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Thile our country is blessed with a rich culture and great sceneries, it is ironic that we are also prone to natural calamities. More often than not, we are devastated by earthquakes, floods, landslides, tropical storms, typhoons, and volcanic eruptions. Millions worth of properties are destroyed and hundreds of our countrymen are killed. Thousands of foreigners visit the Philippines every year because of her tourist attractions, yet in contrast, we are also listed as one of the most disaster-prone countries in the world.

Aside from our country's high vulnerability to natural calamities, our countrymen are also to blame for aggravating the outcome of disasters. Environmental degradation caused by deforestation, uncontrollable waste disposal, water pollution, and unrestrained ground water extraction contribute to the ill effects of natural calamities. Moreover, the dearth of geohazard information and its poor dissemination are also contributing factors.

Despite its key role in national development, NAMRIA remains to be financially constrained from updating all its topographic maps; more so from converting them to digital or geographic information systems (GIS) format as what most users need today. Low-key as it is in pursuing its function and mandate as the country's central mapping agency, it cannot avoid catching public interest especially in times of national catastrophes. With its present mapping capability, not many know how extensive NAMRIA's role is in terms of disaster management and mapping.

For the Panaon Island landslide tragedy in 2003, NAMRIA collaborated with four other government agencies to undertake a geohazard mapping project to produce raininduced and earthquake-triggered susceptibility maps. This year in the wake of the Guinsaugon tragedy, the agency was tasked to do topographic mapping of priority areas for the geohazard mapping program of the Department of Environment and Natural Resources (DENR).

The agency aligns its programs and activities in support of disaster management. For a project to identify areas susceptible to flooding, it produced a sea-level rise vulnerability map of the National Capital Region and its neighboring provinces. It also produced fire-risk potential and soil erosion susceptibility maps from a watershed resource mapping project. And its regular updating of nautical charts are useful in preventing ferryboat-related tragedies and in aiding search and rescue operations.

NAMRIA has already seen many times of great tragedy and it has readily responded to the call to save lives. Constraints notwithstanding, the agency is able to generate the maps needed for the national government's program on disaster management. This is due in part to the agency's dedicated pool of technical experts who consider themselves first and foremost as government servants.*

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Disasters: An Overview

by Xenia R. Andres

e have heard of disasters whether natural or man-made many times in our life. We may even have seen or experienced them for ourselves. As spectators, we may have, in one way or another, extended assistance to and empathized with the victims. As victims, we may have received aid such as food and psychological counseling. Recovery efforts take time to materialize and usually, what was lost can never be regained. Disasters could happen anytime and anywhere; therefore, it is important to know more about them so that we will know how to respond when they happen.

When Disasters Strike

According to the Asian Development Bank-published Disaster Manager's Handbook, most definitions of disasters tend to have the following characterizing ideas: marked disruption of normal patterns of life, with effects on humans and social structure, and community needs such as medical and social care. Disasters can be earthquakes, volcanic eruptions, tsunamis, tropical cyclones, floods, landslides, wildfires, droughts, epidemics, major accidents, and civil unrests. These can cause the loss of lives, livelihood, and national income; damages to properties, crops, and infrastructures; and disruption of production, lifestyle, and essential services.

Each disaster presents varied characteristics, general countermeasures, and problem areas for management. The onset of a flood, for example, may either be gradual or sudden while it is mostly rapid for landslides. An effective medical and health plan is necessary as a general countermeasure for epidemics while land management and special plans such as those for irrigation are essential for droughts. A problem area during volcanic eruptions is the timeliness and accuracy of decisions for evacuation while for tsunamis, it is the timely dissemination of warnings.

The most common disaster action areas are: (1) hazard or possibly threatening event identification; (2) vulnerability assessment or identification of settlements, communities, and assets susceptible to devastation; and (3) risk evaluation or high-risk areas identification. The first process involves mapping to determine geographically where natural and man-made hazards could occur.

The Disaster Management Continuum

Though presented in various forms and terms depending upon local circumstances, the disaster management cycle generally includes prevention, mitigation, preparedness, disaster impact, response, recovery, and development.

Prevention measures are undertaken to delay and/or prevent disaster incidents from occurring and/or harming communities and vital installations. These include dam construction and promulgation of land-use regulations. **Mitigation** involves programs for countrywide or communitywide disaster impact reduction such as agricultural programs to reduce crop hazards and safety codes for transport systems.

Preparedness actions facilitate rapid and effective response of governments, organizations, communities, and individuals to disaster events. Sample activities are public education and awareness training programs on disaster and warning systems provision. This phase is three-pronged. *Warning* is the time or period when a hazard has been identified but is not yet threatening a particular area; *threat* is the time or period when a hazard has been identified and is assessed as threatening a particular area; and *precaution* is an action taken after receipt of warning to offset effects of disaster impact (Carter, 1991).

Disaster impact is the point in which a disaster happens. **Response** measures like evacuation, search, and rescue are undertaken to save lives, to protect property, and to directly deal with the disruptive and destructive consequences of a disaster event. This phase is also called *emergency* response because of the necessity to carry out emergency measures in two or three weeks following disaster impact. **Recovery** refers to the assistance given to communities and the country which



Maps are indispensable tools for disaster management.

subsequently restores them to their appropriate functioning level. Under this phase are the activities of *restoration* (essential services), *rehabilitation* (physical and psychological), and *reconstruction* (infrastructure replacement).

In *Development*, disaster outcomes are considered in future policies for national progress such as modernization of building systems and research and development. *Disaster management* is crucial because it poses many challenges, namely: (1) everthreatening natural and man-made disaster phenomena; (2) development of new disaster threats such as terrorism, hazardous materials, and atomic and nuclear sources; (3) geography; and (4) losses in development and built-up assets.

Philippine Disaster Management

The Philippines is considered as one of the most disaster-prone countries because it is located along the Pacific typhoon belt and fire ring. Hydrological, meteorological, geological, and environmental hazards abound such as drought and red tide poisoning. There are also air and maritime disasters and complex emergencies wherein the cause and assistance to the affected communities are complicated by the intense levels of socio-political dynamics. The country's recent tragedies are the landslide in Barangay Guinsaugon, Saint Bernard, Southern Leyte which buried villagers alive in massive mountain rocks and soil and the Wowowee show stampede.

Disasters...

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The legal bases for the Philippine disaster management system are Presidential Decree (PD) No. 01, series of 1972, as implemented by Presidential Letter of Implementation (LOI) No. 19, series of 1972, and PD 1566 dated 11 June 1978. LOI 19 provides for the organization, mission, and functions of the Office of Civil Defense (OCD) as a bureau under the Department of National Defense while PD 1566 provides for the strengthening of the Philippine disaster control capability and the establishment of a nationwide community disaster preparedness program. This program aims to ensure effective and efficient implementation of the civil protection program through an integrated, multi-sectoral, and community-based approach and strategies for the protection and preservation of life, property, and the environment.

The highest policy-making, coordinating, and supervising body at the national level for Philippine disaster management is the National Disaster Coordinating Council (NDCC). Chaired by the Defense Secretary, its team members are composed of representatives from 17 institutions from the government and the private sector. The Council advises the President on the status of the nation's disaster preparedness and management plans and recommends the declaration of state of calamity and release of national calamity funds as needed. NDCC's operating arm and secretariat is OCD, which is primarily tasked with coordinating the activities and functions of various government agencies and instrumentalities, private institutions, and civic organizations for the protection and preservation of life and property during emergencies.

Also partners in disaster management are local private and nongovernmental institutions and international organizations such as the Philippine National Red Cross, the Citizens' Disaster Response Center, and the United Nations Disaster Relief Organization. These entities extend assistance on pre-disaster activities, response operations, recovery programs, and future developments.

NAMRIA's Role

The outputs of NAMRIA's activities are used for various applications in disaster management. Base map production is undertaken in support to planning for disaster and relief operations and the development of risk maps, among others. Also produced are thematic maps such as land use maps for zoning and land cover maps for before- and after-disaster studies. Maps are moreover employed in regulating the use and disposition of public and forest lands, monitoring exploitation and rate of depletion of natural resources, and planning for resource development and conservation. Nautical charts are useful for search and rescue operations while magnetic data from the Magnetic Observatory of NAMRIA are vital inputs to earthquake monitoring. In this and another previous issue of Infomapper, NAMRIA featured disaster management and mapping as part of its information, education, and communication program.

Since the 1990s during the Luzon earthquake and the Mt. Pinatubo eruption, NAMRIA has been actively contributing to disaster management in its projects, including collaborations with local and international groups. An example is the Land Cover and Land Use Project in 1999-2000 with the Asia-Pacific Network for Global Change Research and in support to the International Geosphere Biosphere Program. The project investigated the interannual dynamics of deforestation, regrowth, and other land use and land cover changes using remote sensing and GIS technologies.

NAMRIA also developed in 2002-2003 a GIS-based Climate Information System for the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) to meet the country's increasing demands for climate information and prediction services which are especially relevant to the agricultural sector. The system which focuses on rainfall analysis is now helping PAGASA with its critical function of providing timely and reliable forecasts and advisories on extreme weather and climate conditions.

