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Abstract

This report describes a demonstration of the Framework for Integrating the Complexity of Urban Systems (FICUS) as applied to a theoretical humanitarian crisis (HC) analytical framework for Bangladesh provided by the U.S. Navy Joint Intelligence Center Pacific (JICPAC). This type of framework is used to monitor the risk of abuse or attack involving systems within the U.S. Navy Pacific Command area of responsibility. Output from the FICUS data-conflation model was used to populate this theoretical HC framework with socioeconomic survey-response data usable at fine scales of resolution. A key feature of the FICUS methodology is that it accounts for both known and unknown uncertainties in the data using statistically transparent techniques. The report discusses both the successes and limitations demonstrated by the case study. An inherent and expected limitation of this technology is that because it was developed for population-survey data conflation, it could not greatly facilitate insight into aspects of an HC framework addressing indicators such as macroeconomic investment, commerce, or construction policy.

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Preface

This study was conducted for the Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology under Research, Development, Test, and Evaluation (RDT&E) Program Element 622784T41, "Military Facilities Engineering Technology"; Project P2 458304, "Framework for Integrating the Complexity of Urban Systems (FICUS)." The technical monitor was Ritchie L. Rodebaugh, CEERD-TZT.

The work was performed by the Land and Heritage Conservation Branch of the Installations Division (CEERD-CNC), U.S. Army Engineer Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL). At the time of publication, Dr. Michael L. Hargrave was Chief, CEERD-CNC; Michelle J. Hanson was Chief, CEERD-CN; and Ritchie L. Rodebaugh, CEERD-TZT was the Technical Director for Geospatial Research and Engineering. The Deputy Director of ERDC-CERL was Dr. Kirankumar Topudurti and the Director was Dr. Lance D. Hansen.

The Commander of ERDC was COL Ivan P. Beckman and the Director was Dr. David W. Pittman.

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1 Introduction

1.1 Background

The Framework for Integrating the Complexity of Urban Systems (FICUS) was developed under the sponsorship of the Office of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASA(ALT)) to equip military planners with the data and knowledge necessary for understanding megacities and other dense urban environments (Ehlschlaeger et al. 2018). The multi-year project was led and executed by researchers with the U.S. Army Research and Development Center, Construction Engineering Research Laboratory (ERDC-CERL).

The overall FICUS effort included a collaboration with the U.S. Navy Joint Intelligence Center Pacific (JICPAC). JICPAC operates an intelligence data-fusion center that conducts current-situation analyses, data-collection management, and long-range assessments and threat estimates. The Center is responsible for a variety of intelligence products and processes. Some efforts produce immediate results while others require months or even years to produce. JICPAC fuses all source intelligence and defining analytical approaches to provide integrated and timely intelligence to U.S. Pacific Command (PACOM)[*] decision makers at all levels, from the headquarters to deployed units.

In this project, the FICUS project team focused on risk-assessment frameworks of the type that JICPAC develops to monitor the risk of abuse or attack for systems within the PACOM area of responsibility. The research team acquired diverse sociocultural data sets for input to the FICUS data-conflation model in order to produce outputs that are valid at fine geospatial resolutions while methodologically accounting for uncertainties and data gaps. The project hypothesis was that populating a representative theoretical JICPAC-developed humanitarian crisis (HC) framework with FICUS output could improve the situational and intelligence insights available to PACOM decision makers working with their real-world frameworks.

* In May 2018 the name of PACOM was changed to U.S. Indo-Pacific Command (USINDOPACOM). In this report the combatant command's previous name is retained for continuity with other FICUS studies.

The present report describes the results of applying FICUS outputs to a JICPAC hypothetical HC framework using data for Bangladesh, with attention to both the strengths and limitations of FICUS application to analyses that encompass conditions, factors, and indicators that fall beyond the scope of available sociocultural survey data.

1.2 Objective

The objective of this project was to evaluate the applicability and effectiveness of FICUS data-conflation methods and analytical framework to large and diversified sociocultural data sets for Bangladesh, as applied to a hypothetical HC framework developed by JICPAC.

1.3 Approach

The FICUS data-conflation model, which is briefly reviewed in Chapter 2, was applied to the hypothetical HC framework to improve otherwise-unavailable sociocultural understanding of the implications of a prospective humanitarian crisis in Bangladesh, a nation within the PACOM area of operation that is characterized by highly dense urban environments. A large and diversified collection of Bangladesh sociocultural survey data was conflated using FICUS technology, and that data product was used as input to populate the hypothetical HC analytical framework.

The process and techniques for populating the hypothetical HC framework and integrating it with fine-resolution geospatial maps are described in Chapter 3, with reference to an Appendix that supplements the discussion and illustrates the procedure. Chapter 4 concludes with remarks on the expected applicability of the FICUS framework to other analytical spheres.

1.4 Scope

For purposes of this demonstration, the sponsor provided the researchers a hypothetical HC framework instead of one currently used by PACOM in order to avoid disclosure of a currently fielded Navy analytical tool. This reported phase of the larger work package focused on applying FICUS to the JICPAC hypothetical framework and assessing the results in terms of methodological strengths and gaps.

From this point forward, for brevity, we refer to the representative theoretical HC framework as “the JICPAC HC framework” or “the HC framework.” Nevertheless, it is important for the reader to understand that, for purposes of information security, the HC framework used in this study is not an operational PACOM tool.

2 FICUS demographic models

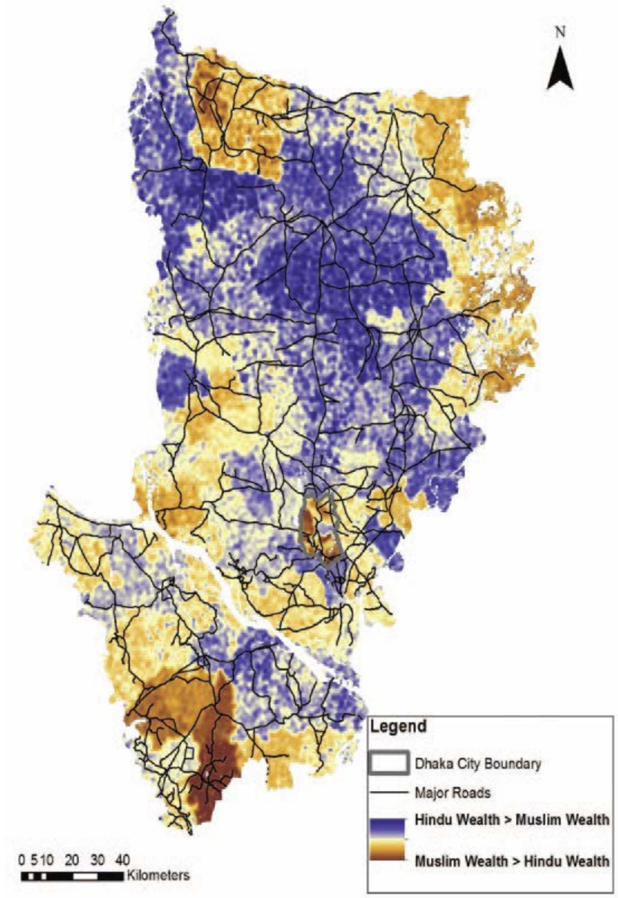
2.1 Modeling methodology

Previous FICUS research produced a methodology to represent and combine sociocultural and geographic data layers to improve the utility of the information in characterizing dense urban environments. FICUS is a data-conflation model and framework that combines massive demographic databases with map layers of sociocultural, infrastructural, and environmental metrics that can be aligned specifically to military operational use. Unique to the FICUS model is its ability to account for all input data error and model uncertainties. The model requires that source data be constructed using a spatiotemporal uncertainty model to present alternative representations of the data layers based on the known errors and uncertainties.

The model uses data from the subject nation's census, the U.S. Agency for International Development (USAID), and DoD-sponsored surveys. The model also requires subject-matter experts (SME) to base the range of the framework's weighting factors on their own knowledge about the completeness of the data sources for operational requirements. The collected survey responses are applied using Monte Carlo simulations within the FICUS framework to create a range of likely results for each framework component.

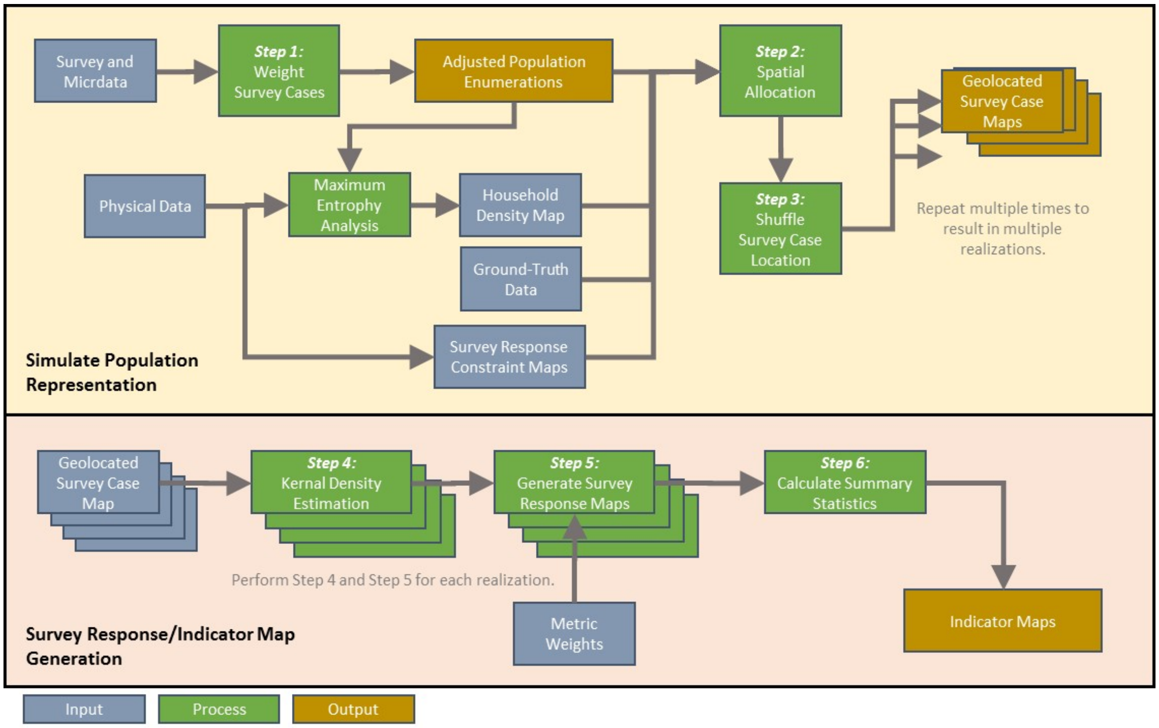
Presentation of the variability allows decision makers to understand the utility of the available data. The results are generated in the form of geospatial thematic maps at a resolution of 200 meters per grid cell. Each grid cell contains the range and distribution of possible metric values for the population within 800 meters of its location. Figure 1 shows an example of metric outputs from the FICUS model for correlations and contrasts of wealth distribution in between prominently Muslim and Hindu populations.

Figure 1. Estimated average wealth inequity between
Muslims and Hindus near Dhaka, Bangladesh (Ehlschlaeger et al. 2018).



Details of the FICUS model are published in Ehlschlaeger et al. (2016 and 2018). The technique follows six primary steps, which are each labeled in Figure 2. The first three steps focus on simulating the population within the landscape. This sequence includes accurately representing population densities and fitting population demographics within that representation. Key to the first three steps is an understanding of the environmental factors that influence the attractiveness of a site for a household to locate. The last three steps generate indicator maps of the simulated households. Critical to these last three steps is an intentional focus on the errors and uncertainties in the input data in a way that will help end users understand the impacts of those deficiencies on their application and, ultimately, improve the utility of the information for decision makers.

Figure 2. Survey response mapping process.



Each of the six procedural steps is listed and explained below:

1. **Weight Survey Cases.** Survey cases are replicated a number of times to match demographic characteristics in the overall estimated population enumerations. The replication process fits the results and the cases are weighted using a sum of least squares, minimizing specific desirable survey responses.
2. **Spatial Allocation.** Household survey cases are realized into plausible geographic locations. Ultimate household-location maps are based on a household-density maps, ground-truth data, and survey shuffling for optimization. The process of maximum entropy analysis generates household-density maps.
3. **Shuffle Survey Case Location**. Survey case locations are shuffled to improve spatial statistics. This task optimizes a set of proportional and spatial statistics for each population realization to create realistic clustering of survey responses.
4. **Kernel Density Estimation**. For each desired combination of survey responses, proportion maps are generated on each population realization throughout the study area, representing the percentages of simulated survey cases with such responses. This estimation process is done cell by cell across a regularized grid.

5. **Generate Survey Response Maps.** Map algebra analysis is used to generate survey response maps for 1 to n realizations.
6. **Calculate Summary Statistics.** Throughout the study area, box plot summary statistical maps are compiled on the minimum, maximum, median, medium, 1st quartile, and 3rd quartile of realizations at all study area locations, as well as the standard deviation and interquartile range for these locations. Both the summary statistics and the kernel analysis for each realization provide error and uncertainty estimates.

Steps 1 through 4 are repeated dozens, hundreds, or even thousands of times to create enough alternate realizations to provide representative distributions for important survey answers at critical geographic locations. For example, a survey response that is answered seldom would require a larger number of realizations for its Poisson distribution to reflect the variation of reality, while a survey response answered by about 50% of the households or people would take fewer realizations to define the resulting normal distribution.

2.2 Humanitarian crisis framework

The purpose of the Navy's representative HC framework is to show estimated risk levels in a way that allows for comparison within and across nations. JICPAC chose Bangladesh as a case study for demonstrating the usefulness and functionality of a computational framework to support better-informed decision making by PACOM. However, for purposes of analysis, the five conditions listed in the left column of Table 1 technically represent the highest level of the HC framework. Starting with the left-hand column, the *Conditions* lists the most probable high-level category of events that may initiate or represent a developing humanitarian crisis in Bangladesh. The two columns to the right—*Factors* and *Indicators*—each decomposes a condition into descriptors for mid-level factors and low-level indicators, respectively that more precisely identify distinct HC drivers and disruptions that commonly impact affected populations, respectively.

Table 1. The hypothetical JICPAC HC framework

	Conditions	Factors	Indicators
Humanitarian Crisis	Natural Hazards	Geophysical Effects/Consequences	Earthquake/Earth Movement
			Landslide
			Volcanic Activity
		Climatological Effects/Consequences	Flood
			Severe Storm (thunderstorm, hurricane, tornado, cyclone, winter storms, etc.)
			Tsunami/Tidal Surge
			Drought
		Ecosystem Disruptions	Epidemics/Pandemic
			Severe Insect Infestation
			Commodity Destruction/Infection
			Wildfire
	Human-Behavioral Impact	Contamination and Degradation	Food Processing Contamination
			Chemical or Other Industrial
			Nuclear/Radiological
			Biological (Animal Husbandry)
		Vulnerable Groups	IDPs/Refugees
			Undernourished Population (Not Gov't Priority, Resiliency)
			Casualties, Injured, Sick
			Targeted Groups (Genocide/Violence)
		Substandard Conditions	Civil Infrastructure Failure (Dams, Levies, Bridges, Buildings, Roads)
			Hazardous Working Conditions (Mine, Ag, Industrial)
			Overcrowding and Dangerous Housing
			Polluted and Disease-Bearing Environment (Swamps, Etc.)
	Services Failure	Law Enforcement/Policing Deficiencies	Policing/Patrol Deficits
			Inadequate Investigations and Prosecution
			Prisons and Jails (lack of capacity)
			Inadequate Facilities/ Property Protection
		Health & Medical Service Insufficiencies	Doctor (Health Care Professionals) and Access to Primary Care
			Hospitals/Clinics and Secondary Care (Medical Specialists)
			Availability of Pharmaceuticals (Antibiotics)
			Delayed or Deficient Mortuary Affairs
		Utilities Disruption	Inadequate Sanitation
			Water Shortfalls
			Lack of Communications Availability
			Energy Deficits
	Readiness and Response Inadequacy	Lack of Preparation and Warning	Pre-Positioning Supplies
			Hazard Plans, Personnel Training, and Exercises
			Established Detection Sensors (Buoy's Etc.)
			Dissemination/ Alert Broadcast Deficits
		Emergency Response Shortfalls	Inadequate Fire and EMS Services
			Extraction and Debris Removal (Equipment)
			Inadequate Search and Rescue
			Insufficient Lift/Evacuation, Transportation Capacity
		Civil/Military Authority Failures	[Lack of] Established / Delegated Authority
			Insufficient Interoperable Communications
			Lack of Technical/ Functional Response Competency
			Breakdown of Situational Awareness (COP)
	Resilience Deficiencies	Insufficient Investment/Assistance	Insurance/ Reinsurance
			Insufficient Loans/ Debt Forbearance and Cancellation
			Foreign/Federal Relief/Grants/Social Funds (Aid)
			Decreased Foreign Investment Based on Assessed Risk
		Malfunctioning Commerce / Services	Absenteeism and Work Stoppages
			Production Decreases
			Failure of Normal Trade to Return
			Failure to Re-Establish Markets (Retail, Groceries, Etc.)
		Inadequate Construction/Reconstruction	Insufficient Rebuilding of Shelter/Housing
			Sustained Lack of Operational Utilities (the Grid)
			Delays to Re-establishment of Transportation Systems
			Diminished Agricultural Production

A brief summary of each HC *condition* follows. The first, *Natural Hazards*, signifies a high level of geological or environmental crisis that may occur over a limited duration of time, but which often propagates serious, disruptive consequences onto a large population for years to come. The *factors* emerging from natural hazards, in this representative HC framework, each represent a key category of natural-hazard event that requires further analysis and input data to help in order to develop actionable insights. For the *Ecosystem Disruptions* factor under Natural Hazards, the framework developers provided four *indicators*: flood, severe storm, tsunami, and drought (Table 1).

The second condition, *Human Behavioral Impact*, represents negative impacts on populations caused by human activities and behaviors that degrade community health, endanger various populations, or lead to substandard or imperiled living environments.

The third condition, *Service Failure*, addresses the failure of providers (mostly government, but in some cases private-sector) to sustain adequate basic services that offer affected populations an acceptable daily standard of living. These services comprise factors that encompass effective, rules-driven law enforcement and courts; the general availability of health and medical services; and safe, effective, and reliable public utilities.

The fourth and fifth conditions—*Readiness and Response Inadequacy* and *Resilience Deficiencies*—mostly account for the general ability of a system to withstand, respond to, and recover from humanitarian crises and natural disasters.

3 Operationalizing the Framework

This chapter describes the FICUS quantitative approach to populating the HC framework. Conceptually, this task involves identifying measures (or metrics) for the lowest level of the indicator-based framework and then calculating a combined score that represents risk at each higher stratum of the framework. The assumptions and procedures for calculating both score play a central role in the usefulness of the results to analysts and decision makers, and this fact accentuates the importance of the SME role.

The first step is to define metrics on the basis of the case study survey questions. Surveys used in this FICUS HC case study (see Appendix) include the Bangladesh national census, the USAID Demographic and Health Survey, and a specialized DoD survey of vulnerable populations. Once metrics (or input data) are identified, SMEs evaluate each component—every metric, indicator, factor, and condition—based on (1) the overall accuracy of the information collected for that component and (2) how relevant the subcomponents are to the component definition. SMEs may apply weights to address the first evaluation. In the second evaluation, they may consider the influence of unknown variables—possible unidentified information that could affect the analysis. Finally the algebraic calculations are executed to produce output maps. The assumptions applied to the case study have a major impact on the quality of FICUS model output.

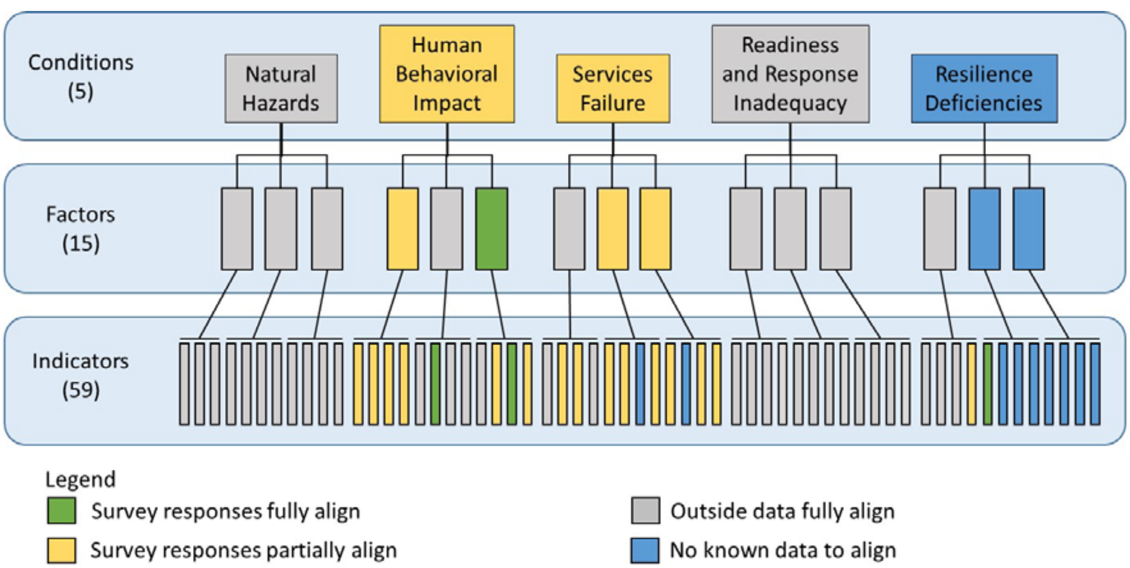
3.1 Indicator data

As discussed in Chapter 2, an indicator is a bottom-level descriptor of an event or characteristic falls under one of the five top-level conditions listed in the HC framework. The metrics assigned to these discrete lower-level components help analysts and decision makers understand the big picture as it may develop in the midst of a humanitarian crisis.

The HC framework helps to map the relationships between indicators in a systematic way, exploring not only individual inputs to a situation but also the combined effects of multiple variables, including exogenous elements. For example, indicators can signal how toilet types are related to utility disruption, in different countries or areas within the subject nation. JICPAC in particular uses those signals to stimulate discussion across and within its area of responsibility. The indicators within the HC framework were selected from theoretical research based on the most appropriate and informative set of indicators to understand and mediate cross-country and cross-situational risks in humanitarian crises.

At this point it is important to understand that, because the FICUS methodology was designed to aggregate and conflate social science and geospatially explicit mapping data, FICUS is potentially applicable almost entirely to the sociocultural aspects of a framework to which it is applied. In the present case study, much of the hypothetical HC framework falls outside the scope of conditions, factors, and indicators that can be informed by sociocultural data. Consequently, many conditions, factors, and indicators do not fully align with the FICUS data-conflation output. Figure 3 illustrates the alignment of FICUS survey-set data to the HC framework. Green highlights indicators perfectly matched by available FICUS survey and census questions. Yellow indicates a partial alignment. These indicators partially align with the definition of the indicator, factor, or condition to be represented using FICUS output. Gray-highlighted indicators, while not aligned with FICUS data, can be compiled from other existing data streams. Blue highlights known gaps in available data, indicating the need for a new data-collection task.

Figure 3. Alignment of FICUS data to the HC framework.



Of the 59 HC indicators represented in Table 1, we identified 26 that are completely or mostly measurable from the survey responses processed within FICUS. In general, survey responses used in FICUS were, poorly matched to the Natural Hazards condition in the HC framework. Natural hazards, and their subordinate factors and indicators, must ultimately be addressed by organizations specializing in geophysical, climatological, and ecological expertise. The Human-Behavioral Impacts condition was found to align well with FICUS survey data output, addressing a majority of the indicators. The Service Failure condition indicators were reasonably aligned to the conflated FICUS survey responses, with at least partial matching of most indicators. The Readiness and Response Inadequacy condition indicators were poorly matched to (i.e., beyond the scope of) the FICUS survey data set. This HC framework condition would be better addressed using data compiled about those topics by government organizations. The FICUS survey set also was poorly matched the Resilience Deficiencies condition indicators; the surveys addressed only employment status, but not other critical HC framework indicators such as macroeconomic investment, commerce, or construction policy.

