Geophilosophical Realness of Risk: A Case Study In National Housing Authority Resettlement Sites In Albay, Philippines

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Research

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GEOPHILOSOPHICAL REALNESS OF RISK:
A Case Study in National Housing Authority Resettlement Sites in Albay, Philippines

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Abstract. The *Geophilosophical* realness of risk, as introduced in this study constitutes risk **hotspots** or **coldspots** information that are stored and sorted in **hexagonal bins** which represent geographical space. Using the binning technique, the author disclosed the 29,400 hectares in Albay Philippines are 99% significantly sited as risk hotspot physical space. Also, about 7,100 hectares, and 3,100 hectares have 95% and 90% significant risk hotspots, respectively. This study also presents resiliency being measured as a **risk quantity**, nearing a zero z-score that is enveloped by the fundamental geoinformation prerequisite to select safe, comfortable, and accessible space. The z-scores represent the risk hotspots and coldspots contained in hexagonal bins which mimic geographical aspects of the **risk realness** in Albay. The same z-scores were substituted for the 25 resettlement sites which provided answers to the query "what are the risk realities in NHA resettlement sites?" The results characterized the risk that are spreading at 14 resettlement's sites in Albay are generally located within risk hotspot areas. This information is significant in preventing and mitigating risk receptively and responsively. The researcher concludes that DRRM entails interdisciplinary thinking to apply geospatial data science to risk governance. This dissertation revealed that government intervention may be ineffective when people are steadily allowed to occupy risk hotspots that weakens their capacity to defy the quantified risk as well as the accumulated and unbearable risk residuals caused by the unforeseen effects of changing climate such as volcanic eruptions, lahar, increasing flooding, and pandemics. The *Metatheorem*s in this study posit that dependable preparedness is unlikely if the risk hotspots and coldspots of geographical locations are unknown or unclear, which would guide environmental planners, engineers, development managers, and decision makers to direct the people to suitably select safe space, comfortable sites, and accessible sites. Furthermore, this study presents that scientifically informed policy is a must-risk-reduction solution to restore stability (state of balance). Therefore, the practical implication of this study is providing a basis where a decision maker can picture when stability is unattainable the approach is to bring the development in the tri-nodal cities outside the risk trending areas in Albay.

Keywords: geophilosophy, hotspots, coldspots, hexagonal bin, risk quantity, risk realness

1 Introduction

The Philippines is the third most disaster-prone country in the world according to the World Bank where there is low uptake of research and analytic thinking to inform local decision making on disaster risk management. Disaster risk reduction documentation started as early as 1814, after Mayon erupted disrupting people's lives and displacing them to look for lands suitable for planting crops far from this volcano but located near rivers and accessible to outside assistance.[1][3][4]. As multiple hazard events naturally re-emerge, the land morphology relatively implies physical and environmental modifications, making people vulnerable to environmental changes and discovered to be dangerous. [1][3][4] Evacuation-return behavior of farmers within a complete no-build-zone model (Mayon 6-Km Permanent Danger Zone of Albay), allowing barangay social and institutional facilities such as schools, barangay halls, and other developments turning into the new norm that contributed to the uncontrolled sprawl within the permanent and extended danger zones realization of the tri-nodal spatial developments now trending in Legazpi City, Tabaco City and Ligao City. [1][3][4] Undesired developments were analyzed using Open Street Map spatial data as well as the uncontrolled construction of buildings along the old railroads and rights-of-way, near rivers prone to flash floods carrying lahar deposits. [1][3][4]

This study sought to measure risk, residual risk, and extraneous errors, logical to the concept of assessing risk reality phenomenon. This study focuses on the significance of the implementation of Sendai Framework 2015-2030 to link to disasters happening within the 25 km radius referenced at the crater of Mayon Volcano to reduce human and economic losses by avoiding the creation of new risks in the built environment. This paper presents the conceptual framework of the study, applied from a *Geophilosophical* perspective, applying the semantics to stir up reasoning to quantify the risk reality, thus understanding risk reality conceptual space variables: multiple hazards, landscape vulnerability, passive exposure, preparedness, competency, and coping capacity. [1] [5][7][8]

Fig.1, where *H* symbolizes the combined scores of multiple hazards in Albay**.** The V symbolizes the combined scores for landscape vulnerability, which characterizes the condition of a piece of geographically enclosed land ajar to alteration (physical changes) brought by 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. Landscape vulnerability is a variable to quantify risk reality. [1][4][6][9][10] The E symbolizes the combined scores which measure the static position of dwelling structures, or tangible human assets that may be sited in hazard-prone areas likely to experience hazard events of different magnitudes. [1] [4][6][9][10] The preparedness, competency, and coping capacity variables carries the score that characterizes the overall capability of the local government in terms of income classification of LGUs approved by the Department of Finance to substitute the varying data associated with risk reduction and local growth.[1] [4][6][9][10] The preparedness (Cp) was linked with the spatial equality in terms of mitigation interventions, on the contrary one the landscape vulnerabilities are unmitigated, this variable is then linked with unsafe conceptual space. [1] [4][6][9][10] The competency (Cm) was linked with the social injustice in terms of competency to live comfortably which characterizes the general population repetitively evacuated or relocated to avoid any fatal accidents at times their lives are affected by hazard events such as volcanic eruption, flooding and so on. Also, competency variable was linked with careful selection of comfortable conceptual space that plainly connecting the people to the place of work and social support facilities.[1] [4][6][9][10] The comfortable conceptual space is also linked with the social injustice in terms of spatial accessibility (road and/or tape drive access) characterizing the general demands of the elderly, youngsters, significant women, PWD, displaced, exposed and other deprived people. [1] [4][6][9][10] The coping capacity (Co) was linked with the receptive accessibility variable. It is also spatially linked with active exposure and preparedness at all levels of risk reduction management. [1][4][6][9][10]

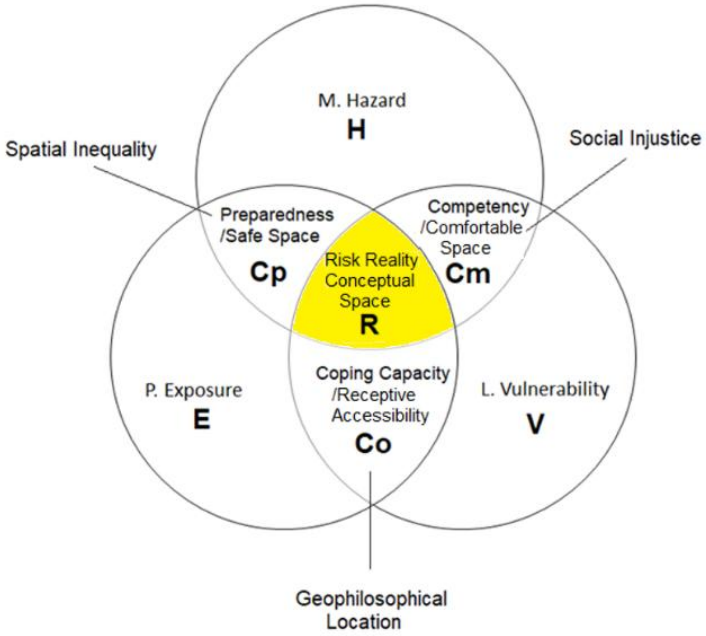

Fig.1 Risk Reality Conceptual Space (Abante, 2020)

The Y-junction of the Gärdenfors-inspired conceptual spaces are attributed to the three (3) paired variables that are logical where risk reality is expressed as Risk → function (Multiple Hazards, Landscape Vulnerability, Passive Exposure, Preparedness, Competency, Coping Capacity) where H →multiple hazards; V → Landscape Vulnerability; E → passive exposure; Cp → preparedness (tied with safe conceptual space); Cm → Competency (tied with comfortable space); and Co → Coping capacity is tied with receptive accessibility). [1][4][6][9][10][31][32][33] [35][36][37][38][39][40][41][42][43]

2 Methods

The study was designed to contextualize and examine the on risk hotspots and coldspots to quantify risk realities suffered by National Housing Authority (NHA) resettlement sites in Albay using GIS overlay and hexagonal binning technique to store and sort information to assess spatial patterns and quantify risk elements' statistical data to determine where the risk hotspot and coldspot are located using the ArcGIS's Getis-Ord Gi* Statistical and Moran's *I* Test. The researcher put together *Metatheorems* objects and parameters to requisite to perform the following: risk-enhanced resettlement site selection modeling; review the risk realness that is reliant to the computational risk reduction; and test the proposed site selection model parameters for settlement or resettlement sites as well as to examined the actuality of *Geophilosophical* realism of assessing the potential risk recurring in addition to the accumulated residual risk from past hazard events.

2.1 Organizing Primary Spatial Data.

Primary data were collected from OpenStreetMap and published spatial data by government line agencies. The input data were classified into ordinal scale having an ordering rating and organized to depict in a vector data formal language supported by the database built-in the GIS software used in characterizing risk elements' features it represents. In processing and quantifying the risk reality as well as selecting safe space, comfortable space, and accessible space or suitable sites for settlement/resettlements, binning techniques proved storing weighted values were achieved using the binning parameters as shown in Fig. 2.

	Risk Reality	Class Description	Very High Risk 95 to 99% Hotspot	High Risk 90 to 95% Hotspot	Moderate Neutral	Low Risk 90 to 95% Coldspot	Very Low Risk 95 to 99% Coldspot
Risk Element	Multiple Hazards	Quantity	≥ 500	≥ 450 < 500	≥ 180 < 450	≥ 60 < 180	< 60
		Description	Very High Multiple Hazards	High	Moderate	Low	Very Low
	Landscape Vulnerability	Quantity	≥ 13	≥ 10 < 13	≥ 8 < 10	≥ 5 < 8	< 5
		Description	Critical Condition	Somewhat Unsafe Condition	Neutral	Somewhat Safe	Stable Space
	Passive Exposure	Quantity	5	4	3	2	1
		Description	Critical location	Unsafe location	Neutral	Somewhat Safe Location	Safe Location
	Preparedness	Quantity	5	4	3	2	1
		Description	Unprepared	Insufficient Preparedness	Neutral	Somewhat Prepared	Prepared
	Competency	Quantity	5	4	3	2	1
		Description	Incompetent	Somewhat Incompetent	Neutral	Somewhat Competent	Competent
	Coping Capacity	Quantity	5	4	3	2	1
		Description	In bad condition	Poor Coping Capacity	Neutral	Somewhat High Coping Capacity	High Coping Capacity

Fig. 2 Risk Reality Binning Parameters (Abante, 2020)

The multiple hazards aggregated scores are classified into five classes regarded as very high to extremely high, high, moderate, low and very low to absent. The landscape vulnerability aggregated scores are separated into five classes regarded as very high to extremely high, high, moderate, low and very low to absent. The passive exposure were classified into 5 classes, although in this case study the interpretation of critical locations are areas near or within 100 m reckoned from the OSM building footprints and/or OSM road centerlines to also picture where the development or sprawl are located. The preparedness, competency and coping capacity were classified into five classes regarded as very high to extremely high, high, moderate, low and very low to absent.

The risk reality was regarded as the location or bin where Hotpot is possible and likely. It was interpreted as the multiple hazards variables having to with any of the following: unstable slopes; critical elevations; regular flooded

areas were given 100 weights, soil erosion prone areas which were based on soil characteristics, areas near riparian rivers were given 20 weights, foreshore extent altered by storm surge were given 20 weights, areas susceptible to geomorphological changes cause by Lahar, areas susceptible to Lava were given 100 weights. OSM Buildings and roads coincidence (passive exposure) which were given the highest score and were extracted by buffering the lines (OSM road) and polygons (OSM buildings) with 100 meters to represent nearness or density using Geoprocessing Mapping tools of ArcGIS. Preparedness, Competency and Coping Capacity were assumed comparable to the income classification of cities and municipalities in Albay to model risk hotspots, but this variable may partiality affect the risk hotspot analysis, on the other hand these variations also were assumed at the same level or equitable to 1 up to 5.

2.2 Risk Reality Contextualization

In this study, risk reality refers to the quantified risk state where the function (risk reality) ~ multiple hazards, landscape vulnerability, passive exposure, preparedness, competency, and coping capacity. Risk Realness refers to the state of being at risk. The contextualization was necessary to portray the risk reality parameters that is geocentric and grounded golden ratio and golden triangle that disclosed the vertices of resiliency that were reckoned at the geometric center. The risk realness was regarded as a space promoting safety and protection. It also refers to the state of being at risk wherein the state of actuality or existing situation is objectively lucid in the physical environment where limits are contained in a hexagonal-shaped area whose segments are measured equidistant at 500 m.

2.2.1 Risk Reality Geometric center

In this study, the conceptualization of the geometric center was grounded by the Fibonacci Golden Ratio and Schoen Golden Triangle. The geometric center is where the risk reality is at 0.008 units. It is regarded to be a resilient space or a Gärdenfors-inspired conceptual space when it conforms to the three criteria: safe, comfortable, and accessible space. Table 1 and Fig. 4 shows that the geometric center is positioned at plane coordinates x0, y0 . It pertains to the vertex of the first isosceles triangle $\Delta 1 \rightarrow$ lowest risk reality quantityhighest risk reality quantity H x V x ECp c Cm xCo 1 x 1 x 15 x 5 x 5 1 125 0.008 near zero risk reality quantity proving that the vertex of resiliency is significant when risk reality quantity is nearing zero.

2.2.2 Risk Reality Phi

The base line segment AB, where the object theorem is written as line segment AC $\rightarrow$ line segment AB$\rightarrow$ 125 segment quantity units $\rightarrow$ also regarded as the Risk Location Quotient (RLQ) unit. When R > 125 risk quantity regarded as exceeds the upper limit in quantifying risk reality it is regarded that the computation result defies the golden ratio. It is interpreted as an end which leads to a new beginning moving from one sensitive phase to a more intense risk level because the risk reality $\rightarrow 125 \neq$ Fuzzy Risk Reality > 125.

This study proved that the receptive-responsive-stability isosceles $\Delta \equiv$ unreceptive-unresponsive-socio-spatial risk reality isosceles $\Delta \rightarrow congruent\ (\equiv)$ Socio-spatial Fuzzy Reality isosceles Δ are congruent ($\equiv$) when grounded by the Fibonacci Golden ratio and Schoen Golden triangle, where C $\rightarrow$ Vertex of Resiliency $\rightarrow$ Angle kappa $\rightarrow 36°$, and AC $\rightarrow$ BC are asymptotic quantity segments with angle Alpha $\rightarrow \alpha \rightarrow$ angle Beta $\rightarrow \beta \rightarrow 72°$ and the φ upper limit $\rightarrow$ 125 and φ lower limit $\rightarrow$ 1 is regarded for risk reality$\rightarrow$hotspot, thus when $\varphi > 125$ it is regarded to represent the hotspot $\rightarrow$ Risk Fuzzy Reality and when $\varphi < 1$ it is regarded to represent information on resiliency or risk coldspot.

