identify hazards and areas of high risk, and to identify and implement measures to reduce that risk. Mainstreaming DRR into land use planning can systematically reduce the impact of specific hazards, such as floods or landslides, which frequently cause disaster due to inappropriate land use. Land use planning can also reduce the vulnerability of people and infrastructure by identifying appropriate (safe or low risk) locations for settlement and construction and by defining and applying adequate building standards during plan implementation. In this way, mainstreaming DRR into land use planning is a way to achieve safer and more sustainable development, by protecting communities, houses, livelihoods, schools and hospitals and other components of development from disaster.

Above all, risk-sensitive land use planning is useful for controlling exposure, which is the main spatial component of risk (i.e. people, property, systems, or other elements present in hazard zones). Reducing exposure through land use planning involves prioritizing and shifting development into safe, low-risk areas. However, vulnerability, which is when people, property or systems are susceptible to the negative effects of a hazard, can also be reduced through land use planning. This involves policy and provisions which target, and seek to reduce specific aspects of vulnerability such as poor construction, poor transportation and road access, lack of evacuation routes and evacuation sites, poor drainage systems and waterways etc.

The implementation of LUPs in Bangladesh, as in many countries, is a challenge, and mainstreaming DRR into land use planning does not produce LUPs which are any easier to implement. This is slow work: shifting development towards low-risk zones, and implementing policies to reduce vulnerability takes time and requires sustained effort. Budget and human resources for implementing LUP are often insufficient. But it is worth noting that many countries, including both developed and developing countries, struggle to achieve compliance with land use plans, and to successfully mainstreaming DRR into their spatial development processes.

PART 3

GUIDELINES FOR MAINSTREAMING DRR INTO LAND USE PLANNING

Farmers plant rice seedlings
© Ulric Johannesen

Objectives and Outcomes of Mainstreaming DRR into Land Use Planning

Mainstreaming DRR into land use planning aims:

- to make spatial development decisions based on a broad range of information, including disaster risk information;
- to reduce the exposure of communities and assets;
- to ensure that assets and communities are located in appropriate areas, from a disaster risk perspective;
- to reduce the vulnerability of communities and assets; and
- to avoid the creation of new hazards or risks through inappropriate spatial development.

The overall outcome of this process is the protection of new and existing development, and the avoidance of creating new forms or risk through current and future spatial development. This outcome can be achieved by utilizing land and natural resources in a way which carefully considers all aspects of local conditions, and specifically the disaster risk conditions.

Approach to Mainstreaming DRR into Land Use Planning

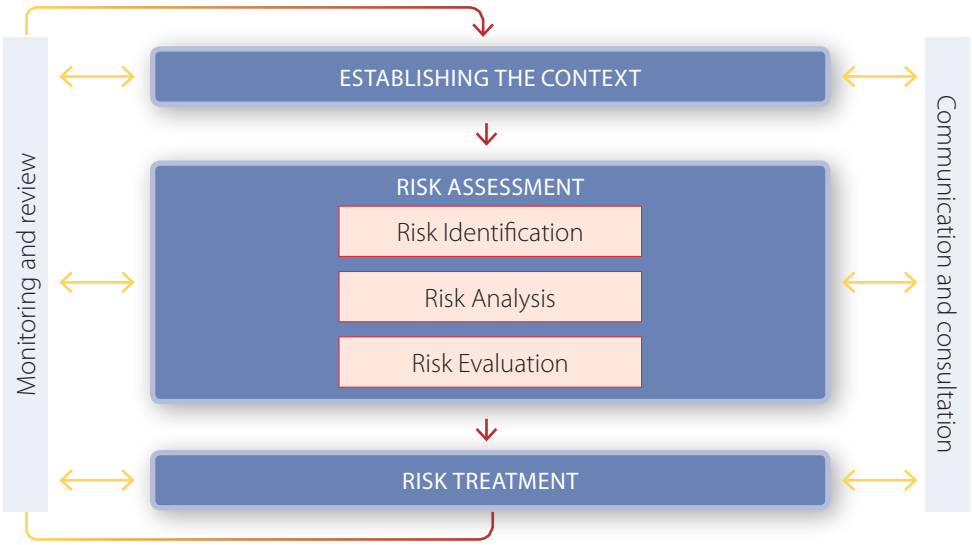
A systematic approach is required to achieve the above objectives. The overall method is to systematically incorporate relevant disaster risk information (risk identification, risk assessment, risk evaluation) as well as disaster risk treatment measures into relevant stages of the LUP process. This is the 'mainstreaming approach'.