3.2 Risk value

Each metric variable must be normalized for 'apples-to-apples' comparisons. The user assigns a range of values between 0 and 1 to all possible survey question responses representing the possible extent of risk contribution. Threshold values are shown in Table 2. A value of "0" equates to total chaos while a value of "1" equates to no perceived risk.

Table 2. Normalizing survey responses based on a range of values between 0 and 1 representing the possible extent of risk contribution.

Color	Metric Value	Description
	1	Minimal risk. Has no impact on risk.
	0.75	Minimal risk. If the weights of all metrics with a .75 value sum to 2.0 or greater, indicator will be slight risk or worse even if all other metrics have a 1.0 value.
	.500…1	Minimal risk. If the sum of all weights with a metric value of .500…1 is 1.0, any other metric has a value < 1.0, indicator will be slight risk or worse.
	0.5	Slight risk. If the weights of all metrics with a .5 value sum to 2.0 or greater, indicator will be slight risk or worse even if all other metrics have a 1.0 value.
	0.2500…1	Slight risk. If the sum of all weights with a metric value of .500…1 is 1.0, any other metric has a value < 1.0, indicator will be medium risk or worse.
	0.25	Medium risk
	.12500…1	Medium risk.
	0.125	High risk
	0.0625	Extreme risk

If the level of risk is uncertain, a range of values (min and max) may be specified. A wider range indicates less certainty of the risk contribution, and a tighter range indicates more certainty of the risk contribution.

For example, the metric “HHTypeToilet” within the “Inadequate Sanitation” indicator consists of answers “Sanitary Water (sanitary with water seal),” “Sanitary (no water seal),” “NonSanitary,” and “None” (see Table 3). As “Sanitary Water” is the most sanitary toilet option, it is given both a minimum and maximum value of 1.0, equating to no risk. An answer of “None,” which means there is no toilet and bush/open space is used, is the least sanitary option and therefore given a minimum value of 0.001 (extreme risk) and a maximum value of 0.25 (medium risk).

Table 3. Weights and risk values for example indicator.

Indicator: Inadequate Sanitation						
Metric Weight		Survey Question Metric Name	Survey Question	Question Responses	Response Risk Value	
Min Value	Max Value				Min Value	Max Value
1.0	1.0	HHTypeToilet	What is your toilet facilities type?	Sanitary with water seal	1	1
				Sanitary no water seal	0.8	1
				Non-sanitary	0.001	0.25
				None	0.001	0.25
0.4	0.6	PercievedIssueSanitation	Can you tell me whether sanitation is more or less serious in your community than in the rest of Bangladesh?	Not an issue	1	1
				Less serious	0.25	0.9
				More serious	0.07	0.5
0.35	0.7	PercievedEffortSanitation	Can you name an organization or public figure that you believe is working hard to improve sanitation in Bangladesh today?	Yes	1	1
				No	0.25	0.98
0.6	0.8	ToiletShared	Do you share this toilet facility with other households?	Yes	0.2	0.75
				No	1	1
0.1	0.15		Unknown Proportion			

3.3 Weights

Screening requires the evaluation of a combination of indicators. Multiple indicators are often aggregated into a factor or condition, usually for comparison across locations or to indicate change over time. Weights are assigned to metrics, indicators, factors, and conditions, allowing each component level to be rolled-up to the next. Components are weighted against the other components within that level (e.g., all the metrics in one indicator, all the indicators in one factor, etc.). Users define weights as a numerical value between 0 and 1 based on contribution to risk, with 0 being the least important/constraining on the next level up, and 1 being the most important/constraining. Again, weights can be defined in terms of a numerical range to address an uncertain risk-contribution level.

If all weights within a grouping add up to 1, then each unit contributes to the accumulation of risk. For example when characterizing healthcare deficiencies, the availability of doctors, facilities, and pharmaceuticals all contribute to overall risk.

If any one weight (or more) within a grouping equals 1, then it (or they) drive the overall risk. For example when characterizing climatological consequences, either flood, severe storm, or drought can impose the overall risk. In this example, all three characterizations would receive a weight of 1, and irrespective of the event the largest value becomes the overall risk value.

To illustrate, there are four survey question metrics within the "Inadequate Sanitation" indicator (see Table 3). As the "HHTypeToilet" is the most constraining metric, it is weighted both a minimum and maximum value of 1.0. As such it is the most constraining metric for the indicator, which ensures that the indicator's risk value is determined by the household toilet type. The "PerceivedEffortSanitation" metric consists of a qualitative question about organizations of public figures working to improve sanitation, which does not provide much information for measuring adequate sanitation. For this reason, it is weighted the lowest (i.e., least influential) of the four metrics. Thus, if the household in question has no toilet, and is therefore given a number within the range of extreme risk at the "HHToiletType" metric level, then the indicator will also be evaluated as extreme risk, regardless of the risk evaluations of the other metrics. In other words, it doesn't matter if a surveyed household shares a toilet with other households or whether the respondent thinks sanitation is an issue in the region if the respondent's household doesn't have a toilet. The weighting of 1.0 to 1.0 establishes that metric as the driver of extreme risk. It is for these reasons that SMEs should apply the weight values.

3.4 Unknown components

In nation-scale case studies similar to the type we discuss here, it is likely that certain metrics, indicators, factors, or conditions will not be known to the study group. It is also likely that some number of unknown variables will affect the accuracy of the FICUS output. In such situations, users may add an unknown component. This procedure inserts a random value that accounts for additional variables. This value is assigned a weight and treated the same as any other component.

Continuing with the indicator example in Table 3, “Inadequate Sanitation,” the JICPAC framework specifies that metrics should include percentage of sanitation facilities damaged; percentage of population with access to sanitation (compared to historical data); and satisfaction with access to sanitation. The four metrics listed for this indicator in Table 3 cover these specifications rather well, and the data used to create the metrics are considered to be reliable. As such, this unknown metric for the Inadequate Sanitation indicator is assigned a minimum weight of 0.10 and a maximum weight of 0.15. Additional data on city-wide sanitation system provisions and larger urban sanitation issues could further decrease the unknown weighting values.

3.5 Roll-up computation

Favorability functions calculate the overall component values using the risk value and the weight. Favorability functions were originally known as sieve mapping (McHarg 1969), and were also called map overlays. Before map overlay existed as a computer algorithm, clear acetate maps were inked at locations least favorable to an activity or land use. Stacking the acetate maps on top of each would provide a visual method to assessment each location’s suitability or risk. Bonham-Carter (1995) described digital map overlay as favorability functions, which include easier weighting of individual maps and exact measures of suitability or risk. Traditionally, two general types of favorability functions have been used—additive-based favorability (equation 1), referred to as *weighted linear combination* (WLC) (Malcwewski 2000); and *constraint-based favorability function* (CBFF) (equation 2):

$$\mathbf{M}_y = {\sum_{i=1}^{n} w_i \mathbf{M}_i}/{w_i} \tag{1}$$

$$\mathbf{M}_y = {\prod_{i=1}^{n} w_i \mathbf{M}_i}/{w_i} \tag{2}$$

where

$\mathbf{M}$ = a map with values between 0.0 and 1.0
$\mathbf{M}_y$ = the resulting indicator or risk assessment map
$\mathbf{M}_i$ = the i^{th} of n criteria maps
w_i = the i^{th} weight to its criteria map

A problem with WLC-based risk assessments is that a large risk can be masked by other low risk or no risk at the same location. For example, a location where gang violence creates a high risk should have high risk even though other criteria, such as well funded after school programs, may indicate a low risk. On the other hand, CBFF risk assessment does not allow for groups of criteria to positively reinforce each other; every criterion constrains the indicator to the value of criteria and no higher.

An ideal favorability function will allow both additive and constraint-based characteristics to be declared both within criteria map locations and the criteria map weighting. Equation 3, called power-based favorability function (PBFF), achieves this goal:

$$\mathbf{M}_r = \prod_{i=1}^{n} \mathbf{M}_{i,r}^{w_i},\ 1.0 \leq \sum_{i=1}^{n} w_i \tag{3}$$

where

$\mathbf{M}$ = a map with values between 0.0 and 1.0
$\mathbf{M}_r$ = the r^{th} realization map of indicator values
$\mathbf{M}_i$ = the i^{th} of n criteria maps
w_i = the i^{th} weight to its criteria map

While PBFF's equation 3 is less intuitive than WLC and CBFF, using criteria variables as the constant of a power function allows it to be equivalent to WLC when the criteria weights sum to 1.0. Also, PBFF allows criteria weights to influence the indicator like both WLC and CBFF when criteria weights sum to be greater than 1.0. For example, if a criterion has a weight of 1.0, its indicator will have the same or lower risk value, just as in CBFF. Criteria with weight less than 1.0 in PBFF will allow the indicator to have a higher value when other criteria are positive. Owing to the product function in PBFF, criteria map locations can also serve as constraints when those locations are given a value of 0.0 or other extremely low values.

Another benefit to using PBFF is in the calibration process, which is similar to CBFF process. Risk model developers can adjust individual criteria map weights or the values for criteria map locations to calibrate the map to the desired indicator values without having to adjust other criteria map weights. Traditional risk-assessment techniques require carefully choosing the indicator's criteria weights, adjusting all of them to whenever calibration is performed. PBFF provides for an opportunity for nonlinear optimization algorithms, such as neural nets or genetic algorithms, to create criteria map weights as well as the function variables that minimize the errors to known indicator values.

3.6 Quantifying errors and uncertainty

A stated goal of the FICUS effort was to explicitly represent errors and uncertainties within all products. For the PBFF to specifically quantify uncertainty, equation 5 becomes the uncertainty quantified (UQ) power-based favorability function (PBFF):

$$\mathbf{M}_r = \mathbf{M}_{u,r}^{w_u} \times \prod_{i=1}^{n} \mathbf{M}_{i,r}^{w_i}, 1.0 \leq w_u + \sum_{i=1}^{n} w_i \quad (5)$$

where

$\mathbf{M}_{u,r}$ = the r^{th} realization map of simulated uncertainty for an indicator
w_u = the weight of that uncertainty

The simulated uncertainty map should be a random field of values between 0.0 and 1.0 with a histogram like the distribution of values within the criteria maps. The random field should have spatial autocorrelation to the largest spatial dependence of the criteria maps. For example, if the criteria maps used kernel analysis on demographic factors, the random field should have positive spatial autocorrelation equal to the kernel analysis diameter. While the present research used the random field described in Ehlschlaeger (2002), there are many theoretical random field models to choose from, for example GSLIB (Deutsch and Journel 1992). While equation 5 explicitly represents the known uncertainties in the modeling process, the modelers were expected to represent the unknown uncertainties as well. Using UQ PBFF, modelers had to estimate the range of values for all weights, w_u and w_i, that might exist to account for the lack of perfect understanding between the criterion and the indicator. We asked the modelers to imagine which unavailable criteria would have helped to better explain the indicator. Then, modelers were asked to estimate which of those unavailable criteria had the least correlation with available criteria. Uncorrelated unavailable criteria would be indicated by higher values and greater ranges of the uncertainty weight w_u. This uncertainty weight produces the same behavior in the risk-assessment model as the criteria weights.

4 Conclusion

The tools and techniques described in this report reflect an attempt to express frameworks using quantitative values in a manner while also accounting for uncertainties about the operational environment. The techniques described here also present a geospatial method to link observable data to the framework indicators, using them to calculate a risk value and margin of error. Representing risk geographically is critical to understanding complex social environments, especially in densely urban terrain.

Implementing quantitative measures for the frameworks makes it possible to more easily compare changes as new data are made available. Further, it offers the ability to trace backwards from high-level factors down to the metrics. This capability makes it possible to explore the impact of changing the weights of different components at a higher level, facilitating accurate calibration of an analytic framework. Finally, the explicit accounting for uncertainty at each level allows analysts to more faithfully represent their understanding of the framework values, particularly when SMEs are not available. This reduces the uncertainty of those judgments.

Generally, there are likely to be gaps in any framework that are either not obvious or are obscured by other framework components. Finding and filling these gaps is vital to approach the highest possible accuracy. A hybrid approach—the integration of existing data and theoretical methods—can identify and address critical gaps in a framework. Both data availability and theoretical methods inform framework development in distinct ways. The geospatial risk maps provide intuitive methods for calibration and validation via qualitative techniques. When framework map errors are identified, there is an explicit connection to all modeling decisions and data streams to determine whether there is a logical flaw in the framework model or calibration is necessary to improve the analytic framework.

Although the data requirements of the hypothetical HC framework exceeded the scope of the FICUS model, the exercise succeeded as an explanatory case study for linking indicators to higher-level planning objectives. With the addition of spatially representative quantitative metrics, identification of uncertainty, and weighting of the importance of individual components, FICUS technology offers analysts the ability to more accurately and precisely communicate knowledge of an operating environment. This, in turn, provides a genuine pathway toward a data-to-decisions paradigm.

References

[Editor's note: The sources listed here include all that are referenced in the body text and the Appendix.]

Adebayo, E. F., Uthman, O. A., Wiysonge, C. S., Stern, E. A., Lamont, K. T., and Ataguba, J. E. 2015. A systematic review of factors that affect uptake of community-based health insurance in low-income and middle-income countries. *BMC Health Services Research* 15: 543. http://doi.org/10.1186/s12913-015-1179-3. Accessed at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4673712/ on 7 Dec 2016.

Amdal, James R., and Stan L. Swigart. 2010. Resilient Transportation Systems in a Post-Disaster Environment: A Case Study of Opportunities Realized and Missed in the Greater New Orleans Region. Gulf Coast Research Center for Evacuation and Transportation Resiliency. Oct 2010. Accessed on 1 Feb 2017 at https://ntl.bts.gov/lib/43000/43700/43782/10-01.pdf.

Baldocchi, Dennis. "Ecosystem Succession: Who/What is Where and When." University of California Berkeley. Accessed on 21 Dec 2016 at https://nature.berkeley.edu/biometlab/espm111/ESPM%20111%20Ecosystem%20Succession.pdf.

Banglapedia: National Encyclopedia of Bangladesh. "Housing". Sept 2014. Accessed on 1 Dec 2016 at http://en.banglapedia.org/index.php?title=Housing.

Birkmann, Jorn, Torsten Welle, Dunja Krause, Jan Wolfertz, Dona-Catalina Suarez, and Neysa Jacqueline Setiadi. 2011. "2. WorldRiskIndex: Concept and results," WorldRiskReport 2011. Alliance Development Works, Berlin, Germany, 2011, pgs 13-42.

Bonham-Carter, G. F. 1995. Geographic Information Systems for Geosciences. Oxford: Pergamon.

CARE International and ProAct Network. Quick Guide: Post-Disaster Debris Management. Accessed on 17 Jan 2017 at https://www.humanitarianresponse.info/system/files/documents/files/Quick%20guide%20post%20disaster%20debris%20management.pdf.

Center for Disease Control (CDC). 2016. "Diphtheria, Tetanus, and Pertussis (DTaP) VIS". Oct 2016. Accessed on 30 Nov 2016 at http://www.cdc.gov/vaccines/hcp/vis/vis-statements/dtap.html.

Center for Disease Control (CDC). 2016. Fact Sheets – BCG Vaccine. Sept 2016. Accessed on 28 Nov 2016 at http://www.cdc.gov/tb/publications/factsheets/prevention/bcg.htm.

Center for Disease Control (CDC). 2015. "The Food Production Chain – How Food Gets Contaminated." Mar 24, 2015. Accessed on 29 Dec 2016 at https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/production-chain.html#chain.

Center for Disease Control (CDC). 2016. “Guidelines for Vaccinating Pregnant Women”. Aug 2016. Accessed on 6 Dec 2016 at http://www.cdc.gov/vaccines/pregnancy/hcp/guidelines.html.

Center for Disease Control (CDC). 2016. “Measles Vaccination”. Nov 2016. Accessed on 30 Nov 2016 at http://www.cdc.gov/vaccines/vpd/measles/index.html.

Center for Disease Control (CDC). 2016. “Polio VIS”. Oct 2016. Accessed on 28 Nov 2016 at http://www.cdc.gov/vaccines/hcp/vis/vis-statements/ipv.html.

Center for Disease Control (CDC). 2012. “Section 11: Epidemic Disease Occurrence.” Principles of Epidemiology in Public Health Practice, Third Edition. Accessed on 20 Dec 2016 at https://www.cdc.gov/OPHSS/CSELS/DSEPD/SS1978/Lesson1/Section11.html#_ref47.

Cohen, Jillian Clare. 2005. Pharmaceuticals and corruption: a risk assessment. World Bank. Accessed on 5 Jan 2017 at http://www1.worldbank.org/publicsector/anticorrupt/corecourse2007/Pharmaceuticals.pdf.

Cullet, Philippe. 2003. ‘Patents and Medicines: the Relationship between TRIPS and the Human Right to Health’. International Affairs 79(1).

Deutsch, C. V., Journel, A. G. (1992) GSLIB: Geostatistical Software Library and User’s Guide. Oxford: Oxford University Press. 340 pgs.

Donfouet, H. P. P., Mahieu, P.-A. (2012). Community-based health insurance and social capital: a review. *Health Economics Review* 2, 5. http://doi.org/10.1186/2191-1991-2-5. Accessed on 7 Dec 2016 at https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3402932/

Ehlschlaeger, C. 2005. Incorporating Second-order Properties for Cluster Detection Analysis and Agent Based Modeling. GeoComputation 2005 Conference Proceedings, August 2005. Accessed on 29 Nov 2015 at http://www.geocomputation.org/2005/

Ehlschlaeger, C. R. 2002. Representing multiple spatial statistics in generalized elevation uncertainty models: moving beyond the variogram. International *Journal for Geographic Information Science* 16(3): 259-285.

Ehlschlaeger, C. R., Gao, Y., Westervelt, J. D., Lozar, R. C., Drigo, M. V., Burkhalter, J. A., Baxter, C. L., Hiett, M. D., Myers, N. R., Hartman, E. R. 2016. Mapping neighborhood scale survey responses with uncertainty metrics. *Journal of Spatial Information Science* 13: 103-130.

Endsley, Mica. 2000. “Theoretical underpinnings of situation awareness: A critical review.” In: Situation Awareness: Analysis and Measurement. Routledge, pp. 3–32.

Environmental Protection Agency (EPA). 2016. “Biological Pollutants’ Impact on Indoor Air Quality.” September 2016. Accessed on 29 Dec 2016 at https://www.epa.gov/indoor-air-quality-iaq/biological-pollutants-impact-indoor-air-quality.

European Commission's Humanitarian Aid and Civil Protection (ECHO). Civil-military relations in humanitarian crises. Fact Sheet. Accessed on 3 Jan 2017 at http://ec.europa.eu/echo/files/civil-military-relations/civilmil_humanitarian_crises_en.pdf.

Federal Emergency Management Agency (FEMA). 2016. "Urban Search and Rescue." 24 Jun 2016. Accessed on 17 Jan 2017 at https://www.fema.gov/urban-search-rescue.

"Firewise." 1998. Wildfire News and Notes. Wildland Fire Management Terminology. Vol. 12, No. 1, pp. 10. March, 1998. Accessed at http://www.firewise.org/pubs/wnn/vol12/no1/pp-10.html.

Food and Agricultural Organization of the United Nations (FAO). 2016. Guidance Note: Meeting Fuel and Energy Needs in Protracted Crises – The SAFE Approach. 2016. Accessed on 13 Jan 2017 at http://www.fao.org/3/a-i6633e.pdf.

Foodborne Outbreak Online Database Tool (FOOD). Center for Disease Control. Accessed on 29 Dec 2016 at https://wwwn.cdc.gov/foodborneoutbreaks/

Geographical Information Science. Stockholm: Swedish Department of Planning and Environment, pp. 75–87. (Also available at www.scangis.org/scangis2005/papers/hansen.pdf).

George T.S. 2002. Minamata: Pollution and the Struggle for Democracy in Postwar Japan. Cambridge, MA: Harvard University Asia Center.

Heuvelink, G. B. M., Burrough, P. A. Stein, A. 1989. Propagation of errors in spatial modeling with GIS. *International Journal of Geographical Information Systems*, 3(4): 303-322.

Ho, Y.C., K.Y. Show, X.X. Guo, I. Norli, F.M. Alkarkhi Abbas and N. Morad. 2012. Industrial Discharge and Their Effect to the Environment, Industrial Waste. Prof. Kuan-Yeow Show (Ed.) ISBN: 978-953-51-0253-3, InTech, Available from: http://www.intechopen.com/books/industrial-waste/industrial-emissions-and-theireffect-on-the-environment-.

Hylander L.D., Goodsite M.E. 2006. Environmental costs of mercury pollution. *Science of the Total Environment*, 368, 352–370.

International Federation of Red Cross and Red Crescent Societies (IFRC). "Climatological hazards: Wildfires / urban fires." Accessed on 29 Dec 2016 at http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/wildfires/

Institute for the Study of International Migration (ISIM). 2007. "Internal Displacement Frequently Asked Questions." Guiding Principles on Internal Displacement. Washington, DC: Georgetown University. Accessed on 30 Dec 2016 at http://www.law.georgetown.edu/idp/english/id_faq.html.

Jibson, R. W., and D. K. Keefer. 1989. Statistical analysis of factors affecting landslide distribution in the new Madrid seismic zone, Tennessee and Kentucky. *Engineering Geology*, 27: 509–542.

John Hopkins Primary Care Policy Center. "Definitions." Baltimore, MD: John Hopkins Bloomberg School of Public Health. Accessed on 3 Jan 2017 at http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-primary-care-policy-center/definitions.html.

Kelsey, J.L., Thompson, W.D., Evans, A.S. 1986. Methods in observational epidemiology. New York: Oxford University Press p. 216.

Liebhold, A., Bentz, B. 2011. Insect Disturbance and Climate Change. Washing ton, DC: U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. Accessed on 21 Dec 2016 at www.fs.usda.gov/ccrc/topics/insect-disturbance/insect-disturbance.

Maat, Sytse de. 2014. "Kacca, Pucca, and Vernacular Architecture." The Perfect Slum. Feb 2014. Accessed on 1 Dec 2016 at http://theperfectslum.blogspot.com/2014/02/kacca-pucca-and-vernacular-architecture.html.

Malczewski, J. 2000. On the use of weighted linear combination method in GIS: common and best practice approaches. *Transactions in GIS* 4(1):5–22.

McHarg, I., 1969. Design with Nature. New York: Natural History Press.

Millennium Ecosystem Assessment. 2005. Ecosystems and Human Well-Being: Synthesis. Washington, DC: Island Press. Accessed on 19 Dec 2016. at http://www.millenniumassessment.org/documents/document.356.aspx.pdf

Natural Disasters Association (NDA). "Earthquakes." Accessed on 22 Dec 2016 at http://www.n-d-a.org/earthquake.php.

Natural Disasters Association (NDA). "Landslides." Accessed on 22 Dec 2016 at http://www.n-d-a.org/landslide.php.

National Flood Insurance Program (NFIP). 2016. "Definitions." FEMA. May 2016. Accessed on 22 Dec 2016 at https://www.fema.gov/national-flood-insurance-program/definitions#F.

National Geographic. "Volcanoes 101." Video and 2 minute read. Accessed on 22 Dec 2016 at http://environment.nationalgeographic.com/environment/natural-disasters/volcano-profile/.

National Oceanic and Atmospheric Administration (NOAA). "Tsunami Vocabulary and Terminology." Accessed 22 Dec 2016 at http://www.tsunami.noaa.gov/terminology.html on.

National Weather Service (NWS). 2008. Drought Public Fact Sheet. May 2008. Accessed on 22 Dec 2016 at http://www.nws.noaa.gov/om/brochures/climate/DroughtPublic2.pdf.