By diagramming all the segments' complex numbers, vertices draw from asymptotic segments by similar triangle technique where angles: 36°, 72°, 108°, 144°, 180°, 216°, 252°, 288°, 304° and 324° were revealed by drawing the parallel (//) lines or perpendicular lines which started the diagramming in the geometric center where R $\rightarrow$ 0.008 positioned at coordinates x_0, y_0. The *Metatheoretic* presentation of stability and/or asymptotic line segments of the series of Isosceles Δs is regarded continuous connectivity of φ when segments of the $\Delta s \rightarrow$ base of the Δ representing the stability segment quantity $\rightarrow$ asymptotic segments representing the receptiveness and/or

responsiveness → 1→1:1 ratio → when $125 < \varphi \geq 1$ → it represent risk reality, thus when $\varphi > 125$ is regarded as risk fuzzy reality.

Analyzing the stability → φ → 1:1 ratio → regarded as receptiveness-responsiveness proportion → 1 to the risk reality → $\varphi \rightarrow \frac{125 < \varphi \geq 1}{125 < \varphi \geq 1}$ Ratio regarded as unreceptiveness-unresponsiveness proportion → risk reality → $125 < \varphi \geq 1$, the φ result is regarded to a *Metatheorem* for Phi → $\varphi \rightarrow \frac{Risk\ Hotspot\ (Upper\ Limit)}{Risk\ Fuzzy\ Reality\ (125/2Cosine72°)} \rightarrow \frac{Risk\ Hotspot\ (Upper\ Limit) + Risk\ Fuzzy\ Reality\ (Risk\ Hotspot\ Upper\ Limit/2Cosine72°)}{Risk\ Hotspot\ (Upper\ Limit)}$ →

$$\frac{Risk\ Hotspot(Upper\ Limit)}{Risk\ Fuzzy\ Reality\ \left(\frac{125}{2Cosine72}°\right)} \rightarrow \frac{Risk\ Hotspot\ (Upper\ Limit) + Risk\ Fuzzy\ Reality\ (Risk\ Hotspot\ Upper\ Limit/2Cosine72°)}{Risk\ Hotspot\ (Upper\ Limit)}$$

$$\rightarrow \frac{125}{R\ (125/2Cosine72°)} \rightarrow \frac{125 + R(125/2Cosine72°)}{125} \rightarrow \frac{2Cosine\ 72°}{R} \rightarrow 1 + \frac{125R}{2Cosine72°} \rightarrow Phi\ \varphi = R^2 + \frac{2Cosine72°R}{AB} - \frac{(2Cosine\ 72°)^2}{AB}$$

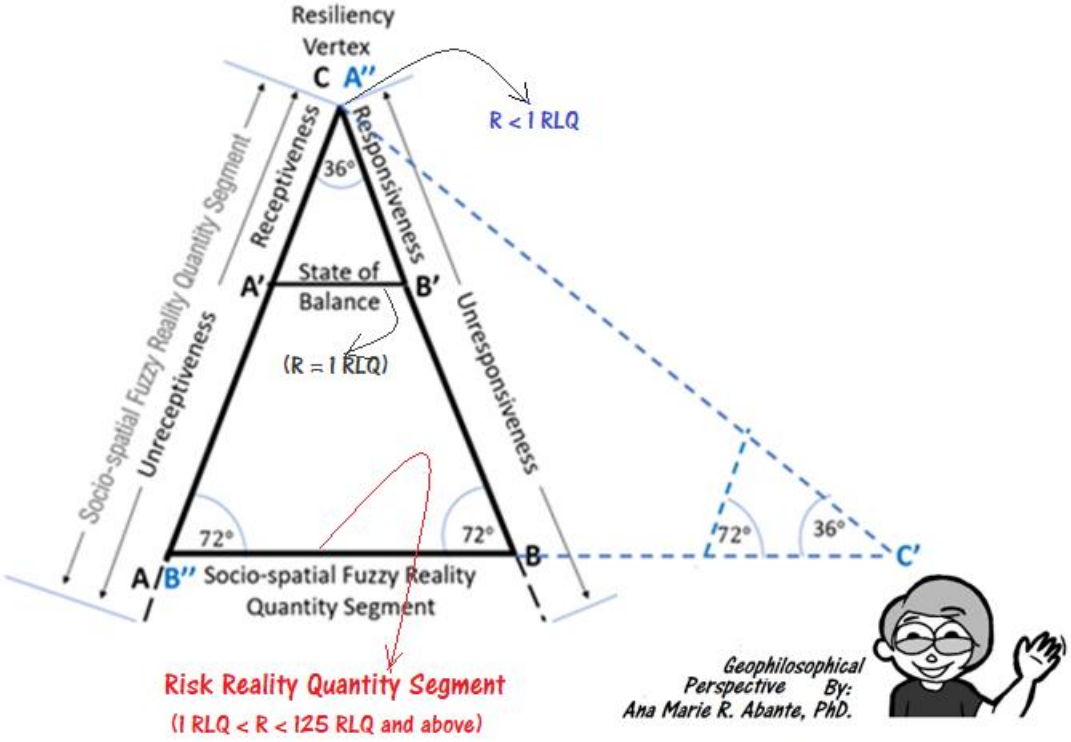

Fig. 3. Risk Reality Isosceles Δ Grounded by Schoen Δ (Abante, 2020)

The study proved that a spiral drawn after connecting the 25 vertices of resiliency of respective isosceles Δs as shown in Table 1 when reckoned at the geometric center created a perfect circle when adding two more isosceles triangles. Table 1 proved that the geo center of risk reality is not at the centroid of a circle. The risk reality circle was a result of interconnecting the 27 arcs (spiral), then it continuous to loop once it formed the risk reality circle keeping the Risk Reality Phi, mathematically written as

$$\text{Risk Reality Phi } \varphi \rightarrow R^2 + \frac{2Cosine72°R}{AB} - \frac{(2Cosine\ 72°)^2}{AB} \rightarrow R^2 + 0.00494427R - 0.00305572. \quad (1)$$

Fig. 4 revealed the relationships of the geometric center relative to the stability as shown in Fig, 3. This study bring to light when the risk reality is one unit it depicts stability. Table 1 divulged the risk reality lower and upper

limits are consistent with the geometric center and spiral tail, respectively. The geometric center of the risk reality as shown in Fig. 4, and Fig. 6 are not located at the centroid of the risk reality circle that is grounded by Fibonacci Golden Ratio and Schoen Golden Triangle. The risk reality circle also revealed the asymptotic lines connecting the vertices segments 24 and 25 upward direction (following the flow from the geometric center, while the segments 25 and 26 downward direction where the flow also referred to the geometric center disclosing where the stability at segment 25 plunged to a length identical to stability segment 23.

Fig. 4 substantiate the risk reality quantity in terms of arc lengths. These arc lengths are keys to measure the prevention, mitigation, preparedness, response, and recovery quantity units (arc lengths) to obtain risk reality at one unit hinting a stability. The line of stability in this study refers to the fulcrum of the asymptotic quantity segments (Phi) depicting the Receptive-Responsive DRRM as shown in Fig. 6.

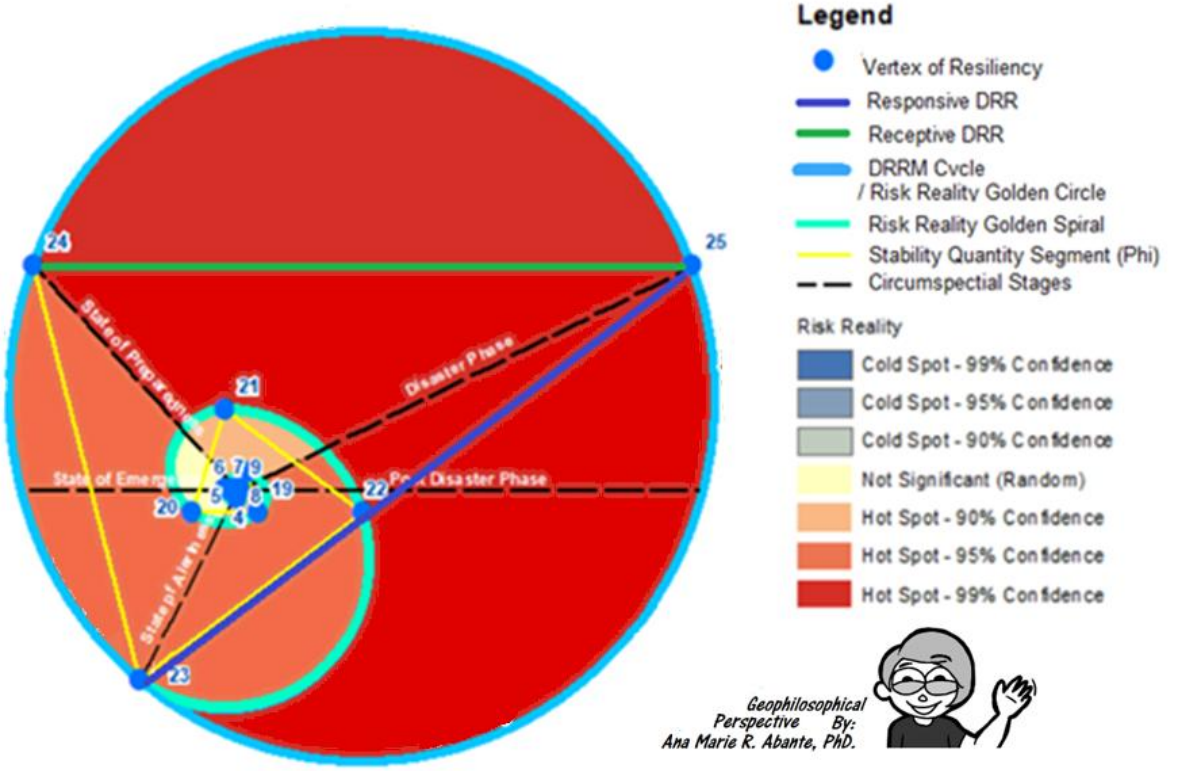

Fig. 4 Risk Reality Circle Grounded by Fibonacci Golden Ratio and Schoen Golden Triangle (Abante, 2020)

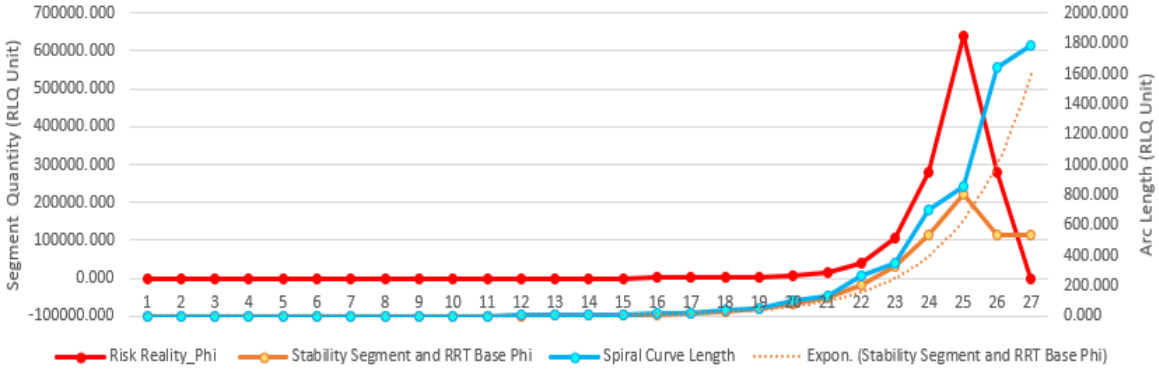

Fig. 5 Risk Reality Quantity Chart (Abante, 2020)

2.2.3 Vertices of Resiliency

The vertex of resiliency refers to the point (geometry) where segment receptiveness and segment responsiveness are measured at approaching Sine 18° where Risk reality is equal to one, at an angle 36° where the opposite segment is regarded as the state of balance line of the golden (isosceles) triangle as shown in Fig 3 and Fig. 5. The vertices of resiliency disclosed the relationships of the following: geometric center with risk reality equal to 0.008 unit positioned at 0.0; stability line with risk reality equal to one unit; risk reality upper limit with risk reality equal to 125 unit positioned at the end (spiral tail) shown in Table 1 and Fig. 4. The index table also revealed the 27 segments that are regarded as the baselines of the 25 isosceles triangles having 72° asymptomatic angles and 36° vertex angles. The spiral tail rests on the 23rd vertex. It is where the last arc connects the 25th vertex with 23rd and 24th vertices. The line segment connecting the 23rd and 24th vertices hinted at the longest stability line as illustrated in Fig. 3, Fig. 4, and Fog. 5.