In 2004, NAMRIA collaborated with four other government agencies for the mapping and analysis of areas susceptible to geologic hazards. The collaboration included the efforts of the Mines and Geosciences Bureau (MGB)-DENR, the Philippine Institute of Volcanology and Seismology (PHIVOLCS), the Bureau of Soils and Water Management, and PAGASA. The 1:250,000-scale thematic maps produced provide preliminary and indicative information on flooding and raininduced and earthquake-triggered landslides susceptibility. The maps are useful for analysis, planning, and hazard mitigation at the regional level. The compilation of maps is available upon request from NAMRIA.

The agency's current activities for disaster management are the conduct of large- and medium-scale topographic base mapping in support to NDCC and geohazard mapping and the implementation of two projects with the Japan International Cooperation Agency (JICA): Mapping Policy and Topographic Mapping for an Integrated National Development Plan and Enhancement of Hydrographic Capabilities.

Gaining Ground

The best defense we can have against disasters is preparedness and the Philippines has long been involved in its activities, from organization and planning, the harnessing of technology, to the conduct of public education and awareness training programs. Time and again we have been battered by a series of disasters and we generally still suffer a great deal from their effects. What is still wrong? What can still be done? Maybe we should try to look at how we treat nature and our environment. To be effective, therefore, disaster management should be implemented as a comprehensive and continuous activity, not as a periodic reaction to individual disaster circumstances (Carter, 1991). Perhaps there still will come a time when not all of us can be at great risk.*

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Tide Stations and Geohazard Mapping

The tide stations established throughout the coastal regions of the country are specifically operated for the hydrographic surveying activities of the Coast and Geodetic Survey Department (CGSD) of NAMRIA, the end result of which is the production of nautical charts used for sea navigation.

To date, there are 10 primary tide stations which serve as main references for the observation of the occurrence of high and low tides. Considering, however, the varied tidal patterns in the country and owing to the archipelagic nature of our islands, the stations are inadequate for a full study and understanding of the whole tide characteristic of our country. These tide stations therefore need further densification.

Initial Purpose

The tide stations primarily serve as the bases for making sounding corrections of bathymetric surveys done in all the hydrographic activities of CGSD. Actual depth measurements carried out by the survey vessels are taken on either high or low tide occurrences. The soundings are then corrected to the sounding datum for nautical production, which is the mean lower low water. These corrections are computed from the observed actual tidal data at the tide stations.

Through the processing of these tidal data is also made possible the prediction of the times of high and low water on daily occurrences. The office therefore comes out with an annual publication of *Predicted Tide and Current Tables* which serves various purposes to coastal users. The publication is available for sale in the different sales offices of NAMRIA.

Tidal Observations and Geohazard Mapping

Along coastal areas, a water-related hazard that may affect the environment is coastal flooding. Coastal flooding can be caused by rains which may be largely alarming during typhoon seasons and also to some extent, during water discharges from tributary sources. Flooding may also be aggravated by poor drainage systems which hamper the water flow outwards to the sea. by Rene G. Eclarino*

Coastal flooding may also be attributed to tidal dynamics. Coastal flooding could occur during times of higher tides and could be aggravated if it occurs simultaneously with downpours during rainy seasons. As such, the operation of tide stations greatly contributes to the mitigation of this kind of scenario by giving early knowledge on the times of the occurrence of high and low tides. This information can help concerned people prepare for any eventuality and assess the situation for proper actions. Thus the impact of coastal flooding can be lessened.

The tide prediction publication of NAMRIA is truly an essential data support to any hazard mapping involving water level. Maps of floodplain areas integrated with information on high tides give a good account of possible coastal flooding times during the season of rains and other natural phenomena.*



Flood-prone areas in the Philippines Source: Natural Disaster Mitigation in the Philippines (conference proceedings), p. 20, 1994



Process flowchart of the Oceanography Division

* Chief, Oceanography Division, Coast and Geodetic Survey Department

Preparing for Tsunamis Using Tidal Information

by Anna Marie L. Fallorina

tsunami is a sea wave that may become one or more massive waves of water as it hits land. These sea waves are popularly known as "tidal waves," but are wrongly named as such since they are not caused by the tidal action of the moon and the sun like the regular ocean tides. Rather, they are long water waves generated by sudden displacements of the land under water. The most common cause of significant tsunamis is the sudden displacement along a submarine fault caused by an earthquake. Natural hazards such as a submarine volcanic eruption and large submarine landslides may also cause a tsunami.

Tsunamis have occurred in all the oceans. Majority of them are observed in the Pacific Ocean, which is ringed, from New Zealand through East Asia, the Aleutians and the western coasts of the Americas as far as the South Shetland Islands, by zones of high seismic and volcanic activity. About 180 tsunamis were recorded in the Pacific between the years 1900 and 1970. Of these, 35 caused casualties and damage near the source only, whereas nine spread destruction throughout the Pacific. The effects of these waves on the coastal areas of the Pacific are characterized by maximum destructive force at the water's edge. Because of the impact of the waves, breakwaters and piers collapse, sometimes sweeping away their foundation material.

Tidal Observation

A tsunami can be recorded on tidal stations, which make up one component of a tsunami warning system. Tidal observations from these stations are very vital in such a warning system. The conduct of tidal observation in the Philippines started in 1902 using a tide gauge. In 1952, the then Bureau of Coast and Geodetic Survey acquired a tide-predicting machine which could take into account 32 tidal components. IBM 360/30 computer-aided tidal predictions came about in 1969 and replaced the tide-predicting machine.

To date, the processes of tidal analysis and prediction have come a long way with the use of modern PCs and software programs. The collaboration and exchange of oceanographic data with both local and foreign entities continues to be given high regard by the present CGSD of NAMRIA.

Aside from data inputs for storm surges and tsunami studies, tide stations provide: (1) actual tidal information for various activities in research, planning, navigation, charting, and coastal infrastructure design; (2) data on daily occurrences of either high or low tide for coastal activities; (3) bases in determining datum planes for ground elevation and charting references; (4) data inputs for tide prediction; (5) additional information on flooding scenarios; and (6) inputs for weather forecasting.

Disaster Mitigation

Countries have taken precautions to protect coastal areas against tsunamis. Seawall construction along low-lying coastal stretches, breakwater construction at the entrances to bays and harbors, and planting trees, such as pine in Japan, are measures for disaster mitigation. Although they do not afford safety against flooding, belts of pine trees can play a vital role by ridding the tsunami of some of its energy and by acting as a filter for solid objects it carries, thus reducing its destructive power.

However, large engineering works are expensive and in most exposed coastal areas, there is little hope of providing effective protection to property. All that can be done is to ensure that loss of life is reduced by the timely evacuation of people near the coastal areas. It is obvious that timely and reliable warnings of approaching tsunamis are crucial to any evacuation procedure.

Warning Systems

The only permanent tsunami warning system in operation at the present time is that operated for the entire Pacific basin by the United States National Weather Service. It is based at the Tsunami Warning Center in Honolulu, Hawaii. Since 1965, the Pacific Tsunami Warning Center (PTWC) has operated under the support of the Intergovernmental Oceanographic Commission. In 1966, an International Coordination Group for the Tsunami Warning System in the Pacific was set up. With this international warning system, civil defense organizations in most of the



Legaspi tide station

countries bordering the Pacific Ocean already receive warnings of tsunamis several hours before these reach the coasts. They are thus able to put into action previously prepared plans for the evacuation of people from the endangered coastal areas.

Regional Activity

In the Philippines, the Legaspi Tide Station is equipped with a telemetry system for continuous monitoring of actual sealevel heights. This was established by PWTC in 1993 as part of the Pacific Warning System. The tide observer of NAMRIA closely collaborates with PHIVOLCS for tidal observation and for monitoring the operation of the telemetry. PTWC personnel supervise the maintenance of the telemetry instrumentation set up.

Because of the time spent in collecting seismic and tidal data, the warnings issued by the Honolulu Warning Center cannot guard areas against tsunamis generated in adjacent waters since the Legaspi station is the only tide station in the country that is equipped with telemetry capability. Protection measures against tsunamis in the first hour after generation cannot be addressed. Regional warning systems need to be established in some areas for effective operation of the warning system.

These regional systems will generally have data from a number of seismic and tide stations telemetered to the central headquarter. Nearby earthquakes are located, usually in 15 minutes or less, and a warning based on seismological evidence is released to the area. Since the warning is issued on the basis of seismic data alone, it ...continued on page 13

Interfacing Natural Disaster Risk Management Activities with the Strategic Comprehensive Land Use Planning Process: A Framework

eventy-five percent of the world's population lives in areas affected at least once (from 1800-2000) by the impact of hydrological, meteorological, and geological hazards (Westgate, 2004). According to Niekerk (2004), billions of people in more than 100 countries are periodically exposed to at least one disaster triggered by these natural hazards and that more than 180 deaths are recorded daily due to the impact of unmitigated and unmanaged hazards on the volatile conditions in the developing world and elsewhere. Further, while only 11% of the people exposed to natural hazards live in countries classified as exhibiting low human development, they account for more than 53% of total recorded deaths.