Under this approach, the planner must understand both the risk management process and the LUP preparation process so that the former can effectively be integrated into the latter. The risk management process is an internationally established process comprising five key stages as per Figure 3.

These five stages have natural affinities with certain stages of the LUP preparation process:

- At the outset of any urban or land use planning process, planners **collect data** sources and undertake desk reviews, and surveys and field visits to the planning area in order to collect primary data and information. This process within the LUP preparation process can be expanded to the collection of data and information needed to undertake the risk assessment component of risk management process.

FIGURE 3 The risk management process (ISO31000)



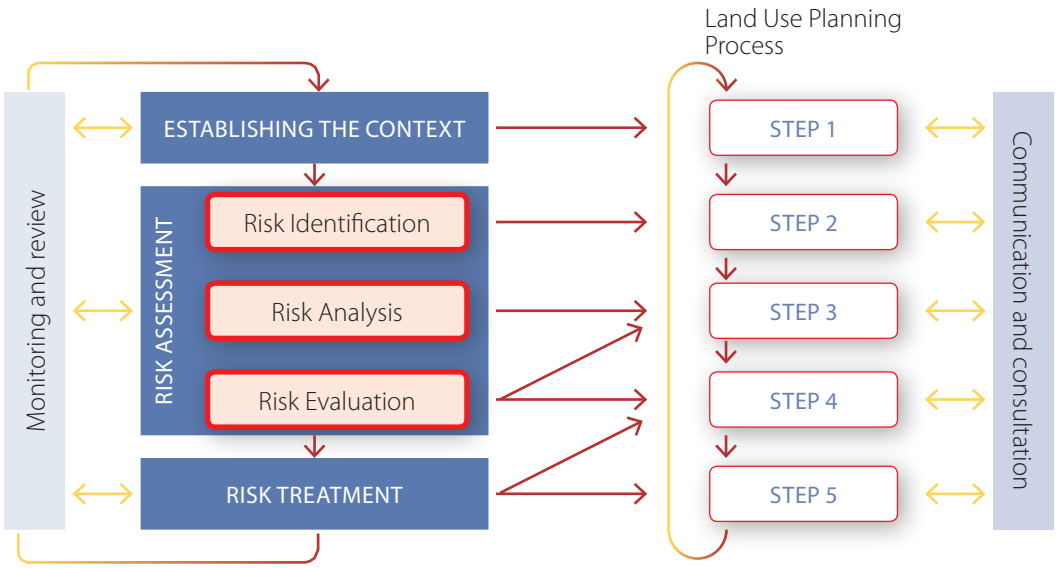
Source: ISO (2009)

- After collecting data and information, a **stage of data processing and analysis begins**. Within this process planners can work with communities and technical staff to identify risks in the planning area, and evaluate the severity of these.
- Risk treatment can take place within the plan formulation phase of the planning process. Based on the risk assessment and evaluation, **specific risk treatment measures can be identified and incorporated into the plan**. These measures can include land use zoning based on flood-heights or other risks, provisions based on expected rainfall or storm activity (for example wide drains, more canals, dredging or maintenance programs for waterways and rivers, provisions for construction such as specific techniques to combat cyclone and wind-loading, designation of protected areas such as wetlands and mangroves which can greatly reduces floods and storm surges. A great variety of risk treatment measures are available (see the associated manual for a full listing).

In this way, the stages of the disaster risk management process are systematically included into the land use planning process. This is outlined in Figure 4 and further described in Table 7. The planning team should be consulting and communicating with stakeholders throughout this process. Similar, monitoring and review is essential and should take place throughout the land use planning process, not just as an after-thought.