Table 1. Vertices of Resilience Index Grounded by Grounded by Golden Ratio and Triangle. (Abante, 2020)

	Series of Resiliency Vertices				Risk Reality Golden Triangle			Risk Fuzzy Reality Phi	Spiral Curve (Arc Length)	Risk Conceptual Space (RRT Area in RLQ units)	Remarks
ID	Vertex and Asymptotic Segments		Vertex X	Vertex Y	Receptiveness Segment Quantity	Responsiveness Segment Quantity	Risk Reality Segment (RRT Base) Phi				
1	Vertex 1	Vertex 1 of Δ1	-0.004	0.013	0.013	0.008	0.008	-0.003	0.009	0.000	Geometric Center
2	Vertex 2	Vertex 2 (When AB =AC = BC of Δ2)	0.013	0.000	0.022	0.013	0.013	-0.003	0.018	0.000	
3	Vertex 3	Vertex 3 (When AB =AC = BC of Δ3)	-0.015	-0.021	0.035	0.022	0.022	-0.002	0.023	0.000	
4	Vertex 4	Vertex 4 (When AB =AC = BC of Δ4)	-0.032	0.033	0.057	0.035	0.035	-0.002	0.046	0.001	
5	Vertex 5	Vertex 5 (When AB =AC = BC of Δ5)	0.059	0.033	0.092	0.057	0.057	0.000	0.060	0.003	
6	Vertex 6	Vertex 6 (When AB =AC = BC of Δ6)	0.013	-0.108	0.148	0.092	0.092	0.006	0.121	0.007	
7	Vertex 7	Vertex 7 (When AB =AC = BC of Δ7)	-0.181	0.033	0.240	0.148	0.148	0.020	0.158	0.018	
8	Vertex 8	Vertex 8 (When AB =AC = BC of Δ8)	0.133	0.261	0.388	0.240	0.240	0.056	0.317	0.047	
9	Vertex 9	Vertex 9 (When AB =AC = BC of Δ9)	0.327	-0.336	0.628	0.388	0.388	0.150	0.415	0.122	
10	Vertex 10	Vertex 10 (When AB =AC = BC of Δ10)	-0.689	-0.336	1.016	0.628	0.628	0.395	0.830	0.319	
11	Vertex 11	Vertex 11 (When AB =AC = BC of Δ11)	-0.181	1.228	1.644	1.016	1.016	1.035	1.086	0.836	
12	Vertex 12	Vertex 12 (When AB =AC = BC of Δ12)	1.972	-0.336	2.661	1.644	1.644	2.709	2.173	2.188	
13	Vertex 13	Vertex 13 (When AB =AC = BC of Δ13)	-1.511	-2.866	4.305	2.661	2.661	7.090	2.844	5.728	
14	Vertex 14	Vertex 14 (When AB =AC = BC of Δ14)	-3.664	3.759	6.966	4.305	4.305	18.553	5.688	14.995	
15	Vertex 15	Vertex 15 (When AB =AC = BC of Δ15)	7.607	3.759	11.271	6.966	6.966	48.556	7.446	39.257	
16	Vertex 16	Vertex 16 (When AB =AC = BC of Δ16)	1.972	-13.586	18.237	11.271	11.271	127.093	14.893	102.778	
17	Vertex 17	Vertex 17 (When AB =AC = BC of Δ17)	-21.901	3.759	29.508	18.237	18.237	332.682	19.495	269.075	
18	Vertex 18	Vertex 18 (When AB =AC = BC of Δ18)	16.726	31.823	47.746	29.508	29.508	870.889	38.990	704.451	
19	Vertex 19	Vertex 19 (When AB =AC = BC of Δ19)	40.599	-41.650	77.254	47.746	47.746	2279.891	51.038	1,844.283	
20	Vertex 20	Vertex 20 (When AB =AC = BC of Δ20)	-84.401	-41.650	125.000	77.254	77.254	5968.605	102.077	4,828.394	
21	Vertex 21	Vertex 21 (When AB =AC = BC of Δ21)	-21.901	150.705	202.254	125.000	125.000	15625.615	133.620	12,640.889	Vertex C
22	Vertex 22	Vertex 22 (When AB =AC = BC of ΔABC	242.853	-41.650	327.254	202.254	202.254	40907.770	267.240	33,094.273	Vertex C'
23	Vertex 23	Vertex 23 (When AB =AC = BC of ΔACC'	-185.528	-352.888	529.508	327.254	327.254	107096.924	349.821	86,641.931	**Vertex C" &Spiral 23 (Tail)**
24	Vertex 24	Vertex 24 (When AB =AC = BC of ΔCC'C"	-392.639	420.062	800.216	529.508	529.508	280381.810	699.643	211,860.672	Vertex C"'
25	Vertex 25	Vertex C"'	878.346	420.062	1270.985	800.216	800.216	640350.241	855.399	508,531.521	Vertex C"''
26					1270.985	529.508	529.508	280381.810	1,639.514		
27					1270.985	529.508	529.508		1,782.081		Spiral 25

2.2.4 DRRM-Circumspectial Isometric Stages Grounded by Risk Reality Phi

The DRRM-Circumspectial Isometric Stages is presented to advocate the pairing of the five Circumspectial stages with the five DRRM cycles to measure risk reality through the geospatial information model that verbalizes that stability that is logical to site selection (space allocation). [1][4][5][6][9][10][11][12][32][33] While the DRRM cycle is itemized into prevention, mitigation, preparedness, response, and recovery, the circumspectial stages reckons where to twitch these five risk reduction interventions. [1][6][9][10] The five circumspectial stages are regarded as the state of alertness, state of emergency, state of preparedness, disaster phase and post-disaster phase.

[1][6][9] The risk realness (geospatial) information give a rough idea of the complex interaction between a potential damaging physical event (regarded as multiple hazards in this study) combined with the vulnerability of NHA resettlement sites (where landscape critical condition and exposure (situation or nearness) are quantified and classified into hotspot, random or coldspot .[1][11][12]

Fig. 6 is grounded by Fig. 5 wherein the arc lengths are measurements of the DRRM cycle: prevention, mitigation, preparedness, response, and recovery. These five arc lengths concur with the five line-segments of the DRRM Circumspectial stages that are reckoned at the geometric center: State of Alertness; State of Emergency; State of Preparedness; Disaster Phase and Post Disaster Phase are reckoned at the geometric center of the risk reality circle. The Stability line-segment is measured from the end nodes of line-segments 'State of Alertness' (Vertex 23 in Fig. 4, Fig.5 and Table 1 as spiral tail) and 'State of Preparedness' (Vertex 24 in Fig. 4, Fig.5 and Table 1) measured from the geometric center. Preparedness is bounded by an arc line (risk reality partition) measured from Vertex 24 to Vertex 25 (as shown in Fig. 4, Fig. 5 and Table 1). Similarly, the line segment connecting Vertex 24 and Vertex 25 concur with the receptive risk reduction segment quantity (asymptotic segment (Phi as shown in Fig. 4) of the small Risk Reality Triangle (RRT) as shown in Fig. 3). Likewise, Vertex 25 and Vertex 23 concur with the responsive risk reduction segment quantity (asymptotic segment (Phi as shown in Fig. 4) of the small Risk Reality Triangle (RRT) as shown in Fig. 3). The Disaster Phase line segment in Fig.6 and Fig. 3 is measured from Vertex 25 to the geometric center. A horizontal line is drawn to create the partition of quick response and recovery. A line is drawn parallel to the Post Disaster Phase and measured from the geometric center is called the state of emergency. The researcher presents the State of Calamity can be drawn in between the State of Preparedness and Disaster Phase. The State of Calamity is seen as reliant on the State of Preparedness. Considering the preparedness remains a variable and perceived to be constantly changing, the five partitions relatively changes as hazard events intensifies and/or exposure continue to increase.

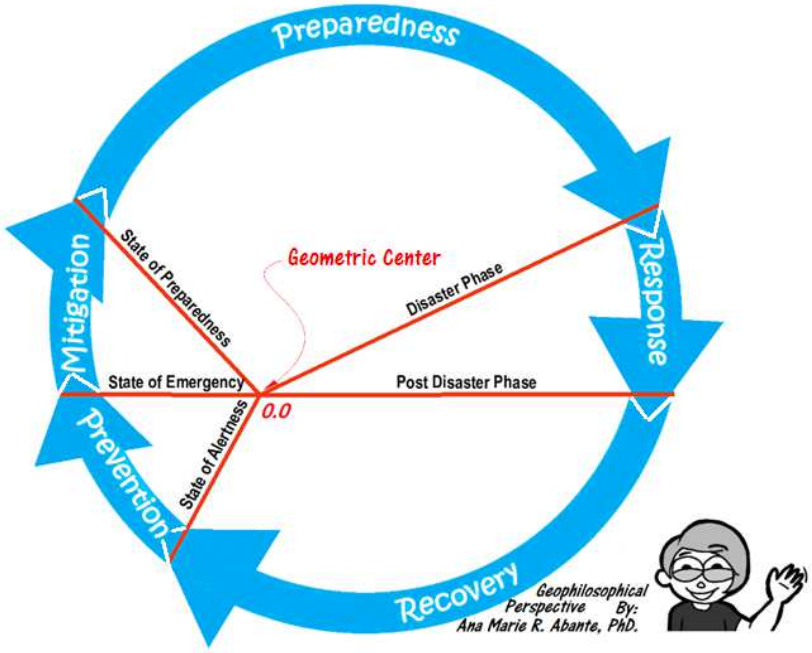

Fig. 6 DRRM-Circumspectial Isometric Stages Parameter (Abante, 2020)

2.3 Risk-enhance Resettlement Site Selection Modeling

The risk-enhance resettlement site selection modeling using geospatial information and ArcGIS software tested the following: *Metatheorem*s object grounded by geophilosophical perspective on risk reality; Risk Reality Context Model Grounded by Golden Spiral; and Site Selection Modeling Grounded by Risk Reality Context Model.

[1][26][27][28][29][30] The Binned Risk hotspot and coldspot was regarded to mimic the risk reality in Albay. [1][7][8][26][27] The geospatial information (Geoinformation) data model built up for this study revealed the non-exercise of the hexagonal binning technique leads to complexities in quantifying risk and evaluating the risk reality. [1][5][6][9][10][11][12][26][27][28][29][30] The binned statistical data were processed using the Gates Ord Gi* (geostatistical tool) to analyze the neighborhood of values for risk and its constituents. The Moran's index characterizes weight matrices significance for autocorrelation analysis. The z-scores were categorized into 7 levels of significance. The geospatial aspects and impact of data as illustrated and pinpoint the causes of specific geographic patterns that were reliant to the visual inspection and image interpretations were limited to the knowledge of the researcher's technical experiences as a photogrammetrist, cartographer, GIS specialist, geodetic and civil engineer and an environmental planner practicing land use planning) to interpret the risk variables and sub-variants.

2.3.1 Hexagonal Binning Technique.

The risk hotspots and coldspot in Albay highlights the hexagonal binned data disclosing where the hotspots in terms of: multiple hazards binned geoinformation, landscape vulnerability binned geoinformation, passive exposure binned geoinformation, and capability (Preparedness, Competency and Coping Capacity) binned non-spatial data (attributes). [1][17][18] The data binning was reckoned 25 km from the crater of Mayon Volcano in Albay where the urban development trends (and sprawl) and constraints (risk hotspots) are located using hexagonal bin maps. Hexagonal bin map (tessellated cells created using ArcGIS 10.8 version) is fishnet-like or honeycomb-like hexagonal polygons arranged perfectly to store and sort the risk reality information distributed in the 25 resettlement sites in Albay. The 1,541 hexagonal bins which covers the 25 km radial distance measured from the crater of Mayon Volcano having an area of 154,160.14 hectares, plays an important role in analyzing the spatial variation of risk reality in Albay. Risk reality was measured in every 100 Ha of land to depict the degree of confidence and rendering of risk hotspot and coldspot spatial patterns. Visualization of risk reality on the basis (real physical space) is doable using hexagonal bins with 100 Ha area coverage, wherein an average person with a 0. 50-meter pace factor can walk a 500-meter radius (distance) or take 1,000 steps with 3-meter/second speed can measure the one-side of the hexagon in just 3-minutes or it takes 18 minutes to walk round a flat physical space regarded as a hexagonal bin. Fig. 7 demonstrates that the hexagonal bins (circularity of a hexagon grid) is a better way to represent data more naturally than square grids. The hexagon (bin) polygon (rather than a perfect circle) is a tessellated polygon regarded as a Hexagonal bin in this study.

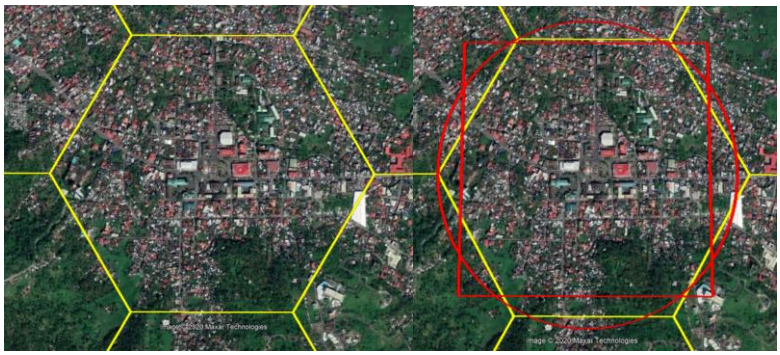

Fig. 7 Tessellated Hexagonal Bins (Polygons)

2.3.1 Situational Analyses.

The higher portion of the Mayon Volcano is a natural park (located within the permanent danger zone) reserved for the conservation of native plants and animals, their associated habitats and cultural diversity. At least a 24.4 km road network that leads access to the 8 km extended danger zone (remain an alienable and disposable and desirable for production forest uses. Without seeing the force of sprawl as people go forward to develop their lands and constructions of buildings near the gullies, alluvial fans at the foot slopes of the volcano, old railroads which were

ruined by repetitive volcanic eruptions, people remain playing against disaster risk as multiple hazard events iteratively happen again and again.

The undesired buildings were built along rights-of-ways such as barangay/purok roads, farm-to-market roads, trails and tracks of trucks hauling the gravels and sands needed to develop cities and municipalities, dikes, evacuation routes, and so on. [1][3][4][31] The barangay (village) nodal centers or the location of the barangay halls is interconnected with road and road-like patterns. Density of buildings surrounding the barangay nodal centers varies depending on the slope, lift and other landscape features such as river and its bank erosion due to severe rainfalls. [1][4]

2.3.2 Risk Areal Differentiation

In this study this refers to the method to get the difference between two calculated risk quantities, wherein the negative residual value implies worsen risk reduction actions are applied to reduce risk; In contrast, the practical implication of positive residual affirms corrective risk reduction measures. [34] The geographic location (point features) of the 25 resettlement sites was overlaid with the hexagonal bins (polygon features) using ArcGIS's Geoprocessing Tool. The intersection of point and polygon features made possible transferring the hotspot, random and coldspot z-scores attributes from polygon to point map features. Then the areal differential technique was applied to get the residual risk (ΔR).

2.4 Receptive and Responsive DRRM Review

The Receptive-Responsive DRR Isometric Index as shown in Fig. 8 was created to simplify risk reduction parameters. It was tested and applied to review the relationship of the safe conceptual space reliance with the risk reality z-scores of the resettlement sites that may be safe, but not necessarily comfortable and accessible or may be comfortable temporarily (somewhat located far flung) but safe or resilient area. *Metatheorems* were used to further review the risk reality z-scores.[1] Notice the line formed by the cell with numerical value equal to one. It act as a partition when risk reality is less than or greater than one unit.