With these scenarios in mind, the United Nations (UN), national governments, nongovernmental organizations (NGOs), and academic and research institutions worldwide have made significant strides in promoting and establishing policies, programs, and strategies for disaster risk reduction or "the systematic development and application of policies, strategies, and practices to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevent) or to limit (mitigate and prepare) adverse impacts of hazards, within the broader context of sustainable development" (UN-ISDR, 2003). These include awareness campaigns, risk assessments, enhancing risk reduction arrangements and poverty alleviation plans, training programs, and research. Along this line, disaster response like early warning systems, regional response units, and food security monitoring are being put in place. Despite these preparations, many communities, especially in the Philippines, are becoming increasingly vulnerable to disasters as technological, environmental, political, and economic change combine to increase disaster risks.

Disasters hinder human development. Gains in development are inextricably linked by Randolf S. Vicente*

up with the level of exposure to disaster risk within any given community. In the same light, the level of disaster risk prevalent in that community is linked up with the developmental choices exerted by that community (UN Development Program [UNDP], 2004). Studies also reveal that the secondary effects and indirect costs of disasters have long-term effects on societies, regardless of their level of development. What then can be done to counter risk increase and how can it be known that policy and development decisions are actually reversing this state of risk increase?

It is at the local level that most land use patterns are determined, infrastructure is designed and provided, and many other development issues are decided. It is also at this level that losses due to natural hazards are most felt. Because of the decentralized approach to these issues, there is much within the power of a typical unit of local government to bring about sustainable and mitigative approaches to growth and development within its jurisdiction.

Policy decisions and physical development choices at the local level usually originate from the formulation or adoption of a framework and comprehensive land use plans (CLUPs). Programs, projects, and activities designed to influence various characteristics of growth and development within their planning jurisdictions can be instituted this way. For instance, planning practitioners and decision makers make natural disaster risk management (NDRM) planning part of the overall physical framework and local land use planning exercise.

This article provides several options on how national and local government units (LGUs) may interface DRM activities with the preparation of strategic CLUPs. Pre- to post-disaster risk mitigation activities and measures are also presented.

Points of Reference

The Philippines' Natural Hazardscape

Being in the Pacific Ring of Fire, the country experiences a variety of natural disasters due to its geographical location and physical environment. This ring is a zone of frequent earthquakes and volcanic eruptions that encircle the basin of the Pacific Ocean. Other natural forces include tropical cyclones, droughts, and landslides or mass wasting.

The country lies on the Philippine plate which is between the Pacific and Eurasian plates. The crustal movements result in the convergence of the Philippine and Pacific plates which both tend to subduct beneath the Eurasian plate, thus forming earthquakegenerating faults. The effects of earthquakes include damage to infrastructure, landslides, fires, and tsunamis. Of the 200 Philippine volcanoes located along the seismic belt (Ring of Fire), 22 are classified as active. Lava and pyroclastic flows, lahars, poisonous gases, earthquakes, tsunamis, and landslides are among the dangers associated with volcanic eruptions. The Philippines also lies within the typhoon belt. Every year, about 20 tropical cyclones enter the archipelago and leave damaging effects such as floods and landslides. All of these hazards cause human casualties and damage to property, including immense losses in settlement areas, infrastructure, and agricultural lands.

Disaster Coordinating Councils

By virtue of PD No. 1566, dated 11 June 1978, NDCC replaced the then National Disaster Control Center. The decree also created the different regional and local disaster coordinating councils (DCCs). NDCC serves as the focal inter-institutional organization in disaster risk management. It establishes priorities in the allocation of funds, services, and relief, and plays an advisory role to lower DCCs through OCDcontinued on next page

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Editors' note: Due to space constraints, we cannot publish the references consulted for this article. Interested individuals may avail themselves of the list from the author.

Interfacing...

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by issuing guidelines covering emergency preparedness and disaster operations.

PD 1566 likewise stresses a policy of self-reliance among local officials and their constituents in responding to disasters or emergencies. It explains the organization of DCCs and their duties and responsibilities and provides the guidelines for selfplanning of disaster operations to be observed in all planning activities. These guidelines include the (1) preparation of a National Disaster and Calamities Preparedness Plan (NDCPP) by OCD; (2) conformance of planning factors and guidelines of all national and local government entities to the approved NDCPP; (3) proper documentation and furnishing to NDCC through OCD of all implementing plans; and (4) revision and updating of implementing plans as necessary and furnishing of copies of the updated plan to NDCC and OCD.

Identification of at-Risk Areas through Multi-Hazard Mapping

In 1991, the Philippine government started a process to integrate disaster mitigation and sustainable development issues within the Medium-Term Philippine Development Plans (MTPDP). Under such a framework, local governments are required to integrate their disaster management plans into their respective local government plans. The issue of disaster risk management in different areas was regarded under the MTPDP for FY 2004-2010. Among its identified non-structural measures to mitigate the occurrence of natural disasters and to prevent the loss of life and property is the completion of geohazard mapping.

Under NDCC's four-point action plan for disaster preparedness, flood hazard mapping was included under the first action plan. The harmonization of hazard mapping activities of NDCC, OCD, PHIVOLCS, PAGASA, and MGB-DENR was incorporated under the *fourth* action plan. These agencies are responsible for the implementation of the Collective Strengthening of Community Awareness for Natural Hazards program. In support of these endeavors, NAMRIA was tasked to generate and update topographic maps which will serve as input data for multihazard mapping activities undertaken by the above-cited agencies.

To date, rain-induced and earthquaketriggered hazard maps at scale 1:250,000 were published through the integration of various thematic maps from MGB-DENR, PHIVOLCS, and PAGASA. NAMRIA facilitated the integration, reproduction, and distribution of said maps to NDCC, agencies producing hazard maps, LGUs, the Philippine Congress, and other users. Present efforts are geared towards the preparation of 1:50,000-scale geohazard maps for better detail and precision. For fiscal year 2006, 126 topographic maps at 1:50,000 scale will be updated and transformed into GIS-ready format. The final maps will show the provinces and municipalities that are highly vulnerable to natural hazards. Hence, LGUs which need to formulate or revise their CLUPs will be easily identified.

In the pipeline is the production and distribution of 1:10,000-scale topographic and hazard maps. Whereas the results of the 1:250,000- and 1:50,000-scale hazard mapping are indicative in nature, the 1:10,000-scale maps will cater to the local or area-based development planning and DRM requirements of the government and other users. At the forefront of this initiative are the National Economic and Development Authority (NEDA), UNDP, and the Australian Agency for International Development. It basically involves the harmonization of the production of largescale base and multi-hazard maps.

Interfacing NDRM Activities with the Strategic CLUP Process

The Strategic CLUP Process

The Housing and Land Use Regulatory Board (HLURB) issued Board Resolution No. 714, series of 2001, entitled "Approving the Guidelines on the Application of Strategic Planning Process to the Preparation of CLUPs." The guidelines were promulgated because the existing 10volume guidelines for the formulation/ revision of CLUPs are only used for cities and municipalities and do not adequately cater to land use demands, issues, and opportunities faced by the country's larger and rapidly expanding cities which are as equally vulnerable to natural hazards. Though it is not a prescriptive document, it aims to serve as a vehicle for encouraging lateral creativity in response to increasing urban growth pressures and problems. It works within the framework of existing government policies, sound planning principles, and the legal framework of the existing CLUP process. The document provides the 10-step process as illustrated through the figure below.

Recommended NDRM Activities and Strategic CLUP Process Interface

With the illustrated strategic CLUP process, how can NDRM activities be interfaced with it? What activities should be undertaken to ensure that the end product (i.e., CLUP) incorporates the



inf 😜 mapper

appropriate risk reduction measures as well as the aspirations of the communities? The table provides the recommended NDRM activities and relevant details. The first column corresponds to the steps shown in the figure.

The concept provided in the table serves as a general guide to planning practitioners and decision/policy makers that it is indeed feasible to harmonize efforts in terms of planning for disaster risk management/mitigation and CLUP formulation as required pursuant to PD 1566, MTPDP, and other related rules and regulations. Some important activities and characteristics, which may not have been considered under the usual process but are vital, are also presented if planning is to be done "comprehensively." It can only be carried out effectively if appropriate stakeholders and expert groups are identified and mobilized; a national DRM strategy which includes legal, institutional, and operational framework is put in place; and other important information and communications infrastructure in support of planning are made readily available.

Points of Departure

This section enumerates some guide questions towards the formulation of specific action agenda in line with the institutionalization of an interfaced disaster risk management and strategic CLUP planning. These are as follows:

a. Have the LGUs or areas been identified and classified as at-risk or highly vulnerable? Are the required information and appropriate maps available for current and future DRM planning purposes? Does the situational analysis, which is prepared prior to "visioning" and "objective setting," reflect the true hazardscape, natural characteristics, environmentally critical areas, and bio-physical condition of the planning area? Is the information (spatial/ non-spatial) network to support planningrelated activities and initiatives available?

b. How many of the municipalities considered as highly vulnerable have actually integrated in their CLUPs their respective disaster or hazard mitigation plans? If so, how many have submitted them to OCD pursuant to the provisions of PD 1566? Are these plans in conformity with NDCPP? Are the strategies and activities embodied in the CLUPs religiously carried out at their level?

