Sensitive Land Use Planning, Malinao, Albay, Philippines

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Abstract. This paper reviews the hazard zone as defined in the zoning ordinance of the Local Government of Malinao. The zonification was completed in accordance with the approved Comprehensive Land Use Plan stipulating the allowed use and regulations of zones to control future land development. This paper brings together an examination of human exposure as well as spatial situations and conditions of their houses within the hazard zone playing with flood risks. The purposive selection sample households were based on characteristics of people residing within it, in which the site concurs with the flood forecasted frequent every 5, 25 and 100 years turned to be significant to better understanding ‘risks computing’ were variables retrieved from the intersecting spaces fused to get the complex interrelationship of the sets of flood hazard, vulnerability and exposure of inhabitants and their place of residence weighted against capability of individual family or household to withstand effects of flooding. The Risk Quotient Object and Field Bases Model were tested in specific location in Malinao. The sample households’ individual risk location quotient varies from high to a very high risk distributions ranging from 8 to 125 numerical values. As Malinao stays on to experience flood hazards, changing climate and other natural calamities, the need to understand the six elements of disaster risk computing at household level is becoming crucial in risk reduction meeting the targets and priorities for action as specified in the Sendai Framework.

Keywords: Zoning, Exposure, Risk Computing, Risk Quotient, Household

1. Introduction

The prevailing principle of the Habitat I which was held in Vancouver in 1976 provides importance to water for life and adopt programs for the sanitary disposal of waste water. Similarly the prevailing principles of the Habitat II which was held in Istanbul in 1996 arrest the deterioration of global human settlements conditions and ultimately creates the conditions for achieving improvements in the living environment of all the people on sustainable basis. In October 2016, the Habitat III held in Quito, the prevailing principles focus on Housing [1] and Sustainable Urban Development to adopt a New Urban Agenda. This work is seen significant in regulating the use of the land and activities in hazard zones particularly those families within the immediate vicinity of rivers and other waterbodies as well as providing guidance to the residents at risk and decision making in land management, land use planning and monitoring local developments [2,3].
Relatedly, the Sendai Framework outlines seven clear targets and four priorities for action to prevent new and reduce existing disaster risks. However, the management of geospatial information plays a key role in understanding disaster risk, strengthening governance to reduce risk, enhancing preparedness for effective response, and to ‘Build Back Better’ in recovery, rehabilitation and reconstruction.

Although the law in Philippines asserts that land below eighteen percent (18%) in slope generally classified as arable and disposable land along edge of normal high waterline of rivers and least streams with channel of at least five (5) meters wide are subjected to legal easements or salvages for strips of mangrove or swamp along shoreline facing the ocean, lakes, and other bodies of water, ancient settlements were already built along rivers so as to Filipino houses were also constructed on the river banks or over shallow waters since Spanish era as such form of settlements provided to control of pueblos (town) wherein the principal and the masses reside around the edifices gridiron arrangements or plaza complex. Also, it is a regulation that no person are allowed to stay in environmental critical areas or ecological buffers longer than what is necessary for recreation, navigation, floatage, fishing, and salvage or to build structures of any kind because flood is rise in water level or river overflow of a consistency of water beyond its confines causing inundation of water onto a normally dry adjacent areas. This paper decry the technical and legal interpretation of the three meter margin to the easement of public use in the general interest of navigation, floatage, fishing and salvage (R.A. 386. Art. 368 known as Civil Code of the Philippines), and the conversion from forty or twenty meters easement to three meters easement of public use in the interest of recreation, navigation, floatage, fishing and salvage (P.D. 1067 known as the Water Code of the Philippines.