Mainstreaming DRR into the land use planning process does not require that the sequential land use planning procedure changes. Rather, what changes is that within each stage of the existing process the planning team acquires and processes additional disaster risk information and makes appropriate spatial development decisions which consider this disaster risk information. The outcome of each stage of the process is improved because the quality of information and decisions made during the stage are enhanced.

FIGURE 4 **Model for mainstreaming DRR into land use planning**



Source: Adapted from ISO (2009)

Table 7 **Summary of activities for mainstreaming DRR into land use planning**

LUP preparation step	Main DRR activity	Enhanced outcome
1. Preparation	• The role of DRR in the planning proposal is defined • Shared vision of resilient spatial development is agreed	• Planning proposal becomes risk sensitive
2. Data and Information Gathering	Hazard and vulnerability data and information is collected	• A more comprehensive range of data and information is collected
3. Data and Information Analysis	• Risk assessment is undertaken • Specific disaster risks are prioritized	• A more comprehensive range of data and information is analyzed • Disaster risk in the planning area is known
4. Plan Formulation	• Disaster risk is treated using different measures (zoning, regulation, policy) • Indicators for monitoring disaster risk are established	• Future spatial development as described in the plan becomes risk-sensitive and resilient
5. Plan Adoption and Gazetting	Advocacy for risk-sensitive LUP	• Risk-sensitive LUP becomes legally binding

Process for incorporating DRR into land use planning

The LUP process deployed and encouraged by UDD, is a five-step process modeled on international LUP standards and strengthened and refined by UDD over the past fifty years of active planning. DRR can be incorporated into the process in the following way.

STEP 1 Preparation

Objective: To establish the conditions of the LUP project, including the key components and objectives for the LUP project, its time frame and methodology, and the human and financial resources needed to undertake the project.

Primary Output: Inception Report

Secondary Output: None

Key Activities: This step includes a number of activities which all contribute to the preparation of the Inception Report as follows:

- Assemble a multidisciplinary planning team and formulate the concept of the LUP.
- Undertake a literature review of all relevant plans and reports of the planning area.
- Identify the goals and objectives for the LUP in consultation with stakeholders. Goals and objectives should be based on principles of sustainable development including key DRR considerations. Such an objective might be to create disaster-resilient communities, or reduce vulnerability.
- Collect basic information on the planning area and prepare a profile of the planning area. This profile is an overall description of the planning area generated through a reconnaissance survey and from secondary information.
- Prepare and agree upon an appropriate working methodology for the LUP. Establish a timeline for the LUP preparation process indicating important dates and milestones.
- Prepare a budget based on the methodology and timeline. Arrange financial and human resources to carry out the planning project, as well as associated logistics.
- Prepare a draft Inception Report. Present the draft Inception Report to the custodian of the LUP (i.e. the upazila or municipality) for consultation and feedback. Revise the Inception Report based on feedback from the public and stakeholders.

Time Required: 5-8 weeks

Partner Organizations: Upazila parishad, pourashava or municipality.

STEP 2

Data and Information Gathering

Objective: To gather comprehensive data (spatial and non-spatial) of the planning area and to assemble this into a database.

Primary Output: Sectoral database for the planning area

Secondary Output: This step involves the production of a broad range of secondary outputs, including:

- Sectoral maps and reports such as demographic, industrial, hydrological, geological, agricultural, transport, environmental, hazard, metrological etc.; and
- Participatory planning documents such as a problem tree, objective trees and participatory rapid appraisal maps.

Key Activities: This step includes a number of activities which all contribute to the preparation of a sectoral database for the planning area as follows:

- Prepare a GIS-based base map of the planning area and digitize any paper-based maps required.
- Establish agreements for data sharing among different agencies as required by the project.
- Set data collection and storage parameters.
- Collect secondary data (usually sectoral) from different institutions such as the Bangladesh Bureau of Statistics or the Bangladesh Meteorological Department.
- Collect primary data through surveys and field visits of the planning area. This may involve input from technical specialists for certain surveys. Ensure that hazard data is collected during relevant surveys (for example, waterways and hydrological surveys should consider rainfall, flood, and water drainage patterns for the areas).
- Collect additional specific hazard data (meteorological, seismic, soil stability etc.) as needed either from primary or secondary sources (such as a local risk assessment) depending on data availability.
- Collect primary socio-economic data using participatory research methods and a socio-economic survey.
- Assemble all data into a database of the planning area.