STEPS IN THE STRATEGIC CLUP PROCESS	NDRM ACTIVITIES	REMARKS
1. Getting Organized	 Identification and mobilization of major stakeholders 	 Involves national, regional, and local DCCs, civil society, NGOs, private sector, community concerned, and other interest groups
2. Setting the Vision	 Integration of the natural disaster vision to the overall vision of the LGU 	 May consider the vision "A community that is resilient to natural hazards and disasters"
3. Determining/ Establishing Existing Condition	 Natural hazard vulnerability assessment Definition of local natural hazardscape and their potential consequences 	 The process must include the conduct of multi-hazard mapping through the use of analytical/sieve mapping techniques. Spatial/GIS modeling is an effective tool for estimating geohazards, flood damage, and landslide susceptibility, among other parameters.
4. Formulating Achievable Objectives	 Formulation of doable NDRM and/or mitigation objectives 	 A consistent national approach across all sectors includes the enhancement of community awareness of natural hazards; reduction of loss of any disaster event; and provision of doable arrangements for response and recovery, among others.
5. Generating Options for Policies and Actions	 Identification of options within the framework of the four critical disaster management processes: risk reduction, readiness, response, and recovery 	 Includes the avoidance and mitigation of hazards; assessment of situation (where we are now) and formulation of action plans for successful recovery mechanisms; identification and monitoring of potential emergency; and implementation of return processes to social and economic normality
6. Evaluating Options and Selecting Preferred Strategy	 Evaluation of options and selection of preferred strategy on NDRM 	 Made consistent with development needs, SWOT analysis, functional role and comparative advantage, and spatial strategies (sectoral/thematic) set by the LGU and interest groups concerned
7. Consultation and Refining Preferred Option	 Consultation and refinement of preferred option for DRM 	 Modify and develop preferred strategic CLUP containing the LGU's vision, goals, objectives, policies, plans, programs, and projects on NDRM based on resource allocation, projections, and time lines
8. Implementing the Strategy	 Strategy implementation concerning agreed and adopted natural disaster risk reduction activities 	 As a consequence, amendment to existing statutory/legal provisions (including zoning ordinance and maps) arising from the strategic CLUP will be necessary.
9. Monitoring and Review	 Monitoring and review of level of implementation, achievements, and outcomes 	 Confirmation on a regular basis that DRM strategies, policies, plans, and programs are consistent with the CLUP
10. Revision of Strategy	 Revision of strategy on risk management including policies, plans, and programs 	 Ensure the relevance of plans and programs in a constantly changing and evolving environment or hazardscape

Interfacing NDRM activities into the strategic CLUP process

c. In consonance with the requirements of the MTPDP, how many LGUs that had experienced severe natural hazards have already prepared and incorporated natural disaster management plans in their respective CLUPs? Assuming that only one LGU has complied, was there an attempt on the part of HLURB or the regional/provincial DCC to review and evaluate if the CLUP submitted merits approval or otherwise? Do government agencies/instrumentalities concerned already issue enabling laws, regulations, and guidelines/standards in line with this concern? In general, are there local experts or professionals from the government or the private sector who are capable of doing such assessments and other risk-scenario development and trends?

d. Are there pieces of evidence of a functional administrative structure, budgetary and staffing allocation, minimum facilities (at the regional, provincial, and municipal levels); genuine public-private partnerships; and "watchdogs" in the area of strategic CLUP *cum* DRM planning?

e. If the planning interface is mandatory, will local chief executives comply? Will such

policy declaration cover those LGUs that have just formulated and revised their CLUPs? Where would the funds for the updating of CLUP come from for municipalities categorized as third class and below?

With these guide questions in mind, the things that need to be done can easily be defined. In a nutshell, action agenda and changes envisaged under the interfaced planning process can be further enumerated under the following major themes, to name a few: (1) spatial data/information infrastructure; (2) legal and policy frameworks; (3) national and local government capacity; (4) institutionalization and advocacy; (5) public accountability mechanisms; and (6) education, research, and knowledge management. Details of these themes could be discussed in detail, perhaps, in a separate article or paper.

Interfacing NDRM activities into the strategic CLUP formulation using the principles of sustainable development should be seriously considered as it takes cognizance of the Philippines' vulnerability to natural hazards. At the very least, ...continued on page 19

Disaster Impact

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"healing", repair, reconstruction &

recovery

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Prevention



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risk assessments ns, arrangements, raining & exercises

Preparedness disaster / emergency Rehabilitation Response

Developme

situation

stabilized no longer direct threat to life/safety

and property

Recovery

Photos courtesy of:





he concerns of disaster management and some of its activities are detailed in the outer cycle. Each country adopts its own format and terminology. The Philippine framework is presented in the inner circle. It aims for a total disaster risk management which includes the promotion of cooperation and partnership among stakeholders in all sectors and at all levels; the establishment of national coordination mechanisms, legal frameworks, and policies; the integration of disaster reduction and response into development policy and planning; the enhancement of disaster risk information management for improved communication, coordination, and decision making; and the promotion of education and public awareness on disaster risks through the effective use of mass media and local information systems.

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National Disaster Coordinating Council

News

HYCOOP program inked, commences

by Elinor C. delos Reyes



Administrator Ventura and Captain Brown during the project signing

NAMRIA Administrator Diony A. Ventura and United States (US) Navy Captain Andrew Brown III, Commanding Officer of the US Naval Oceanographic Office (NAVOCEANO) signed a memorandum of understanding for the conduct of cooperative hydrographic surveys in Philippine waters. The project is called the US and Philippines Hydrographic Cooperation (HYCOOP) Program. The signing was held at NAMRIA, Fort Bonifacio, Taguig City on 20 April 2006. Captain Brown represented US Navy Rear Admiral Timothy McGhee, Commander of the US Naval Meteorology and Oceanography Command.

NAMRIA-CGSD and Singapore-based US NAVOCEANO will jointly implement the hydrographic surveys. The project aims to enhance the capabilities of NAMRIA with regard to quality standards and efficiency in obtaining hydrographic survey data and charting the ports and harbors, harbor approaches, and coastal waters of the country's territorial waters to support the preparation of products derived from the surveys.

The joint survey will involve the collection of, but not limited to, the following information: positioning, water depth, tides, current, bottom samples, sub-bottom profiles, temperature profiles, water characteristics, relevant atmospheric/meteorological variables, sound velocity, aids to navigation, characteristics, information for sailing directions/port index updates, and side scan sonar data.

The US Department of Navy, through NAVOCEANO, will provide: personnel to

participate in planning and execution of survey operations; technical support in the onsite calibration, maintenance, and repair of electronic equipment associated with the survey operations; information related to surveying techniques, operation and maintenance of electronic survey equipment;

survey equipment and written technical materials such as surveying manuals and guidelines; information on training, survey equipment, materials, and spare parts available in US markets; and familiarization of NAMRIA personnel with equipment, survey techniques, and data processing.

NAMRIA-CGSD will: (1) secure permission from authorities for area/land access for temporary placement of visual or electronic navigation equipment needed in the survey support operations; (2) establish geodetic and tide stations and recording of their respective computations, as required, to provide for adequate geodetic and tidal control; and (3) provide personnel to conduct the survey and associated activities, including for manning the survey support stations ashore, and suitable survey vessel, crew, and equipment for use in conducting the surveys.

US survey vessel USNS BRUCE C. HEEZEN will be utilized in the conduct of the joint hydrographic surveys. She initially left for Balintang Channel, Batanes Islands on 22 April 2006 with two members of the NAMRIA personnel joining the 20-day survey activities. The conduct of hydrographic surveys of RP maritime waters in the Visayas will resume in either October or November of this year. Planned for the joint project is the conduct of semestral hydrographic surveys once a year for the duration of five years. The data/information collected will be fully shared by both NAMRIA and NAVOCEANO.*

NAMRIA-JICA projects implemented

by Alberto B. Sta. Ana/Elinor C. delos Reyes

NAMRIA, through its departments for Coast and Geodetic Survey and Mapping, is currently implementing two projects with JICA.

The hydrographic project aims to improve NAMRIA's capability in hydrographic data acquisition and processing techniques; paper and electronic nautical chart compilation, including databasing techniques; and tidal observation and data analysis. JICA will provide experts in the fields of hydrography, oceanography, and nautical charting; the necessary equipment and other materials such as a multibeam system for the motor launch, a nautical chart digital data compiling system, and tide gauges; and technical training in Japan for counterpart personnel.