Also, the empowerment to prepare land use plans and regulations in the Philippines [4] lies with the LGUs but most of these units have not yet developed their own comprehensive land use plans and zoning ordinance. Based on the latest inventory of HLURB, the LGUs with Updated CLUPs as of 1st Quarter 2017 in Bicol Region comprise of the following: Legazpi City, Daraga, Malinao, Libon, Basud, Canaman, Milao, Minalabac, Pamplona, Sangay, Sipocot, Masbate City, Baleno, Cataingan, Cawayan, Molpo, Placer, Sorsogon City, Castilla, and Juban. Out of 114 LGUs, 21 or 18% have Approved CLUP. However, only 11 LGUs or 10% of total number of LGUs in Bicol mainstreamed DRRM/CCA into CLUP.

However, the lack of geospatial information, although scientific planning is proven effective with the use of technologies such as GIS, Remote Sensing, GNSS and so on, the process or geospatial information modeling to produce a scaled-replica of the real world is tedious and costly oftentimes ends up neglected [5]. Nevertheless, the local officials of the Municipality of Malinao (Malinao) had formulated their CLUP using GIS technology but limited spatial data. It carried out based on the analyses of land use patterns in planning using old topographic maps, tax maps, thematic maps and other available maps all digitized and converted into shapefiles format, in which serve as baseline to plan and address issues on rural and urban settlements, particularly decrease in agricultural crops situated in the alluvial plains near or within the flood and liquefaction prone zones [6]. Through land use space allocation and zonation, spots and places were made available to apportion suitable lands for residential, commercial, farming, timber, infrastructure, and so on. The masses were informed about the potential risks on their households, but they think it was an exaggerated plan and regulations. This uncertainty deferred the approval and ratification of the land use plan and regulations. But when TD Juaning as stated by PAGASA, dumped about 500 millimeters of rain in a span of 15 hours in the downstream of Malinao causing flash flood at the alluvial flats along Quinal 'B' River as high as high as three meters inundation in July 2011, this event prompted the approval and ratification of the CLUP and Zoning Ordinance (ZO) were pushed by the local government then approved in the same year thus it will soon expire by year 2019.
This paper laid emphasis on checking the conformity of social structures such as residential houses, school and so on located within the regulated hazard zone; testing the set-based geometry space risk model proximity with Quinali ‘B’ River; quantifying the risk and its elements as well as capability of individual sample households; and lastly validating the hazard zone stated in the approved land use plan and zoning ordinance with the newly published flood return periods 100, 25 and 5 years respectively. Now that the needs to mainstream disaster risk reduction and climate change in development processes turn into a policy in socioeconomic development and physical plan formulation, assessment of trends in the actual land utilization become a challenging work as buffers as defined in Water Code, Civil Code, and the Revised Forestry Code in the end delineate the legal easements suitable for open public use areas or zones adheres to balance of nature and to reduce disaster risks within the 15 years target and priorities of the Sendai Framework.

2. Data and Methods

The first approach, was to identify informants or sample households constantly vulnerable to the physical characteristics and land condition situated in alluvial flat area and basin of the Mayon Volcano, Mount Masaraga and Mount Malinao Watershed streams all flowing to Quinali ‘B’ River; and contained within an absolute space called Hazard Zone, in which these households were directly affected by 2011 and 2016 flooding resulting to living in makeshift light materials or rebuilding their homes better. The 12 purposely selected sample households were verified in the ground using Mobile GPS and by assigning HPQ IDs as sequential control number encoded in the questionnaires, GIS_ID as collective numbers denoting the provincial (31), municipal (010), barangay (006) numbers combined with household code assigned by the barangay, and lastly latitude and longitude denoting the geographic location of respective samples. The Mobile GIS mapping activity attest the exposure and location of the samples within the HZ.

The zoning map as shown in Figure 1 disclose the spot of the study area, in which the Land Use Map in the left reckon dwelling structures denoted by yellow polygons and school campus denoted by blue polygon, while in the Approved Zoning Map the spot was zoned as part of the HZ.

