4.11 Case Study: Risk and Suitability Analysis

Disclaimer: This is a first attempt to provide guidance in preparing the information product needed for the CLUP and is intended to be used hand-in-hand with Volumes 1 and 2. As more knowledge is gathered, the IP will be updated. Likewise, revisions may be required due to new or changing land use policies. Furthermore, data will continuously be prepared by the custodians, which may require updates. For the latest update, please check HLURB Homepage: http://www.hlurb.gov.ph/ or contact HLURB, telephone +632 927 2698.

Step 1: Background and Objective of the GIS Analysis

Natural hazards are recognized as one of the many challenges to development. In the past consecutive years, natural hazards such as floods, landslides, volcanic and seismic activity, tropical storms, storm surges, etc. have caused major loss of human lives and livelihood, the destruction of economic and social infrastructure, as well as environmental damage.

Natural disasters are typical results experienced by people living in conflict with the environment. These are consequences due to the failure to take into account hazards and risks on land use, zoning, development decisions and spatial planning policies.

By planning for and managing land use to enhance sustainability, vulnerability to disasters, can be reduced. Land Use Plans enable local governments to gather and analyze information about sustainability of land for development so that limitations of
hazard-prone areas are understood by policy-makers, potential investors and community residents.

In the planning process, it is crucial that hazard prone areas are delineated to determine its impact in relation to people, to employ appropriate mitigating measures to reduce the risk, and to eventually make the LGUs well prepared when a disaster occurs.

Although it is important to determine areas suitable for future development, it is also just as important to conserve and safeguard certain areas, such as protected areas, from development for posterity and to protect the environment.

It is essential to develop a more effective way of incorporating the mitigation of the effects of natural disasters into spatial planning, and to incorporate knowledge, technology and key players (data providers, information providers, data/information management and end users) in the field of risk assessment and land use planning.

If there are certain areas designated by law or by the national agencies through their guidelines, that are meant to protect and conserve such areas for sustainability, then these areas should be appropriately reflected in the CLUP, and not used for other purposes such as urban development, in order to avoid conflicts and overlaps in decision-making.

In this example, the Risk and Suitability Analysis will bring out two components/layers that can be superimposed on the existing land use situation:

An analysis of the natural environment from the Land Use and Environment Studies of the CLUP database with risk implications;

An analysis of legally-imposed restrictions on land uses mandated by current laws, ordinances, codes, policies and guidelines, such as NIPAS, taken from the land management sector of the CLUP database, that affect and limit future land use and zoning in the municipality/city.

The Objective is to use GIS to define development limits to the negative impact or does not put more stress on the environment and to delineate regulated areas.

**Step 2: Identify the Indicators to Evaluate Suitable Areas for Future Development**

A spatial view of natural and man-made hazards needs to consider all kinds of hazards through a multi-hazard or multi-risk approach. The use of hazard related controls through the planning process may not be well supported by some stakeholders. Developers and landowners may regard such controls as costly and unnecessary interference and as the cause of loss in land value. These parties may seek to degrade or remove controls through local pressure or through legal appeals.

A strategic approach to risk reduction or avoidance includes the following measures:
Promulgation of guidelines (standards) to guide regulated uses/zones;
Maintenance of natural processes to ensure that natural systems contribute to the protection, resilience and rehabilitation of areas affected by hazards;
Location of elements at risk, such as new human settlements, economic activities and infrastructure, away from areas exposed to natural hazards to decrease their vulnerability;
Development that responds to the site conditions and in particular the nature of risk, so as to significantly reduce the vulnerability of that development. Proactive measures, for example Environmental Impact Assessments, should be initiated and strict enforcement should be adhered to;
Re-zoning of existing areas with urban land use with risks and/or and in conflict with non-urban land use that should prevail in combination with strict enforcement of development control;
Streamlining and harmonization of licenses, permits, etc issued, based on opposing land use interests and conflicting laws and policies.

Step 3: Create the Database

Attribute

The nine first attribute tables in the environmental section may be used. Refer to Chapter 5.05, tables EM01 Soil Type - EM09 Subsidence.