New Economics Foundation. 2015. Financial System Resilience Index: Building a strong financial system. Accessed at on 31 Jan 2017 http://b.3cdn.net/nefoundation/3898c6a7f833389375a_y1m6ixqbv.pdf.

North Carolina Forest Service (NCFS). February 2016. “Common Forest Insect Pests.” Raleigh, NC North Carolina Forest Service. Accessed on 29 Dec 2016 at http://www.ncforestservice.gov/forest_health/forest_insects.htm

Patz, J.A., T.K. Graczyk, N. Geller, and A.Y. Vittor. 2000. Effects of environmental change on emerging parasitic diseases. *Int J Parasitol* 30: 1395–1405.

Patz, Jonathon A. and Ulisses E.C. Confalonieri. 2005. “Human Health: Ecosystem Regulation of Infectious Diseases.” Chapter 14 in Ecosystems and Human Well-being: Current State and Trends, Volume 1. Ed. Rashid Hassan, Robert Scholes, Neville Ash. Washington DC: Island Press. Accessed 20 Dec 2016 at http://www.unep.org/maweb/documents/document.283.aspx.pdf on.

Sigdel, K.R. and Dol Raj Kafle. 2015. “Nepal needs better communication infrastructure to respond to disaster.” WACC Global. 11 May 2015. Accessed on 12 Jan 2017 at http://waccglobal.org/articles/nepal-needs-better-communication-infrastructure-to-respond-to-disaster.

Smout, Elizabeth (2015. “Communicating in a crisis like Ebola: Facts and figures.” SciDevNet. 29 Apr 2015. Accessed on 12 Jan 2017 at http://www.scidev.net/global/ebola/feature/communicating-crisis-ebola-facts-figures.html.

The Asahi Shimbun. 2010. Agreement reached to settle Minamata suit. Available at http://www.asahi.com/english/TKY201003300438.html [Last accessed 20 March 2012].

The World Bank. 2010. Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention (Overview). The International Bank for Reconstruction and Development. Washington, DC: The World Bank.

Thomson B, Poms R, Rose M. 2012. Incidents and impacts of unwanted chemicals in food and feeds. *Quality Assurance and Safety of Crops and Foods* 4: 77–92.

Townsend, Anthony M. and Mitchell L. Moss. April 2005. Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications. Center for Catastrophe Preparedness and Response & Robert F. Wagner Graduate School of Public Service. New York University. Accessed on 12 Jan 2017 at https://www.nyu.edu/ccpr/pubs/NYU-DisasterCommunications1-Final.pdf.

Tulane University. 2012. Haiti Humanitarian Assistance Evaluation from a Resilience Perspective. New Orleans, LA: Tulane University’s Disaster Resilience Leadership Academy and State University of Haiti.

United Nations Development Programme (UNDP). 2013. Guidance Note – Debris Management. Accessed on 17 Jan 2017 at http://www.undp.org/content/dam/undp/library/crisis%20prevention/SignatureProductGuidanceNoteDebrisManagement11012013v1.pdf.

United Nations Division for Sustainable Development (DSD). 2016. Report of the Secretary-General, the Sustainable Development Goals Report, “Sustainable Development Goal 16.” Accessed on 3 Jan 2017 at https://sustainabledevelopment.un.org/sdg16.

United Nations High Commissioner for Refugees (UNHCR). 2001. "Coordination in Complex Emergencies." 1 Sept 2001. Accessed on 30 Jan 2017 at http://www.unhcr.org/en-us/partners/partners/3ba88e7c6/coordination-complex-emergencies.html.

United Nations High Commissioner for Refugees (UNHCR). 2017. "Search and rescue response and coordination (natural disasters)." Accessed on 17 Jan 2017 at https://emergency.unhcr.org/entry/51487/search-and-rescue-response-and-coordination-natural-disasters.

United Nations Human Rights Office of the High Commissioner (OHCHR). 2016. "Questions and Answers about IDPs." Accessed on 30 Dec 2016 at http://www.ohchr.org/EN/Issues/IDPersons/Pages/Issues.aspx#1.

U.N. International Strategy for Disaster Reduction (UNISDR). May 2009. UNISDR 2009 Terminology on Disaster Risk Reduction. Geneva, Switzerland.

U.N. International Strategy for Disaster Reduction (UNISDR). 2004. Living with risk: A global review of disaster reduction initiatives (Vol. 1). United Nations Publications.

United Nations. 2004. A more secure world: Our Shared Responsibility. Report of the Secretary-General's High-level Panel on Threats, Challenges and Change. Accessed on 29 Dec 2016 at http://www.un.org/en/peacebuilding/pdf/historical/hlp_more_secure_world.pdf.

United Nations Office for the Coordination of Humanitarian Affairs (OCHA). 2013. OCHA on Message: Civil-Military Coordination. Accessed on 3 Jan 2017 at https://docs.unocha.org/sites/dms/Documents/OOM_CMCoord_11November2013_eng.pdf.

———. July 2015. "The Humanitarian Impact of Gaza's Electricity and Fuel Crisis." Accessed on 13 Jan 2017 at http://gaza.ochaopt.org/2015/07/the-humanitarian-impact-of-gazas-electricity-and-fuel-crisis/.

United States Office of the United Nations High Commissioner for Refugees (USA for UNHCR). 2016. "What is a refugee?" Accessed on 30 Dec 2016 at http://www.unrefugees.org/what-is-a-refugee/.

United States Department of Commerce. January 2000. Tide and Current Glossary. Silver Spring, MD: National Oceanic and Atmospheric Administration, National Ocean Service, and Center for Operational Oceanographic Products and Services.. Accessed on 22 Dec 2016 at https://tidesandcurrents.noaa.gov/publications/glossary2.pdf.

United States Geological Survey (USGS). 2016. "Hazards." Volcano Hazards Program. 2016. Accessed on 22 Dec 2016 at https://volcanoes.usgs.gov/vhp/hazards.html.

Veregin, H. 1989. Error modelling for the map overlay operation. In: Accuracy of Spatial Databases, pp. 3–18. M.F. Goodchild and S. Gopal, eds. London: Taylor & Francis.

Welle, T., J. Birkmann, J. Rhyner, M. Witting, and J. Wolfertz. 2012. "World risk index 2012: Concept, updating and results." *World risk report* pp 11-26.

Welle, Torsten and Joern Birkmann. 2015. "The World Risk Index – An Approach to Assess Risk and Vulnerability on a Global Scale." *J Extreme Events* 2 (1): 1550003.

Westervelt, J., Bendor, T., Sexton, J. 2011. A technique for rapidly forecasting regional urban growth. *Environment and Planning B: Planning and Design* 38(1): 61-81.

Wrigley, N. 1985. Categorical Data Analysis for Geographers and Environmental Scientists. Harlow, England: Longman.

WHO/UNICEF Joint Monitoring Program (JMP) for Water Supply and Sanitation. "Improved and unimproved water sources and sanitation facilities". Accessed on 1 Dec 2016 at http://www.wssinfo.org/definitions-methods/watsan-categories/.

Woodworth, Brent. May 2005. "The Importance of Information Technology and Telecommunications support in Crisis Management." Accessed on 12 Jan 2017 at http://apps.who.int/hac/events/tsunamiconf/presentations/2_18_logistics_it_telecoms_woodworth_doc.pdf.

World Food Programme (WFP). 2017. Hunger Glossary. Accessed on 3 Jan 2017 at https://www.wfp.org/hunger/glossary.

World Health Organization (WHO). 2015. "Diphtheria." Aug 2015. Accessed on 30 Nov 2016 at http://www.who.int/immunization/diseases/diphtheria/en/.

———. 2006. "Maternal immunization against tetanus". Standards for Maternal and Neonatal Care. Accessed on 6 Dec 2016 at http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/immunization_tetanus.pdf.

———. 2016. "Drought – Technical Hazard Sheet – Natural Disaster Profiles." 2016. Accessed on 22 Dec 2016 at http://www.who.int/hac/techguidance/ems/drought/en/.

———. 2015. "Pertussis." Sept 2015. Accessed on 30 Nov 2015 at http://www.who.int/immunization/diseases/pertussis/en/.

———. 2016. "Earthquakes – Technical Hazard Sheet – Natural Disaster Profile." 2016. Accessed on 22 Dec 2016 at http://www.who.int/hac/techguidance/ems/earthquakes/en/.

———. 2016. "Landslides – Technical Hazard Sheet – Natural Disaster Profiles." Accessed on 22 Dec 2016 at http://www.who.int/hac/techguidance/ems/landslides/en/.

———. 2017. "Sanitation." Accessed on 12 Jan 2017 at http://www.who.int/topics/sanitation/en/.

World Trade Organization and the World Bank Group. 2015. The Role of Trade in Ending Poverty. Accessed on 31 Jan 2017 at http://documents.worldbank.org/curated/en/726971467989468997/pdf/97607-REPLACEMENT-The-Role-of-Trade-in-Ending-Poverty.pdf.

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Appendix: Metadata for a Theoretical Humanitarian Crisis Framework and Components

1 Natural Hazards Condition Overview

This condition encompasses all categories of natural hazards. The United Nations defines “hazards” as:

> A dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage.
>
> Comment: The hazards of concern to disaster risk reduction as stated in footnote 3 of the Hyogo Framework are “… hazards of natural origin and related environmental and technological hazards and risks.” Such hazards arise from a variety of geological, meteorological, hydrological, oceanic, biological, and technological sources, sometimes acting in combination. In technical settings, hazards are described quantitatively by the likely frequency of occurrence of different intensities for different areas, as determined from historical data or scientific analysis. (UNISDR 2009, pg. 17-8)

Only the Ecosystem Disruptions factor currently has available metric and indicator data.

Factor Weighting Logic

All factors are given both a minimum and maximum weight of 1.0, as it is equally as constraining on the condition as the other factors. This way, any location that is given a high risk value at the metric level will have at least that level of risk.

Factor (heading number)	Weight Minimum Value	Weight Maximum Value
Geophysical Effects/Consequences (A1)	1.0	1.0
Climatological Effects/Consequences (A2)	1.0	1.0
Ecosystem Disruptions (A3)	1.0	1.0

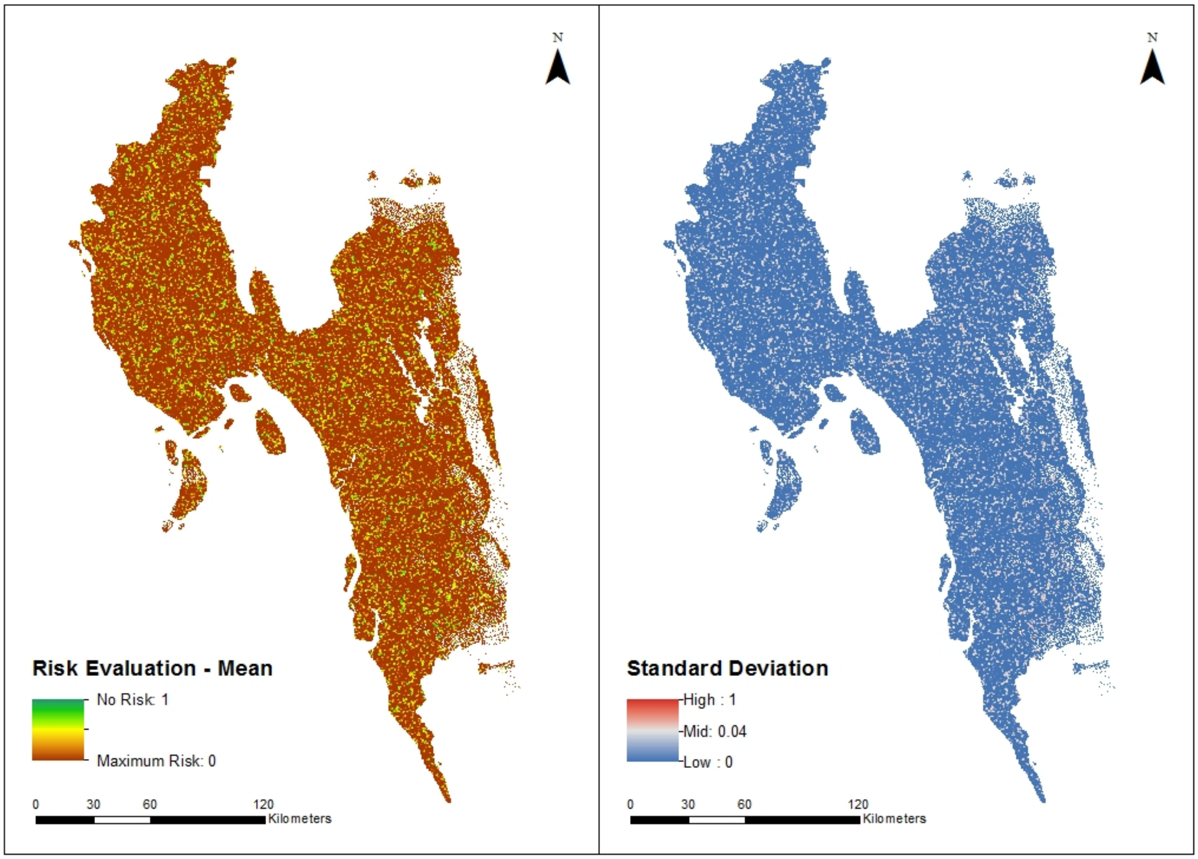
Uncertainty Values

While the factors do encompass multiple aspects of natural hazards, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Condition Uncertainty Min: 0.1
Condition Uncertainty Max: 0.3

Example Outcome

Natural Hazards Condition



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

1.1 Geophysical Effects/Consequences Factor Overview

The Geophysical Effects and Consequences Factor is built on indicators and metrics focusing on geological hazards. Geological hazards include internal earth processes, such as earthquakes, volcanic activity and emissions, and related geophysical processes such as mass movements, landslides, rockslides, surface collapses, and debris or mud flows. (UNISDR 2009). Tsunami risk measures could be placed within this factor as an indicator, but instead it is under the Climatological Effects/Consequences factor.

For the Humanitarian Crisis framework, this factor includes the indicators of earthquake/earth movement, landslide, and volcanic activity.

None of these indicators are available from Phase Zero Assessment of Urban Security Threats research, as there is no metric data for any of them. Some indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

As each indicator is equally constraining on the factor, each indicator is weighted a minimum of 1.0 and a maximum of 1.0. This way, any location that is given a high risk value at the metric level will have at least that level of risk.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Earthquake/Earth Movement (1.1.1)	1.0	1.0
Landslide (7)	1.0	1.0
Volcanic Activity (1.1.3)	1.0	1.0

Uncertainty Values

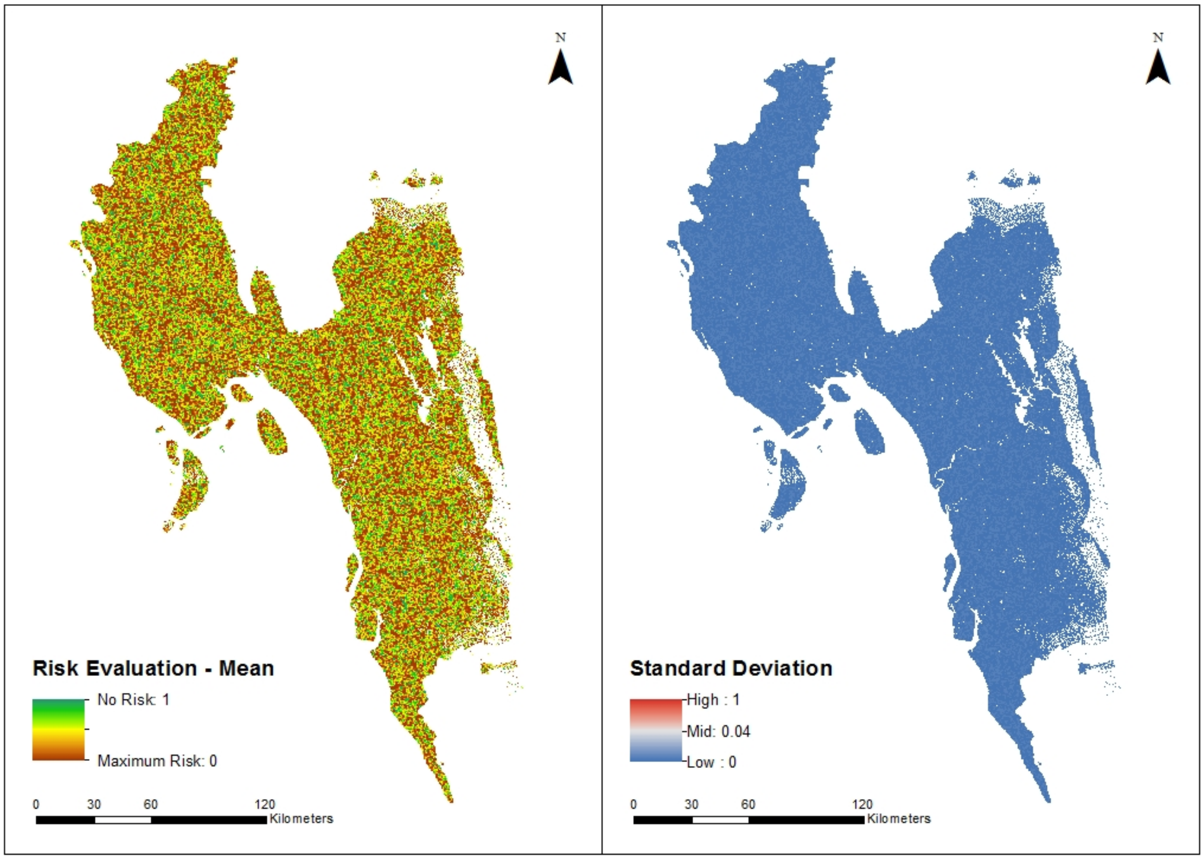
While the factors do encompass multiple aspects of geophysical natural hazards, these low uncertainty values reflect the potential for additional factors (like tsunamis) to be added to increase accuracy.

Certain regions of the world with coarse topography may also want to include indicator and metric data on sinkholes, and/or decrease the uncertainty values to reflect their absence. The same can be said for subsidence (ground level dropping due to groundwater removal). As these are not issues for Bangladesh, they are not taken into consideration in determining the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Geophysical Effects/Consequences Factor



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

1.1.1 Indicator: Earthquake/Earth Movement

Earthquakes are the shaking of the earth's surface caused by the movement of tectonic plates (NDA). This movement can cause surface faulting, fires, tremors vibration, liquefaction, landslides, aftershocks and/or tsunamis (WHO 2016). The World Health Organization lists factors of vulnerability to earthquakes as location of settlements in seismic areas and population size; inadequate building practices and regulations; dense concentration of building with high occupancy; and the absence of warning systems and lack of public awareness on earthquake risks (WHO 2016).

PACOM specifies that metrics should include: number of earthquakes of magnitude 5.0 and higher on the Richter Scale or Moment Magnitude Scale; level of classification based on seismic intensity scale; percentage of buildings damaged due to earthquake(s); percentage of buildings destroyed or rendered uninhabitable due to earthquake(s); percentage of commercial and residential land area rendered unusable due to earthquake(s); number of casualties ("excess deaths", injuries) due to earthquake(s); crude mortality rate; percentage of buildings that are properly retrofitted to withstand earthquake(s); monetary damage due to earthquake(s); percentage of geographic area built on rock versus sand or other soft soils; and population density in vulnerable areas.

<u>Metric Weighting Logic</u>

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

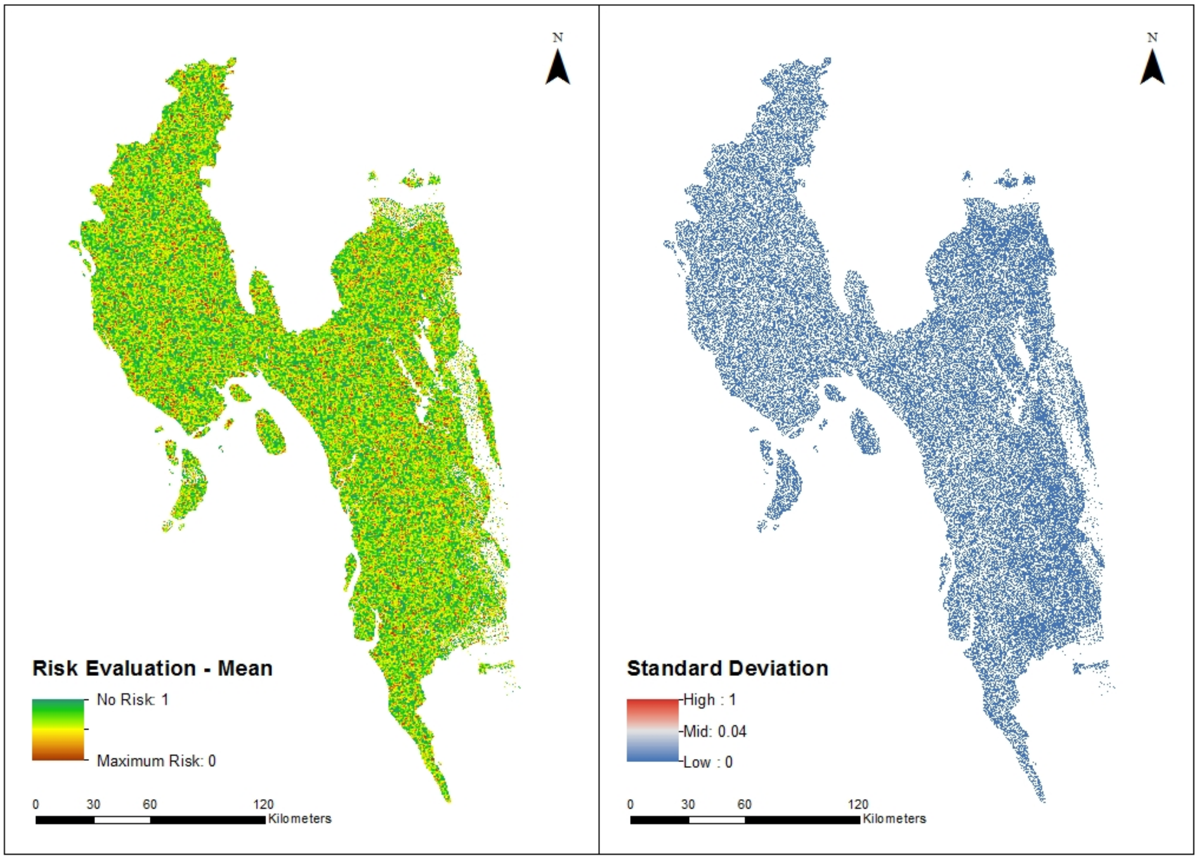
<u>Uncertainty Values</u>

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Earthquake/Earth Movement Indicator



References

Natural Disasters Association (NDA). "Earthquakes." Accessed at http://www.n-d-a.org/earthquake.php on 22 Dec 2016.

World Health Organization (WHO) (2016). "Earthquakes – Technical Hazard Sheet – Natural Disaster Profile." 2016. Accessed at http://www.who.int/hac/techguidance/ems/earthquakes/en/ on 22 Dec 2016.

1.1.2 Indicator: Landslide

Landslides are defined by the downslope transport of soil and rock resulting from natural or man-made phenomena (“Landslides” 2016). Causation can include saturation of slope material following a rainfall, seismic activity (i.e., earthquakes), undercutting of cliffs and banks by waves and rivers, removal of vegetation (i.e., deforestation), and modification of slopes (NDA, “Landslides”).