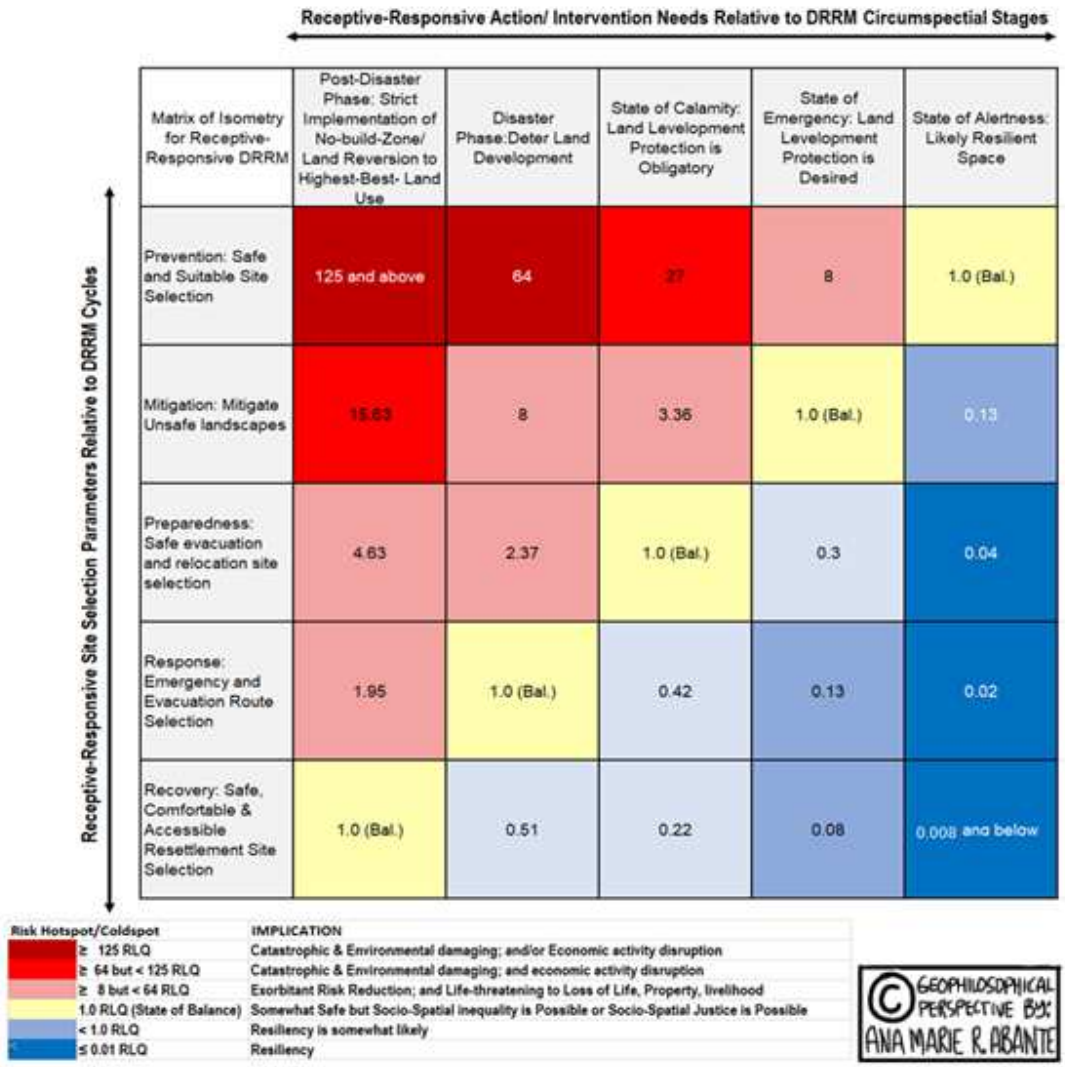

Fig. 8 Receptive-Responsive DRR Isometric Index (Abante, 2020)

3 Results

The risk reality and trend in terms of spatial information on multiple hazards, landscape vulnerability, passive, exposure and the nonspatial information on capability are regarded as the combination of the preparedness, competency, and coping capacity of the government. The hotspot incidence in terms of 623 bins or 62,300 Ha regarded as the combined building and road incidences. Of all the risk elements this information is the independent variable of risk reality. Risk cannot exist in bins when passive exposure is nil. See the bin map at the end of the discussion. Unlike the first three (3) risk elements, the Capability is expressed as non-spatial information representing the attributions regarded as the other three (3) elements of risk, these are: preparedness, competency, and coping capacity. These elements characterize the denominator, taking the part (pairing) in cutting the multiple hazards, landscape vulnerability and exposure, the pairing are as follows: multiple hazards and preparedness, landscape and competency, and exposure and managing capacity. These pairing constitute the three (3) conceptual spaces supported by *Metatheorem*s, these are: a safe conceptual space indicating there is spatial equality, comfortable conceptual space to stand for social justice, and philosophical location (conceptual space). Since the passive exposure is involved as an independent variable when paired with coping capacity hinted at the

geophilosophical location as a conceptual space is the most important information that connotes land utilization and zoning.

The risk realities findings in the 25 resettlement sample sites in terms of: risk reality z-score processing result, risk reality overlay analysis result, risk realities tabulation, and visualization of risk realities in NHA resettlement sites. [1][19][20][21][22][23][24][25] The risk realities suffered by the NHA resettlement sites in Albay in terms of charting: risk reality, descriptive style, and conceptual space tabulation, risk reality suffered by NHA resettlement sites. [1][5]

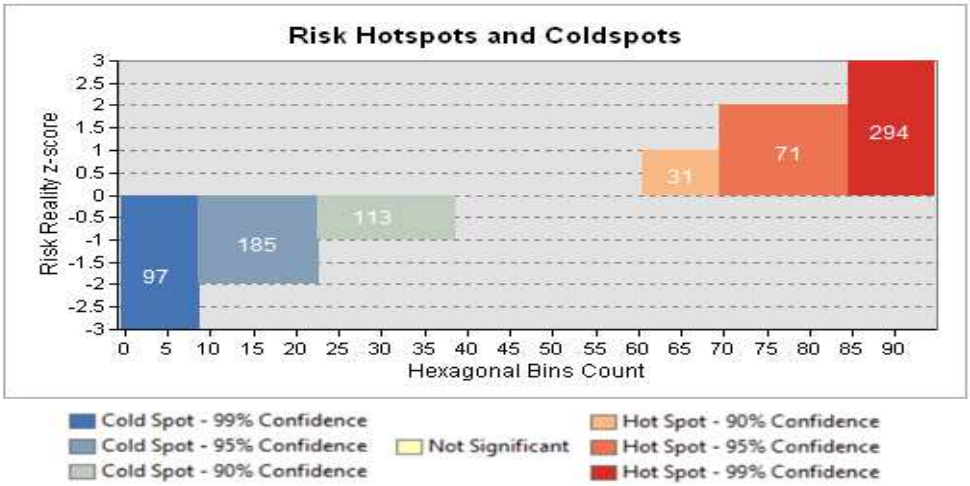

Fig.9 Risk Hotspots and Coldspots Bin Count

The more people utilize danger zones the more financial content is required to stay balanced following a zero-casualty strategy of Albay. Therefore, the bin maps for preparedness, competency and coping capacity were inputted with the income class of the urban centers and municipalities. It means each hexagonal bin is attributed to income class weighted from 1 (lowest) to 5 higher, indicating the 5% budget allocation for DRRM programs and activities. See the bin maps at the end of the discussion on risk hotspots and coldspots in Albay. This graph below disclosed the sum of risk hotspots, random/insignificant or coldspots information that connects the risk reality z-scores: 294 hexagonal bins or 29,400 hectares of land are labelled as 99%, significantly hotspot, 71 hexagonal bins are labelled 95%, significantly hotspot, 31 hexagonal bins are 90%, significantly hotspot, 113 hexagonal bins are 90% significantly coldspot, 185 hexagonal bins are 95% significantly coldspot and 97 hexagonal bins are 99% significantly coldspot. The ArcGIS's Getis-Ord Gi* Statistical and Moran's *I* Test results also disclosed the general hotspot wherein the areas with z-scores varying from 1.65 to 1.96 cover the resettlement sites disclosed the following: Legazpi City, Ligao City, Tabaco City, Bacacay, Camalig, Daraga, Guinobatan, Libon, Malilipot, Malinao, Oas, Polangui, Sto. Domingo and Tiwi. On the contrary, the coldspots are generally depicted by z-score between <1 and z-score ≤ 2.58 which cover the following watershed divides: Balobo (Ligao-Guinobatan area), Banwang Gurang (Camalig-Jovellar area), Ogod (Camalig-Jovellar area) , Polangui (Polangui-Oas area), Quinali 'A' (Camalig, Guinobatan, Ligao, Oas and Polangui area), Quinali 'B' (Malinao-Tabaco), Taque and Tiwi-Sangay area. Other fields are barely random values.

The risk realities suffered by resettlement sites are regarded as the lack of spatial quality regarded as receptiveness is unlikely (U) and short of social injustice regarded as responsiveness is unlikely (U) where stability is reliant on the segment quantity of unreceptiveness and unresponsiveness. The N indicates no certain suffering based on the scientific data findings, although some recipients of housing projects may disagree with this geospatial information modeling results. The following research output reveals the risk realities suffered by resettlement sites in terms of the following: risk reality, descriptive trend, conceptual space tabulation, and risk reality suffered by NHA resettlement sites. Table 2 exhibit the risk realities suffered by the resettlement site in Albay: Likely (Li), Somewhat Likely (SLi) and Unlikely (U); Social Justice: Likely (Li), Somewhat Likely (SLi) and Unlikely (U);

Receptiveness: Likely (Li), Somewhat Likely (SLi) and Unlikely (U); Responsiveness: Likely (Li), Somewhat Likely (SLi) and Unlikely (U); and Stability: Likely (Li), Somewhat Likely (SLi) and Unlikely (U). [1] It also demonstrates where stability is unlikely regarded as suffering risks by resettlement sites. Based on scientific findings, the following suffered risk: Cullat (Daraga), Lamba (Legazpi), Ligao City, Miisi (Daraga), Oson (Tabaco City), Pinabobong (Tabaco City), Quitago (Guinobatan), Salvacion (Tabaco City), San Vicente (Tabaco), Sto. Domingo, Tabaco Housing Project, Tagaytay (Camlig), Taysan (Legazpi City).

Table 2. Risk Realities Suffered by NHA Resettlements in Albay (Abante, 2020)

ID	NHA Resettlement Site	Present Risk Reality			Risk Trend					
		Z-score	Risk Reality	Residual	Phi	Phi Impact	Trend	Receptiveness	Responsiveness	Risk Suffered
1	Amore Resettlement Project	-1.38	C	N	N.A.	N	C	Li	Li	N
2	Banquerohan Resettlement Project Ph I	-0.66	C	N	N.A.	N	C	Li	Li	N
3	Banquerohan Resettlement Project Ph II	-1.31	C	N	N.A.	N	C	Li	Li	N
4	Bascaran Resettlement Project	-0.43	C	N	N.A.	N	C	Li	Li	N
5	Camalig Resettlement Project	-0.49	C	N	N.A.	N	C	Li	Li	N
6	Cullat Resettlement Project	3.32	H	Y	11.02	Y	F	U	U	Y
7	Daraga Resettlement Project Ph I	-0.81	C	N	N.A.	N	C	Li	Li	N
8	Daraga Resettlement Project Ph I	-0.82	C	N	N.A.	N	C	Li	Li	N
9	Daraga Resettlement Project Ph II	-0.40	C	N	N.A.	N	C	Li	Li	N
10	Lamba Resettlement Project	0.61	H	Y	0.37	Y	H	U	SLi	Y
11	Ligao Resettlement Project	2.26	H	Y	5.12	N	F	U	SLi	Y
12	Mauraro Resettlement Project Ph II	-0.55	C	N	N.A.	N	C	Li	Li	N
13	Miisi Resettlement Project	4.19	H	Y	17.53	N	F	U	U	Y
14	Oas Resettlement Project	-0.32	C	N	N.A.	N	C	Li	Li	N
15	Oson Resettlement Project	4.54	H	Y	20.61	Y	F	U	U	Y
16	Pinabobong Resettlement Project	3.40	H	Y	11.57	N	F	U	U	Y
17	Polangui Resettlement Project	-1.62	C	N	N.A.	N	C	Li	Li	N
18	Quitago Resettlement Project	1.08	H	Y	1.18	N	C	U	SLi	Y
19	Salvacion Resettlement Project	2.54	H	Y	6.44	Y	F	U	SLi	Y
20	San Vicente Resettlement Project	0.69	H	Y	0.48	Y	H	U	SLi	Y
21	Sto. Domingo Resettlement Project Ph I	0.86	H	Y	0.74	Y	H	U	SLi	Y
22	Tabaco Housing Project	0.69	H	Y	0.48	Y	H	U	SLi	Y
23	Tagaytay Resettlement Project	1.97	H	Y	3.89	Y	H	U	SLi	Y
24	Taysan Resettlement Project	-0.07	Ra	Y	N.A.	N	Ra	U	Li	Y
25	Taysan Resettlement Project	1.84	H	Y	3.40	Y	H	U	SLi	Y

Note: C→Coldspot; H→Hotspot; Ra →Random; F→Fuzzy Reality; Y→Yes; N→No; VH →Very High; H→High; M→Moderate; L→Low; VL→Very Low; N.A.→Not Applicable; Li→ Likely; SLi → Somewhat Likely; U →Unlikely

4 Discussion

The Risk Reality in Albay in terms of the spatial aspects of the three risk elements such as multiple hazards, landscape vulnerability and passive exposure, locate the risk hotspots or coldspots in the study area. The multiple hazards hotspots with 99% level of confidence are located within the Mayon 6 km permanent danger zone; between the 6 to 8 Km extended Mayon danger zone covering Tabaco City and Malilipot. It also includes areas near the Albay Lineament fault line crossing the town of Libon, Oas, Ligao City, Guinobatan, Camalig, Daraga, ending in Legazpi City. In terms of the landscape vulnerability, hotspots with 99% level of confidence greatly cover the 4 Km buffer area reckoned from the 6 km permanent danger zone. Measuring Passive Exposure relies on the location of building and road network where the said multiple hazards and passive vulnerable hotspot areas exist. The technique

on binning information on hexagonal cells reveals that about 29,400 hectares in Albay are significant risk hotspots, with 99% confidence. Also, at least 7,100 hectares of land are significant risk hotspots, with 95% confidence, and 3,100 hectares are significant risk hotspots with 90% confidence. The risk hotspot areas reach up to 15 kilometers from the Mayon Volcano's crater, covering Legazpi City, Daraga, Camalig, Guinobatan, the eastern section of Ligao City, Tabaco City, Malilipot, the western portion of Bacacay and Sto. Domingo. In terms of Coldspots or areas measured to be resilient: within the 25 km radius study area measured from the Mayon's crater, the mountainous portion of Mount Malinao (covering Malinao and Tiwi), Mount Masaraga (covering western portion of Tabaco City, eastern portion of Polangui and Ligao City), mountain hill ranges of the watershed and production forest (covering Libon, Oas, southern portion of Ligao City, Guinobatan and Camalig) and Jovellar) are measured as coldspots, with 90% level of confidence.