NAMRIA will ensure the: (1) smooth operation and sustainability of the project during and after the period of the cooperation program; (2) effective utilization of the equipment to be provided and of the technologies, knowledge, and experiences acquired to contribute to the economic and social development of the country; and (3) active involvement in the project of all concerned agencies, beneficiaries, and institutions. The pilot areas are the harbors of Batangas, Manila, Cebu, and the approach of Cebu.

For the topographic mapping project, JICA will: (1) formulate an organizational development plan; (2) conduct a human resources development program, technical training, and promotion mechanisms for topographic mapping and associated products; (3) establish survey and mapping standards; (4) implement pilot projects and technology transfer; and (5) prepare an action program for nationwide 1:50,000-scale topographic mapping. NAMRIA, in cooperation with other concerned government agencies and LGUs, will provide the study team with available data/ information related to the study, securityrelated information, and counterpart personnel, among others.

The project involves the updating of 1:50,000-scale topographic base maps covering Pampanga and Agno River Basins, which are priority areas under MTPDP.*

NAMRIA conducts orientation on PRS92

by Concepcion A. Bringas

NAMRIA hosted an activity on 24 May 2006 at the NAMRIA Lecture Hall to orient the participants on the Philippine Reference System of 1992 (PRS92) as being the fundamental component of our country's spatial data infrastructure. The participants were representatives from the Department of Budget and Management (DBM), NEDA, and DENR.

NAMRIA Administrator Diony A. Ventura, in his welcome remarks, highlighted the importance of PRS92 to the country's development which justifies its inclusion in MTPDP. He also stressed the need for a closer coordination of NAMRIA with DENR, DBM, and NEDA whose support are vital in the mandatory completion of PRS92 by year 2010.

The accomplishments of the project's various components, namely, Densification; Survey and Map Integration; Geodetic Network Information System; Information, Education, and Communication; and Program Management were presented by NAMRIA Director Efren P. Carandang. Among the significant accomplishments are the establishment of 330 first-order and 1,250 second-order geodetic control points (GCP); the



Engineer Randolf S. Vicente, NAMRIA Plans and Operations Division Chief, receives his award as Most Outstanding Geodetic Engineer in Government Service during the 32nd Geodetic Engineers of the Philippines, Inc. (GEPI) Annual National Directorate Meeting and Convention held in Dapitan City, Zamboanga del Norte on 01-03 June 2006. This is the second time for him to be given such an award by the organization; the first was during the 18th GEPI-National Capital Region Annual Regional Convention on 05 May 2006. Among his other prestigious awards are Government Officer of the Year: Best in Public Service in 2003 and Recognition for Exemplary Service in Government in 2004.

completion of training courses on Global Positioning System (GPS) and Surveying and Map Integration which were attended by DENR regional technical staff; provision of digital copies of regional GCP maps to DENR regional offices; integration of all NAMRIA topographic maps into PRS92; and the production of a PRS92 primer and an audiovisual production.

Director Carandang likewise pointed out the tasks of other concerned units in order to successfully implement PRS92. The concerned units are the Lands Management Bureau (LMB), the DENR regional offices, and the mapping and surveying groups from the private and non-government sectors. The tasks are the establishment of control points; the recovery of old control points; the reestablishment of lost, disturbed, and destroyed control points; connection surveys; and research and development in transformation parameters, among others.

Other topics presented were an overview of PRS92 by NAMRIA Assistant Director Enrique A. Macaspac; the *Philippine Geodetic Referencing Infrastructure Development* by Engr. Randolf S.Vicente, NAMRIA Plans and Operations Division Chief; and the *Densification and Cadastral Data Integration* by Engr. Bienvenido F. Cruz, LMB Geodetic Surveys Division Chief.

The orientation provided the participants with the insights as to the significance of PRS92 to national development. A DBM participant expressed the urgency of NAMRIA's enlisting the full support of DENR officers in charge of prioritizing department projects and coordinating with the recommending and approving authorities of DBM. NAMRIA is lobbying for funding support for PRS92 from DBM and NEDA.

NAMRIA and LMB are the major implementing offices of DENR for PRS92. DENR is the leader of the PRS92 Program Steering Committee through Undersecretary for Lands, Manuel D. Gerochi. The members are the NAMRIA Administrator and the respective directors of LMB, the Forest Management Bureau, MGB, the Protected Areas and Wildlife Bureau, and the DENR Planning and Policy Studies Office. The committee is supported by the Regional Operations Committee composed of DENR Regional Executive Directors. NAMRIA serves as the PRS92 National Secretariat.*

Preparing for Tsunamis...

from page 6

is to be anticipated that warnings will occasionally be issued when tsunamis have not been generated. Since the warnings are issued only to a restricted area and confirmation of the existence or nonexistence of a tsunami is rapidly obtained, dislocations due to the higher level of protection are minimized. PTWC plans to set up more tide stations in the Philippines that can monitor tidal measurement in real-time mode to form part of the regional warning system. Tsunamis affect only landmass at the edge of some of the world's oceans. They can, however, be with a destructive force greater than other types of disasters. Protecting lives and property begins with good land planning, placing high economic investments out of reach of a potential tsunami, and implementing a warning and evacuation system that will maximize the safety of persons living near the coastlines.*

References.

http://dmc.engr.wisc.edu/courses/hazards/BB02-03.html www.phivolcs.gov.ph

NAMRIA GEOMATICS TRAINING CENTER Room 319, NAMRIA Building, Lawton Avenue, Fort Bonifacio, Taguig City TRAINING CALENDAR* Second Semester 2006 Telefax Number: (632) 810–5466 Email: <u>oss@namria.gov.ph</u> or <u>namria@denr.gov.ph</u> Website: <u>namria.gov.ph</u>				
Course Title		Training Fee(Php)	Date	
Geographic Database Management	(GDM – 01)	12,000.00	July 17–21 and 24–28	
Introduction to GIS	(GIS – 01)	6,000.00	August 21–25	
Advanced GIS	(GIS – 03)	6,000.00	September 25–29	
Management of GIS Projects	(GIS – 04)	3,600.00	October 23–27	
Introduction to GIS	(GIS – 01)	6,000.00	November 13–17	
Advanced GIS	(GIS – 03)	6,000.00	December 4–8	

*Subject to change without prior notice

Eclarino, R. 2005. Tide Stations in the Philippines. Infomapper, July: 7-9, 18.

The Sub-classification of Forestlands Program

by Jesus L. Gerardo*

Forestland is one of the four major groups in the classification of lands of the public domain in the 1987 Philippine Constitution. The three others are agriculture (or alienable and disposable), mineral, and national park. The Philippines has approximately 15.06 million hectares of forestlands. These consist of classified forests, permanent forests, and forest reservations, including certain civil and military reservations and mangrove forests.

The total land area of the country is about 30 million hectares. Forty-eight percent or 14.4 million hectares is estimated to be forestlands. The primary criterion in the demarcation/delineation of forestlands is topography. Lands of the public domain must have generally over 18% slope gradient (for uplands) to be classified as forestlands.

Forestlands have become hosts to about 8.6 million (1991 estimate) of the total population of the country either as formal or informal settlers. The socioeconomic functions of forestlands have invariably been recognized. However, signs of environmental stress and threats of continuing/unabated degradation, consequent of competing land uses and unsustainable practices in the uplands, have increasingly become a concern of national magnitude. Figures may be unavailable but the attendant environmental and social costs of unsustainable developments in the forestlands may already be outweighing the economic gains.

Owing to their seemingly "open access" conditions, much of the once lushly vegetated forestlands now comprise a mosaic of various land uses/cover, e.g., agriculture, grasslands, settlements, plantations, and similar production uses. Unfortunately, many of these land uses are unsustainable in nature and are mainly for sustenance purposes for most of the upland settlers. The urgency for sustainable development and management of the country's forestlands is one of the overriding factors in the implementation of the sub-classification program.

Background

Letter of Instruction No. 1262 dated 28 July 1982 officially launched the subclassification of forestlands program. The then Ministry of Natural Resources (MNR) was the lead agency assisted by the subclassification committee created and charged with policy making and implementation.

MNR Administrative Order (MAO) No. 225 dated 11 July 1983 was issued prescribing the general procedures and guidelines in the implementation of subclassification. By virtue of this MAO, funds allocated to the land classification (LC) program were tapped for the implementation requirements. Later, the regional LC teams coalesced and became the sub-classification teams or land evaluation parties (LEPs) comprising the field component of the program.

DENR Administrative Order No. 15 was subsequently issued on 19 May 1995. It embodies the revised guidelines in the implementation of sub-classification. NAMRIA serves as the co-chairman and National Sub-Classification Secretariat (NSS) of the National Technical Evaluation Committee (NTEC) headed by the DENR undersecretary for policy and planning. It also has technical supervision over the regional LEPs which comprise the field component of the program. policy of attaining sustainability of development in the environment and natural resources sector, particularly the forestlands.

Central to the program is the meaningful and systematic evaluation and analysis of the suitability or fitness of forestlands to a given land utilization type or category based on the biophysical attributes of the land (slope, soil, land use, etc.) vis-à-vis the economic suitability, ecological integrity, and socio-cultural acceptability requirements of the proposed or potential land use.