Second, in order to get the desired output, these samples went through GIS overlay analysis to check their specific locations to verify if they are situated in flood hazard zone or not. The technique used in collecting pertinent data are using Mobile GPS to collect the geographic location or latitude and longitude and geo tags of structures being evaluated, assigning identification numbers and codes such as HPQ IDs as sequential control number encoded in the questionnaires, GIS_ID as collective numbers denoting the provincial (31), municipal (010), barangay (006) numbers combined with household code assigned by the barangay, and lastly survey questionnaires to collect the data about families’ capability in terms of HH
members coping capacity, competency and preparedness. With ArcGIS it was easy to create or re-create map layers gathered from Malinao and build attributions necessary to re-create a replica or the Purok 1 located in Balza, Malinao. The 12 ‘purposely selected sample households’ or a set of objects/locations with properties represent the approximately 80 exposed household of Purok 1, Barangay Balza, Malinao. The pre-selected samples as revealed in ArcGIS containing set-based geometry spaces to be constantly vulnerable to the physical characteristics and land condition. Overlays analysis allow the visualization of alluvial flat areas and the basin of the Mayon Volcano, Mount Masaraga and Mount Malinao Watershed streams all flowing to Quinali ‘B’ River. Although the result of 12 samples seem small proportion of the entire municipality conversely affected by the by 2011 and 2016 flooding, it affected totally washed out residents but choose to stay in makeshift light materials after flooding events. Some households rebuild their homes safer by building new two-storey residential building but remain exposed. In this study, the capability at HH level was treated ‘subsets of objects’ with spatial properties comprising coping capacity, competency, and preparedness.

Third, to be able to quantify the disaster risks location quotients or estimates, the following approaches were completed:

2.1 Hazard Assessment

This refers to the inspection and ground validation relative to flood occurrences brought by Quinali ‘B’ River over flows during heavy rains of several hours. Informants were asked to show marks of inundations that appear to be that the flood in year 2011 is twice higher compared to flood occurred in 2016. Informants attest that flood inundation in year 2011 is higher compared to flood occurred in 2016. According to MDRRMO the Quinali River swell up to 3 meters inundation near the bridge thus the same was also spotted by the local residents of Balza. The Figure 2 below denotes the household 008 of Purok 1, Barangay Balza with GIS ID Number 31-010-006-P-008 and located at 576086 Latitude, 1481842 Longitude projected at WGS84. Furthermore, the specific location of household with P-008 code assigned in Balza Spot Map.

![Figure 2. Flood Inundation, Year 2011 and 2016](image-url)
2.2 Vulnerability Assessment

The researcher defines the ‘vulnerability assessment’ [7] as a study of the steady physical environment and the conditions of inhabitants (human ekistics) living in that same physical space. Vulnerability in this study is a mixture of the ‘Permanent Landscape Vulnerability’ and the ‘Human Vulnerability’.

The ‘Permanent Landscape Vulnerability’ in this study is defined as ‘sets of objects’ geographically enclosed inert physical space likely to adverse consequences associated with floods, bank erosion and other hydrological related hazards that may occur when river discharge exceeds its channel’s volume causing the river to overflow onto the downstream alluvial flats as well as the coastal area that convey different states of discomfort, security, worries, distress, angst, and more. But the assessment was dependent to the criteria and classification set by the researcher, precision of spatial data and maps, and the data provided by the informants. The ‘inert physical factors’, such as the drainage network of the 3 mountains enclosing the catchment space dictates how much precipitation the Quinali ‘B’ River can receive and how rapidly it will come, it appears in the old topographic maps that Quinali ‘B’ River naturally collects a great volume of water or increasing discharge coming from the mountains, instead farmers converted most of the former river beds to rice lands then build their residence near these critical fields and/or the intrinsic characteristics of alluvial plains where the soil permeability of clay in Malinao prevented water from infiltrating flood water, which make it desirable for planting rice; and more. It likewise applies to the characteristics of ‘ekistic household units’ in terms of condition of housing units construction materials and/or dendritic housing patterns and its physical layout of the transportation network relative to escape en routes to safe evacuation centers, and/or existing flood mitigation infrastructures intended to lessen vulnerability, the national government constructed a flood control dike along Quinali ‘B’ River to reduce river overflow so as to protect the lives and properties of the communities at risk.