PACOM specifies that metrics should include: number of landslides; percentage of buildings damaged due to landslides; percentage of buildings destroyed or rendered uninhabitable due to landslides; percentage of commercial and residential land area rendered unusable due to landslides; number of casualties due to landslides; percentage of landslide-prone area bolstered to minimize landslide impact (i.e., sandbags, retaining walls, surface and subsurface drainage, movement of soil, removal and replacement of landslide-prone soil/rock, preserving vegetation, rock fall protection); monetary damages due to landslides; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

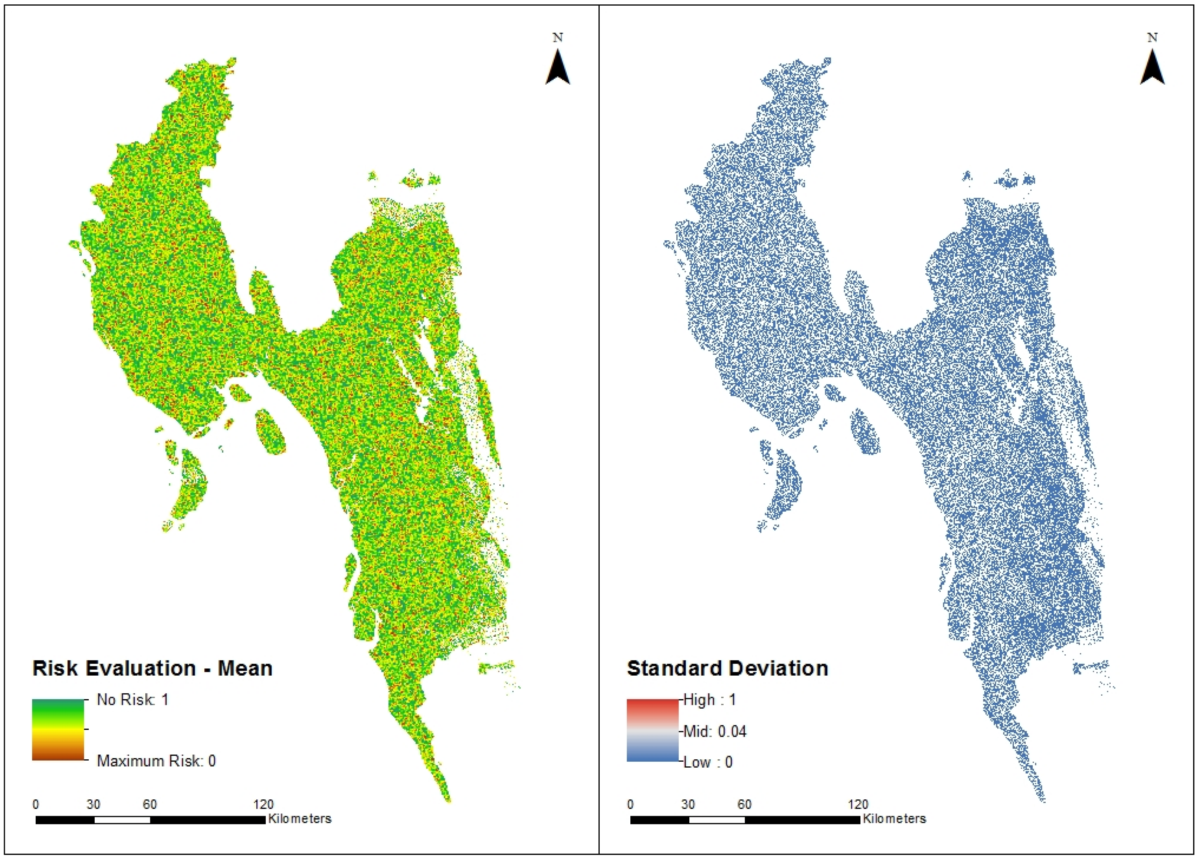
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Landslide Indicator



References

Natural Disasters Association (NDA). "Landslides." Accessed at http://www.n-d-a.org/landslide.php on 22 Dec 2016.

1.1.3 Indicator: Volcanic Activity

Volcanoes are vents or ruptures within the surface of the earth through which molten rock, debris, and gases from earth's interior are emitted ("Volcanoes"). Hazards include tephra/ashfall, lava flows, lahars, volcanic gas, pyroclastic flows, and landslides (USGS 2016).

PACOM specifies that metrics should include: number of volcanic eruptions; percentage of buildings damaged, destroyed, or rendered uninhabitable due to volcanic activity; percentage of commercial and residential land area rendered unusable due to volcanic activity; number of casualties due to volcanic activity; crude mortality rate; monetary damages due to volcanic activity; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

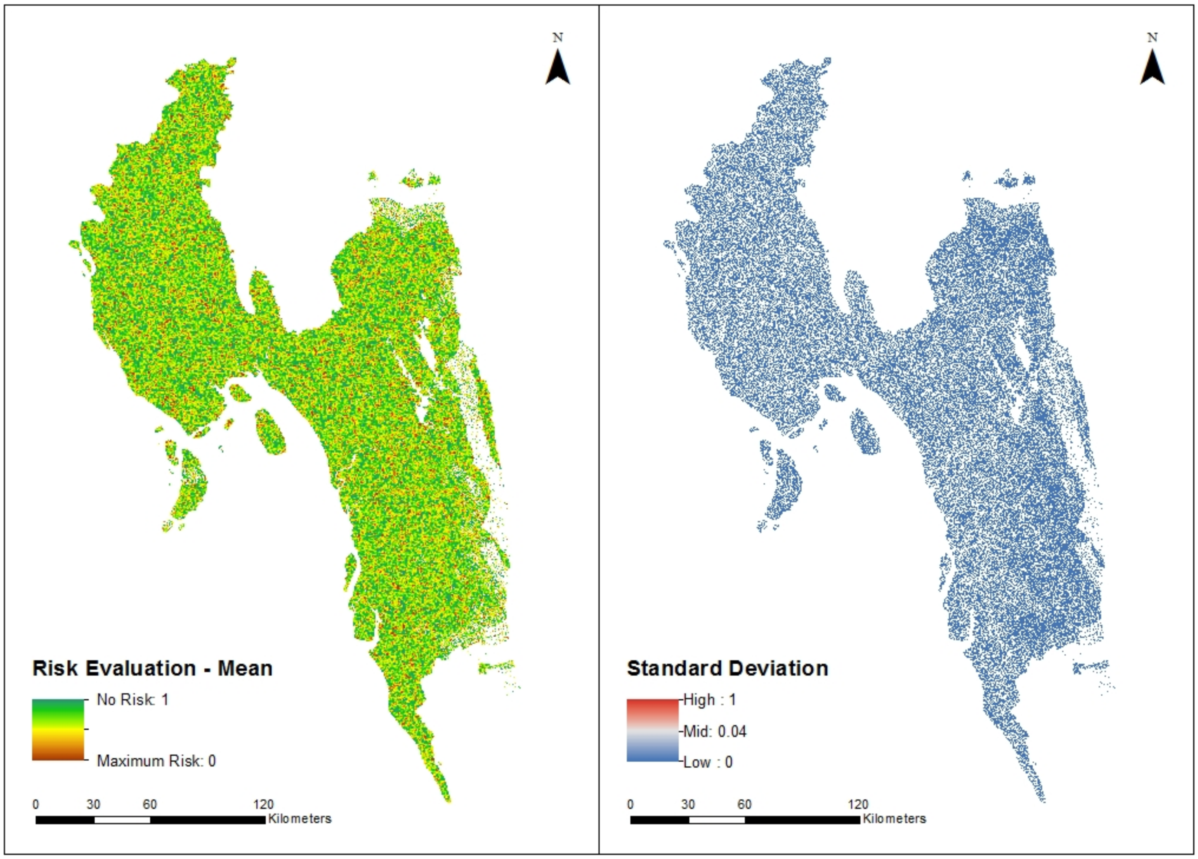
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Volcanic Activity Indicator



References

United States Geological Survey (USGS) (2016). “Hazards.” *Volcano Hazards Program*. 2016. Accessed at https://volcanoes.usgs.gov/vhp/hazards.html on 22 Dec 2016.

“Volcanoes.” National Geographic. Accessed at http://environment.nationalgeographic.com/environment/natural-disasters/volcano-profile/ on 22 Dec 2016.

1.2 Climatological Effects/Consequences Factor Overview

The Climatological Effects and Consequences Factor is built on indicators and metrics focusing on hydro-meteorological natural hazards. These are defined as a process or phenomenon of atmospheric, hydrological or oceanographic nature that may cause loss of life, injury or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage (UNISDR 2009). Hydro-meteorological hazards include tropical cyclones (also known as typhoons and hurricanes), thunderstorms, hailstorms, tornados, blizzards, heavy snowfall, avalanches, coastal storm surges, floods including flash floods, drought, heatwaves and cold spells. Hydro-meteorological conditions also can be a factor in other hazards such as landslides, wildland fires, locust plagues, epidemics, and in the transport and dispersal of toxic substances and volcanic eruption material." (UNISDR 2009, pg 18). As such, there may be some metrics that are used multiple times within the framework, as they apply to multiple indicators/factors.

Since PACOM's planning horizon is only 5-10 years out in terms of evaluating risk, climate change is not accounted for in this factor.

For the Humanitarian Crisis framework, this factor includes the indicators of flood, severe storm, tsunami/tidal surge, and drought.

None of these indicators are available from Phase Zero Assessment of Urban Security Threats research, as there is no metric data for any of them. Some indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

As each indicator is equally constraining on the factor, each indicator is weighted a minimum of 1.0 and a maximum of 1.0. This way, any location that is given a high risk value at the metric level will have at least that level of risk.

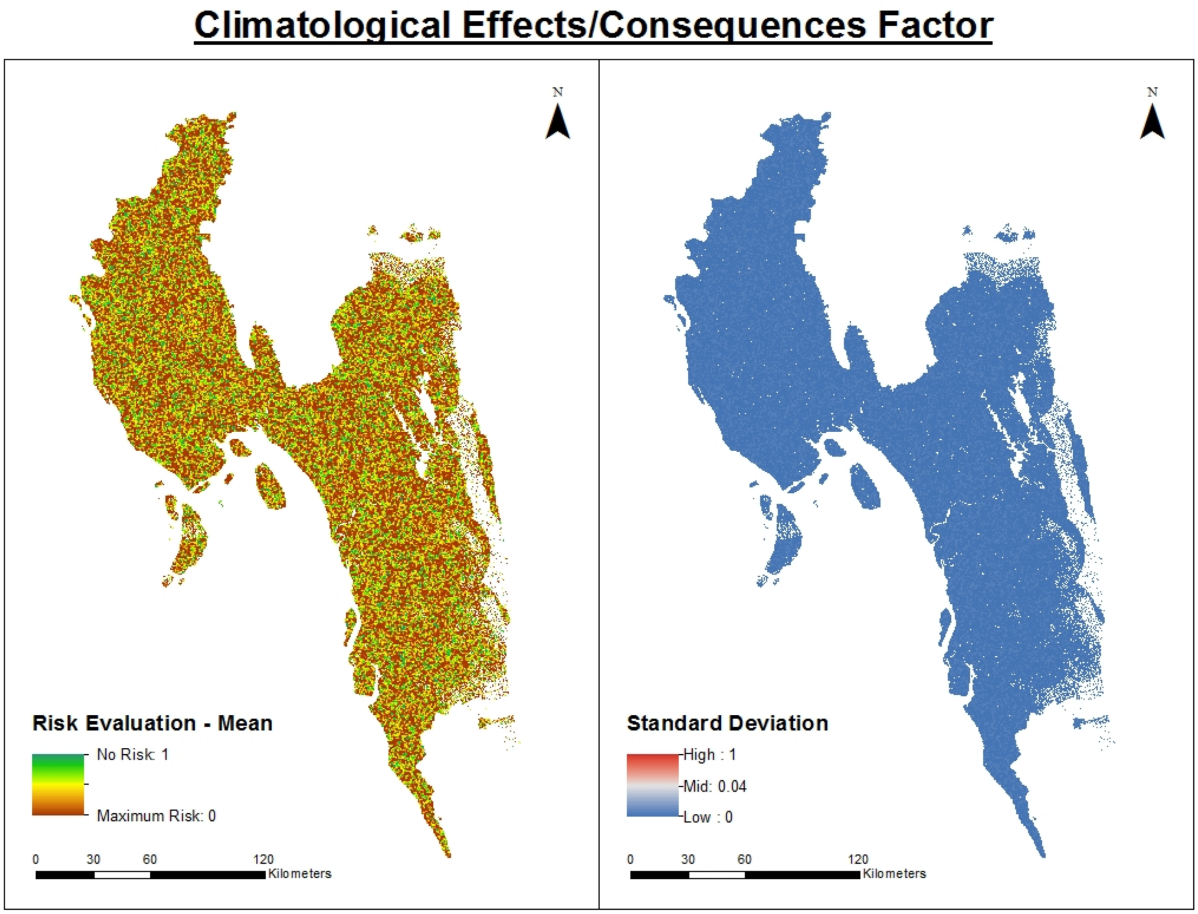
Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Flood (1.2.1)	1.0	1.0
Severe Storm (1.2.2)	1.0	1.0
Tsunami/Tidal Surge (1.2.3)	1.0	1.0
Drought (1.2.4)	1.0	1.0

Uncertainty Values

While the factors do encompass multiple aspects of climate-related natural hazards, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

1.2.1 Indicator: Flood

According to the National Flood Insurance Program (NFIP), a flood is defined as (2016):

- A general and temporary condition of partial or complete inundation of 2 or more acres of normally dry land area or of 2 or more properties from:
  - Overflow of inland or tidal waters; or
  - Unusual and rapid accumulation or runoff of surface waters from any source; or
  - Mudflow; or
- Collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above.

PACOM specifies that metrics should include: number of floods, percentage of buildings damaged, destroyed, or rendered uninhabitable due to floods; percentage of commercial and residential land area rendered unusable due to floods; number of casualties due to floods; number of infections/diseases resulting from bacteria/chemicals/mold/mildew exposure from floods; crude mortality rate; monetary damages due to floods; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

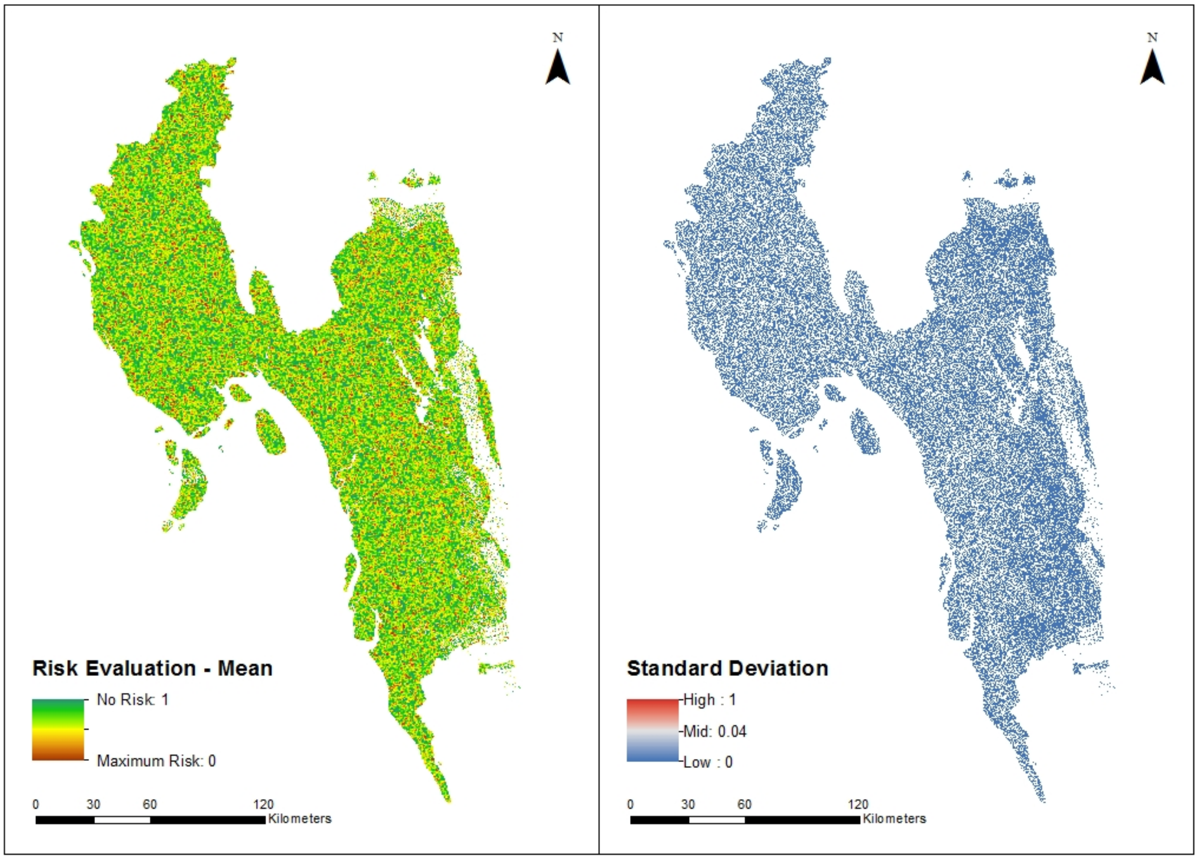
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Flood Indicator



References

National Flood Insurance Program (NFIP) (2016). "Definitions." *FEMA*. May 2016. Accessed at https://www.fema.gov/national-flood-insurance-program/definitions#F on 22 Dec 2016.

1.2.2 Indicator: Severe Storm

The definition for “severe storm” in terms of what makes up this indicator is purposefully left broad – it includes thunderstorms, hurricanes, tornados, cyclones, severe winter storms, etc. As each geographical region experiences varying types and degrees of severe weather, it would be irrational to narrow down the kinds of metrics that can fit into this indicator.

PACOM specifies that metrics should include: number of severe storms (wind gusts in excess of 58 mph or equivalent OR hail of one inch in diameter or larger; OR classification as tornado, cyclone, hurricane, winter storm); percentage of buildings damaged, destroyed, or rendered uninhabitable due to severe storms; percentage of commercial or residential land area rendered unusable due to severe storms; number of casualties due to severe storms; crude mortality rate; monetary damages due to severe storms; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

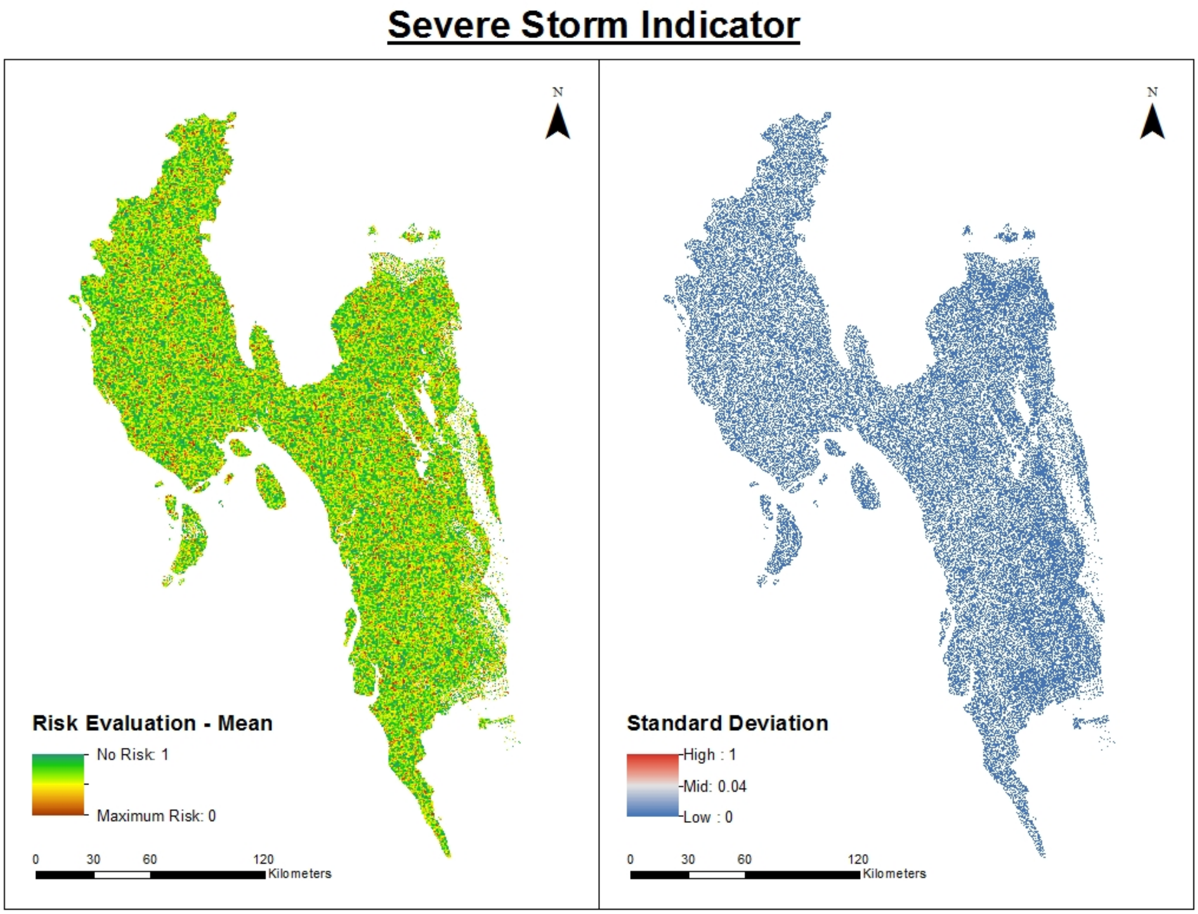
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



1.2.3 Indicator: Tsunami/Tidal Surge

Tsunamis are a series of ocean waves produced by earthquakes or underwater landslides (NOAA "Tsunami"). In contrast, a tidal wave is a shallow water wave caused by the gravitational interactions between the Sun, Moon, and Earth (US Dept. of Commerce 2000, p. 26).

PACOM specifies that metrics should include: number of tsunamis; percentage of buildings damaged, destroyed, or rendered uninhabitable due to tsunamis/tidal surges; percentage of commercial or residential land area rendered unusable due to tsunamis/tidal surges; number of casualties due to tsunamis/tidal surges; crude mortality rate; monetary damages due to tsunamis/tidal surges; percentage of coastal erosion; width and slope of the continental shelf; policies and measures in place to mitigate vulnerabilities (e.g., sea level change); population density in vulnerable areas; and percentage of ports, major roads, and rail lines at or below 4 feet of elevation.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

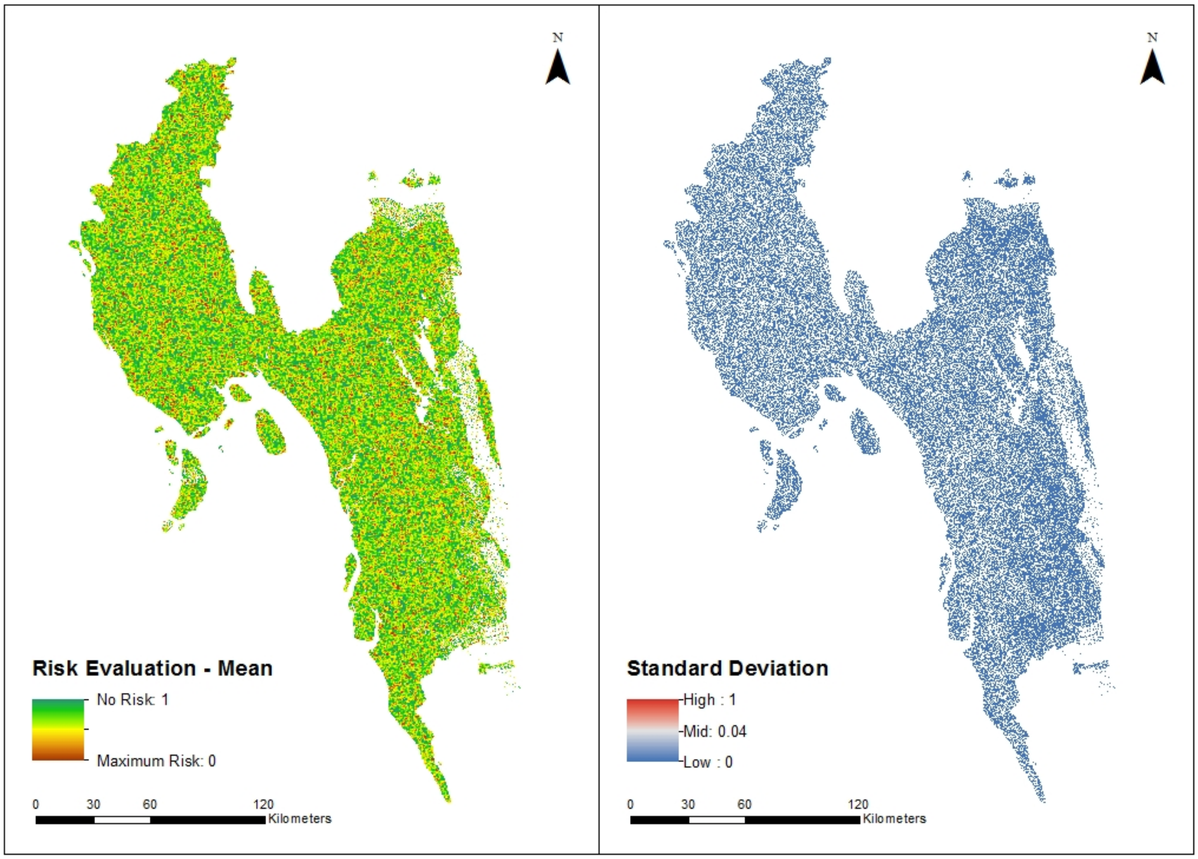
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Tsunami Indicator



References

United States Department of Commerce, National Oceanic and Atmospheric Administration, National Ocean Service, and Center for Operational Oceanographic Products and Services (2000). *Tide and Current Glossary*. January 2000. Accessed at https://tidesandcurrents.noaa.gov/publications/glossary2.pdf on 22 Dec 2016.