Time Required: 20-24 weeks

Partner Organization(s): Related organizations

STEP 3

Data and Information Analysis

Objective: To analyze the collected data in order to gather a clear understanding of the overall development patterns of the planning area, as well as specific sectoral development options, future socio-economic growth scenarios and disaster risk.

Primary output: Sectoral analytical reports and maps (social map, hazard map, risk map, land use map, natural resources map, drainage map, contour map etc.).

Secondary outputs: Report of Strengths, Weaknesses, Opportunities and Threats (SWOT); Participatory Rapid Appraisal Report; priority matrix, seasonal calendar for disasters etc.

Key Activities: The planning team partners with a consultant (firm or individual) in order to undertake the activities of this phase, including:

- Analyze the demographic, social and economic data to forecast future population growth scenarios.
- Analyze the economic and local industry data and produce sectoral reports on relevant industries. Common sectors include transportation, agriculture, tourism, industry and retail.
- Analyze environmental data and produce an environmental report focusing on natural resources, natural hazards, current land use patterns, drainage patterns and topography. This report includes a risk assessment with hazard and risk maps, and a seasonal calendar of hazard activity. Evaluate risk and determine priorities for treating risk.
- Undertake a locational analysis using GIS.
- Undertake a Strengths, Weaknesses, Opportunities and Threats (SWOT) analysis of planning parameters.
- Prepare reports based on information gathered and analyzed and relevant outcomes.

Time Required: 16-20 weeks

Partner Organization: Consultant (individual or firm)

STEP 4

Plan Formulation

Objective: To prepare the draft LUP in consultation with stakeholders.

Primary outputs: Structure Plan, Urban Area Plan, Detailed Area Plan.

Secondary outputs: Sectoral Action Plans.

Key Activities: This step includes a number of key activities which collectively allow the planning team to produce a draft land use plan, and includes:

- Determine appropriate planning standards for the planning area.
- Formulate different overall scenarios for medium to long-term (10-20 years) spatial development in the planning area. Such scenarios are based on population forecasts, sectoral development reports, the environmental report, and current and expected disaster risks for the planning. These scenarios are probabilistic pictures of the planning area and factor in future population growth and limits and challenges to growth. Consider how natural hazards are likely to change over the planning period – especially through the predicted impact of climate change on rainfall and storm or cyclone activity etc.
- Elaborate a series of draft land use planning proposals for the future development of the planning area based on the scenarios. These provide alternative development options, which can be compared. Sectoral proposals should include specific policy for reducing and managing disaster risk within these sectors.
- Present various land use planning and sectoral development proposals to stakeholders for consultation and feedback through meetings and focus group discussion at the upazila or municipality.
- Revise the sectoral development proposals based on inputs and feedback from stakeholders. Harmonize sectoral development proposals into a single proposal and incorporate this into the overall land use plan for the planning area. The resulting land use plan should optimize and balance competing interests and needs in the planning area.
- Elaborate the Structure Plan, Urban Area Plan and the Detailed Area Plan. These different plans include different maps and reports as well as specific policy for managing disaster risk across the planning area through the use of building regulation, development controls, zoning etc.

- Elaborate overall indicators to monitor the implementation of the plan including its DRR aspects as part of the Detailed Area Plan.
- Prepare a list of priority projects including key hazard management infrastructure projects such as canals, levees etc.

Time Required: 12-16 weeks

Partner Organization: Upazila, pourashava or municipality, beneficiary.

STEP 5

Plan Adoption and Gazetting

Objective: To convert the planning documents into legal documents for implementation.

Primary output: Gazette Notification.

Secondary outputs: Leaflet, poster, advertisement.

Key Activities: This step is comprised the following key activities:

- Assist the upazila or municipality to arrange public hearings for the validation of the risk-sensitive LUP.
- Present the draft LUP documents (Structure Plan, Urban Area Plan, and Detailed Area Plan) to the public for feedback and review.
- Consider suggestions from the public hearing as revise the draft LUP documents accordingly.
- Submit the finalized LUP documents to the Ministry of Housing and Public Works for gazetting.
- The upazila or municipality formally adopts the gazetted LUP documents.