The ‘Human Vulnerability’ in this study is defined as ‘point objects’ referring to ‘fields’ storing data or so residents of Balza dwelling inside the most susceptible to flooding and bank erosions. It applies to the characteristics of the family members’ biological needs, sensation, perception, emotional needs, and moral values.

**Figure 3.** Vulnerable Informants and Samples
2.3 Exposure Assessment

The researcher defines the ‘exposure assessment’ as a study of the inhabitants (human ekistics) situated or residing in a hazard or no-built zone. ‘Exposure’ is symbolized by ‘point objects’ referring to measured absolute geographical location or projected coordinates of any structure existing in an enclosed polygon subsets denoting the hazard zone. The researcher inventoried only those households situated to be severely exposed households within Purok 1, Balza, Malinao using GIS to validate their geographic location relative to flood return periods. Figure 4 display the analytical map presenting the extreme exposure of residents and public school symbolized by yellow and green polygon objects.

![Exposure Geo-Objects Model](source: Balza-Malinao, 2009, 2017)

**Figure 4. Exposure Geo-Objects Model**

2.4 Capability Assessment

The researcher treat the ‘capability assessment’ as a study of coping capacity, competency and preparedness to relocate to safer location or residence or to escape the danger or evacuate/transfer upon announcement of evacuation phase of the Disaster Risk Reduction Management Council of Malinao [8,9]. The ‘Capability’ is a disintegrated ‘subsets of objects’ with spatial properties relative to subsets or fields, these are: coping capacity, competency, and preparedness fields, result of analysis of object features (polygon and/or point), attributes and/or field or related databases) and its relationship with information about livelihood, family income, household members age, gender and sensitivity, plans to resettle, evacuation practices, participation in risk reduction related activities, land valuation and ownership, and so on.

2.5 Disaster Risk Assessment (DRA) Modeling

The Risk Quotient Object-Based Model discloses a factor resulting after overlaying analysis of the intersections of hazard, vulnerability, exposure and capability objects and characteristics.

Table 1 is a Risk Sets of Objects or Fields Numeracy Menu that comprise the matrix of object or field properties covering five level scale (5x5 = 25 cells) the 1, 2, 3, 4, and 5 numerical values to convey an ordinal likelihood, these are: 1) classifying risk into five levels denoting: Level 1, Level 2, Level 3, Level 4 and Level 5; 2) grouping risk into five degree denoting: very low, low, moderate, high and very high; 3) sorting the Flood Predictions into five spans denoting: 100 Years or more; >50 to <100 Years; >25 to 50 Years; >5 to <25 Years; and <1 to < 5 Years; 4) Symbolizing into five colors for simple visualization denoting: White, Yellow, Orange, Red and Dark Red; and lastly risk sets of objects or fields denoting: hazard; vulnerability; exposure; Capability.
The Risk Quotient Object-Based Model of Balsa discloses a factor resulting after overlaying analysis of the intersections of hazard, vulnerability, exposure and capability objects and characteristics. The first overlay analysis is finding the intersections of the 3 subsets of Risk set, namely: hazard, vulnerability, and exposure. The second overlay analysis is finding the intersections of the 3 subsets of Capability, namely: coping capacity, competency and readiness. The proportion of the 2 resultants, where the 1st result serves as the numerator and the 2nd as the denominator, the end effect is the hazard quotient or risk factor useful for predicting disaster risk to significant for decision making and physical developments limited only to the survey area.