Priority target areas include, but are not limited, to the following: integrated area development projects, growth centers, community-based forestry program areas, National Integrated Protected Areas System areas, ancestral lands, administrative regions/areas, and river basins or major watersheds.

NSS processes the completed subclassification projects and submits them to the NTEC Technical Working Group for review. NTEC conducts the final evaluation in accordance with policies and guidelines and endorses them to the Office of the DENR Secretary for subsequent approval of the administrative order.

Completed sub-classification projects include the provinces of Abra, Tarlac, Pangasinan, Marinduque, and Basilan.*

Concept

Sub-classification implies the proper allocation of forestlands into their most suitable and rational uses such as agriculture, production, protection, agro-forestry, grazing, fishponds/fish farms (for mangroves), settlements. parks/ recreation areas. commercial, and industrial. The program is in pursuit of the national



General process flow

* Chief, Land Resources Division, Remote Sensing and Resource Data Analysis Department

Technical Paper

Modeling the Spatial Occurrences of Rain-Induced Landslides and Identifying Potential Landslide Hazard Zones Using RS/GIS¹

by Arturo S. Daag², Olive R. Molina³, Estella C. Gumabon³, Dennis T. Buena³, Manzul K. Hazarika⁴, and Aleinmar Htwe⁴

I. Introduction

The Philippines is an island archipelago situated between the Pacific Ocean in the east and the China Sea in the west. It has a tropical climate with two seasons: rainy from June to November and dry from December to May. PAGASA has classified the country into four climatic zones. Areas facing the eastern coast falling under types II and IV are zones that are more vulnerable to large magnitudes of rainfall during the wet season. Type II is characterized by no dry season with very pronounced rainfall from November to January, Type IV by rainfall that is more or less evenly distributed throughout the year.

During the rainy season, most of the long-duration and high-intensity rainfall is associated with typhoons or an intensified Inter-Tropical Convergence Zone (ITCZ). The country experiences an average of about 21 typhoons a year and several ITCZs, which is why many rain-induced landslides may occur.

The country's topographic conditions moreover consist mainly of hilly to mountainous regions wherein there is considerable thick soil development. These geomorphological and climatological conditions make many parts of the Philippines prone to landslides.

In recent years, there have been several catastrophic landslides brought by severe rainfall. In November 2004, a series of strong typhoons caused heavy rainfall in the provinces of Quezon and Aurora. One day's rainfall of about 350 millimeters affected the Agos watershed, causing numerous landslides in large areas in REal, Infanta, and General NAkar (REINA) in Quezon province. This particular landslide event is the focus of this project-study on the spatial distribution of landslide occurrences using different models.

II.Rationale and Objectives

Many parts of the Philippines are prone to landslides due to the country's wet climatic and steep topographic conditions. The worldwide threshold record for rainfalltriggering landslide is 100 to 150 millimeters per day. This threshold can be achieved during the passage of a typhoon or an intensified ITCZ. The frequency of occurrences of large devastating landslides in the Philippines can be from 1 to 5 years. Thus it is important to consider that areas prone to landslides should be mapped in advance so that proper mitigation measures can be emplaced before disasters strike.

This paper aims to: (a) map landslide occurrences using remote sensing (RS)/GIS technologies to quantify the extent of slope instability; (b) establish the spatial correlation of landslide occurrences with different physical parameters using RS/GIS; (c) use different appropriate landslide susceptibility mapping approaches that can be applied on large watersheds from rapid heuristic to deterministic models; and (d) produce a landslide-susceptibility map based on different models and determine their applicability.

III. Review of Rain-induced Landslide Incidents in the Philippines

Some of the more recent devastating landslides that occurred in the Philippines were reviewed, emphasizing on rainfall threshold level. Most of them are associated with typhoons or intensified ITCZs. These are the Camiguin landslide and flashflood event on 06-08 November 2001; the Cherry Hills landslide in Barangay San Luis, Antipolo City on 03 August 1999; the Panaon Island, Southern Leyte and Northeastern Surigao landslides on 19 December 2003; the Dingalan, Aurora and REINA, Quezon landslides and flashflood events from mid-November to early December in 2004; and the Guinsaugon, Southern Leyte landslide on 17 February 2006.

IV. Scientific Framework

The project emphasized the applicability of remotely sensed data such as satellite images and aerial photographs to map landslide occurrences that cannot be easily mapped on the ground and assessed the various factors that contribute to the occurrence of landslides. Several thematic maps were utilized and extracted from the satellite and remotely sensed data and from other ancillary data sources. Using GIS, the factors that affect the probability of landslides were correlated with various thematic maps, using rating and ranking algorithms. For a deterministic approach to landslide mapping, the area was evaluated using an existing slope instability model.

V. The Study Area

The study area is located in the eastern part of Luzon Island, within the provinces of Rizal and Quezon. It covers the whole Agos watershed area (approximately 1,260km²) that was heavily affected by the November 2004 landslides and flashflood. It encompasses the municipalities of Antipolo, Tanay, and Montalban in Rizal and REINA in Quezon. Areas heavily affected by the landslides and flashflood were the municipalities in Quezon since they occupy the lower portion of the watershed.

VI. Materials and General Methods Pre-fieldwork Data and Analysis

The pre-fieldwork data utilized for the study included LANDSAT Enhanced Thematic Mapper (ETM) image dated 08

... continued on next page

¹ This is a condensed version of the official report on the Japan Aerospace Exploration Agency-Asian Institute of Technology (AIT) mini-project study which was presented in Hanoi, Vietnam in February 2006. A copy of the original paper, appendices, and references list may be obtained from the authors or the editors of this publication.

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Modeling... from page 15

December 2002 and colored near-vertical digital aerial photographs taken in May 2005. The LANDSAT ETM image in false color composite representation showed that the study area is very rugged with dense vegetation except on relatively flat areas that are inhabited and cultivated. The image was then classified according to land cover. One of the many uses for the image was for mapping all old landslides so that the spatial occurrences can be correlated with various physical parameters. It turned out to be very difficult and nearly impossible to map old landslides due to scale limitations (30 meters) of the ground resolution.

A limited set of aerial photographs representing the area was also considered. Rectification and geo-referencing of the aerial photographs were initially made by using topographic maps at 1:50,000 scale. These were then mosaicked and all landslide occurrences were carefully digitized. Land cover classifications were likewise extracted. In one of the study models, finding landslide locations was necessary, especially on the initiation point. This was done through digitizing the landslide polygon and points.

Fieldwork Data Gathering

Fieldwork was conducted on 05-09 December 2005 in REINA to collect field data related to the assessment of landside occurrences in the region and their potential hazards. Among the activities conducted were the mapping and verification of land cover image interpretation and landslide areas using a handheld GPS receiver; field measurements of soil engineering properties; and soil samples for laboratory analysis.

VII. Methodologies

Thematic Overlay

The concept behind this method was to altogether evaluate, correlate, and rank the different thematic maps. Many algorithms exist in trying to establish systematic ratings but the weight index method (WIM) was used. The analytical hierarchy process (AHP) was also tested but the result was not good.

The weight index and the decision support system methods were both utilized for evaluating several thematic maps that were known to influence rain-induced landslides. Sourced from various government agencies, these include climate, drainage system, erosion, fault, geologic, land cover, road, slope, and soil maps.

Weight Index Value/Expert Judgment System Method

The multi-parametric landslide modeling entailed a simple mathematical algorithm in order to arrive at a final landslide hazard map. For each layer or theme parameter, the susceptibility to landslides was rated from values of 0 to 10 by an expert. The value 0is assigned if the parameter has no influence at all on the occurrence of landslides and 10 if it is highly influential.

All thematic maps were initially rated individually, thus reducing subjectivity because each theme was rated with similar ranges. However, experts know that each theme has different weights or degrees of influence towards generating the landslides. For example, parameters such as slope versus land cover differently influence landslide susceptibility. In order to address this issue, a multiplying factor (influential factor or weight factor) was assigned for each theme before the landslide susceptibility rating was derived.

It is important to note that the map outputs were generally indicative of areas prone to rain-induced landslides in various degrees. These should be calibrated later with historical rain-induced landslides in order to properly estimate the rainfall magnitude required to generate a landslide in a specific area. The strength of this method lies on the availability and details of several thematic maps and on the ability to evaluate several factors contributing to landslides.

Decision Support System Using SMCE

The inputs for the Spatial Multi-Criteria Evaluation (SMCE) application are a number of thematic maps treated as criteria or effects and a criteria tree that contains the way the criteria are grouped, standardized, and weighed. The output is one or more maps of the same area called *composite index maps* that indicate the extent to which the criteria are or are not met in different areas.

In the resulting map can be compared and calibrated the defined criteria and criteria trees to determine differences and to discover the reasons that resulted in a significantly different composite index map. This may lead to certain decisions as to why the composite index map is either high or low at a certain location. The advantage of SMCE is that the different themes can be standardized in various ways. Unlike the AHP and weight index models, the factors should be evaluated numerically. In some situations, assigning numerical weights to thematic maps is not easily conceivable. The SMCE comes with a variety of standardizations per theme, namely: pair-wise comparison, direct value method, rank order, and specified target (goal) with various regression functions.