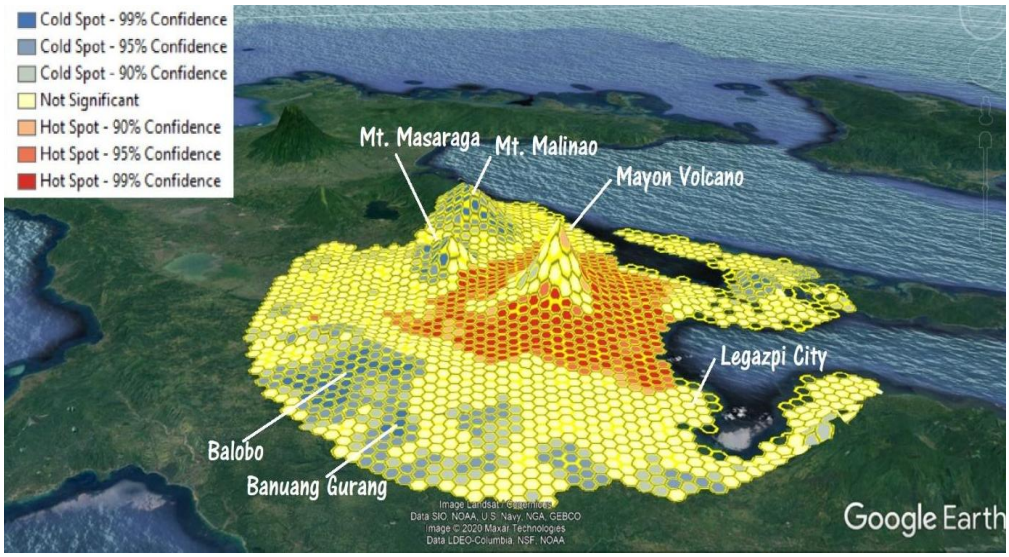

Fig. 10 Risk Hotspot and Coldspot Tessellated Bins Visualization in Google Earth Platform

Although these hotspots and coldspots outline the risks in spatial aspects relative to quantifying spatial equality, the term social justice remains reliant to the nonspatial aspects of capability. [1][35][36][47][38][39][40] These non-spatial aspects include *preparedness, competency and coping capacity* of the LGUs, where preparedness, competency and competency ratings were based on income class, and the 5% mandatory fund for prevention, mitigation, preparedness, response and recovery. [1]The variations which influence risk reality to either boost local development (if risk is reduced to bearable quantity), or to a worsened state if risk realities continue accruing. [1] A worsened risk reality implies that the socio-spatial reality in terms of spatial equality, social justice accessibility and stability are unmet. [1]

Socio-spatial reality, in terms of spatial equality, social justice accessibility and stability in the NHA resettlement sites in Albay were examined. This revealed the existence of a spreading risk in the following resettlement sites: Miisi and Cullat in Daraga ; Pinabobong, Tabaco Housing, Salvacion and Oson in Tabaco City, Taysan Phase I and II, and Lamba in Legazpi City; Ligao City; Quitago in Guinobatan; Sto. Domingo and Tagaytay in Camalig. A total of thirteen (13) out of twenty-five (25) resettlement sites in Albay are located within risk hotspot areas. Spatial equality (safe conceptual space) is unlikely (unsafe space) in all the above-mentioned resettlement sites except Taysan I in Legazpi City. In terms of Social Justice (comfortable conceptual space) are unlikely (unsafe space) in Cullat, Miisi, Oson, and Pinabobong, and the rest of the sample sites are found to be slightly likely comfortable sites. In terms of the accessibility of resettlement sites, Oson, Pinabobong and Quitago are unlikely accessible (not easily accessible), but Lamba, Miisi, Tagaytay, Taysan Phase I and II and Sto. Domingo seems slightly likely to be accessible. The nearness of Cullat, Ligao, Salvacion, San Vicente and Tabaco Housing to the social facilities mostly located in the tri-nodal cities of Albay (Legazpi, Ligao, Tabaco) place these resettlement sites likely accessible. But because these 13 resettlement sites are consequently located in risk hotspot areas, by applying the *Metatheorems* of this study, stability for these sites is unlikely.

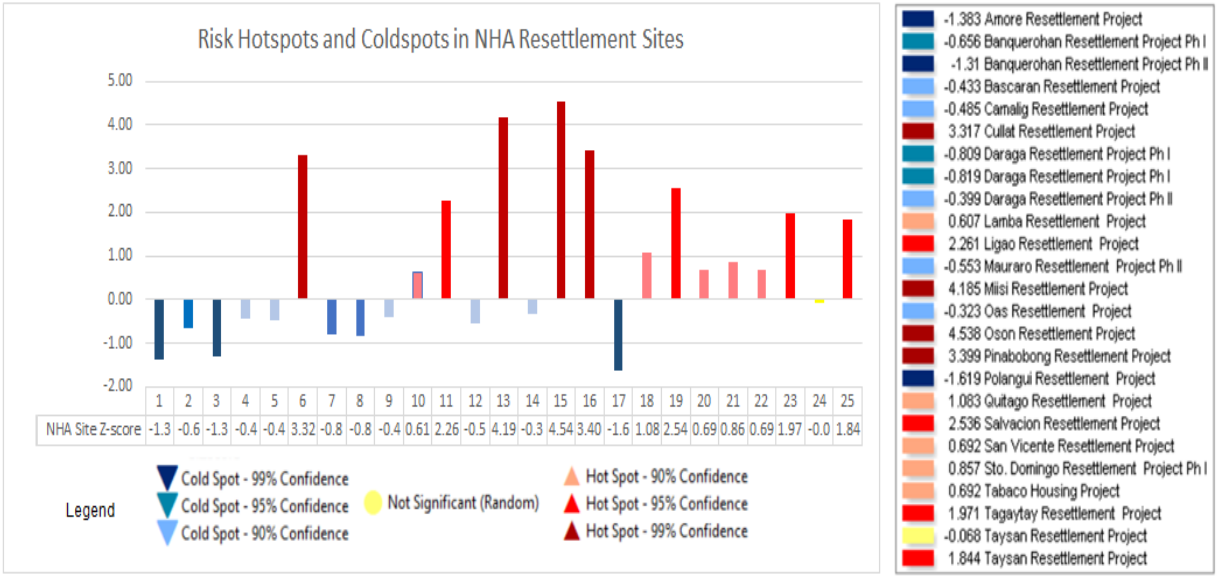

Fig. 11 Risk Realness in Resettlement Sites in Albay, Philippines

Fig. 11 presented the risk realities in terms of hotspot and coldspot to exemplify the results after overlay analysis. The risk reality are regarded as the z-scores and classification of hotspot and coldspot: Very Low indicating 95% to 99% significantly coldspot or Very Low Risk Class (VL); Low indicating 90% significantly coldspot or Low Risk Class (L); Moderate indicating random negative or positive z-score values between -89% to 89% confidence (M), High indicating 90% to 95% significantly hotspot or High Risk Class (H), and Rising Uncertainties indicating 99% significantly hotspot (VH) determine whether spatial equality is likely or not.

In tallying the risk reality values in the resettlement sites in Albay as shown in Table 2, it was revealed that fourteen (13 significantly risk hotspot and 1 insignificant value) out of the twenty-five NHA resettlement sites suffered in terms of the risk reality z-scores quantity where risk reality regarded hotspot or coldspot; Phi hinted spreading risk in resettlement sites. Moreover, out of the fourteen resettlement sites, four significantly need attention to reduce their disaster risk, these sites are: Oson and Pinabobong, in Tabaco City; and Cullat and Miisi, in Daraga town. Of these four sites, Cullat is a unique case: the hexagonal bin where this spot coincides generally characterizes the neighborhood oh high values interpreted by the Getis-Ord Gi* statistical tool in ArcGIS 10.8 version.

Taking part in validating the precise location relative to the physical landscape where Cullat resettlement sits as shown in Fig. 12, it was learned the binned information on slope carries a generalized weight of 4 indicating a high landscape vulnerability value. This shows that more detailed information and smaller size of hexagonal bins can bring more variations that can improve outcomes. Consequently, Cullat resettlement site carries a higher z-score. Each hexagonal bin carries a specific numerical value regarded as Risk Reality function (multiple hazards, landscape vulnerability, passive exposure, preparedness, competency, and coping capacity). Furthermore, the result of this study acknowledges the limitations of data model carries the accuracies of 1:50000 scale input maps only to show that it fits for macro planning or risk rapid assessment. Merely the same approach in site selection may be adopted for micro planning or comprehensive risk assessment.

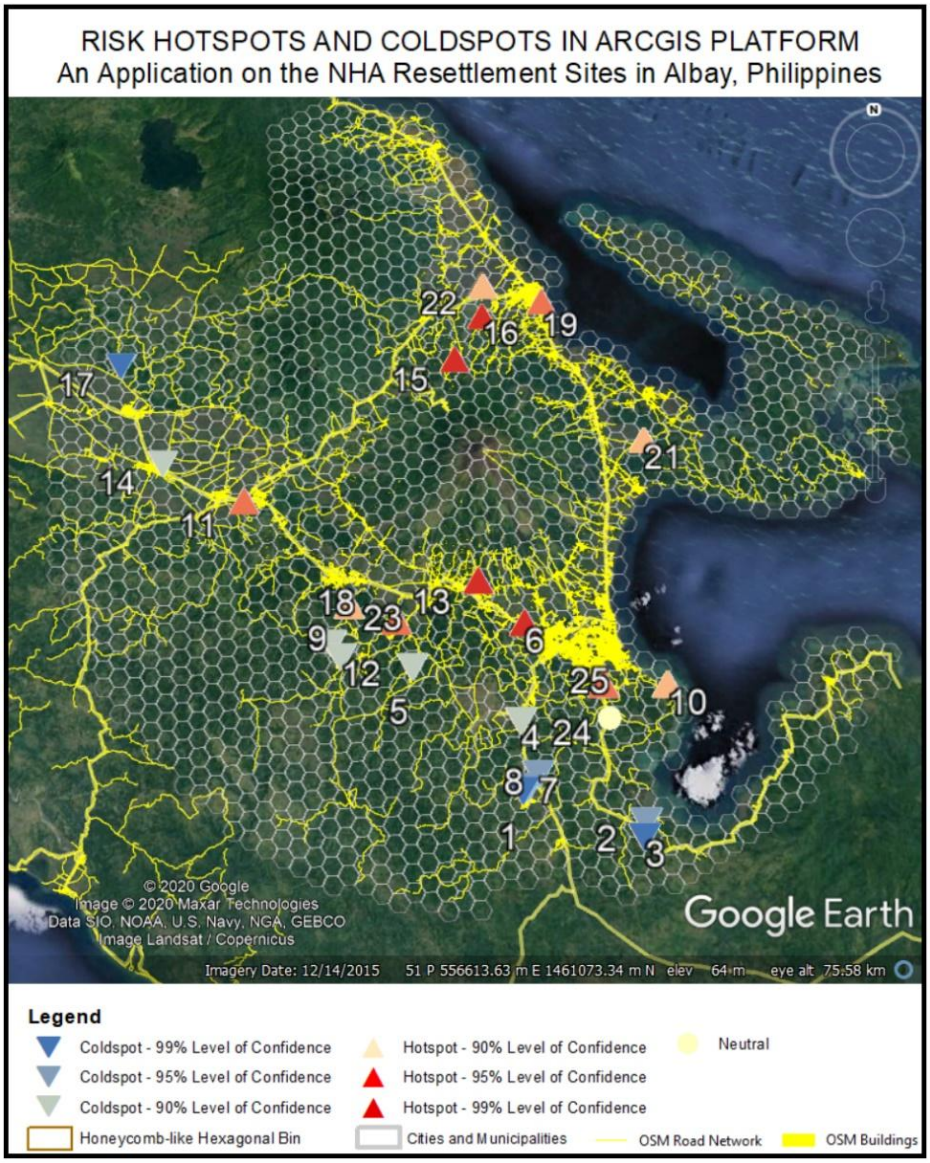

Fig. 12 Risk Reality in NHA Resettlement Sites in Albay, Philippines

5 Conclusions

Risk realities in terms of hotspots or coldspots is reliant on the receptive and responsive DRRM which entails an interdisciplinary thinking applying geospatial data science to characterize the multiple hazards, landscape vulnerable, and passive exposure hotspots or coldspots impacting Albay Province.

The researcher concluded that at least 14 resettlement sites in Albay will continue to suffer if the National Housing Authority, and other relevant agencies will delay relocating exposed residents to a safe space (with respect sill to the spatial equality), comfortable space (considering social justice), accessible sites approximately near the basic social services of the government. It further concluded that unreceptive and unresponsive mitigation actions affect whether the exposed population will become fully prepared or remain unprepared to withstand repetitive hazard events and the intrinsic effects of repetitive temporary evacuation of housing project beneficiaries.

When stability is unlikely (at household, community level), meaning existing in an unsafe situation, there is a larger financial requirement to capacitate the local government units. Further, that while the risk realities in the 14 resettlement sites will continue to accrue based on the scientific findings (grounded by *Metatheorems* Objects on Stability, Risk Reality, and Risk Trends), more suffering will be experienced when risk becomes unbearable, where full recovery at any level is unlikely.

As the Risk-enhanced Resettlement Site Selection Model exhibited the realness of risk, spatial equality, social injustice, safe space, comfortable space, it allows visualization in the form of maps, graphs and tables revealing where receptive and responsive risk reduction is greatly needed. As a final point, risk reality is quantifiable and actionable, when supported by *Geophilosophical* reasoning supported by *Metatheorem* objects on risk reality where stability is the fulcrum to quantify receptive-responsive risk reduction interventions

Availability of data and materials

N. A.

Competing interests

N. A.

Funding

The author is a faculty member and recipient of the Bicol University Human Resource Development Program..

Authors' contributions

Abante, A. M. R. designed the Risk Reality Conceptual Space Model for her dissertation for the Doctor of Philosophy in Development Management to measure and prove the uniqueness of risk, residual risk and extraneous errors that are logical to the concept of assessing risk reality (conceptual space grounded by geographic concepts) phenomenon.

Abante, A. M. R. conceptualized the Risk Reality Isosceles Δ Grounded by Schoen Golden Triangle for her dissertation for the Doctor of Philosophy in Development Management to prove risk reality is measurable.

Abante, A. M. R. conceptualized the Risk Reality Circle Grounded by Fibonacci Golden Ratio and Schoen Golden Triangle for her dissertation for the Doctor of Philosophy in Development Management to prove that stability changes as it pivots the geocentric center which hinted where the resiliency is hinged as well as proving the relationships of the vertices of resiliency that are interconnected and arranged opposite of the with the stability baselines of all isosceles triangles where the asymptotic segments hinted at receptive and responsive risk reduction.

Abante, A. M. R. created the Vertices of Resiliency Index Grounded by Grounded by Golden Ratio and Triangle

Abante, A. M. R. designed the computational DRRM-Circumspectial Isometric Stages Framework Model needed to analyze the resulting risk reality z-scores to assess risk realness stored and sorted in hexagonal bins. This research output is part of her dissertation manuscript for the Doctor of Philosophy in Development Management.

Abante, A. M. R. crafted the risk-enhanced resettlement site selection modeling, a technique to review the risk realness that is reliant to the computational DRRM-Circumspectial Isometric Stages Framework Model. The National Housing Authority resettlement sites in Albay, Philippines were reviewed to test the proposed site selection model parameters for settlement or resettlement sites as well as examined the actuality of

Geophilosophical realism of assessing the potential risk recurring in addition to the accumulated residual risk from past hazard events.