1.2.4 Indicator: Drought

Drought is defined by the National Weather Service as a deficiency in precipitation over an extended period, usually a season or more, resulting in a water shortage causing adverse impacts on vegetation, animals, and/or people that occurs in virtually all climate zones (NWS 2008). While droughts are more predictable due to their slow onset, they can and often do result in mass population displacement accompanied with food and water shortages (WHO “Drought”).

PACOM specifies that metrics should include: number and length of droughts; percentage of land rendered non-arable due to drought; percentage of fresh-water wells dried due to drought; percentage of country impacted by drought; number of casualties per capita due to droughts; crude mortality rate’ financial impact of droughts; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

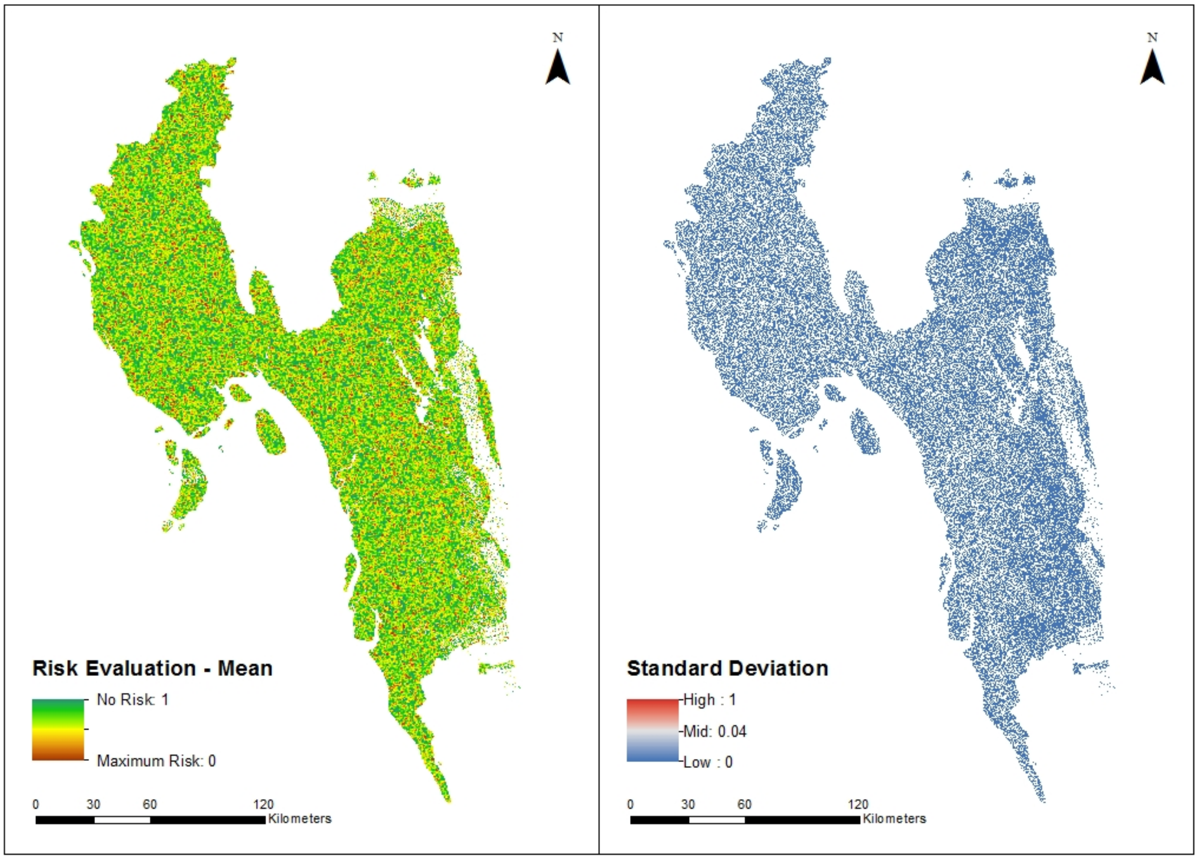
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Drought Indicator



References

National Weather Service (NWS) (2008). *Drought Public Fact Sheet*. May 2008. Accessed at http://www.nws.noaa.gov/om/brochures/climate/DroughtPublic2.pdf on 22 Dec 2016.

World Health Organization (WHO) (2016). "Drought – Technical Hazard Sheet – Natural Disaster Profiles." 2016. Accessed at http://www.who.int/hac/techguidance/ems/drought/en/ on 22 Dec 2016.

1.3 Ecosystems Disruption Factor Overview

The Ecosystem Disruptions Factor focuses more on the more direct human impacts of natural hazards. The Millennium Ecosystem Assessment defines an ecosystem as the dynamic complex of plant, animal, and microorganism communities and the non-living environment interacting as a functional unit (2005, p. V). From their 2005 report:

> Ecosystem services are the benefits people obtain from ecosystems. These include provisioning services such as food, water, timber, and fiber; regulating services that affect climate, floods, disease, wastes, and water quality; cultural services that provide recreational, aesthetic, and spiritual benefits; and supporting services such as soil formation, photosynthesis, and nutrient cycling. The human species, while buffered against environmental changes by culture and technology, is fundamentally dependent on the flow of ecosystem services (2005).

Logically, any disruption to any of these services, which would negatively impacting human well-being, would be classified as an ecosystem disruption.

For the Humanitarian Crisis framework, this includes the indicators of epidemics and pandemics, severe insect infestation, commodity destruction/infection, and wildfire.

Only the Epidemics/Pandemics indicator currently has any available metric data. Other indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All indicators are given both a minimum and maximum weight of 1.0, as it is equally as constraining on the factor as the other indicators. This way, any location that is given a high risk value at the metric level will have at least that level of risk.

Indicator (heading number)	**Weight Minimum Value**	**Weight Maximum Value**
Epidemics/Pandemics (1.3.1)	1.0	1.0
Severe Insect Infestation (1.3.2)	1.0	1.0
Commodity Destruction/Infection (1.3.3)	1.0	1.0
Wildfire (1.3.4)	1.0	1.0

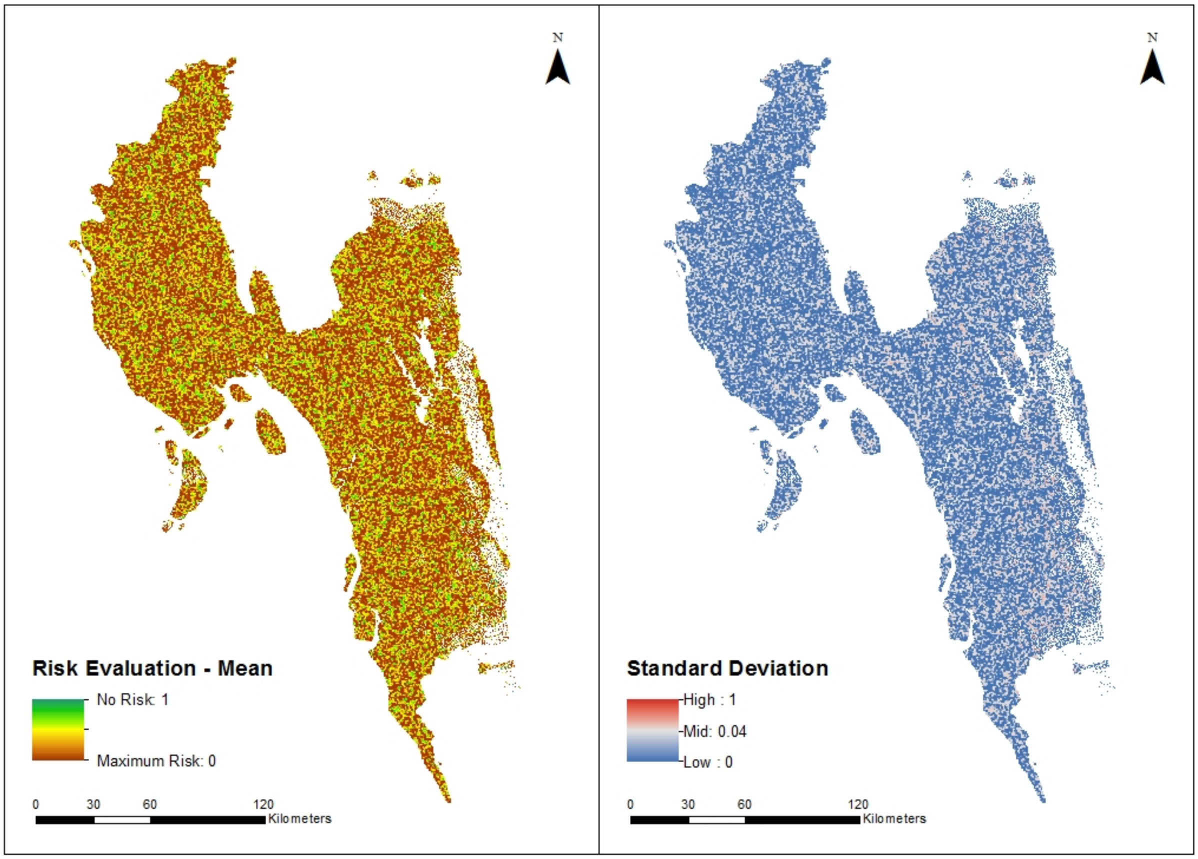
Uncertainty Values

While the factors do encompass multiple aspects of ecosystem disruptions, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy. For example, an indicator that account for water quality and pollution could decrease the uncertainty values from 0.1 to 0.15.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Ecosystem Disruptions Factor



References

Millennium Ecosystem Assessment (2005). *Ecosystems and Human Well-Being: Synthesis*. Island Press, Washington DC, 2005. Accessed at http://www.millenniumassessment.org/documents/document.356.aspx.pdf on 19 Dec 2016.

1.3.2 Indicator: Epidemics/Pandemics

According to the CDC, an epidemic is defined as an increase, often sudden, in the number of cases of a disease above what is normally expected in the population in that area (2012). They occur when an agent and susceptible hosts are present in adequate numbers, and the agent can be effectively conveyed from a source to the susceptible hosts. This can result from: a recent increase in amount or virulence of the agent; the recent introduction of the agent into a new, previously unexposed setting; an enhanced mode of transmission so that more susceptible people are exposed; a change in the susceptibility of the host response to the agent, and/or; factors that increase host exposure or involve introduction through new portals of entry (Kelsey et al, 1986).

A pandemic is an epidemic that has spread over several countries and continents, usually affecting a large number of people (CDC, 2012).

Intact ecosystems maintain a diversity of species in equilibrium and can often provide a disease-regulating effect (the “regulating” ecosystem service mentioned above) if any of these species are either directly or indirectly involved in the life cycle of an infectious disease (Patz et al. 2005). Disease agents with much of their life cycle occurring external to the human host (i.e., non-vector-borne diseases) are subjected to environmental conditions, and it is these diseases for which most linkages to ecosystem conditions have been found (Patz et al. 2000). A disruption in to the disease regulating environment can lead to an epidemic and/or a pandemic.

PACOM specifies that metrics should include: number of epidemics/pandemics; percentage of population with vaccinations; population density in vulnerable areas; number of casualties per capita; crude mortality rate; and financial impact of epidemics/pandemics.

<u>Metric Weighting Logic</u>

As the “Vaccinated” metric (asks is respondent has ever been vaccinated from DHS survey) is the most broad out of all the current metrics, it is weighted the lowest. As all of the other metrics, focusing on different vaccinations against specific diseases, are equally as effective on the indicator, they are all weighted the same.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
Vaccinated (1.3.1.1)	0.2	0.3
VaccineBCG (1.3.1.2)	0.2	0.5
VaccinePolio 1.3.1.3)	0.2	0.5
VaccineDPT (1.3.1.4)	0.2	0.5
VaccineMeasles (1.3.1.5)	0.2	0.5

<u>Uncertainty Values</u>

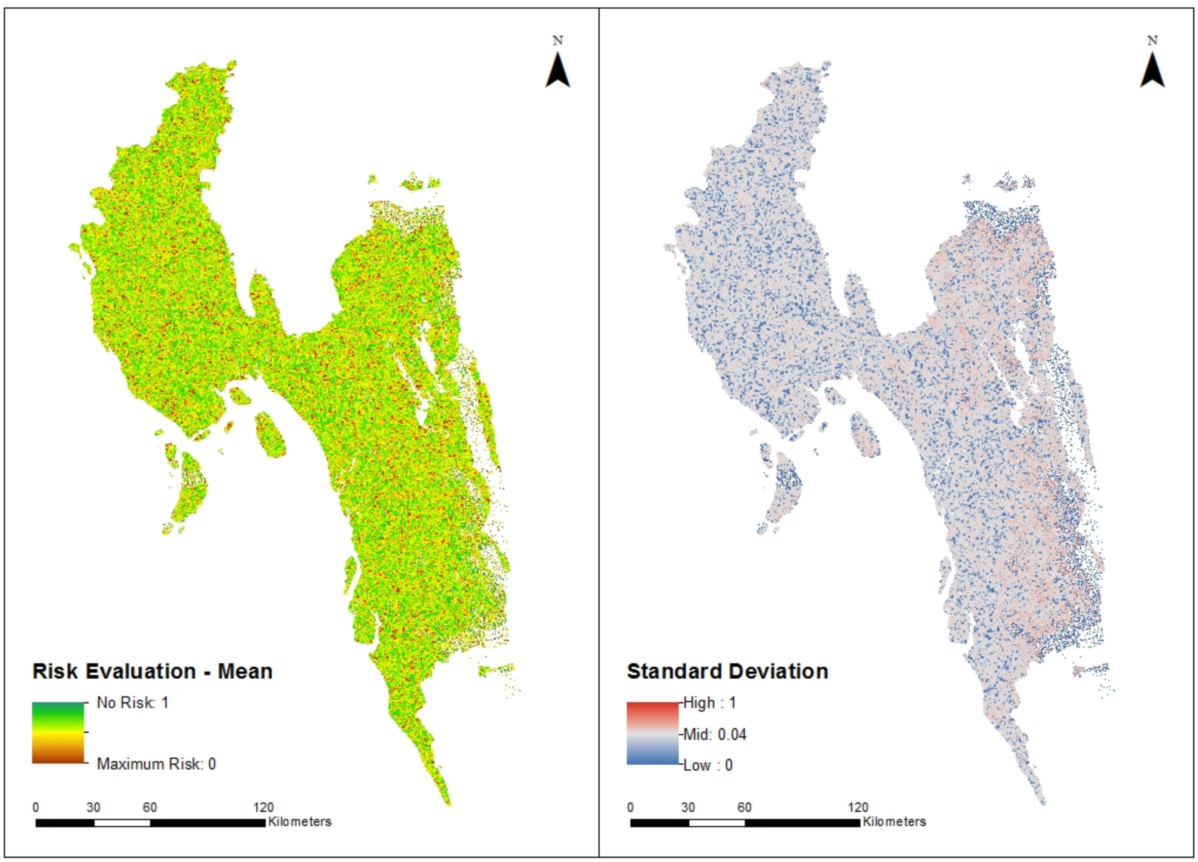
Adding in historical epidemic and pandemic data could lower the indicator uncertainty values. The relatively high uncertainty values are due to the nature of the data which makes up the indicator metrics. Survey data that is projected for an entire country using computer algorithms is less accurate than a government-sanctioned national survey. Compounding this uncertainty value are the questions and answers pulled from the surveys, which only address disease spread with vaccinations.

Alternatively, if this indicator was renamed “Vaccinations” or “Preventative Disease Measures,” it would better reflect the existing Urban Security metrics. This could lower the uncertainty values to a minimum of 0.1 and a maximum of 0.3.

Indicator Uncertainty Min: 0.8
Indicator Uncertainty Max: 0.95

Example Outcome

Epidemics/Pandemics Indicator



References

Center for Disease Control (CDC) (2012). “Section 11: Epidemic Disease Occurrence.” *Principles of Epidemiology in Public Health Practice, Third Edition*. Accessed at https://www.cdc.gov/OPHSS/CSELS/DSEPD/SS1978/Lesson1/Section11.html#_ref47 on 20 Dec 2016.

Kelsey JL, Thompson WD, Evans AS (1986). *Methods in observational epidemiology*. New York: Oxford University Press; 1986. p. 216.

Patz, J.A., T.K. Graczyk, N. Geller, and A.Y. Vittor (2000). Effects of environmental change on emerging parasitic diseases. *Int J Parasitol*, 30, 1395–1405.

Patz, Jonathon A. and Ulisses E.C. Confalonieri (2005). “Human Health: Ecosystem Regulation of Infectious Diseases.” Chapter 14 in *Ecosystems and Human Well-being: Current State and Trends, Volume 1*. Ed. Rashid Hassan, Robert Scholes, Neville Ash. Island Press, Washington DC, 2005. Accessed at http://www.unep.org/maweb/documents/document.283.aspx.pdf on 20 Dec 2016.

1.3.2.1 Metric: Vaccinated

Indicator:	Epidemics/Pandemics
Factor:	Ecosystem Disruptions
Condition:	Natural Hazards
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	N/A

Logic:

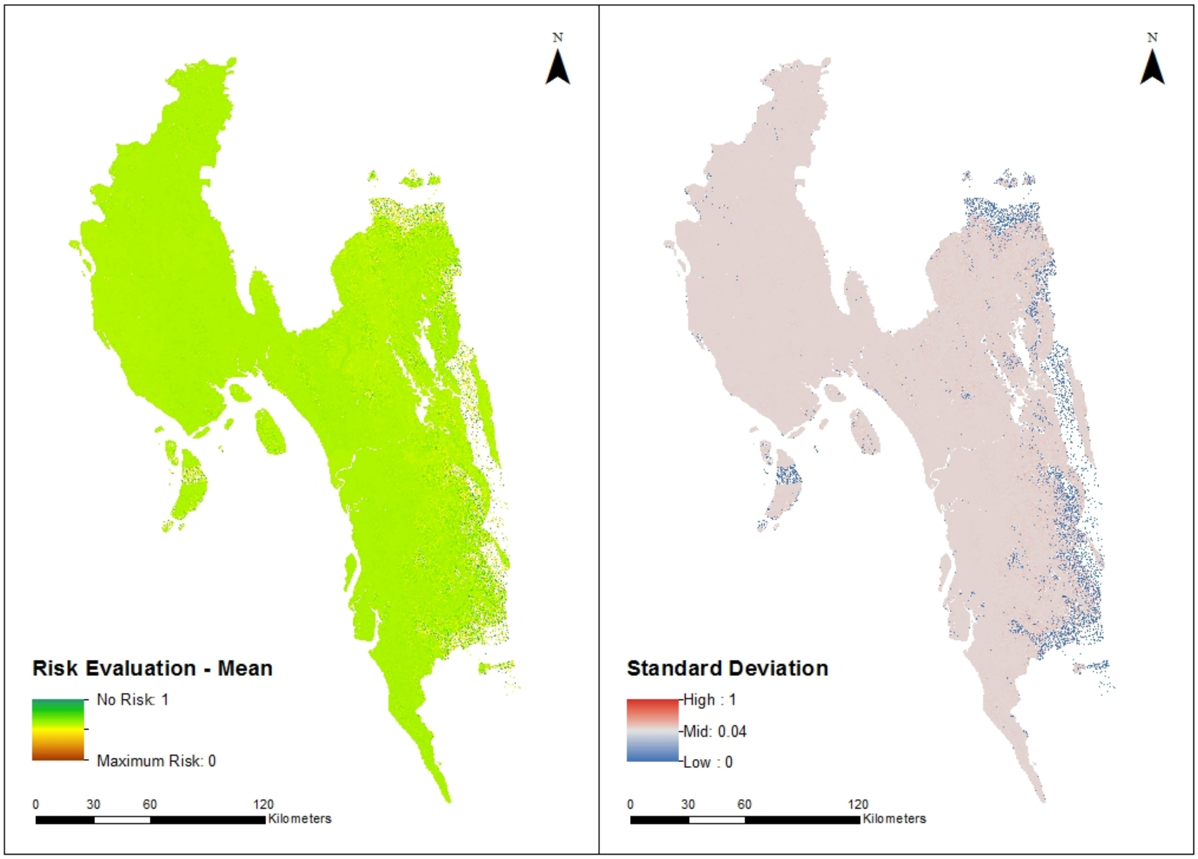
This metric consists of answers to the question “Have you ever had a vaccination?” from the DHS survey. The “No” response is given a minimum value of 0.0625 (extreme risk, ½^4) and a maximum value of 0.500 (slight risk, ½^1). The “Yes” response is given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, ½^0). Maps will range from extreme risk to minimal risk.

This is the first question within the indicator that addresses epidemics and pandemics risk, and is also the most generic question in that it does not address vaccination against specific diseases. Vaccinations can act as preventative measures against epidemics, pandemics, and biological hazards, defined as “Process or phenomenon of organic origin or conveyed by biological vectors, including exposure to pathogenic micro-organisms, toxins and bioactive substances that may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage” (UNISDR 2009, pg 4-5).

Because of the general natures both of this question and the framework (which measures overall risk, not risk for a specific disease or disaster), the “No” response will result in realizations ranging from high risk to slight risk, while the “Yes” response has no impact on overall risk. In addition, the metric as a whole is weighted for importance and impact less than other metrics.