Modeling Landslide Using SIM

A more deterministic rain-induced landslide susceptibility mapping can be achieved using a GIS-based Slope Instability Model (SIM). In this model, the Factor of Safety (FS) that would determine the stabilities of the area was calculated and the method was entirely executed in ARCVIEW software using the Stability Index Mapping (SINMAP) extension.

The discussions in model description were mostly based on the SINMAP manual. It explains the geo-technical engineering aspect of slope, instability formulas used, and the hydrologic aspects on wetness parameters based on a digital elevation model (DEM).

Method Description and Assumptions

In the following equations, the parameters needed are soil shear strengths, slopes, and drainage network. Soil strength parameters need cohesion (C) and angle of internal friction (f). These parameters are normally measured in the laboratory and the process required could be quite expensive. The normal range of values representative of the soil in the area was used. The parameters on slope and drainage network derived from DEM are needed to model the wetness index. The more accurate the DEM, the more accurate the result is. In this study, the available 1:50,000-scale topographic map of NAMRIA was used and the 20-meter contour intervals were digitized. The model also used FS, which is standard in any engineering geological classification of slopes.

Infinite Slope Stability Model FS

The Infinite Slope Stability Model FS (ratio of stabilizing to destabilizing forces) is given as (simplified the same for wet and dry density [Hammond et al., 1992]):

$$SI = \frac{C_r + C_s + C_0 s^2 \theta [\rho_s g(D - D_w) + (\rho_s g - \rho_w g) D_w] \tan \phi}{D \rho_s g \sin \theta \cos \theta}$$

where Cr = root cohesion [N/m2], Cs = soil cohesion [N/m2], q = slope angle, rs = wet soil density [kg/m3], rw = the density of water [kg/m3], g = gravitational acceleration (9.81 m/s2), D = the vertical soil depth [m], Dw = the vertical height of the water table within the soil layer [m], f = internal friction angle of the soil, and ? = the slope angle ? is at an S, the slope as a decimal drop per unit horizontal distance.

The approach with the hydrologic model is the interpretation of the soil thickness as specified perpendicular to the slope, rather than soil depth measured vertically. Soil thickness, h [m], and depth are related as $h = D \cos 2$.

With this change, FS is reduced to

$$FS = \frac{C + \cos\theta \left[1 - wr\right] \tan\phi}{\sin\theta}$$

where w = Dw/D = hw/h is the relative wetness, C = (Cr + Cs)/(h?sg) the combined cohesion made dimensionless relative to the perpendicular soil thickness, and r = ?w/?sthe water to soil density ratio.

The model practically works by computing slope and wetness at each grid point, but assumes other parameters are constant (or have constant probability distributions) over larger areas. The equation amounts to implicitly assuming that the soil thickness (perpendicular to the slope) is constant.

Topographic Wetness Index (TWI)

TWI assumes that higher soil moisture or areas of surface saturation tend to occur in convergent hollow areas. It has also been reported that landslides most commonly originate in areas of topographic convergence (Montgomery and Dietrich, 1994).

These assumptions were made following TOPMODEL and other similar topographically based wetness index models: (1) shallow lateral subsurface flow follows topographic gradients, which implies that the contributing area to flow at any point is given by the specific catchment area defined from the surface topography; (2) the lateral discharge at each point is in equilibrium with a steady state recharge R [m/hr]; and (3) the capacity for lateral flux at each point is T sin?, where T is the soil transmissivity [m2/hr], i.e., hydraulic conductivity [m/hr] times soil thickness, h [m].

Assumptions 1 and 2 imply that lateral discharge q, depth integrated per unit contour length [m2/hr], is q = R a. Assumption 3 differs from a common TOPMODEL assumption (Beven and Kirkby, 1979) such that uniform conductivity of a soil mantle overlying relatively impermeable bedrock is assumed, not hydraulic conductivity decreasing with depth.

In addition, sin? is used rather than tan?. This is more correct because the flow distance is actually along the slope. The difference between tan and sin, though insignificant for small angles, matters for the steep slopes that give rise to landslides. With assumption 3, the relative wetness is

w = Min
$$\left(\frac{R a}{T \sin \theta}, 1\right)$$

The relative wetness has an upper bound of 1 with any excess assumed to form overland flow. The ratio R/T, which has units of [m-1], quantifies the relative wetness in terms of assumed steady state recharge relative to the soil's capacity for lateral drainage of water. The ratio R/T, treated as a single parameter, therefore combines both climate and hydro-geological factors.

Stability Index Definition

To define the stability index, the wetness index equation was incorporated into the dimensionless FS, which became

$$FS = \frac{C + \cos \theta \left[1 - \min\left(\frac{R}{T} - \frac{a}{\sin \theta}, 1\right)r\right] \tan \phi}{\sin \theta}$$

The variables a and q are from the topography with C, tan?, r and R/T parameters. The density ratio r is essentially constant (with a value of 0.5) but allows uncertainty in the other three quantities through the specification of lower and upper bounds. Formally, these bounds define uniform probability distributions over which these quantities are assumed to vary at random. Denote R/T = x, tan = t, and the uniform distributions with lower and upper bounds as C ~ U(C1, C2), x ~ U(x1, x2) (10), and t ~ U(t1, t2).

The smallest C and t (C1 and t1) and the largest x (x2) define the worst-case (most

conservative) scenario under this assumed uncertainty (variability) in the parameters. Areas, where under this worst-case scenario FS is greater than 1, are unconditionally stable and defined as:

$$SI = FS_{\min} = \frac{C_1 + \cos \theta \left[1 - \min \left(x_2 \frac{a}{\sin \theta}, 1\right) r \right] t_1}{\sin \theta}$$

For areas where the minimum FS is less than 1, there is a possibility (probability) of failure. This is a spatial probability due to the uncertainty (spatial variability) in C, tan?, and T. This probability does have a temporal element in that R characterizes a wetness that may vary with time. Therefore the uncertainty in x combines both spatial and temporal probabilities. These regions (with FS min < 1) are defined by SI = Prob (FS > 1) over the distributions of C, x, and t. The best case scenario is when C = C2, x = x1, and t = t2, which leads to

$$FS_{max} = \frac{C_2 + \cos\theta \left[1 - \min\left(x_1 \frac{a}{\sin \theta}, 1\right)r\right]t_2}{\sin\theta}$$

SI = Prob(FS > 1) = 0

Regions with SI > 1 (FSmin > 1), 0 < SI < 1 and SI = 0 (FSmax < 1) are space defined in terms of slope (tanf) and specific catchment's area. This provides a useful visualization medium for understanding this approach. The SI range values are interpreted in the table. The resulting slope instability final map was converted into predicted state that can be useful for the general public.

VIII. Results and Discussions WIM

The initial resulting map based on WIM is shown in Figure 1. Raw total scores ranged from 41 to 120. The higher the area score, the more susceptible it is to landslides. Calibrating the raw map required the statistical distribution of the values and was based on the landslide occurrences, i.e., landslide points as shown in the figure.

After calibration, the raw map was classified. Figure 2 shows the result of the calibration categorized into four regions relative to landslide susceptibility, i.e., *none to low, moderate, high*, and *very high*. Figure 3 is a larger scale extracted from the map and highlights the location of the landslides and the susceptibility classes. It shows that most landslide points fall under high to very high regions.

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Condition	Class	Predicted State	Parameter Range	Possible Influence of Factors not Modeled
SI > 1.5	1	Stable slope zone	Range cannot model instability	Significant destabilizing factors are required for instability
.5> SI >1.25	2	Moderately stable zone	Range cannot model instability	Moderate destabilizing factors are required for instability
25> SI > 1.0	3	Quasi-stable slope zone	Range cannot model instability	Minor destabilizing factors could lead to instability
1.0> SI > 0.5	4	Lower threshold slope zone	Pessimistic half of range required for instability	Destabilizing factors are not required for instability
0.5> SI > 0.0	5	Upper threshold slope zone	Optimistic half of range required for stability	Stabilizing factors may be responsible for stability
0.0> SI	6	Defended slope zone	Range cannot model stability	Stabilizing factors are required for stability

Table of SI range values



Figure 1. Raw score map based on WIM (uncalibrated)

Decision Support System Using SMCE

Raw score results from the SMCE ranged from 0.1 to 0.9. These values were already standardized and normalized (Figure 4). Most of the landslide points fall in the values from 0.5 and above, which is above 45% of the population. The calibration threshold of the map is listed as: none to low, 0 to 0.36; moderate, 0.36 to 0.45; high, 0.45 to 0.50; and very high, 0.50 to 1.0.



Figure 2. Calibrated landslide susceptibility map (WIM)



Figure 4. Raw score from SMCE method



Figure 5. Classified landslide susceptibility map based on SMCE

Figure 5 shows the classified map after the calibration. It can be noted that the threshold for very high susceptibility class accounts for about 55% of the area. The large population for the very high susceptibility class is mainly because the calibration was from the very large magnitude landslide event.