Table 1. Risk Distribution Level Classification Properties of Object Model

| Risk Sets Objects or Fields Numeracy Menu | Level 5 | Level 4 | Level 3 | Level 2 | Level 1 |
|------------------------------------------|--------|--------|--------|--------|--------|
|                                          | Very High | High | Moderate | Low | Very Low |
|                                          | <1 to < 5 Years | >5 to <25 Years | >25 to 50 Years | >50 to <100 Years | 100 Years or more |
| h - Hazard                               | 5.0 | 4.0 | 3.0 | 2.0 | 1.0 |
| ✓ Flood Susceptibility Geometry Space Object | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Regular Flooding may inundate to 3 meters or more | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Hazard event (h) is an element (h<sub>ε</sub>) of Risk denoted as (h<sub>R</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Flood (f) is a subset (f<sub>ε</sub>) of Hazard denoted as (f<sub>ε_h</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| v - Vulnerability                         | 4.0 | 4.0 | 3.0 | 2.0 | 1.0 |
| ✓ Permanent Landscape Vulnerability - Physical Inert Land Condition Geometry Space Object | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Human Vulnerability - Inherent Human Transferable Condition (Highly Susceptible due to decision to reside inside HZ or homeless, etc.) | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Vulnerability (v) is an element (v<sub>ε</sub>) of Risk denoted as (v<sub>R</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| e - Exposure                              | 3.0 | 3.0 | 3.0 | 2.0 | 1.0 |
| ✓ Building Structure Geometry Space Object | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Situated within Hazard Zone/Critical Area | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Exposure (e) is an element (e<sub>ε</sub>) of Risk denoted as (e<sub>ε_R</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| C - Capability denoted as C (Co, Cm, Cp) | 2.0 | 2.0 | 2.0 | 2.0 | 1.0 |
| ✓ Field-based Object | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Discrete information about Individual Household member Competency, Coping Capacity, and Preparedness | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Identifiable information about Coping capacity (Co) as an element (ε<sub>Co</sub>) of Capability denoted as (Co<sub>C</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Identifiable information about Competency (Cm) as an element (ε<sub>Cm</sub>) of Capability denoted as (Cm<sub>C</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |
| ✓ Identifiable information about Preparedness (Cp) as an element (ε<sub>Cp</sub>) of Capability denoted as (Cp<sub>C</sub>) | ✔ | ✔ | ✔ | ✔ | ✔ |

Figure 5 is comprise of risk location quotient after equating the numerator composed of the product of the hazard level of Purok 1, Balza, Malinao, vulnerability and exposure levels of households, divided by the product of coping capacity, vulnerability and exposure levels, where numerical values can be assigned using Figure 5. There are 5 ranges of Risk Location Quotient Distributions Index, these are 1) Very High ranges from greater than 64 to up to 125 maximum numerical values; 2) High ranges from greater than 8 to 64 numerical value; 3) Moderate ranges from greater that 1 to 8 numerical value; 4) Low
or Balanced with numerical value of 1.0; and lastly 5) Very Low is assumed to be near resilient or resilient.

**Figure 5.** Risk Location Quotient Distribution Matrix

**Figure 6.** Risk Quotient Object and Field Based Model

Source: Abante, 2017
The universal set theory, the three elements denoted as (S) of risk, namely: hazard events, denoted as (h), vulnerability denoted as (v) and exposure denoted as (e) comprise the Set of Risk (R) objects. The Flood denoted as (h) is a subset of Hazard denoted as (S). The Capability denoted as (C) comprise of a set of {Coping Capacity denoted as (Co), Competency denoted as (Cm), Preparedness denoted as (Cp). The Risk Quotient Object-Based Model discloses the factor of the absolute space existent amongst the intersections of subsets denoted as h level \( \cap \) v level \( \cap \) e level thus resulting to a numerator object. Thence, the intersection of georeferenced objects related to fields intersecting the Coping Capacity level denoted as Co level \( \cap \) Competency denoted Cm level \( \cap \) Preparedness denoted by Cp level, thus resulting to a denominator Capability denoted as C.