Example Realization Metric Map

Vaccinated Metric



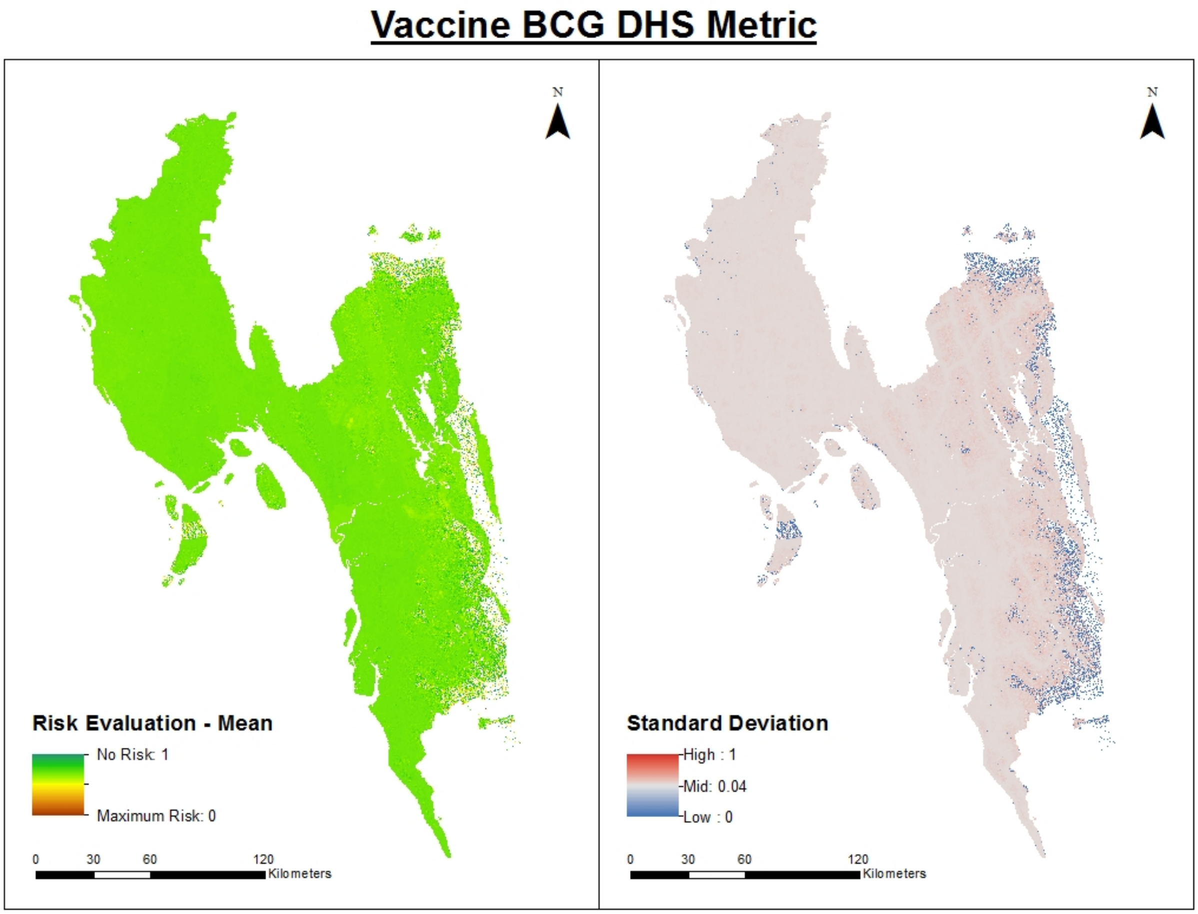
1.3.2.2 Metric: VaccineBCG

Indicator:	Epidemics/Pandemics
Factor:	Ecosystem Disruptions
Condition:	Natural Hazard
Metric Assigned Values:	Vaccination Date on Card (min: 1.0, max: 1.0) Reported by Mother (min: 0.8, max: 1.0) Vaccination Marked on Card (min: 0.9, max: 1.0) No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	http://www.cdc.gov/tb/publications/factsheets/prevention/bcg.htm

Logic: This metric consists of answers to the question concerning vaccination against tuberculosis (TB). BCG, or bacille Calmette-Guerin, is often used in countries with a high prevalence of TB to prevent childhood tuberculous meningitis and miliary disease ("BCG" 2016).

Despite the current PACOM HC framework data entry sheet only citing responses for "Yes" and "No," the answers in DHS have four response options for this question: "Vaccination Date on Card," "Reported by Mother," "Vaccination Marked on Card," and "No." The "Vaccination Date on Card" response has a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). The response "Reported by Mother" has a minimum value of 0.8 (minimal risk) and a maximum value of 1.0. The response "Vaccination Marked on Card" is more certain than the former response but less certain than the latter, hence a minimum value of 0.9 (minimal risk) and maximum value of 1.0. The "No" response is given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.500 (slight risk, $½^1$). Maps will range from extreme risk to minimal risk.

Example Realization Metric Map



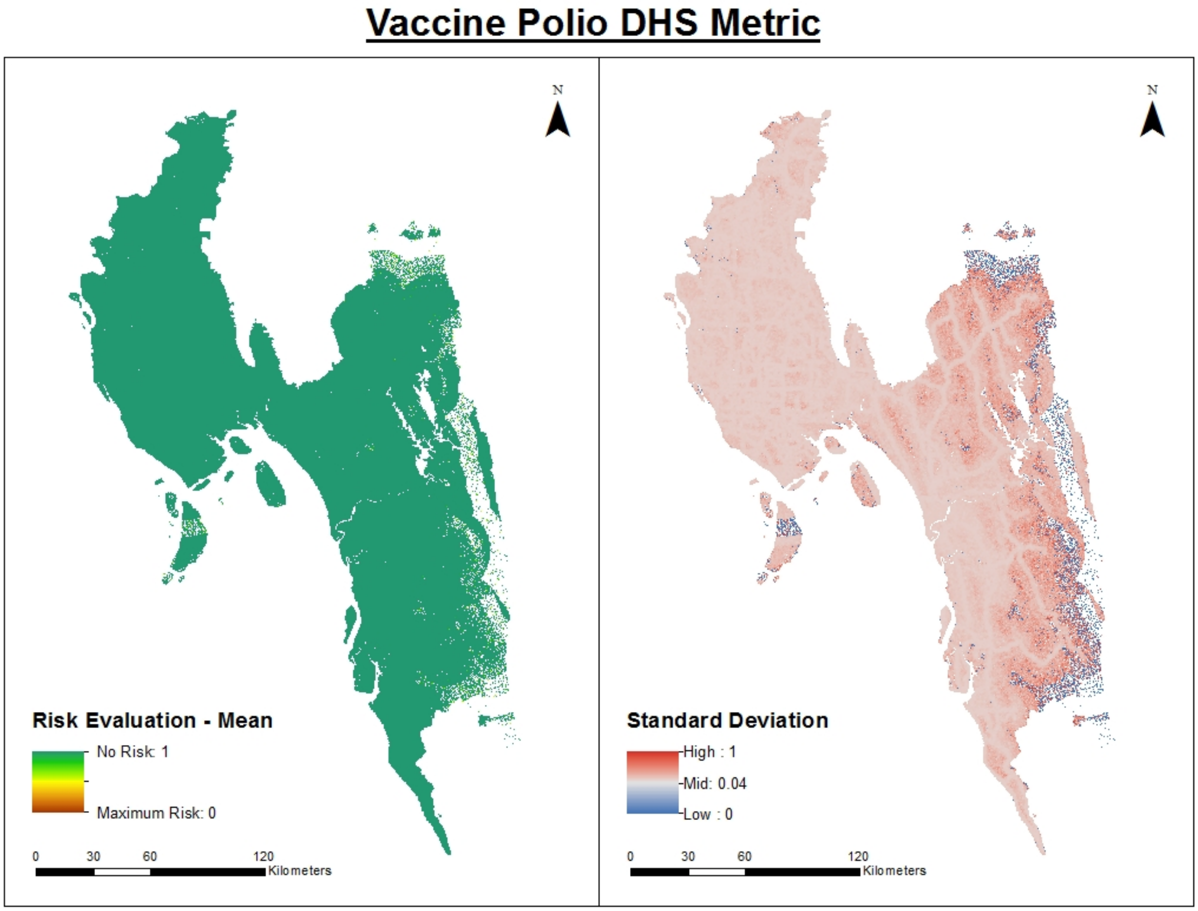
1.3.2.3 Metric: VaccinePolio

Indicator:	Epidemics/Pandemics
Factor:	Ecosystem Disruptions
Condition:	Natural Hazard
Metric Assigned Values:	Vaccination Date on Card (min: 1.0, max: 1.0) Reported by Mother (min: 0.8, max: 1.0) Vaccination Marked on Card (min: 0.9, max: 1.0) No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	http://www.cdc.gov/vaccines/hcp/vis/vis-statements/ipv.html

Logic: This metric consists of answers to the question concerning vaccination against polio. Within the survey, there are three questions about the polio vaccines, one for each version of the vaccine: one for Polio1, one for Polio2, and one for Polio3. These likely refer to the various doses of the inactive polio vaccine (IPV), which are usually given at 2, 4, 6 to 18 months, and 4 to 6 years of age ("Polio VIS" 2016). All of these questions and answers are aggregated into one metric.

Despite the current PACOM HC framework data entry sheet only citing responses for "Yes" and "No," the answers in DHS have four response options for this question: "Vaccination Date on Card," "Reported by Mother," "Vaccination Marked on Card," and "No." The "Vaccination Date on Card" response has a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). The response "Reported by Mother" has a minimum value of 0.8 (minimal risk) and a maximum value of 1.0. The response "Vaccination Marked on Card" is more certain than the former response but less certain than the latter, hence a minimum value of 0.9 (minimal risk) and maximum value of 1.0. The "No" response is given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.500 (slight risk, $½^1$). Maps will range from extreme risk to minimal risk.

Example Realization Metric Maps:

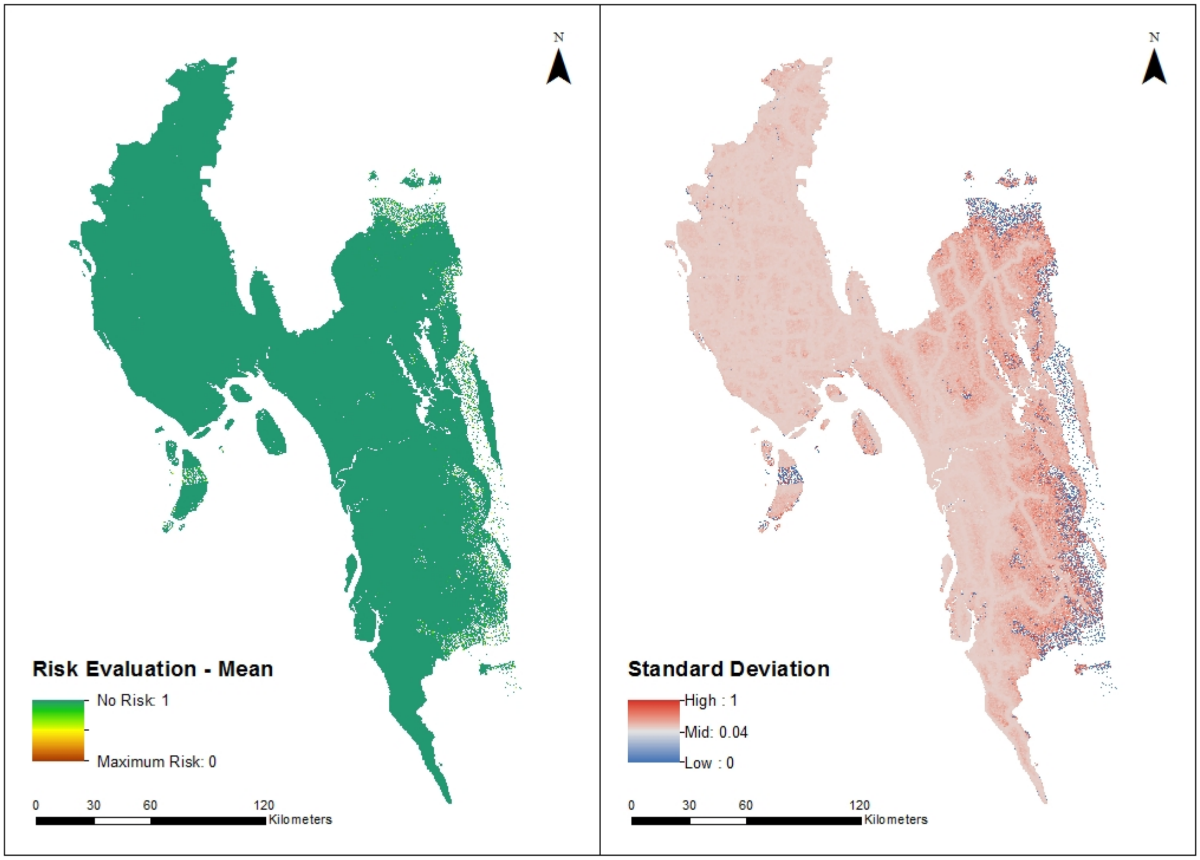

Vaccine Polio DHS Metric
N
Risk Evaluation - Mean
No Risk: 1
Maximum Risk: 0
0 30 60 120
Kilometers
N
Standard Deviation
High : 1
Mid: 0.04
Low : 0
0 30 60 120
Kilometers

1.3.2.4 Metric: VaccineDPT

Indicator:	Epidemics/Pandemics
Factor:	Ecosystem Disruptions
Condition:	Natural Hazard
Metric Assigned Values:	Vaccination Date on Card (min: 1.0, max: 1.0) Reported by Mother (min: 0.8, max: 1.0) Vaccination Marked on Card (min: 0.9, max: 1.0) No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	http://www.who.int/immunization/diseases/pertussis/en/ http://www.who.int/immunization/diseases/diphtheria/en/ http://www.cdc.gov/vaccines/hcp/vis/vis-statements/dtap.html
Logic:	This metric consists of answers to the question concerning vaccination against DPT, or diphtheria, pertussis (whooping cough), and tetanus. Within the survey, there are three questions about the DPT vaccines, one for each version of the vaccine: one for DPT1, one for DPT2, and one for DPT3. These likely refer to the various doses of the DPT vaccine. Older versions of the vaccine were given in 3 sequential doses. The World Health Organization continues to recommend 3 high-quality doses of DPT vaccines, often followed by a booster (“Diphtheria” 2015, “Pertussis” 2015). Never versions of the vaccine, called DTap, are given to children in 5 sequential doses (“Diphtheria” 2016). All of these questions and answers are aggregated into one metric. Despite the current PACOM HC framework data entry sheet only citing responses for “Yes” and “No,” the answers in DHS have four response options for this question: “Vaccination Date on Card,” “Reported by Mother,” “Vaccination Marked on Card,” and “No.” The “Vaccination Date on Card” response has a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). The response “Reported by Mother” has a minimum value of 0.8 (minimal risk) and a maximum value of 1.0. The response “Vaccination Marked on Card” is more certain than the former response but less certain than the latter, hence a minimum value of 0.9 (minimal risk) and maximum value of 1.0. The “No” response is given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.500 (slight risk, $½^1$). Maps will range from extreme risk to minimal risk.

Example Realization Metric Map

Vaccine DPT DHS Metric

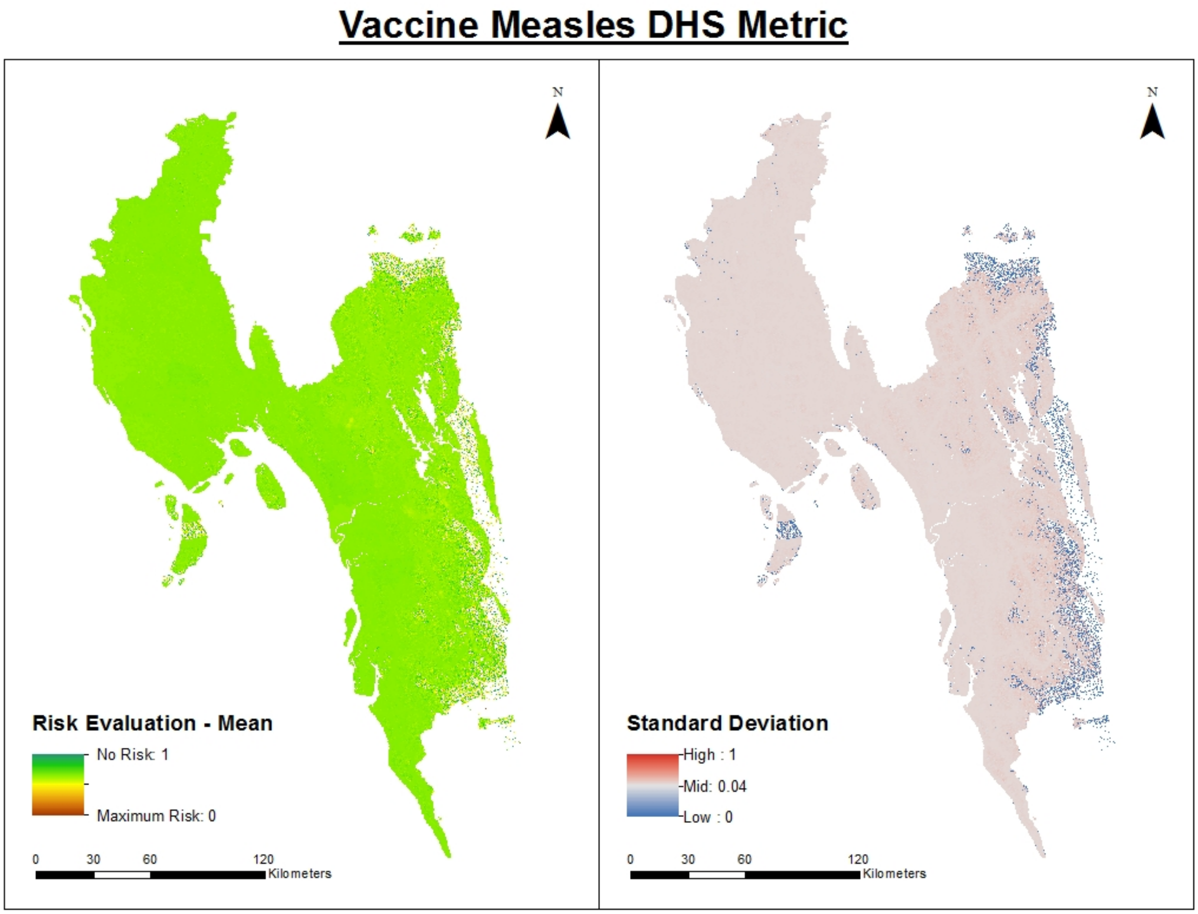


1.3.1.5 Metric: VaccineMeasles

Indicator:	Epidemics/Pandemics
Factor:	Ecosystem Disruptions
Condition:	Natural Hazard
Metric Assigned Values:	Vaccination Date on Card (min: 1.0, max: 1.0) Reported by Mother (min: 0.8, max: 1.0) Vaccination Marked on Card (min: 0.9, max: 1.0) No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	http://www.cdc.gov/vaccines/vpd/measles/index.html
Logic:	This metric consists of answers to the question concerning vaccination against measles. Measles vaccines, or MMR, also vaccinate for mumps and rubella (“Measles” 2016). Despite the current PACOM HC framework data entry sheet only citing responses for “Yes” and “No,” the answers in DHS have four response options for this question: “Vaccination Date on Card,” “Reported by Mother,” “Vaccination Marked on Card,” and “No.” The “Vaccination Date on Card” response has a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). The response “Reported by Mother” has a minimum value of 0.8 (minimal risk) and a maximum value of 1.0. The response “Vaccination Marked on Card” is more certain than the former response but less certain than the latter, hence a minimum value of 0.9 (minimal risk) and maximum value of 1.0. The “No” response is given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.500 (slight risk, $½^1$). Maps will range from extreme risk to minimal risk.

Example Realization Metric Maps

Example Realization Metric Map



1.3.3 Indicator: Severe Insect Infestation

Insect infestations can negatively impact provisioning, regulating, and/or supporting services provided by ecosystems, as they play important roles in pollination, nutrient cycling, disease spread, and waste reduction. Climate change, particularly rising temperatures, has been shown to significantly alter the outbreak dynamics of certain insect species (Liebhold and Bentz 2011).

Forest ecosystems, especially boreal forest ecosystems, are especially susceptible to widespread insect infestations. Obviously, each climate type and ecosystem will have their own specific insect and pest issues The North Carolina Forest Service lists the following common or serious forest insect pests (NCFS 2016):

- Defoliators: feed on the foliage (leaves and needles) of trees. These include pine webworm, pine sawflies, gypsy moth, forest tent caterpillar, eastern tent caterpillar, bagworms, and cankerworms.
- Bark Borers: bore into the bark of trees to feed or reproduce, and are often the most damaging to forest ecosystems. These include south pine beetles, ips beetles, and black turpentine beetles.
- Wood Borers: often secondary pests that bore into the wood of dead or dying trees or green logs to lay eggs. These include sawyer beetles, ambrosia beetles, and sorex wood wasps.
- Seedling, Twig, and Bud Pests: attack seedlings or young succulent tissues of small forest plants. Seedlings can be killed, and large trees can be disfigured. These include pales weevils, tip moths, twig girdlers, and white pine weevils.
- Piercing/Suckling Insects: pierce the surface of soft plant tissues to feed on sap. These include scales, aphids, gall makers, hemlock wooly adelgids, and balsam woolly adelgids.

PACOM specifies that metrics should include: number of severe insect infestations; percentage of consumption crops (e.g., rice, wheat, soy bean) destroyed due to infestation; percentage of production crops or resources (e.g., cotton, timber, bamboo) destroyed due to infection (e.g., boll weevils, nematodes); and financial impact of severe insect infestations.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

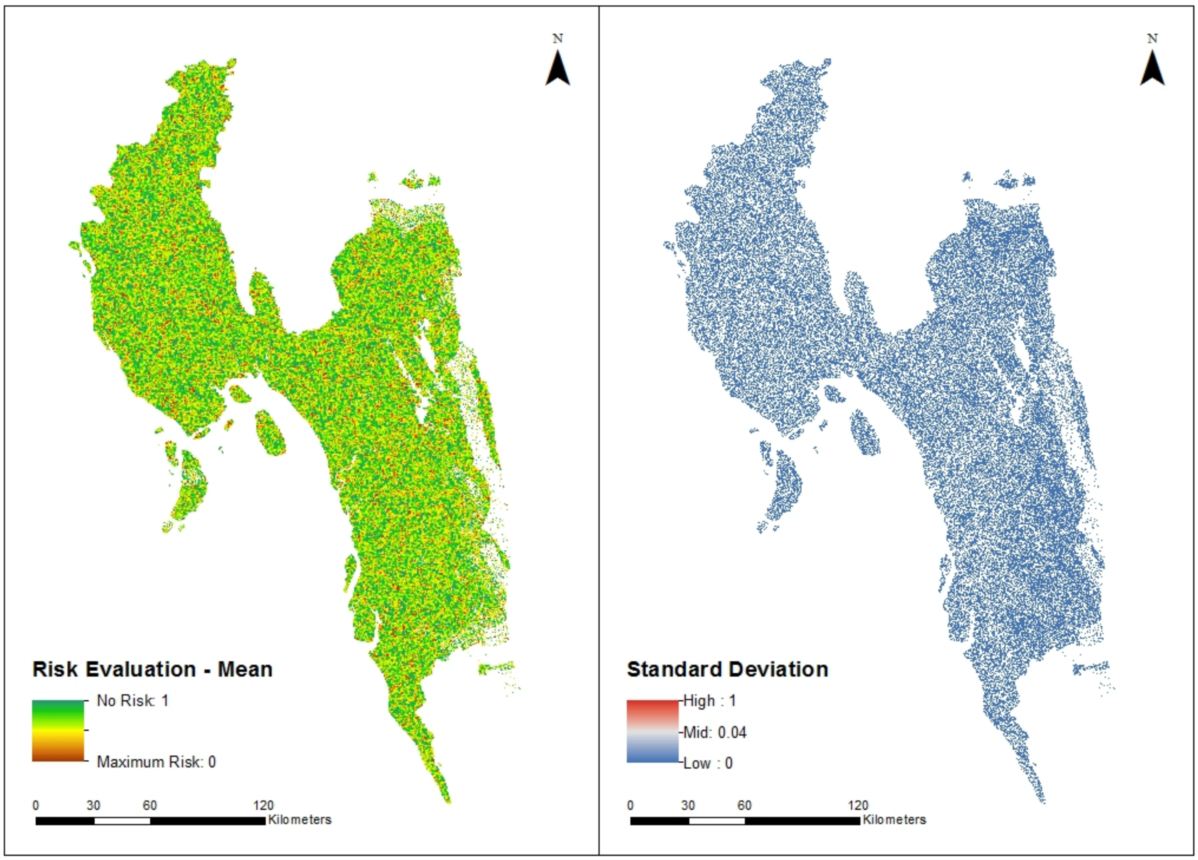
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Severe Insect Infestation Indicator



References

Liebhold, A., Bentz, B. 2011. Insect Disturbance and Climate Change. U.S. Department of Agriculture, Forest Service, Climate Change Resource Center. Accessed at www.fs.usda.gov/ccrc/topics/insect-disturbance/insect-disturbance on 21 Dec 2016.