Slope Instability Index Model Analysis on small controlled area

SINMAP calculates wetness and instability indices based on FS. In order to constrain the applicability of SINMAP into the whole study area, a test site was chosen. A test site is a small area where landslide initiation points have been mapped. The DEM used was rasterized in 5m grid. In order to represent the heterogeneity of the engineering soil parameters, the study area was subdivided into five distinct regions. Each region had a different set of parameters. It can be deduced from Figure 6 that most landslide points fall within the upper to lower threshold, meaning the model is applicable with the range of parameters used. Also presented in the paper were some of the statistical plots of each calibration region and the tabulated statistics of the five calibration regions.



Figure 6. Wetness and instability index map from a small test site

Analysis on a watershed scale approach

After testing the model on a small controlled plot with calibration parameters, the model was executed on the whole study area. Figure 7 shows the wetness index map



Figure 7. Wetness index map of the whole study area

class



of the area. The partially wet and the threshold saturation categories are more vulnerable to landslides. Figure 8 shows the slope instability derived from the calculated FS. Also presented in the paper was a statistical graph correlating FS enveloped with the slopes. This indicates that the critical instability slope would start below 30° at 10% saturation, which may even fall at 18° slope at saturated condition.



Figure 8. Slope instability map based on FS

IX. Conclusions and Recommendations

Based on the study, the following conclusions were drawn:

a. All the methods tested yielded acceptable results. The AHP method was tested but the result was not favorable because it failed to emphasize other significant factors; thus, its non-inclusion in this paper.

b. Among the three methods, the SINMAP is the most accurate landslide predictor because it is physically based. Among the thematic overlay methods, the SMCE is better because it is more objective since the various algorithms have been developed in assigning weights. The WIM is a bit subjective in that assigning numerical values depends on the expertise of the rate.

c. Depending on the availability of data, there are various methods that can be used to assess landslides. For rapid assessment, weight index and SMCE can be easily implemented. The SINMAP method needs elaborative field and laboratory data to make the model run accurately.

d. The final landslide hazard map from the different methods shows that a large part of the area is in high hazard category particularly because it was calibrated based on the large landslide event that occurred in the area. These hazards maps would represent a landslide scenario of large magnitude.

e. The accuracy of correlating landslide occurrences through overlay methods lies on the scale of the input maps. Small-scale thematic maps will lead to generalization of results and are good enough to use as landslide indicators. On the other hand, detailed thematic maps may lead to a more accurate assessment that can be used for local planning and mitigation work.

f. The calibration of maps is a crucial step in the determination of the landslide hazard map. Its accuracy is very much dependent on the mapped landslide occurrences. However, if the landslide points do not represent all the physical parameters in the study area, the result may not be representative of the whole region.

g. The LANDSAT-ETM image even with its scale cannot help much in landslide mapping due to its low resolution. The use of higher resolution imagery will greatly improve the mapping of landslide occurrences.

The following are the recommendations of the study:

a. The mapping done of the old and new landslides was not exhaustive because of the limitations of the available imageries (i.e., LANDSAT-ETM and oblique aerial photographs). The result will improve with use of available high-resolution satellite imagery. This will account well the distribution of landslides of the whole study area since these points are critical in the calibration of the model.

b. Currently, the ideal satellite image for this study is that from the Advanced Land Observing Satellite (ALOS). Its highresolution images and its capability to generate the DEM will best complement the data. The DEM used in the project was based on the 1950 1:50,000-scale topographic map with a 20-meter contour interval.

c. The best method used in this study is SINMAP since it is physically based. However, this model greatly relies on accurate DEM, mapping of the distribution of landslide points, and soil engineering data. ALOS data will greatly contribute in this aspect.

d. The project did not cover risk analysis which is the next important step. Without risk assessment, the importance of the map will not be realized.*

Interfacing...

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everyone should have a duty to refrain from detracting from long-term viability of our living places. We have an affirmative duty to increase future generations' safety over time, a duty which can only be fulfilled through efficient natural hazard management.

Local executives/officials can do what is within their power and authority to make the future safer. As a matter of fact, they have control in terms of land use, the direction and nature of economic development, and capital facilities and societal infrastructure which all affect the vulnerability of our descendants. It is therefore incumbent upon the key players to minimize the destructive impacts, including loss of human life and property.

Much can be done at the local level to promote development that is sustainable, including land uses to help mitigate the impacts of natural hazards. Experts say sustainable development is processoriented and does not focus on static world order; it rather involves a dynamic, evolutionary continuum of action that will forever need readjusting to fulfill its mission. Hazard risk management must be seen as more than an end-state. Instead, it should involve a constant search for ways to incorporate mitigative concepts into policy decisions and development choices to reduce vulnerability to natural hazards for today and tomorrow.

Production of...

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processing software have already been delivered, including the needed computer hardware.

Further Steps

NDCC plans to expand the coverage of geohazard mapping to comprise all highrisks areas for the entire country. This would make a total of 345 map sheets of PNTMS. The entire project is expected to be completed within three years. This year, Phase I is being implemented with a budget allocation of P30 million. Areas covering Luzon and Visayas will use SPOT 5 satellite data. Interferometric Synthetic Aperture Radar data will be used for areas in Mindanao.*

Production of Topographic Base Maps to Support Geohazard Mapping

by Joaquin B. Borja, Jr.*

natural disaster is one of the major hazards that cause losses in lives and properties. Due to its geologic setting and geographic location, the Philippines is among countries in the world most vulnerable to natural disasters. The Philippine archipelago has more than 200 volcanoes distributed in five volcanic belts and 22 of them are considered active. Likewise, more typhoons pass through the Philippine Area of Responsibility than any other country in the world. Of the 20 or so typhoons passing through our area each year, about nine cross or actually hit the Philippines. These conditions make the country at risk from the potential threats caused by landslides, earthquakes, flooding, typhoons, volcanic eruptions, liquefaction, and other natural hazards.

The Need for Geohazard Mapping

Geohazard maps provide information on potential areas that are vulnerable to natural disasters. The recent events that occurred in Barangay Guinsaugon, Saint Bernard, Southern Leyte and the flash floods that devastated extensive areas in Aurora, Ouezon, Mindoro, and Bicol have been hogging the limelight for some time. These catastrophic events caused the loss of many lives and enormous destruction to properties and infrastructures. It is for this reason that there is a need to hasten the production of geohazard maps for the whole country. Once geologic hazards are properly identified and characterized in a map, their effects can be mitigated, if not eliminated, by instituting appropriate preventive measures.

In this context, NDCC spearheaded the production of geohazard maps for the country. Among the agencies involved are NAMRIA, MGB-DENR, PHIVOLCS, and PAGASA. NAMRIA was tasked to produce the necessary base maps of the priority areas in the country that are prone to geologic hazard as identified by the other member agencies.

The Use of Topographic Base Maps for Hazard Mapping

The primary requirement for undertaking geohazard mapping is the

availability of updated topographic base maps. These maps depict the relief of the area, road network, river and drainage systems, settlement areas, and location of prominent places. They present both the horizontal and vertical positions of the features represented by showing mountains, valleys, and plains. They show the fundamental information that are used as a base upon which additional data of specialized nature are compiled, as in this case, hazard maps.

Base maps are where spatial data and information on potential hazards and disasters in a certain locality are integrated and registered into, which are then evaluated and analyzed to be able to come up with various types of decision maps such as geologic hazard maps. Integration, manipulation, and management of various types of map information have become faster and more efficient nowadays with the advent of GIS which is now commonly used for the production of various decision maps.

The most commonly used base maps in the country at present are those at 1:50,000 scale. These maps cover the entire country and were first produced in the 1950s, formatted at 10'x15'. The US Defense Mapping Agency updated the maps covering the portions of Luzon Island in the 1980s and reformatted them to a bigger 15'x15' quadrangle. NAMRIA is mandated to continue updating these base maps now known as the Philippine National Topographic Map Series (PNTMS) consisting of 653 map sheets.

Priority Areas and Project Activities

The priority areas for topographic mapping based on the identified high-risk areas cover Regions II, III, IV, V, and VIII. The base maps will be produced in digital format that would enable the layering of hazard-related information through GIS.The primary image sources to be used in updating map information are SPOT 5 satellite data. SPOT 5 acquires images at a five-meter resolution in panchromatic blackand-white and a 10-meter resolution in color mode. With additional processing, 2.5-meter resolution images can be produced.



Index of topographic base maps covering geohazard areas (1:50,000 scale)

After image acquisition, the major activities of the project are map scanning; geographic referencing of the topographic map image to its true ground coordinates; digitization; edge-matching and editing; and final map layout. As of June 2006, 70% of the targeted 126 map sheets has been converted into digital format and ready for overlay of new data from satellite imageries. The digitization of the remaining 39 map sheets is expected to be completed by July 2006. Twenty-two SPOT 5 satellite imageries are being evaluated for acquisition while

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