Abante, A. M. R. designed the Hexagonal Binning technique to store the risk hotspot or coldspot information to mimic the risk reality in Albay and developed the geospatial information data model to demonstrate that the complexities in quantifying risk reality is doable.

Abante, A. M. R. devised the geophilosophical Metatheorem objects in her dissertation for the Doctor of Philosophy in Development Management to prove the mathematical logic that demonstrates the risk realness varies at different extents of stability. Her dissertation proved that risk trend is a calculated risk reality (risk hotspot) in addition to the residual risk (ΔR) and Phi (φ) when risk exceeds 125-unit quantity.

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Authors' information

The author completed Doctor of Philosophy in Development Management at the Jesse M. Robredo Institute, Bicol University in July 4, 2020; a holder of Professional Masters in Geoinformatics with Specialization in Development and Maintenance of Geographic Information Systems, International Institute for Aerospace Surveys and Earth Sciences (ITC), Enschede, The Netherlands; a recipient of Netherlands Fellowship Program (NFP) in 1997; a graduate of Applied Geodesy and Photogrammetry, University of the Philippines, Training Center for Applied Geodesy and Photogrammtery in 1992; and a graduate of Bachelors of Science in Civil Engineering, Bicol University College of Engineering, Legazpi City in 1989. Presently connected as a faculty in BU College of Engineering. She authors researches that focus in applying geoinformatics in environmental planning and disaster risk reduction. She published four papers in 2018-2019. She received 2 best paper in Bicol University in 2018-2019 and recently attended various training on basic meteorology, flood risk modeling, Safe and Resilient Cities, geomatics and planning, remote sensing, unmanned aerial vehicle road mapping, space science and technology, etc. The author is licensed to practice environmental planning, geodetic engineering and civil engineering in the Philippines.

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Figures

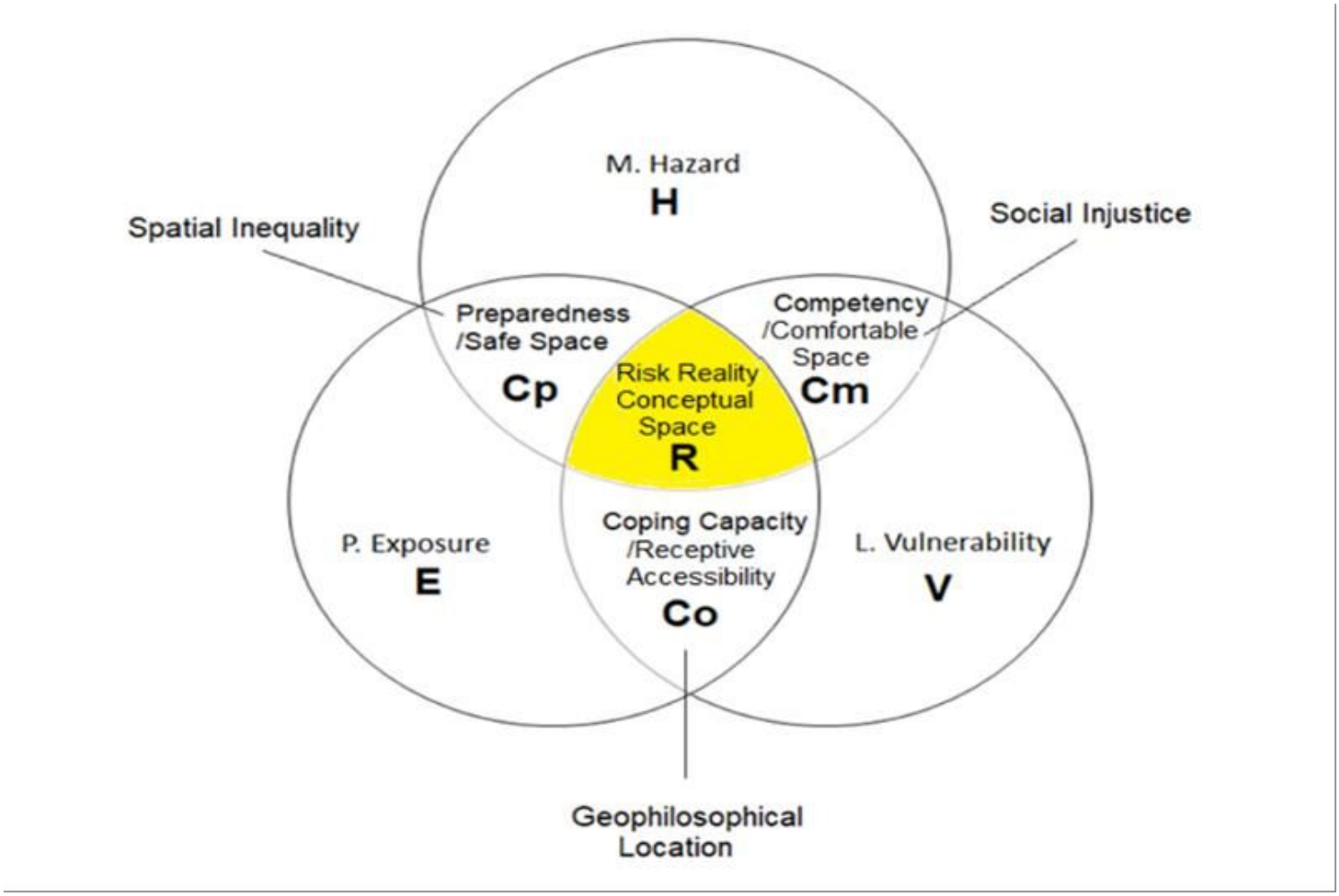

Figure 1

Risk Reality Conceptual Space (Abante, 2020)

Risk Element							
Risk Reality		Class	Very High Risk	High Risk	Moderate	Low Risk	Very Low Risk
		Description	95 to 99% Hotspot	90 to 95% Hotspot	Neutral	90 to 95% Coldspot	95 to 99% Coldspot
	Multiple Hazards	Quantity	≥ 500	≥ 450 < 500	≥ 180 < 450	≥ 60 < 180	< 60
		Description	Very High Multiple Hazards	High	Moderate	Low	Very Low
	Landscape Vulnerability	Quantity	≥ 13	≥ 10 < 13	≥ 8 < 10	≥ 5 < 8	< 5
		Description	Critical Condition	Somewhat Unsafe Condition	Neutral	Somewhat Safe	Stable Space
	Passive Exposure	Quantity	5	4	3	2	1
		Description	Critical location	Unsafe location	Neutral	Somewhat Safe Location	Safe Location
	Preparedness	Quantity	5	4	3	2	1
		Description	Unprepared	Insufficient Preparedness	Neutral	Somewhat Prepared	Prepared
	Competency	Quantity	5	4	3	2	1
		Description	Incompetent	Somewhat Incompetent	Neutral	Somewhat Competent	Competent
	Coping Capacity	Quantity	5	4	3	2	1
		Description	In bad condition	Poor Coping Capacity	Neutral	Somewhat High Coping Capacity	High Coping Capacity

Figure 2

Risk Reality Binning Parameters (Abante, 2020)

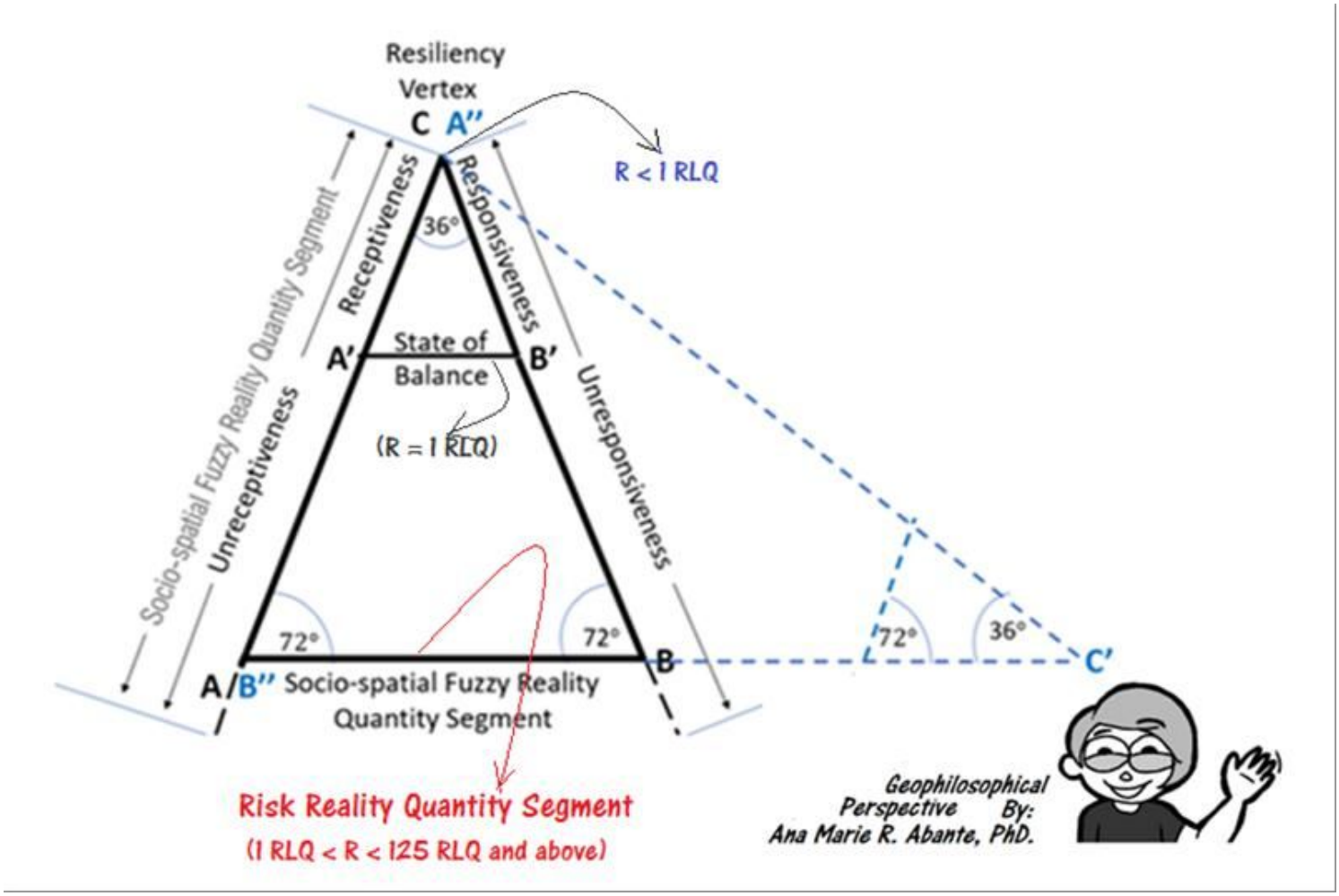

Figure 3

Risk Reality Isosceles Δ Grounded by Schoen Δ (Abante, 2020)

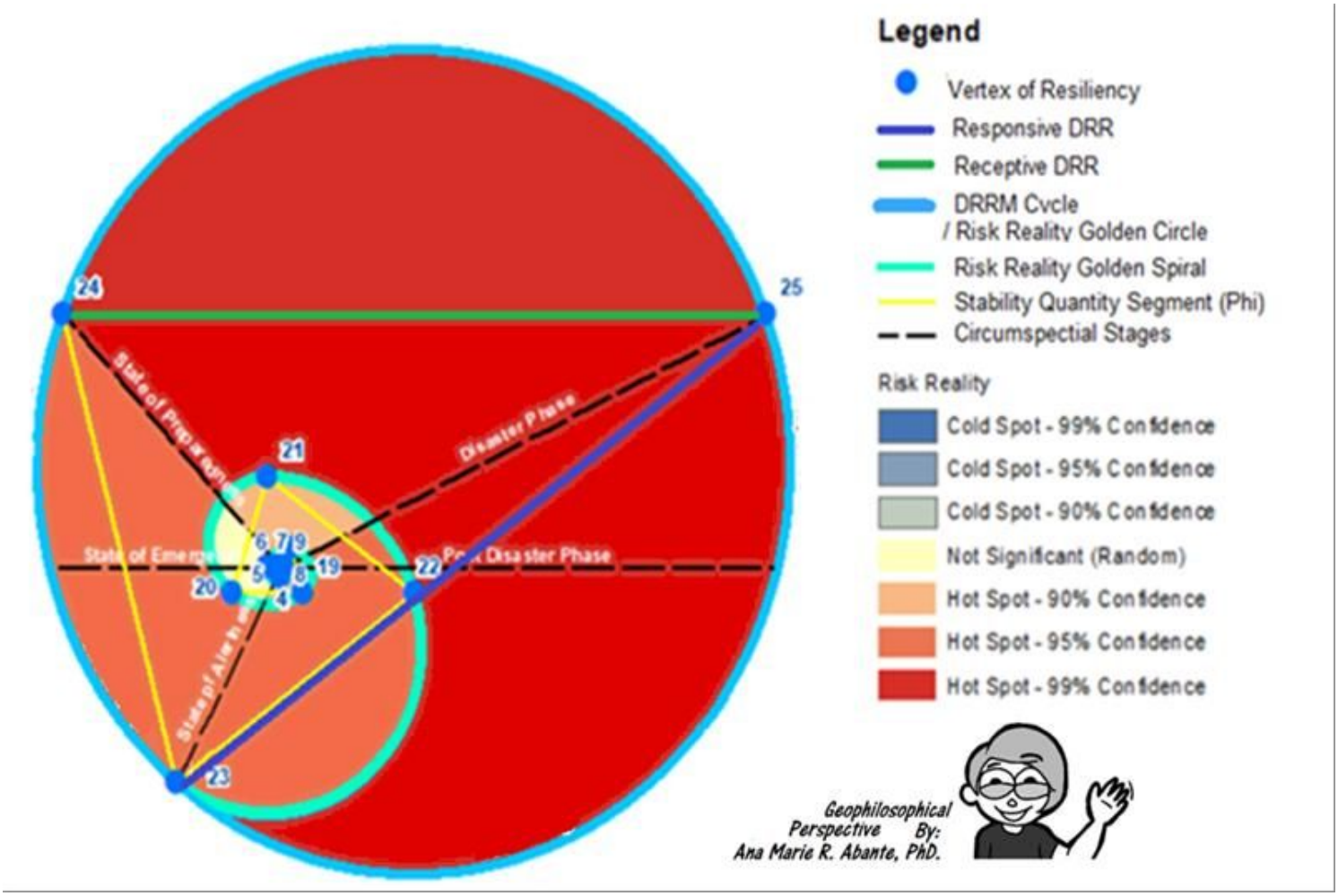

Figure 4

Risk Reality Circle Grounded by Fibonacci Golden Ratio and Schoen Golden Triangle (Abante, 2020)