Lastly, (4) Validate the HZ with the 100 years Flood, 25 years Flood and 5 Years Bicol Flood forecasted by DOST through the Philippine Lidar Project 1. In July 25, 2011, a flash flood traveled unexpectedly swept away rice land, houses and tree branches by the flood as some cars and personal belongings washed away by floodwater. Malinao was submerged when Typhoon “Juaning” (International Code: Nock-ten) dumped about 500 millimeters of rain in a span of 15 hours resulting to a flash flood as high as three meters. Although the entire Province of Albay truly prepared in which evacuation practices escaping disaster risk is already institutionalized, TD Juaning left 1 casualty in Malinao though cause of dying is the snake bite not by drowning [9]. Fortunately, the flood event occurs at day time if not it can easily kill more person as they may get hit by the debris or submerged. Moreover, in December 28, 2016, Typhoon “Nina” (international name: Nock-Ten) again triggered floods and leveled houses in Malinao, Albay, in which exposed residents fled to safer ground before the storm hit and were forced to spend Christmas in school classrooms that were temporarily converted into evacuation shelters. Based on the report of Albay Public Safety and Emergency Management Office (APSEMO) Report, there are 50 families or 250 persons in Malinao evacuees. In May 2017, the Project NOAH 5, 25 and 100 Year Flood Forecasts published recently by Department of Science and Technology, the result after matching and examining HZ analyzed in 2009 by method of overlaying the three flood return period, implies disaster risk. The study reveal possibility of critically and costly risk reduction on the part on the Local Government of Malinao to evacuate exposed residents every time of calamities and increased risks and hardship on the part of every households. Figure 8 display the return periods 5th, 25th and 100th year flooding overlaid with the Hazard Zone, accessibility and the Barangay (Community) administrative jurisdiction.

![Figure 7. Flood Composite Model](image)
3. Result and Discussion

Disaster Risk valuation (DRE) result reliant on the approach in selecting the informants or exposed-houses that is constantly vulnerable to the physical characteristics and land condition and confined within an absolute space called Hazard Zone. The 2011 and 2016 flooding imply 5 year return period is felt. If so, more flood simulation models is desired to do temporal analysis to truly understand DRE. Locating and storing information on marking of flood inundations as well as exposed-resources using geospatial technologies are significant in valuation and evaluation along with monitoring and evaluating the implementation of zoning ordinance specifically those developments enclosed within the environment critical ecosystems and hazard zones [7]. Most of the researches vulnerability theme generally describe not as a mixture of ‘Permanent Landscape Vulnerability’ in which resources are fixed or passive in nature, and the ‘Human Vulnerability’ regarded as active resource capable of lowering vulnerability and escaping danger. In this study, vulnerability and exposure were defined and classified into five categories for the purpose of measuring risk factor. Risk is a factor of numerical values for hazard multiplied by vulnerability and exposure, divided by the capability Assigned value. Capability is measured as the product of the following disintegrated subsets of capability, namely: coping capacity, competency and preparedness of each samples classified based on informants inputs.

![Figure 8: DRE Composite Map](source: Purok1-Balza-Malinao, 2017)

On the sampling, the selection of the study area was purposive and geographically limited within the HZ to collect and examine the likelihood of households at risk. Informants for every sample household as listed in Table 1 and shown in 9 were interviewed and provided data for their respective Household Profile Questionnaires (HPQ), in which it contain facts about their location and household information. The researcher prepared the HPQ, which is a modified questionnaire of the CBMS Questionnaire published by DILG for the purpose of collecting data to measure the capability of every family to escape the danger that may be brought by severe flood resulting from Quinali River overflows. Samples and testing site discloses mean and standard deviation of risk of individual households pointing out risk is measurable at household level. Although the selection of the study area precisely within the hazard zone, it stresses the hazard, permanent landscape vulnerability and exposure to the highest level of classification. Conversely, the mean and standard deviation of: 1) vulnerability of the age dependency group, 2) family income, 3) educational attainment and skills entice competency to get employed or self-employed, and lastly 4) perception on their safety and preparedness to escape flood risk certainly contradict the land use and hazard zone regulations. Calculating the standard deviation individual HH risk location quotient, the confidence intervals based on the estimated standard deviations is illustrated in Table 2.
Table 2. Disaster Risk Estimate