Time Required: 12-16 weeks

Partner Organization: Ministry of Housing and Public Works, municipality or upazila parishad.

High-density riverside development is common in many parts of Bangladesh
© Bread for the World

Implementation and Monitoring of Land use Plans

LUPs are only useful if implemented, and ideally implementation and enforcement of the LUP is considered by the planning team during the planning process. This allows the planning team to incorporate incentives, and monitoring and review mechanisms directly into the LUP itself. Each activity or measure described under the LUP needs to have a corresponding indicator for monitoring and review purposes.

Monitoring should measure both the impact of the LUP and the process taken for implementation. Results from monitoring need to be regularly incorporated into ongoing development and planning. For example, the Detailed Area Plan should be reviewed and renewed every five years. Given the framework plan, the Structure Plan, last for a period of 20 years, four such Detailed Area Plans will be prepared during the full planning period of the Structure Plan. Monitoring and review of the implementation of the first Detailed Area Plan (years 1-5) should be incorporated into the second Detailed Area Plan (years 6-10) for example.

Implementation is the responsibility of the upazila or municipality. Implementation requires a wide range of practical activities which go beyond the scope of these planning guidelines. However, municipalities and upazilas need to consider the following points for facilitating implementation:

- Maintain good communication between the public and key organisations involved in the implementation of the plan. This includes landowners and land developers, local sectoral agencies, national sectoral agencies involved in development projects in the local area, non-government organisations involved in development projects etc.
- Ensure good coordination of activities between all key agencies involved in development projects and plan implementation. This helps to optimize synergies and facilitation implementation, and avoid duplication of activities and non-compliance.
- Consider viable incentives to encourage that landowners and land developers comply with the provisions of the LUP.
- Build internal capacity of staff of the municipality or upazila. Capacity building should focus on improving awareness and understanding of the specific provisions of the LUP, and on useful ways to improve inspection and enforcement of these.
- Consider ways to allocate budget for priority projects. These need to allow for the extra cost of incorporating DRR into development projects. However, the focus should be on the quality of projects not the quantity of projects. Advocacy on the benefits of investing in DRR may need to be developed to facilitate this budget allocation. Above all, finance officers need to understand that incorporating DRR saves national and local money in the long-term, due to reduced losses and reduced rebuilding costs.
- Develop check-lists and other simple tools to improve monitoring of priority projects. Such checklists need to include DRR considerations.

PART 4

WAY FORWARD

Boats use this small tributary for trade and transportation
© Maf Uk

In order to facilitate the application of these guidelines within planning practice in Bangladesh, five recommendations for organizational and professional capacity development can be suggested:

Raising awareness

Planners, planning institutions, government at all levels and the general public need to be aware of the strategic importance of incorporating DRR into LUP and the huge benefit which resilient spatial development will bring to Bangladesh. Awareness rising could be achieved through a range of activities such as:

- advocacy dialogues;
- seminars and symposiums;
- interviews and talk shows (radio and television);
- news articles in both electronic and print media; and
- leaflets, flyers, booklets and guidelines.

Such activities need to be coupled with a strong dissemination strategy, especially leaflets, flyers, booklets and guidelines which need to be circulated to educational institutions, research organizations, local government, development partners and religious centers.

Improving planning capacity

Planners and associated professionals must develop the necessary skills and knowledge for risk sensitive land use planning through the delivery of trainings and training materials, presentations and learning workshops. The primary focus on capacity building efforts should be national and local planners, and upazila and municipality level technical professionals, and should be based on the associated manual for mainstreaming DRR into land use planning which will detail technical aspects of the process, and supported by regular trainings on this theme both for new and experienced professionals. The secondary focus should be on improving the capacity of the next generation of planners, through the introduction and uptake of the guidelines and manual in higher education facilities, and via integration of DRR principles into planning degree curriculum.