North Carolina Forest Service (NCFS) (2016). "Common Forest Insect Pests." *North Carolina Forest Service.* Feb 23, 2016. Accessed at http://www.ncforestservice.gov/forest_health/forest_insects.htm on 29 Dec 2016.

1.3.4 Indicator: Commodity Destruction/Infection

In this context, “commodity” refers to agricultural crops, including both consumption and production crops, and timber. This indicator should take into account commodity destruction due to inclement weather and/or crop infections.

PACOM specifies that metrics should include: number of crops destroyed by inclement weather and/or by infection; percentage of consumption crops destroyed due to inclement weather and/or crop infections; percentage of production crops destroyed due to inclement weather or infection (e.g., Elm disease, root rot, fusarium wilt); and financial impact of commodity destruction/infection.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

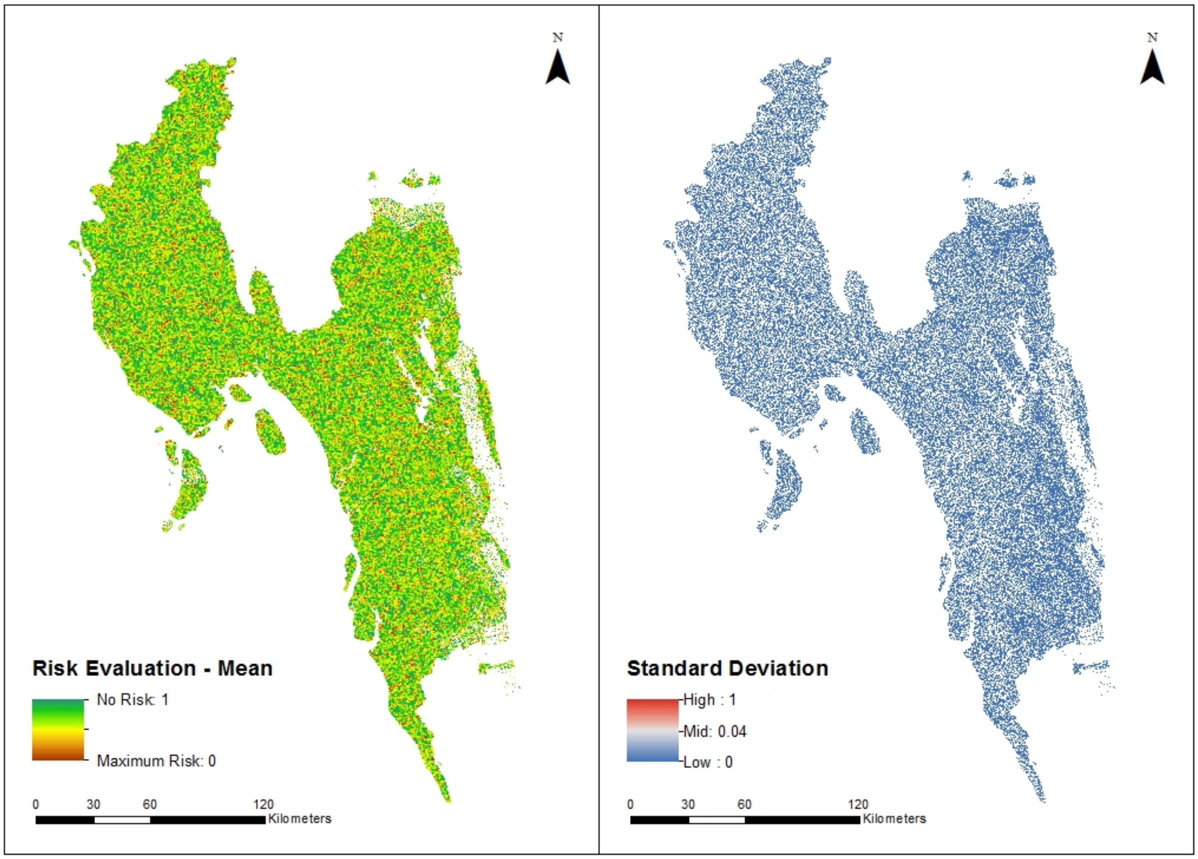
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Commodity Destruction/Infection Indicator



1.3.5 Indicator: Wildfire

The term “wildfire” describes an uncontrolled burning fire, usually in wild lands, which can cause damage to forestry, agriculture, infrastructure, and buildings (IFRC 2016). A wildland fire, or wildfire, is defined as any non-structure fire (other than prescribed fire) that occurs in the wildland (i.e., non-urban areas) (Firewise 1998).

Wildfires, particularly in boreal forests, have historically been important causes of secondary succession in natural ecosystems (Baldocchi). However, man-made causes of wildfires (including climate change) have increased the instances and risk for wildfires around the world.

PACOM specifies that metrics should include: number of wildfires; percentage of buildings damaged, destroyed, or rendered uninhabitable due to wildfires; percentage of land rendered non-arable due to wildfires; percentage of commercial and residential land area rendered unusable due to wildfires; crude mortality rate; monetary damages due to wildfires; and population density in vulnerable areas.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

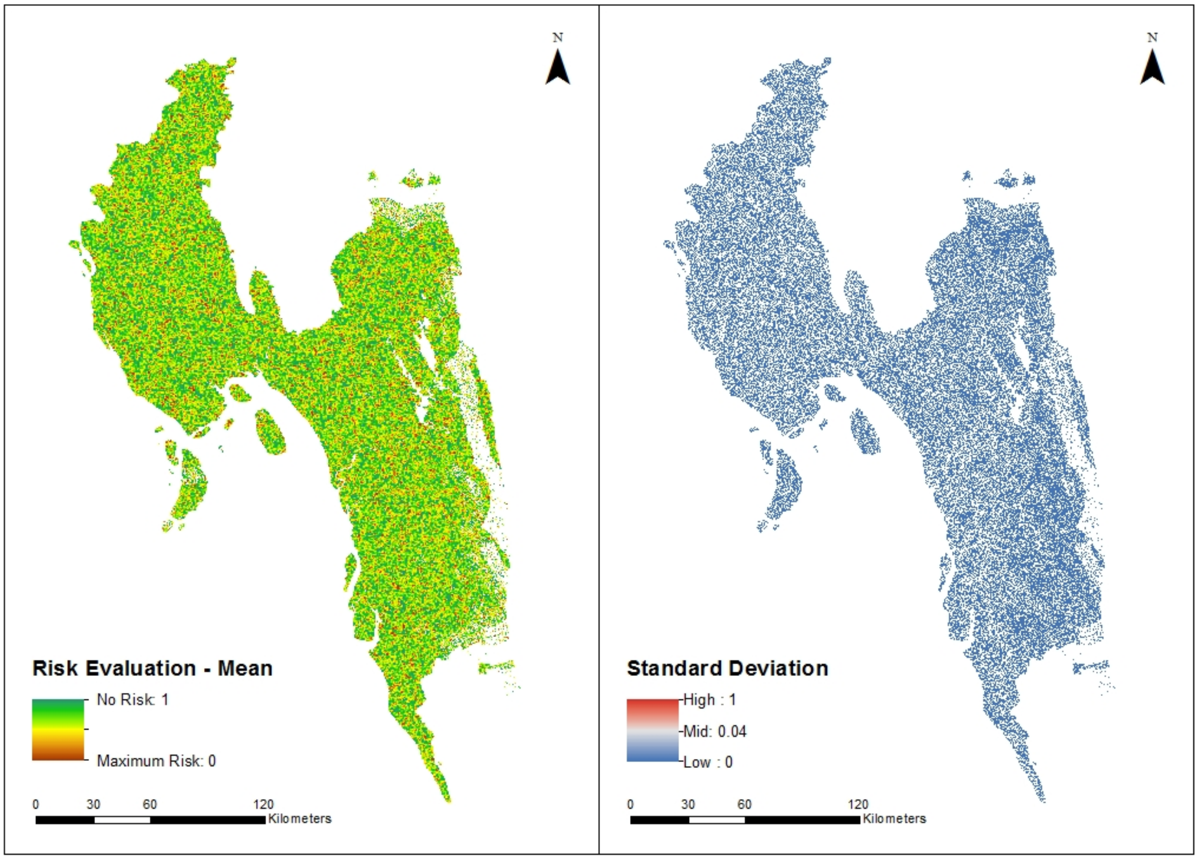
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Wildfire Indicator



References

Baldocchi. Dennis. "Ecosystem Succession: Who/What is Where and When." University of California Berkeley. Accessed at https://nature.berkeley.edu/biometlab/espm111/ESPM%20111%20Ecosystem%20Succession.pdf on 21 Dec 2016.

"Firewise" (1998). Wildfire News and Notes. *Wildland Fire Management Terminology*. Vol. 12, No. 1, pp. 10. March, 1998. Accessed at http://www.firewise.org/pubs/wnn/vol12/no1/pp-10.html.

International Federation of Red Cross and Red Crescent Societies (IFRC). "Climatological hazards: Wildfires / urban fires." Accessed at http://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/wildfires/ on 29 Dec 2016.

2 Human Behavioral Impact Condition Overview

This condition encompasses potential risks and hazards caused by humans. The factor "Contamination and Degradation" addresses the negative human impact on the environment; "Vulnerable Groups" addresses the negative human impact on other humans; and "Substandard Conditions" addresses the negative human impact on infrastructure and the built environment.

The Contamination and Degradation factor currently has no available metric or indicator data, but the Vulnerable Groups and Substandard Conditions factors do.

Factor Weighting Logic

All factors are given both a minimum and maximum weight of 0.333, as they are contributing equally with the condition risk potentially higher than an individual factor's risk level.

Factor (heading number)	Weight Minimum Value	Weight Maximum Value
Contamination and Degradation (2.1)	0.333	0.333
Vulnerable Groups (2.2)	0.333	0.333
Substandard Conditions (2.3)	0.333	0.333

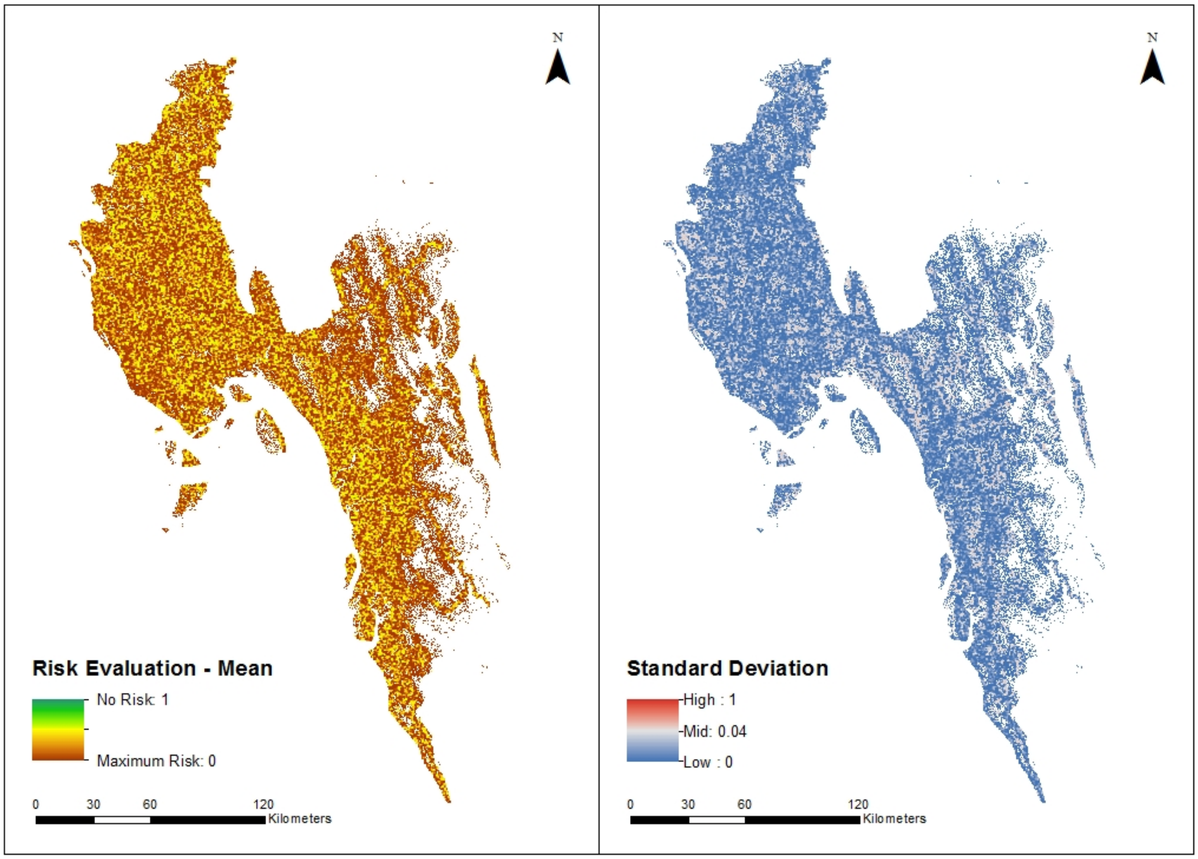
Uncertainty Values

While the factors do encompass multiple aspects of human-caused risk and vulnerabilities, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Condition Uncertainty Min: 0.1
Condition Uncertainty Max: 0.3

Example Outcome

Human Behavioral Impact Condition



2.1 Contamination and Degradation Factor Overview

The United Nations International Strategy for Disaster Reduction (UNISDR) defines environmental degradation as:

> Processes induced by human behavior and activities (sometimes combined with natural hazards) that damage the natural resource base or adversely alter natural processes or ecosystems. Potential effects are varied and may contribute to an increase in vulnerability and the frequency and intensity of natural hazards. Examples include land degradation, deforestation, desertification, wildland fires, loss of biodiversity, land, water and air pollution, climate change, sea level rise and ozone depletion." (UNISDR 2004, pg 39 Table 2.1)

Environmental degradation is also listed as one of six "cluster of threats" to be concerned with now and in the decades ahead identified by the United Nations Secretary General's High-level Panel on Threats, Challenges, and Change (United Nations 2004).

This factor focuses on contributors to the destruction of the natural environment due to man-made causes. Unlike the other factors within the Human Behavioral Impact condition, this factor addresses environmental hazards on a larger scale (regional, national, and/or international). While the indicators and metrics here have just as much potential to severely disrupt ecosystems as the components of the Ecosystem Disruptions factor, these particular components consist of unnatural causes to ecosystem disruption.

For the Humanitarian Crisis Framework, the indicators include food processing contamination, chemical or other industrial, nuclear/radiological, and biological (animal husbandry).

None of these indicators are available from Phase Zero Assessment of Urban Security Threats research, as there is no metric data for any of them. Some indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All indicators are given both a minimum and maximum weight of 1.0, as it is equally as constraining on the factor as the other indicators.

Note: This weighting scheme may, and should, change once metrics are selected to fill in each of the indicators.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Food Processing Contamination (2.1.1)	1.0	1.0
Chemical or Other Industrial (2.1.2)	1.0	1.0
Nuclear/Radiological (2.1.3)	1.0	1.0

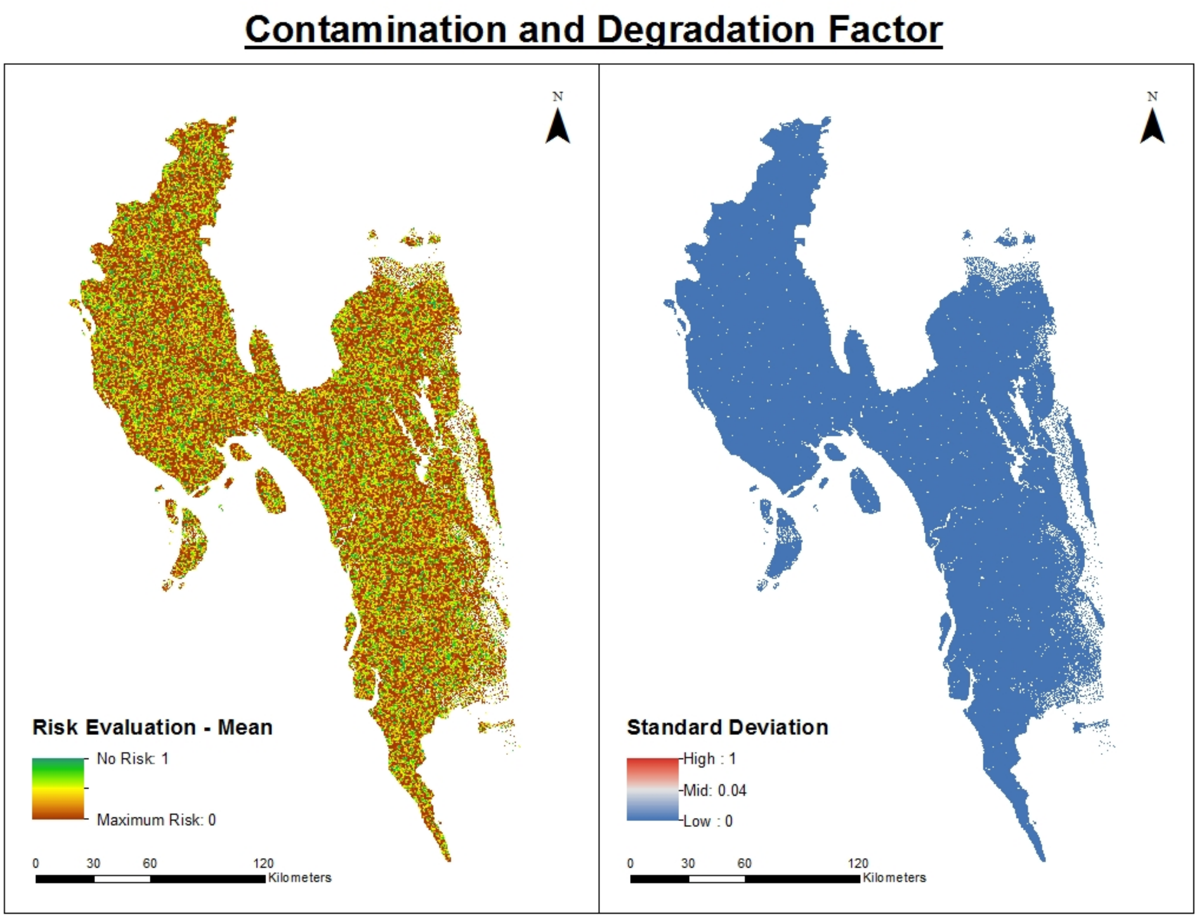
Biological (Animal Husbandry) (2.1.4)	1.0	1.0

Uncertainty Values

This points to the overall thoroughness of the indicators in covering all aspects of contamination and degradation, but also denotes that the addition of indicators (i.e., one measuring land degradation and deforestation) could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.2

Example Outcome



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2004), *Living with Risk: A global review of disaster reduction initiatives*, Geneva, Switzerland, 2004.

United Nations (2004). A more secure world: Our Shared Responsibility. Report of the Secretary-General's High-level Panel on Threats, Challenges and Change. Accessed at http://www.un.org/en/peacebuilding/pdf/historical/hlp_more_secure_world.pdf on 29 Dec 2016.

2.1.1 Indicator: Food Processing Contamination

According to the US Center for Disease Control, food has the potential to be contaminated at every step along the modern food production chain (see Figure 1) (CDC "Food Production Chain" 2015). The food chain involves several steps, and differs depending on the type of food and where the food is eventually eaten. The four major steps are production (growing plants, raising animals), processing (slaughter, roasting, cleaning, bagging, etc.), distribution (transportation and storage), and preparation (getting food ready to eat). A comprehensive list and analysis of foodborne illnesses and contamination outbreaks from 1998 to the present in the United States can be found using the CDC's Foodborne Outbreak Online Database (FOOD) tool (link in citation).

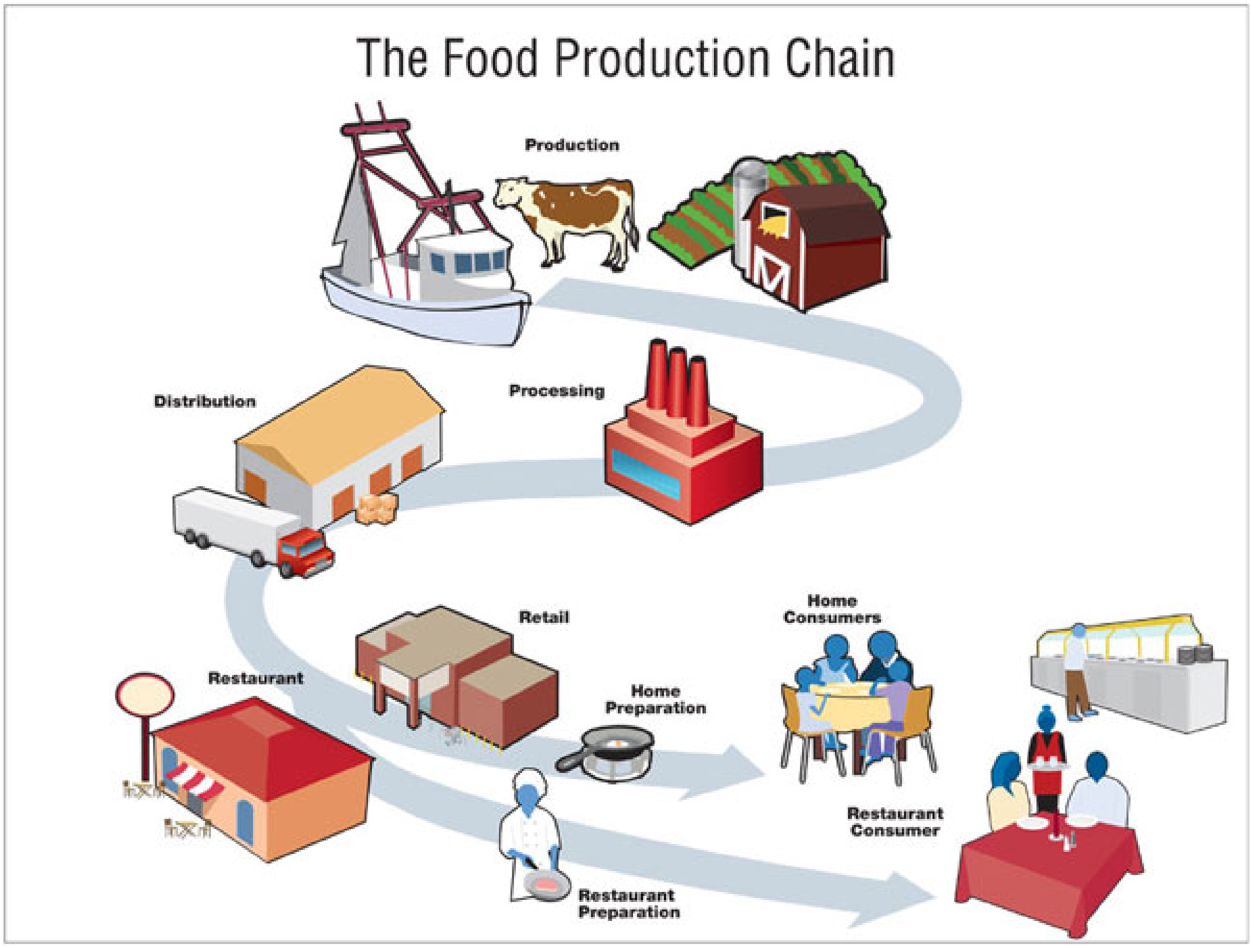


Figure 1: Food Production Chain. Source: https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/production-chain.html#chain

Unwanted chemicals in food include pesticide and veterinary drug residues, fungal toxins (mycotoxins) and other natural toxins, unauthorized use of non-compliant food additives, inappropriate ingredients and processing or environmental contaminants (Thomson et al 2012).