| HP QID | GIS_ID | Location | Disaster Risk Elements Rating | DRE | Likelihood |
|--------|--------|----------|-------------------------------|-----|------------|
|        |        | Latitude | Longitude | Hazard | Vulnerability | Exposure | Coping | Competency | Preparedness |       |
| 1      | 31-010-006-P-020 | 576033 | 1481807 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 2      | 31-010-006-P-019 | 576039 | 1481800 | 5.00 | 5.00 | 5.00 | 3.00 | 3.00 | 1.00 | 13.88 | H |
| 3      | 31-010-006-P-014 | 576064 | 1481829 | 5.00 | 5.00 | 5.00 | 3.00 | 3.00 | 1.00 | 13.88 | H |
| 4      | 31-010-006-P-016 | 576066 | 1481829 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 5      | 31-010-006-P-010 | 576080 | 1481839 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 6      | 31-010-006-P-002 | 576095 | 1481832 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 7      | 31-010-006-P-007 | 576103 | 1481810 | 5.00 | 5.00 | 5.00 | 3.00 | 2.00 | 2.00 | 10.41 | H |
| 8      | 31-010-006-P-008 | 576086 | 1481842 | 5.00 | 5.00 | 5.00 | 3.00 | 3.00 | 1.00 | 13.88 | H |
| 9      | 31-010-006-P-015 | 576059 | 1481837 | 5.00 | 5.00 | 5.00 | 3.00 | 3.00 | 1.00 | 13.88 | H |
| 10     | 31-010-006-P-006 | 576103 | 1481840 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 11     | 31-010-006-P-001 | 576099 | 1481860 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |
| 12     | 31-010-006-P-050 | 576094 | 1481865 | 5.00 | 5.00 | 5.00 | 1.00 | 1.00 | 1.00 | 125.00 | VH |

Source: Purok1-Balza, July 2017

DRE result is reliant on the approach in selecting the informants or exposed-houses (social structures) that is constantly vulnerable to the physical characteristics and land condition and confined within an absolute space called Hazard Zone. The 2011 and 2016 flooding imply 5 year return period is felt. If this is correct, more flood simulation models is desired to do temporal analysis to truly understand disaster risks and its elements. Locating and storing information on marking of flood inundations as well as exposed social resources using geospatial technologies are significant in valuation and evaluation along with monitoring and evaluating the implementation of zoning ordinance specifically those developments enclosed within the environment critical ecosystems and hazard zones. Most of the researches vulnerability theme generally describe not as a mixture of ‘Permanent Landscape Vulnerability’ in which resources are fixed or passive in nature, and the ‘Human Vulnerability’ regarded as active resource capable of lowering vulnerability and escaping danger. In this study, vulnerability and exposure were defined and classified into five categories for the purpose of measuring risk factor in terms of numerical values for hazard multiplied by vulnerability and exposure, divided by the capability Assigned value. The capability is measured as the product of the following disintegrated subsets of capability, namely: coping capacity, competency and preparedness of each samples classified based on informants inputs.

As the validation of HZ extents turned coherent with the flood forecasts and return periods every 5, 25 ad 100 years, the DRE result set in motion the risks that varies from 10.41 (High) to 125 (Very High). The N error of 0.239 is insignificant at this first attempt considering the 12 samples out of 80 potential at risk in their Purok are regarded lacking. For a greater accuracy and reliability the samples for the in all the Purok of Barangay Balza, as well as other barangays of Malinao is desired to calculate the municipal-wide DRE. The result in simulating the Risk Distribution Set-Based Geometry Space Model illustrated the relationships of hazards, vulnerable lives, livelihoods, health, business, communities and so on as stated very similar in the Sendai Framework.

As typical risk assessment models mostly focus on rapid assessment [10,11] of which the six risk elements interrelated in this paper were taken in a broader perspective inevitably 'Risk Location Quotient.
Distributions diverges, this paper's contribute the 'Risk Quotient Model and Field Based Model' which implicitly let out the relationships of the 'sets of point objects' denoting spatial or geographic locations of houses or other social related structures overlaid with the 'set-based geometry space' denoting the area of influence of hazard and passive (landscape) vulnerability equated to the 'sets of point objects' denoting the 'fields' or attributes of capability divided into the coping capacity, competency and preparedness at household level.