The Custodian of Risk and Suitability Analysis data is the MPDO. In most cases the municipality has to rely on secondary sources.

The feature types will be polygon, polylines and eventually points as well.

When determining suitable areas for expansion, first thing to consider are the physical restrictions imposed by nature and current laws and policies.

Geohazard is another important risk indicator to consider. MGB provides a national coverage of ‘Geohazard maps’ which are in paper format, (available as scanned imagery in .jpg file format) at scale 1:250,000, and displayed by regions. For specific parts of the country, there are digital maps at scale of 1:50,000 with a different symbology with regard to hazards. For municipal planning uses, the accuracy of the 1:250,000 data is not sufficient, and should only be considered as indicative. There is however, an ongoing harmonization project among MGB, PHIVOLCS and PAGASA, and because of recent tragedies, these maps are being updated, and will be produced in larger scales. It will thus be easier to get more precise secondary data in the future, for CLUP preparation.

Included in the Geohazard composite maps are the following:

- Floods- are caused by the extreme increase of water level due to heavy rainfall and the geological characteristics such as the soil type that may not be able to absorb the water causing flooding.
- Earthquakes/Fault Lines- are caused by slippage of crystal rock along a fault or...
area of strain and rebound to new alignment.

Landslides - are caused by downslope transport of soil and rock resulting from naturally occurring vibrations, changes in direct water content, removal of lateral support, loading with weight and weathering, or human manipulation of water courses and slope composition.

Volcanic activities - are caused by magma pushed upward through volcanic vent by pressure and effervescence of dissolved gases.

Tsunamis - are caused by fault movement on sea floor, accompanied by an earthquake. A landslide occurring underwater or above the sea, and then plunging into the water. Volcanic activity either underwater or near the shore.

Possible secondary effects of natural hazards resulting to groundwater pollution, ground water over extraction, ground rupture, etc.

In addition, climate change impacts and meteorological extremes can be analyzed.

Below are examples on some of the Geohazard components superimposed on a simple Base Map consisting of Built-up and Road layers.

Other types of hazards specific to an agencies mandate can also be used by the LGU. PHIVOLCS which monitors active fault lines and volcanoes can also be used. They might also have liquefaction (ground subsidence caused by an earthquake) maps which can also be used for risk management. PAG-ASA has storm surge maps for certain coastal areas.

Present the hazards which are within the municipality together with the Base Map. This will give the LGU a broad view of where these hazards are.

Hazards become a risk if these are in populated areas. Presence of hazards within populated areas can be checked by using the Population Density Map overlaid with the
Hazards. The example below shows that a highly populated barangay (shown in red) partly affected by severe flooding, and there is a fault line passing through it.

Hazards also an economic risk when they are within areas with infrastructure, crops, industries and / or livestock. Overlaying the Hazard areas with the Existing Land Use, will show what areas are affected by such risks. The map below shows the agricultural areas in light green which are prone to the risk of severe erosion.

Once the overall image is shown, it will be easier to focus on specific areas of concern, and analyze each hazard individually, thus avoiding cluttered visuals, and have a clearer
picture for each type of hazard.

**Slope** is another risk indicator, which can be taken from the Base Line about IP Slope (Chapter 4.08.03).
Earthquakes/Fault Lines;

It will be much better to have aerial photos available.

Flooding (note that this map can be a combination of the MGB Geohazard map and
municipal records on actual flooding)

Regarding man-made restrictions on land areas of the municipality, only lands classified as Alienable and Disposable (A & D) should be considered for urban expansion. For those areas which are still unclassified, the criteria used for Land Classification should be considered.

The SAFDZ information product will be another component that puts restrictions on
areas for future urban development:

The NIPAS information product displays protected areas to be considered in the CLUP, which is also a restriction to future urban expansion;
Cases of severe air pollution and pollution of water bodies should be shown as a risk for the living environment. Here it is shown that there is air pollution along a road between two crossings where congested traffic causes continuous smog in the air. Also shown is water pollution from the effluents draining into a water body from a factory.