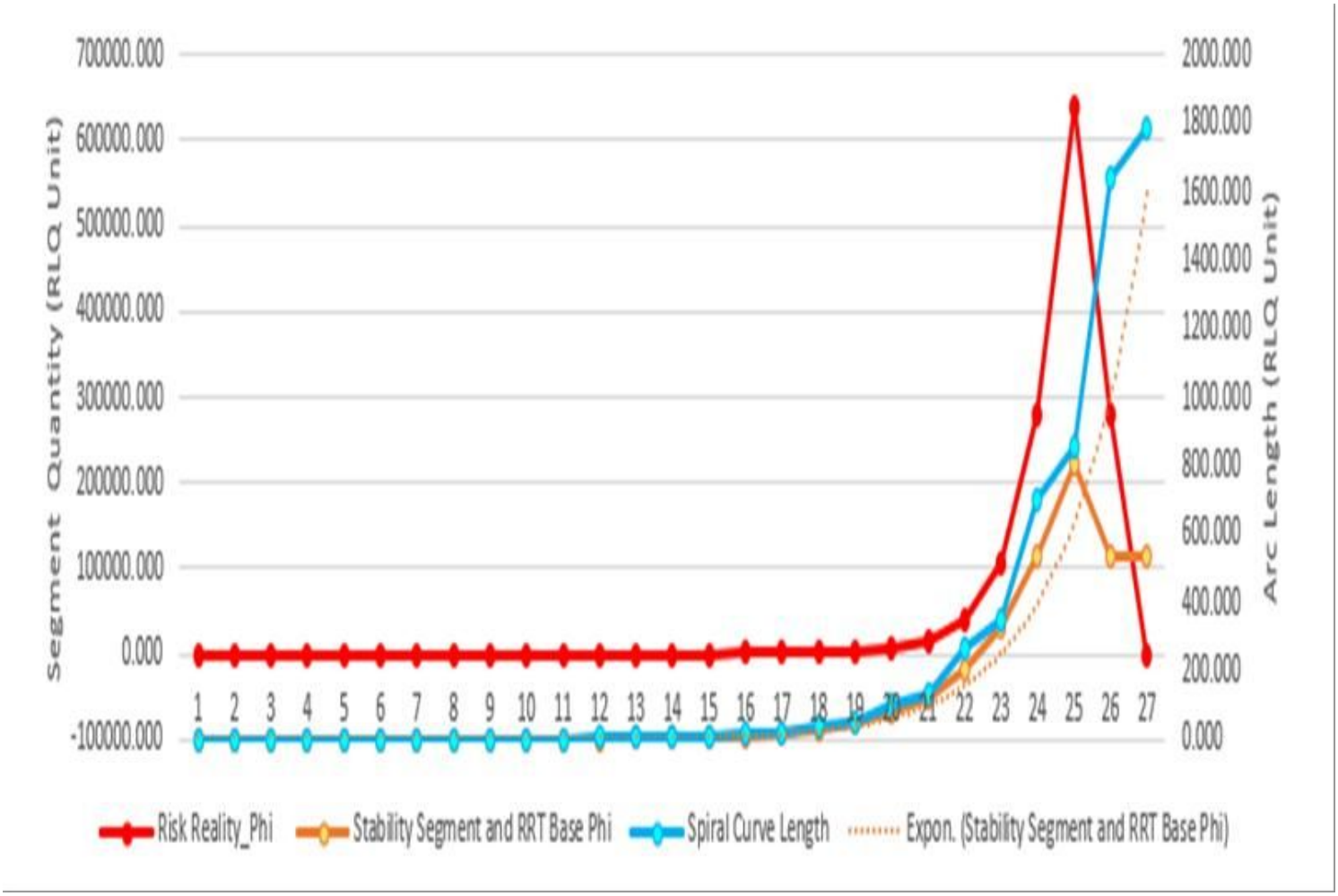

Figure 5

Risk Reality Quantity Chart (Abante, 2020)

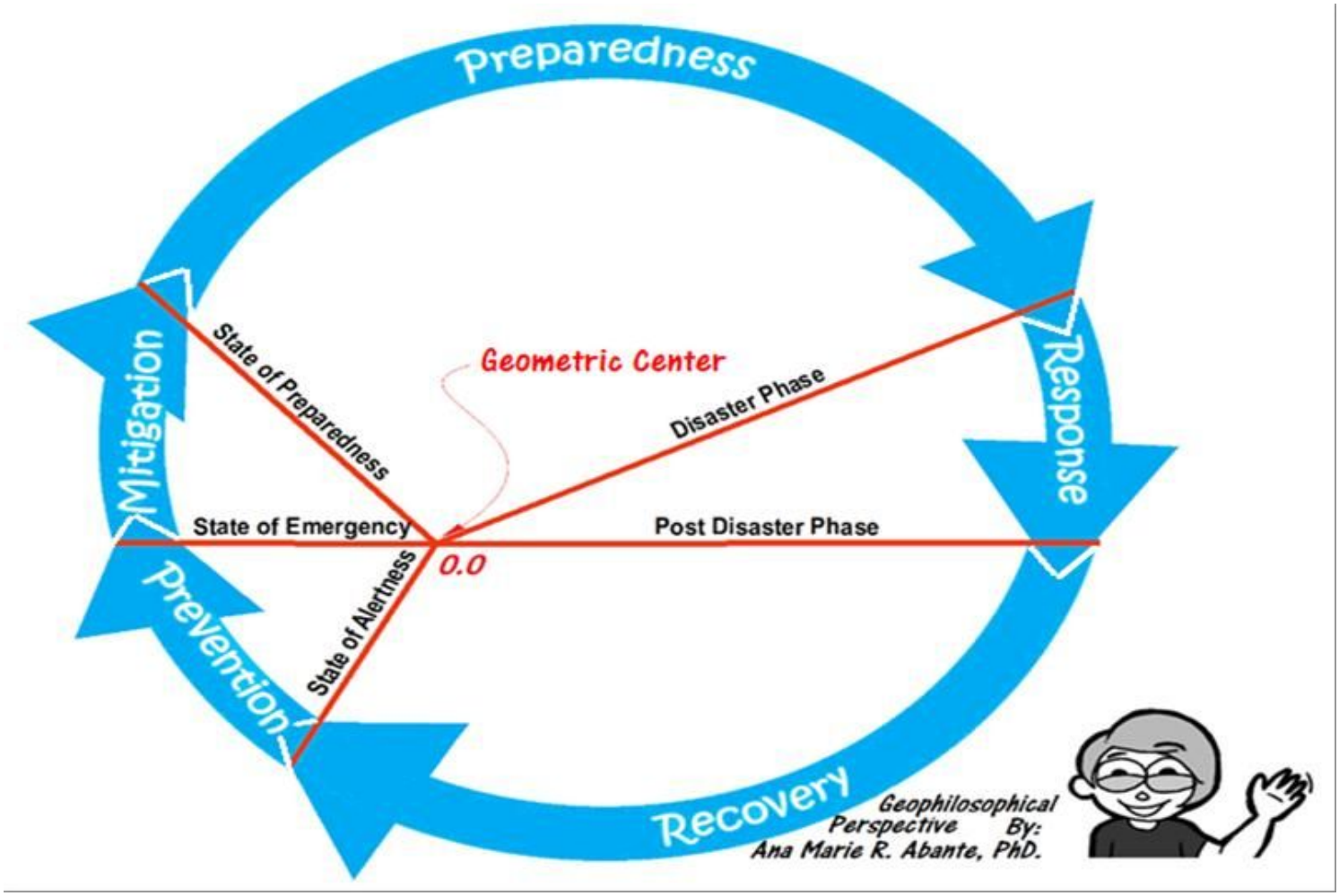

Figure 6

DRRM-Circumspectial Isometric Stages Parameter (Abante, 2020)

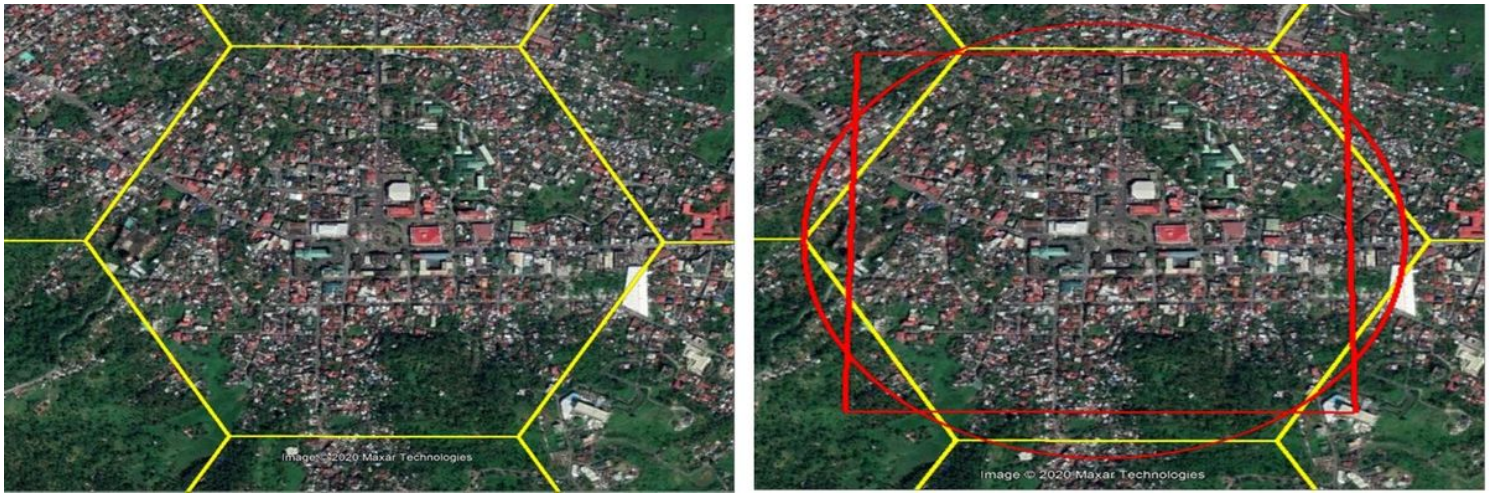

Figure 7

Tessellated Hexagonal Bins (Polygons)

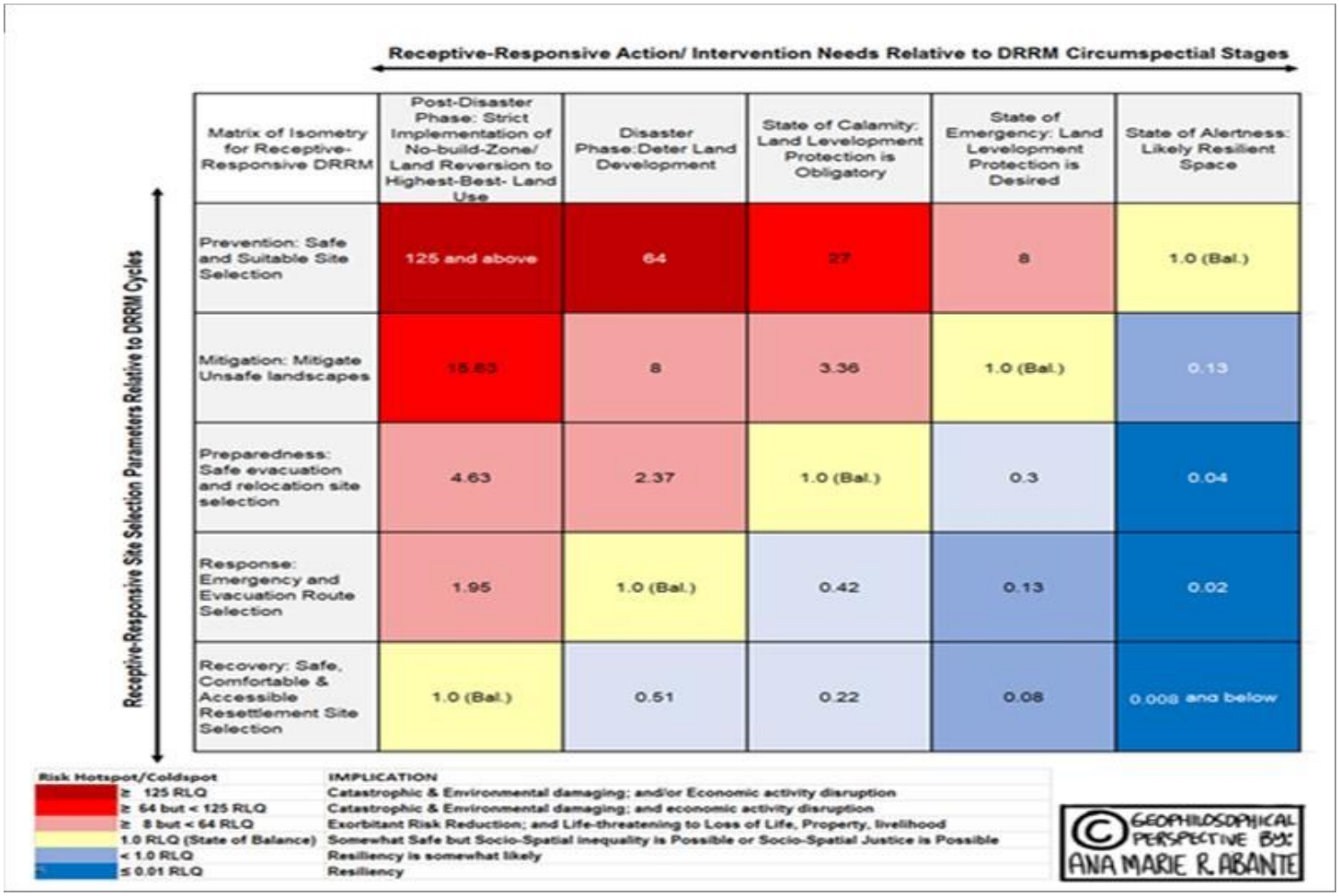

Figure 8

Receptive-Responsive DRR Isometric Index (Abante, 2020)