Building data sharing partnerships

Data collection, access and sharing need to be improved so that planners and associated professionals can find and use the necessary data for risk informed LUP. An essential component of brining DRR into LUP involves the gathering and analysis of data and information on hazards, vulnerability and exposure. For effective uptake of risk-sensitive land use planning, access to such data needs to be improved as well as the establishment of common standards in Bangladesh for data management. Relevant agencies should be encouraged to share data between departments, and with the public, and to manage data according to common national frameworks. In particular, the Department of Disaster Management should establish risk information sharing platform and all

planning agencies should be connected to this platform. The Department of Disaster Management should facilitate the use of this information through trainings in risk information analysis and risk mapping for planners.

Connecting planning organizations

Cooperation amongst all agencies engaged in LUP preparation needs to be improved for more coherent and systematic uptake of risk-sensitive land use planning. Such planning agencies include UDD, Local Government Engineering Department, Capital Development Authority (RAJUK), Chittagong Development Authority, Rajshahi Development Authority and Khulna Development Authority, as well as city corporations and pourshavas, private sector planning agencies and planning research institutions. Cooperation should be facilitated through the re-establishment of an Urban Development Council (UDC) first formed in 1966. The UDC would animate all aspects of national level resilient LUP and spatial development regulation. The UDC would be guided by the Urban and Regional Planning Act -2013.

Strengthening implementation mechanisms on the ground

It is not enough to simply incorporate DRR into LUP; implementation and enforcement of LUP must be strengthened to have a real impact on the ground. This requires improvements to the overall LUP and spatial development control system in Bangladesh, and should be supported by a coherent, systematic and unified legislation. At present, there are scattered provision of planning laws, Acts and ordinances. The recent passage of the Urban and Regional Planning Act 2013 will help to improve this situation by providing a uniform and effective system of city and town planning, building control and resilient urban development throughout the country. UDD should seek to promote this Act using trainings and workshops for planners and other professionals. Local government agencies in urban and rural areas should be encouraged to take up planning responsibilities and UDD should help in formulating relevant standards for such agencies, including standards on housing, open space, education and health and recreational facilities. UDD should also seek to monitor implementation and compliance with such standards and provide trainings to local government agencies for improved enforcement at local level.

REFERENCES

Bangladesh, (2008). *Cyclone Sidr in Bangladesh: Damage, loss and needs assessment for disaster recovery and reconstruction*. (Government of Bangladesh, Dhaka).

Bangladesh, (2009). *Seismic Hazard Assessment of Dhaka, Chittagong, and Sylhet City Corporation Area of Bangladesh*. (Government of Bangladesh, Dhaka).

Bangladesh, (2010). *Barisal Master Plan*, Volumes 1 – 3, (Government of Bangladesh, Dhaka).

Bangladesh, (2011). *State of the Environment*, (Government of Bangladesh, Dhaka).

Bangladesh, (2012). *Building Resilient Future: Bangladesh Reducing Disaster Risks in Changing Climate*, (Government of Bangladesh, Dhaka).

CPD-IRBD, (2004). *Rapid Assessment of 2004 Flood*. Accessed from http://www.cpd.org.bd/downloads/IRBD/Flood.pdf on 22 September 2013.

Dey, N., et al. (2012). '*Assessing Land-use Change and Land Degradation in Bangladesh*.' Stanford Journal of Environment and Human Settlement. Vol. 1. 2012.

EM-DAT, (2013). *The OFDA/CRED International Disaster Database*. University Catholique de Louvain, Brussels. Accessed from http://www.emdat.be/ on 12 June 2013.

FAO and UNEP. 1999.'*The Future of Our Land. Facing the Challenge. Guidelines for Integrated Planning for Sustainable Management of Land Resources*,' (FAO, Rome).

ISO, (2009). *Risk Management – Principles and guidelines on implementation*, (ISO, Geneva).

Jaim, W. and Begum, R., (2003). '*Changes in land use pattern in Bangladesh over the last two decades*.' Bangladesh Journal of Agricultural Economics. XXIV, 1 and 2, (2003) pp.87 – 96.

Shamsuddoha and Chowdhury R. K., (2007). *Climate Change Impact and Disaster Vulnerabilities in the Coastal Areas of Bangladesh*, (Press Bangladesh: Dhaka).