**Step 4: Analyze the Data**

By using relevant Base Map layers, such as Built-up; Roads, Rivers, etc., analyses can be made by superimposing two or more risk layers described in the Step 3.

Overlay analysis is the process of putting two or more layers on top of each other in the GIS to determine areas of convergence of certain features that give a comprehensive picture for a particular purpose, and thus enable the elimination or screening out of those features that are not suitable for that purpose.

The needs assessment layers, if properly constructed, are most useful in the diagnosis of development issues or the process of problem-finding. The problem-finding analysis involves a three-step process. The first step consists of making meaningful observations or making sense out of the data displayed in Needs Analysis. The second step is probing into the causes or explanations behind the observed conditions. This aspect of the inquiry is important in that it probes into the causes of observed conditions and thus provides the clue to finding more fundamental solutions by attacking the causes rather than the symptoms of the problems. The third step further explores the implications of the observed condition if no significant intervention is exerted by anyone anywhere to change the situation. Implications may be negative or positive according to the
perceptions of various groups and sectors of society. It is when negative implications predominate will the observed condition be regarded as a problem.

The analysis can be extended further into determining appropriate policy interventions. This part of the analysis can simply be called the solution-finding phase and is found in Step 6 of the CLUP preparation process and in the building of Scenarios. Policy interventions need not be limited to targeting the negative implications of observed conditions. Positive implications need to be maintained and strengthened through policies that seek to sustain the beneficial effects. Nonetheless, policies intended to remedy the negative implications by eliminating the causative factors deserve priority attention.

There will probably be overlapping and / or contradictory land uses as reflected in the overlays, and this could be attributed to unsynchronized policies, programs and projects, and even interests, of the different sectors, agencies, and institutions both government and private, obtaining in the municipality/city. And for as long as enforcement is weak, these overlapping and contradictory land uses will show on the maps. However, by using GIS, conflicting regulations will become transparent and should signal to the LGU the need to resolve these conflicts.

In determining the areas for urban expansion, the result might show that not all ecosystems can be preserved, not all natural hazards can be avoided and not all regulations can be considered. There may be compromises that have to be made. In the next step, (Development Scenarios), these compromises will have to be evaluated to determine feasibility of adoption. ‘What if’ and ‘Making the best out of it’ will present pragmatic conclusive alternatives.

A simplified end product of the Risk and Suitability Analysis will be categorized into three land use options based on the following cross-sector indicators:
**Step 5: Present the Data**

The Risk and Suitability Analysis layers will be put on top of the Base Map. The example below summarizes all the indicators. The blank/white areas are lands that are suitable for urban expansion:

<table>
<thead>
<tr>
<th>INDICATOR</th>
<th>RURAL</th>
<th>URBAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Area not suitable for urban development</td>
<td>18% &lt; 10%</td>
<td>10% &lt; 10%</td>
</tr>
<tr>
<td>Area suitable for urban development</td>
<td>18% &gt; 10%</td>
<td>10% &gt; 10%</td>
</tr>
<tr>
<td>Existing urban area exposed to hazards and/or in conflict with other legislations/regulations</td>
<td>Within</td>
<td>Outside</td>
</tr>
<tr>
<td>Existing urban area in accordance with zoning and land use</td>
<td>Within</td>
<td>Outside</td>
</tr>
</tbody>
</table>

**Recommendations for CLUP Scenarios:**
- No future urban area development recommended
- Potential for future urban area development
- Retoning and/or take other measures to control development that respond to site conditions and reduces vulnerability to man-made and natural hazards
- Strict enforcement of regulations regarding structures
- Mitigate measures to control source of pollution and/or hazard

*Air and Water Quality – This will be based on observation of an LGU. If data is not available please refer to EMB.*
The information produced through risk evaluation and analysis provides valuable input into identifying:

- future settlement directions;
- type of land use and regulatory instruments needed to manage development to reduce risk; and
- areas of existing settlements vulnerable to disasters that may need mitigation measures.

This information will be useful when the Scenarios are being prepared in the next step in the CLUP preparation, matching the outcome of the Needs assessment and the Vision for the development of the municipality. (See Chapter 4.12 Development Scenarios.)