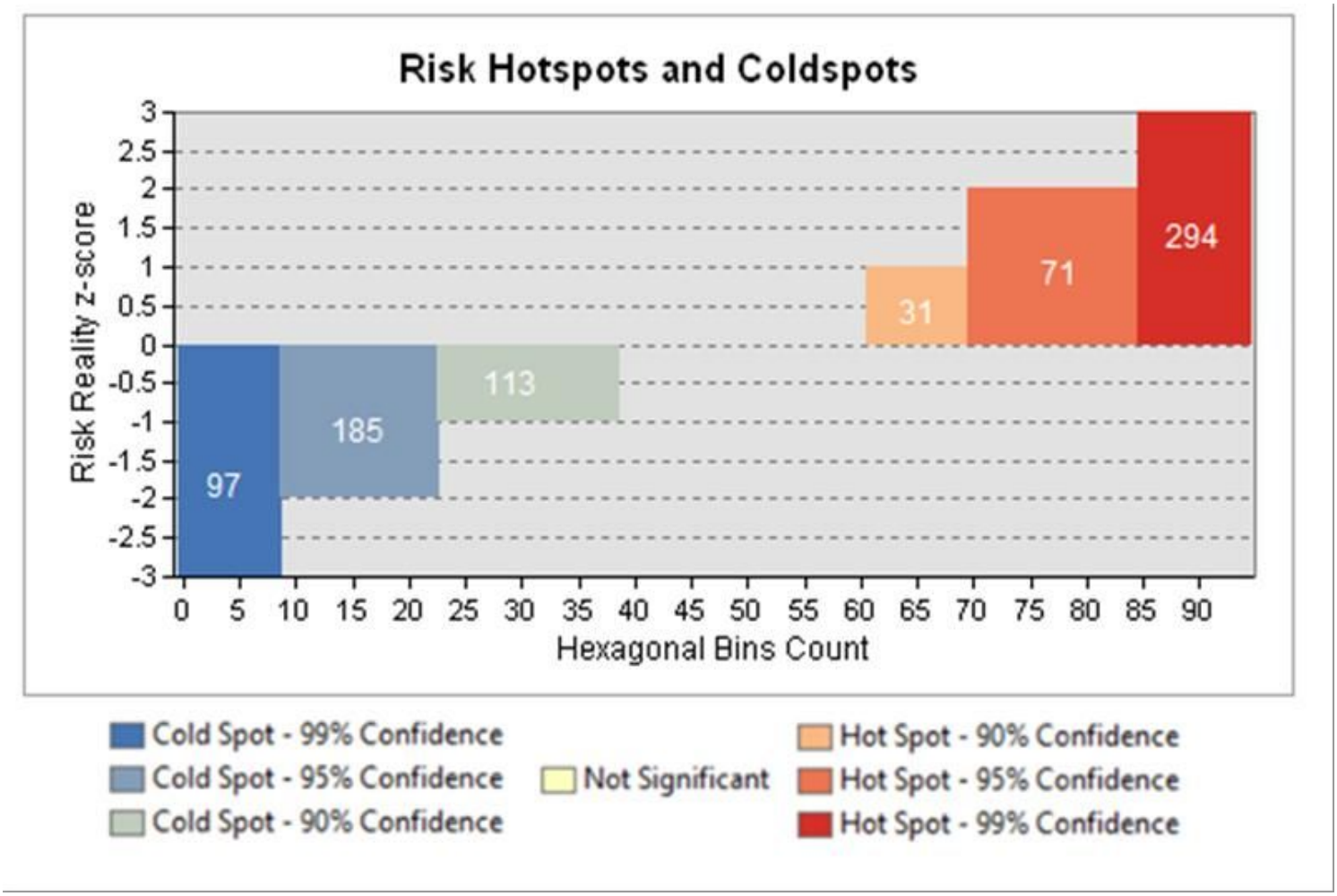

Figure 9

Risk Hotspots and Coldspots Bin Count

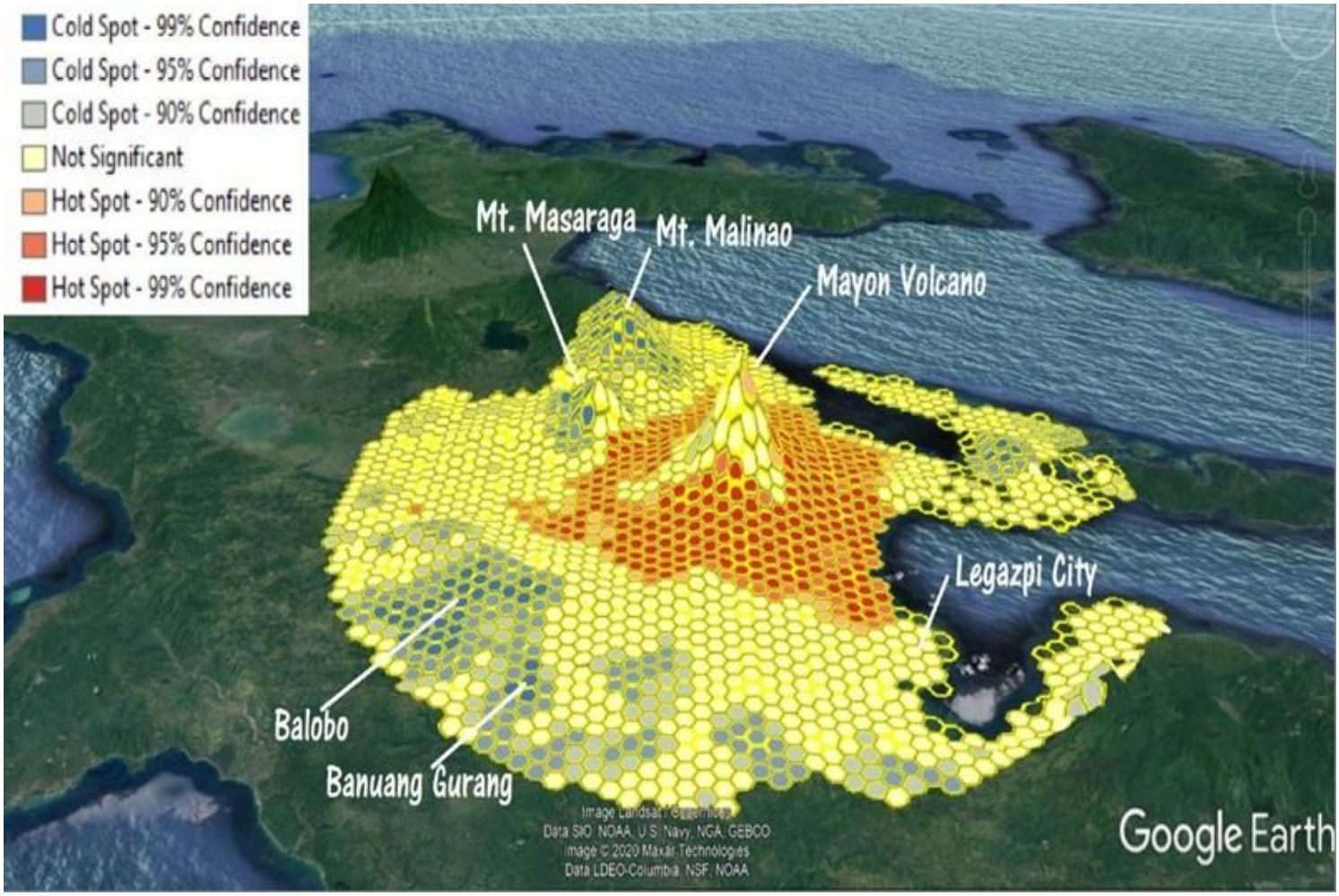

Figure 10

Risk Hotspot and Coldspot Tessellated Bins Visualization in Google Earth Platform

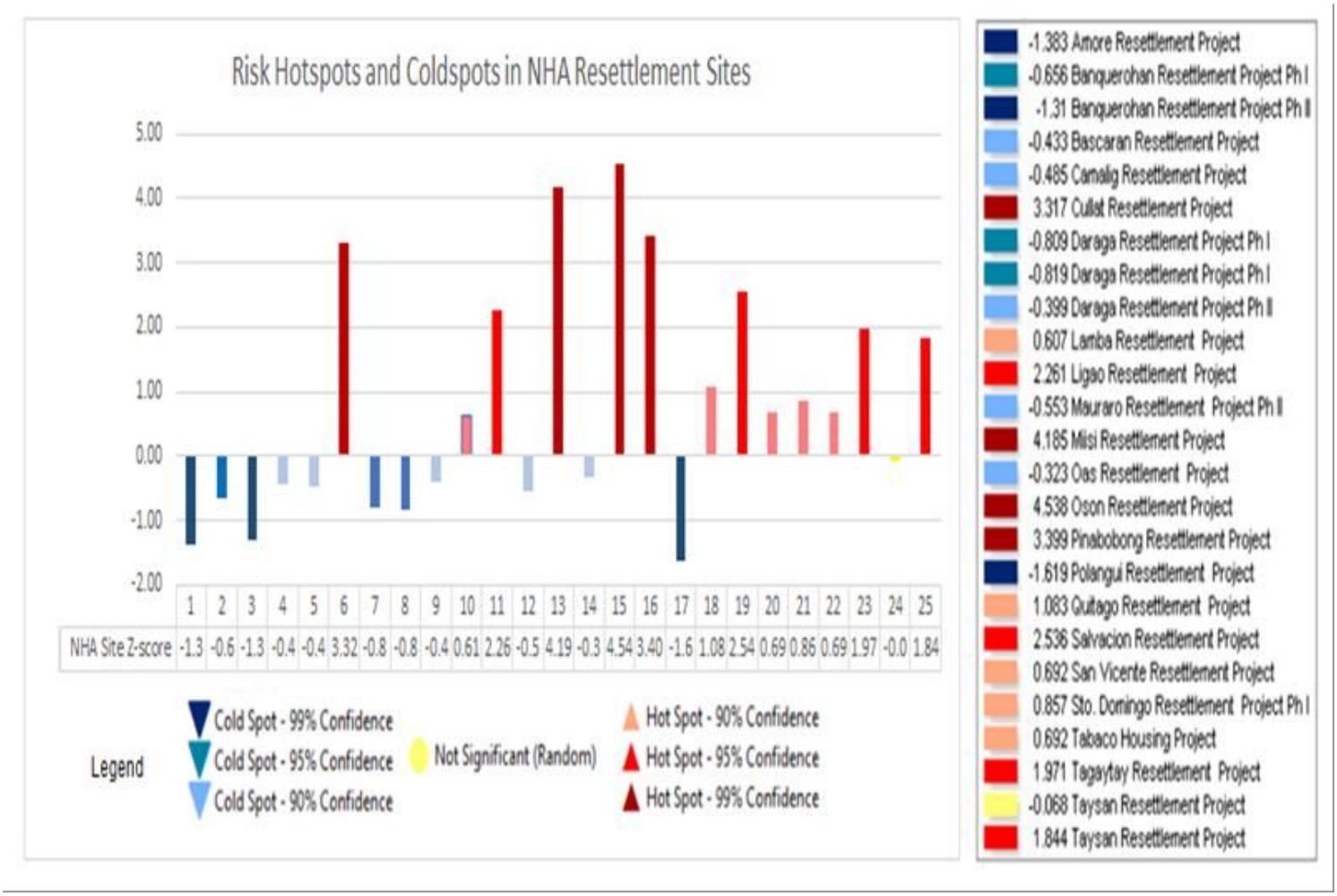

Figure 11

Risk Realness in Resettlement Sites in Albay, Philippines

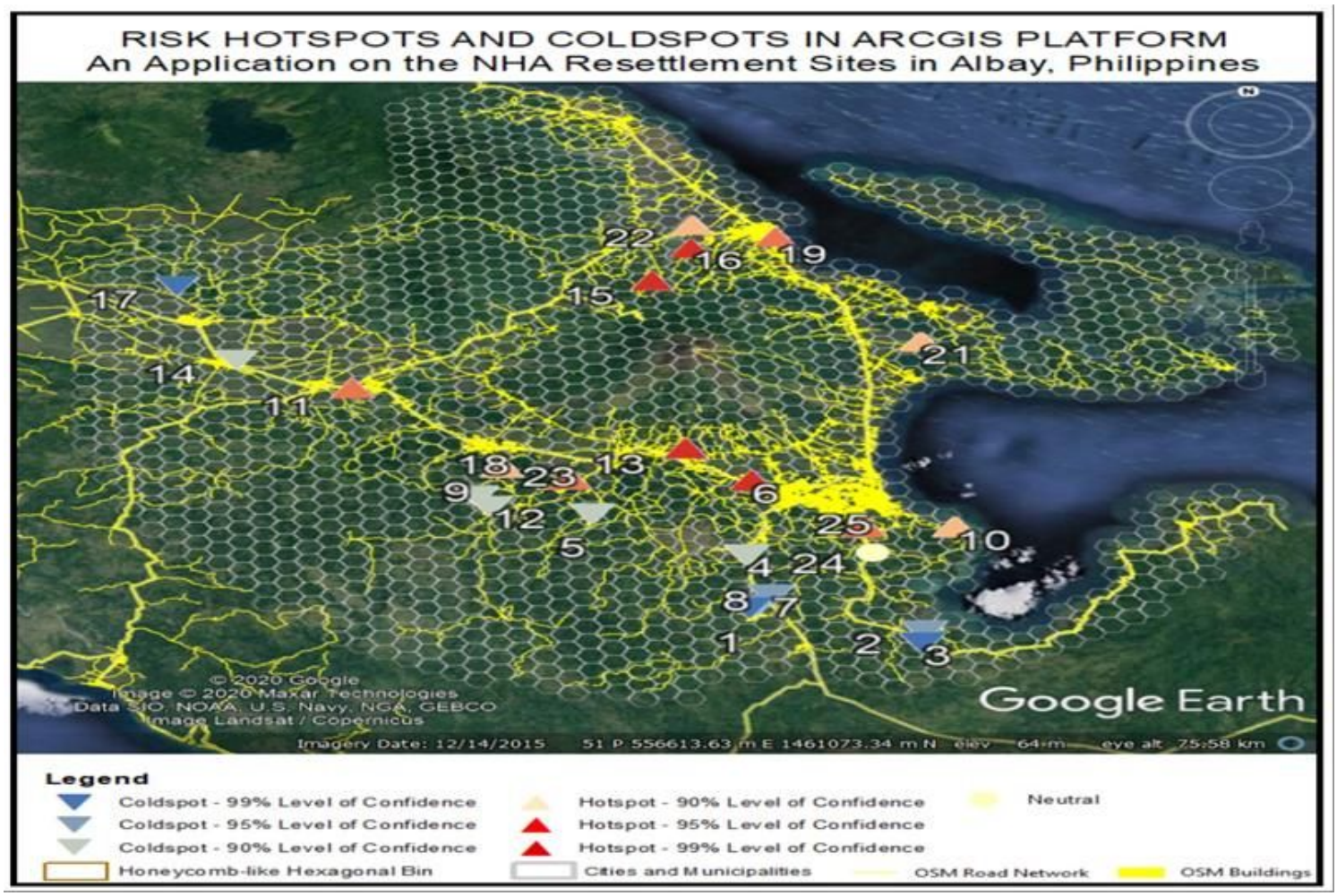

Figure 12

Risk Reality in NHA Resettlement Sites in Albay, Philippines