![Disaster Risk Estimate Graph](image)

*Source: Purok1-Balza-Malinao, 2017*

**Figure 9.** Disaster Risk Estimate Graph

On the DRE, this first attempt in data analysis encompass the risk computing concept of intersections of three objects (polygon features) representing hazard, vulnerability, exposure and capability likelihood. The two selected columns HPQ_ID (or HH Number) and DRE as shown in Table 1 represent the x and y value respectively. In the Ordinary Least Squares (OLS) for DRE per HH, the x values (HH#) are fixed, and find the line which minimizes the squared errors in the y values of the DRE for each sample households varies from 10.41 (High) to 125 (Very High) as the result of . The OSL for DRE by HH line $y = 10.005x$ fitted the bivariate data sets of regressed in the plot as shown in Figure 9. The mean and standard deviation of DRE reckoned is 78.4 (Very High) and 0.965 respectively. Measurement error of 0.239 is insignificant at this first attempt considering 12 samples are regarded lacking. For a greater reliability of samples, further study and appropriate geospatial technology is wanted.

The outcome of risk computing and GIS overlay exercises demonstrated the likelihood and simply hinting flood risks, reoccurring since ancient times, and will continue to happen. And so wanting geospatial information systems designed for communities turn out to be a platform both in environment protection and development planning. However, further study on informants’ perception on the risk they are facing and attitude on preparedness efforts of residents in cooperation with the DRRM managers is seen crucial in DRE as well as in DRRM and CCA as they (exposed residents of Balza) decide where to stay, whichever: (1) designated evacuation center by MDRRMO; (2) chosen temporary space such as two-story residential houses in proximity (located within the same exposed areas where they reside) to stay escaping flood risks; (3) chosen temporary space located outside the exposed areas ‘perceived to be safe
location’ but not necessarily comfortable; or (4) other place safe and comfortable such as residential areas identified as safe and comfortable residential areas.

Of all the risk elements, exposure is the only independent variable where risk transpires only if it holds true. The Disaster Risk Estimates (DRE) is seen significant for decision making in any physical developments and imposing allowed land uses and regulations through a local ordinance. On the capability variable, the study disclosed that the DRE result is dependent on both the researcher’s knowledge and skills in GIM as well as the informants’ perception on their risk against the coping capacity, competency and preparedness weighted against the scientific findings on risk and its elements. Although lot of governments’ efforts on hazard mapping, the variability remains ambiguous on the vulnerability and exposure, but then again significant in fusing all the risk elements in a single integrated information system.

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4. Conclusion

In pursuit of development, disaster risk and climate change resilient ecosystem, and community-based awareness of environmental protection and wise-use of natural resources, public use areas susceptible to flooding within a confined area delineated as a ROW or floodway adjacent to the legal easements as defined by water code, civil code or the revised forestry code, areas that are ecologically significant water courses must be protected from impacts of adjacent developments and human activities such as construction of permanent structures, classifying and/or converting these floodway or legal easement into urban use or for dwelling or even land titling the ecological buffer for private use.

Changing climate now producing more intense and heavy rains initiating floods or causing inundation onto normally dry adjacent areas. Floodways or right of way (ROW) or legal easement that is located in near their places of work or employment, market shopping malls, place of worship and other basic social services are prone to non-conforming land uses and often times consented and granted with land claims due to absence of approve land use plans and zoning ordinance in the local government units such malpractices in land utilization remains unresolved.

Promoting sustainable growth and resiliency as well as reducing disaster risks through geospatial information systems is fundamental in understanding the natural phenomena affecting settlements and developments. This is also true to speed up land use plan formulation and revisions as well as crafting and amending zoning ordinances opt to lessen the risk of the people and properties although prevention, land tenure and property rights remain boundless challenge to planners, engineers and decision makers and development managers.
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