Sources of food contamination can overlap with other indicators in this factor. For example, industrial discharge contaminated seafood with mercury in Minamata Bay, Japan in the 1950's, resulting in hundreds of millions of dollars in compensation costs and lost revenue (George 2002; Hylander & Goodsite 2006; The Asahi Shimbun 2010). While the incident of chemical discharge into the bay would logically fall under the "Chemical or Other Industrial" indicator within this framework, the fact that the discharge affected wildlife which eventually became food would qualify it for the Food Processing Contamination indicator. Essentially, the incident and its effects can be divided up among multiple indicators here. Casualties and costs resulting from the overall effects of the industrial discharge could be accounted for within the "Chemical of Other Industrial" indicator, while casualties and costs resulting directly from the consumption of seafood from the bay could be accounted for in this indicator.

While this indicator is named "Food Processing Contamination," it can and should include instances of contamination at any step in the food production chain.

PACOM specifies that metrics should include: number of reported food contamination incidents; percentage of contaminated farmland; number of casualties due to food contamination; crude mortality rate; and financial impact due to food processing contamination.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

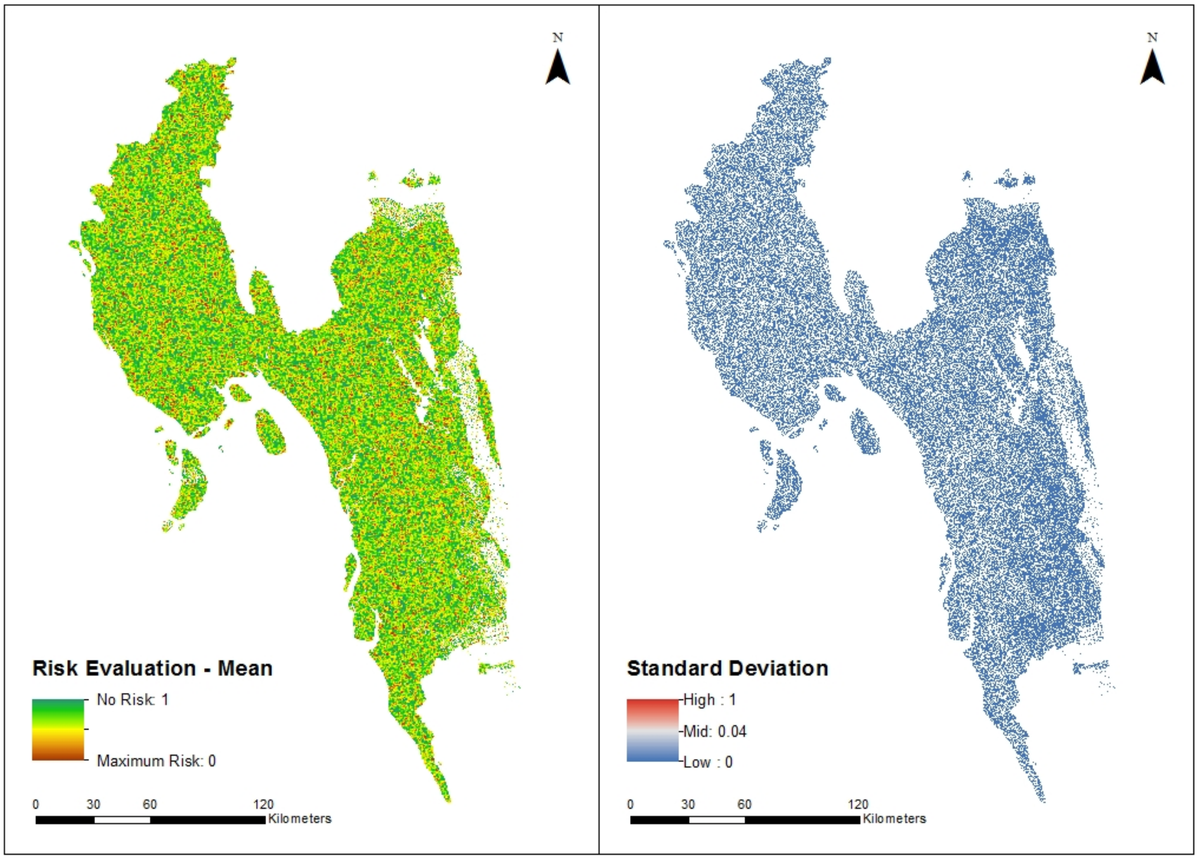
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Food Processing Contamination Indicator



References

Center for Disease Control (CDC) (2015). "The Food Production Chain – How Food Gets Contaminated." Mar 24, 2015. Accessed at https://www.cdc.gov/foodsafety/outbreaks/investigating-outbreaks/production-chain.html#chain on 29 Dec 2016.

George T.S. (2002) *Minamata: Pollution and the Struggle for Democracy in Postwar Japan*. Harvard University Asia Center, Cambridge, MA, USA.

Hylander L.D., Goodsite M.E. (2006) Environmental costs of mercury pollution. *Science of the Total Environment*, **368**, 352–370.

The Asahi Shimbun (2010). *Agreement reached to settle Minamata suit*. Available at http://www.asahi.com/english/TKY201003300438.html [Last accessed 20 March 2012].

Thomson B, Poms R, Rose M (2012). Incidents and impacts of unwanted chemicals in food and feeds. *Quality Assurance and Safety of Crops & Foods*, 4, 77–92.

2.1.2 Indicator: Chemical or Other Industrial

This indicator consists of both chemical contaminants being released into the air, water, and/or soil, and other negative effects on the environment from industrial activities. An overview of industrial discharge and its impacts on the health of both the human population and the environment can be found in Ho et al 2012.

PACOM specifies that metrics should include: number of chemical or other industrial accidents; number of casualties due to chemical or other industrial accidents and contamination (e.g., radiological); crude mortality rate; and financial impact due to chemical or other industrial accidents.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

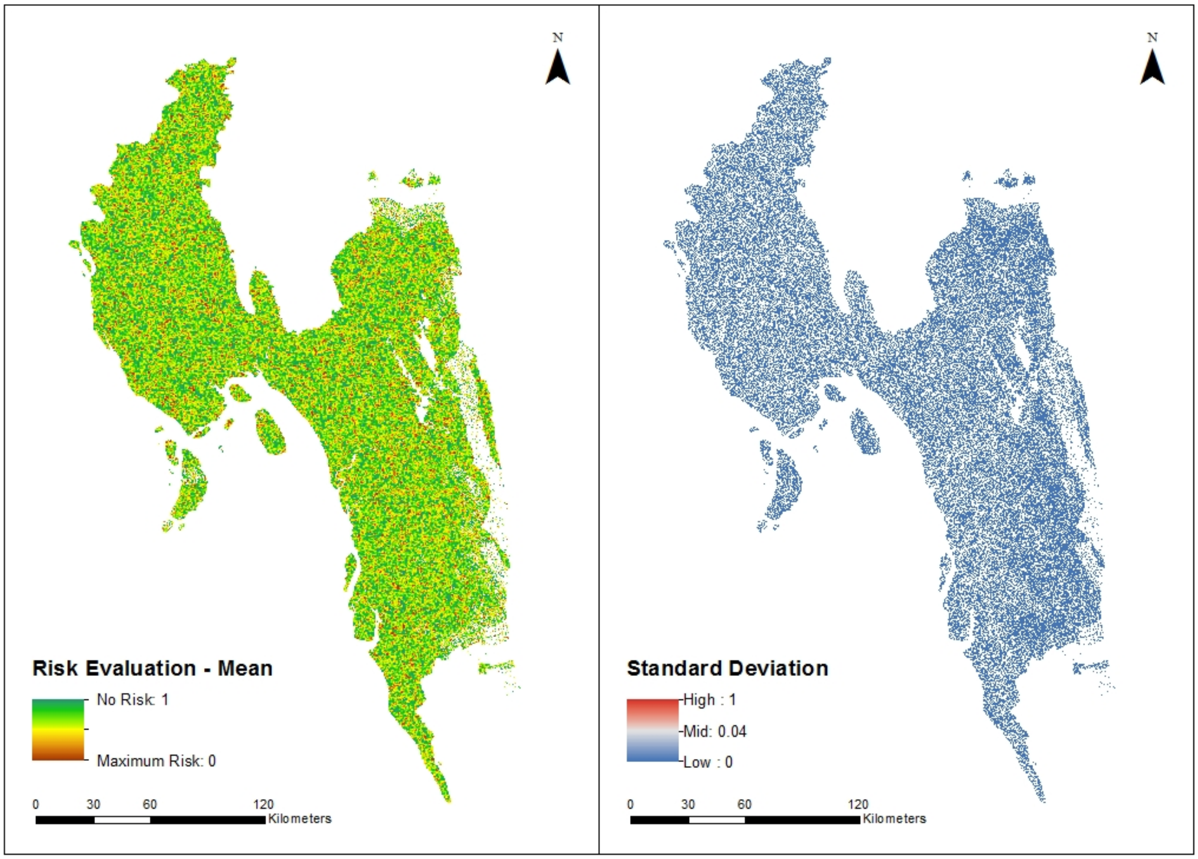
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Chemical or Other Industrial Indicator



References

Y.C. Ho, K.Y. Show, X.X. Guo, I. Norli, F.M. Alkarkhi Abbas and N. Morad (2012). Industrial Discharge and Their Effect to the Environment, Industrial Waste, Prof. Kuan-Yeow Show (Ed.), ISBN: 978-953-51-0253-3, InTech, Available from: http://www.intechopen.com/books/industrial-waste/industrial-emissions-and-theireffect-on-the-environment-.

2.1.3 Indicator: Nuclear/Radiological

This indicator measures the negative impacts of environmental degradation caused by nuclear incidents and/or radiological contaminants. These are often caused by issues with nuclear power plants/reactors, such as the Fukushima Daiichi nuclear reactor in Japan in 2011, and the Chernobyl accident in the then USSR in 1986. As these listed events are the only nuclear energy accidents to be classified as a level 7 event (the maximum classification) on the International Nuclear Event Scale, most nuclear energy incidents occur on smaller scales in terms of costs and casualties.

PACOM specifies that metrics should include: number of nuclear or radiological accidents; number of casualties due to nuclear/radiological accidents and contamination; crude mortality rate; and financial impact due to nuclear/radiological accidents.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

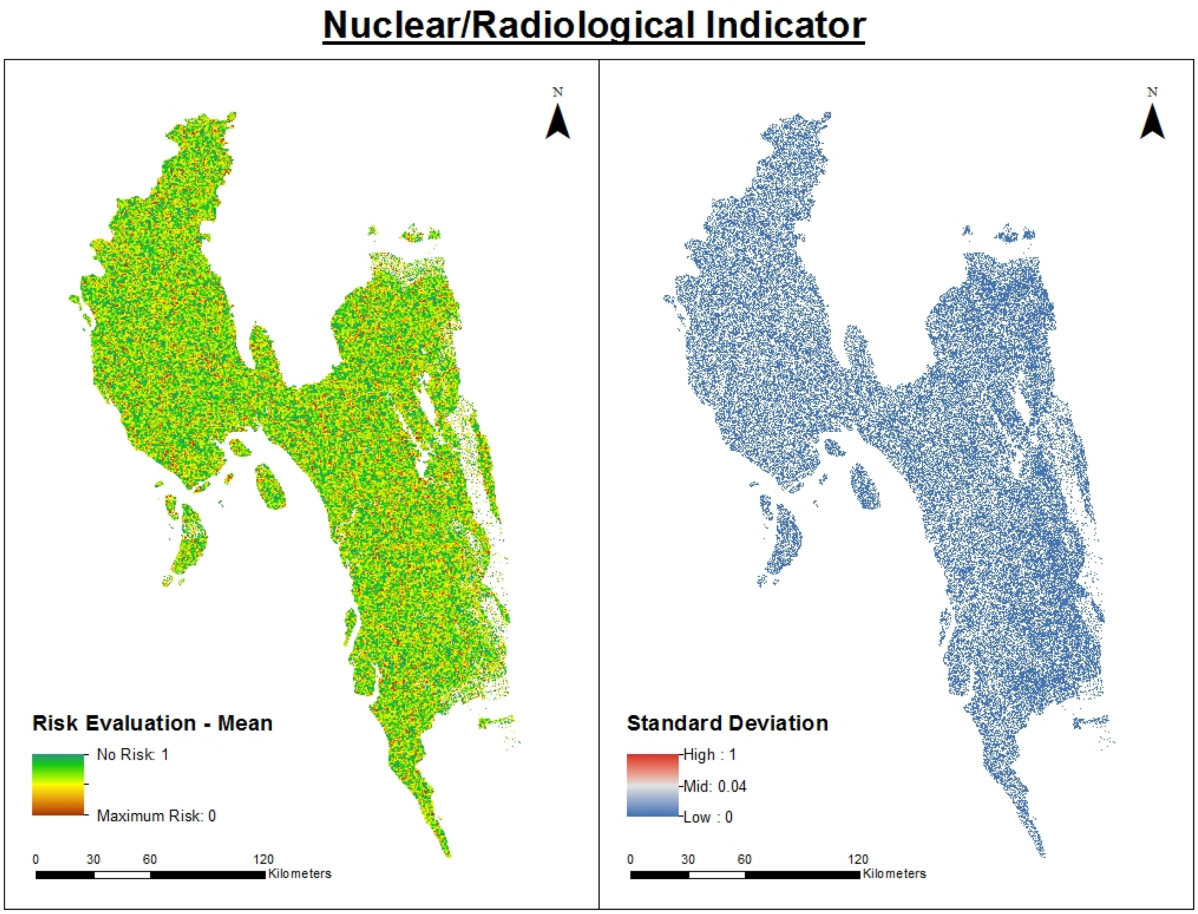
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



2.1.4 Indicator: Biological (Animal Husbandry)

The “Biological (Contamination/Degradation)” indicator accounts for an abnormal and/or harmful presence of biological contaminants, or contaminants that are/are produced by living things. According to the US Environmental Protection Agency (EPA), biological contaminants include bacteria, viruses, animal dander and cat saliva, house dust, mites, cockroaches, and pollen (EPA 2016).

This indicator perhaps has the most overlap with Food Processing Contamination; but rather than addressing the direct impact of biological contaminants on food/human health through food consumption, Biological (Contamination/Degradation) addresses abnormal, harmful presences of the contaminants themselves.

PACOM specifies that metrics should include: number of cases of bovine contamination (e.g., Mad Cow, Listeria, foot and mouth disease); number of cases of poultry contamination (e.g., Salmonella, avian flu); number of casualties due to biological contamination; crude mortality rate; and financial impact due to biological contamination or other incidents.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

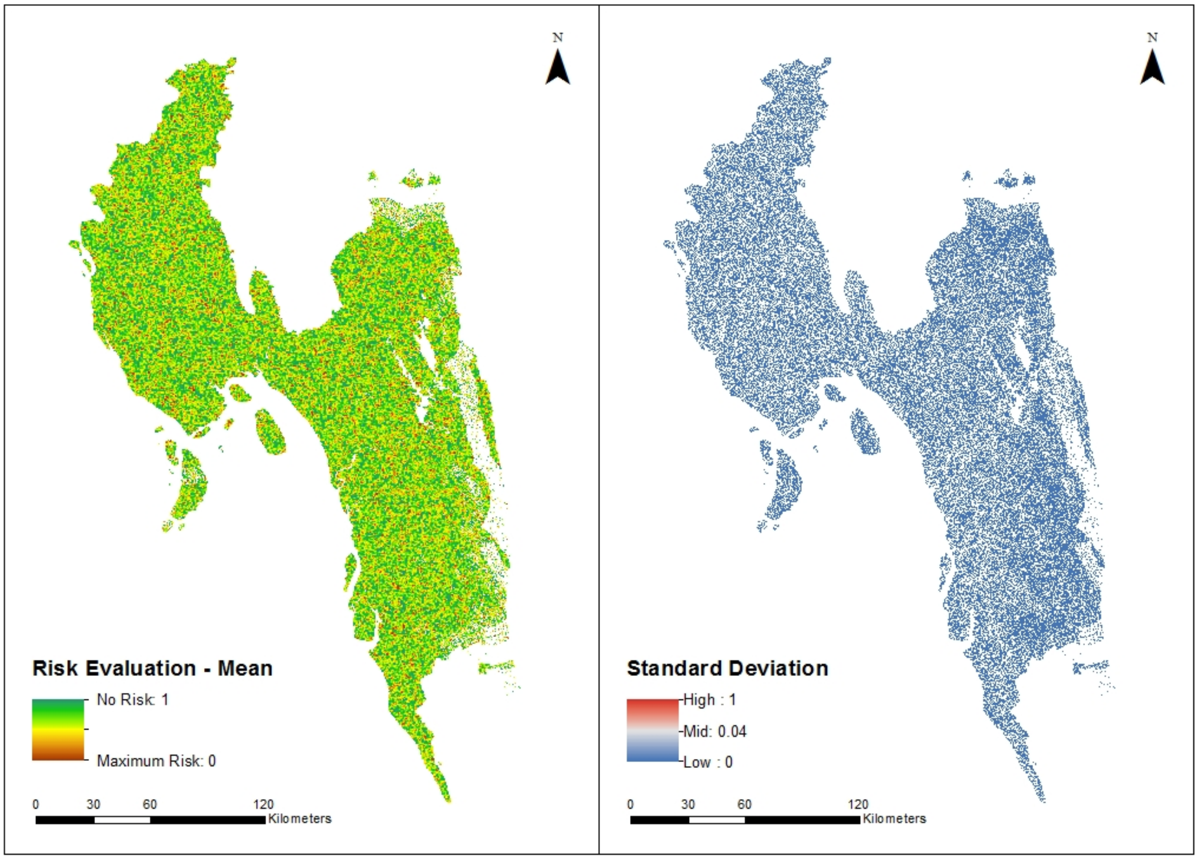
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Biological (Animal Husbandry) Indicator



References

Environmental Protection Agency (EPA) (2016). "Biological Pollutants' Impact on Indoor Air Quality." Sept 2016. Accessed at https://www.epa.gov/indoor-air-quality-iaq/biological-pollutants-impact-indoor-air-quality on 29 Dec 2016.

2.2 Vulnerable Groups Factor Overview

This factor assesses the presence of groups of people who are, due to their current circumstances, more vulnerable to humanitarian crises. There are various definitions of "vulnerability" that are relevant here:

> "Vulnerability: The characteristics and circumstances of a community, system or asset that make it susceptible to the damaging effects of a hazard. This definition identifies vulnerability as a characteristic of the element of interest (community, system or asset) which is independent of its exposure. However, in common use the word is often used more broadly to include the element's exposure." (UNISDR 2009, pg 30)

> "Vulnerability and vulnerability assessment generally relate to the identification of factors (such as social, physical, economic and environmental factors) that, on the one hand, render people or systems susceptible to impacts resulting from natural hazards and climate change, and on the other hand, describe their adapt to adverse impacts of natural hazards. Vulnerability and hence the susceptibility, coping capacities and adaptive capacities of people and systems, however, are not static but are subject to strong dynamics." (Birkmann, et al. 2011, pg 15)

> "…Vulnerability refers to social, physical, economic and environment-related factors that make people or systems susceptible to the impacts of natural hazards and adverse consequences of climate change. Additionally, the Index examines the abilities and capacities of people or systems to cope with and adapt to negative impacts of natural hazards." (Welle, et al. 2012, pg 14)

This factor includes the available indicators of IDPs/Refugees; Undernourished Population; Casualties, Injured, Sick; and Targeted Groups.

Only the Undernourished Population and Casualties, Injured, and Sick indicators currently have any available metric data. Other indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All indicators are given both a minimum and maximum weight of 0.25, as they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
IDPs/Refugees (2.2.1)	0.25	0.25
Undernourished Population (2.2.2)	0.25	0.25
Casualties, Injured, Sick (2.2.3)	0.25	0.25

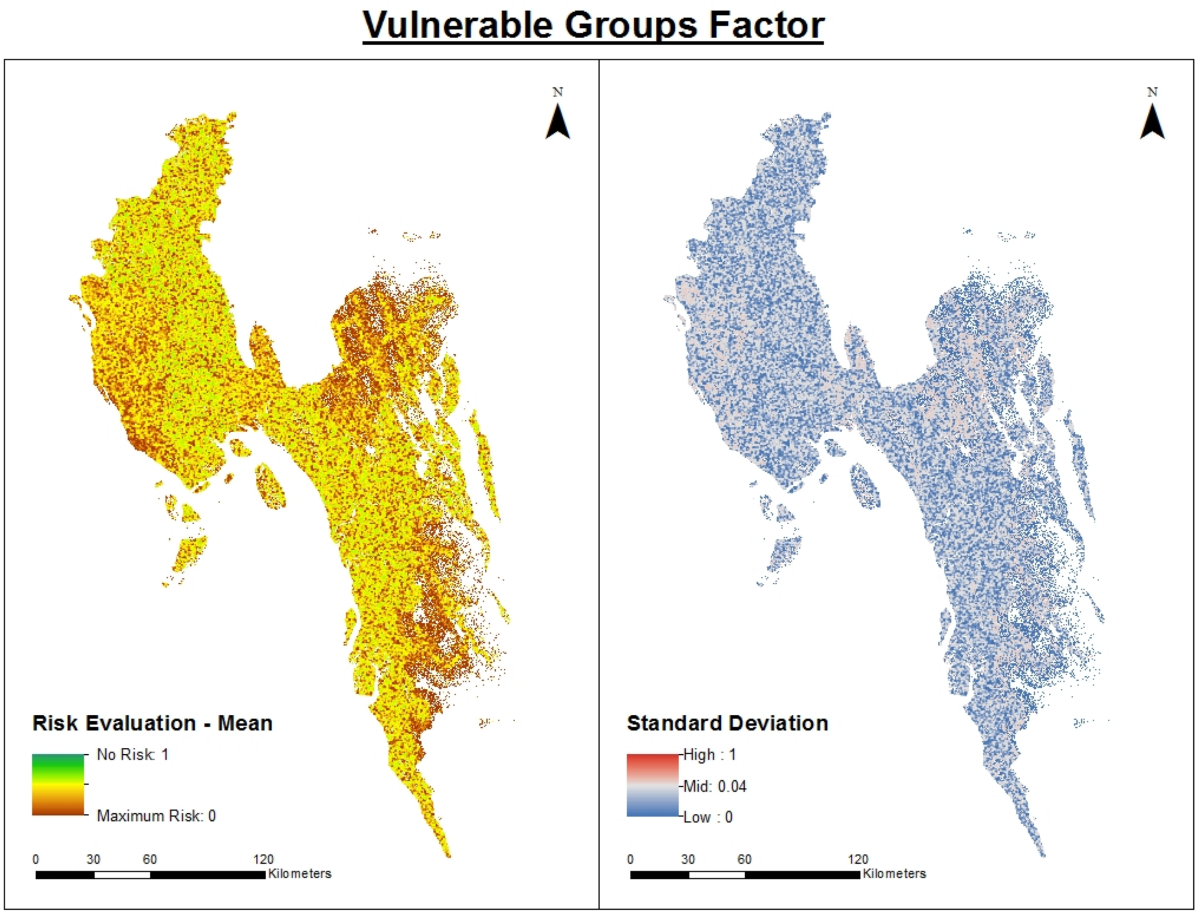
Targeted Groups (2.2.4)	0.25	0.25

Uncertainty Values

This points to the overall thoroughness of the indicators in covering all aspects of vulnerable groups, but also denotes that the addition of indicators (i.e., one measuring those living in regions especially susceptible to natural hazards, employment and other socioeconomic indicators, etc.) could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.2

Example Outcome



References

Birkmann, Jorn, Torsten Welle, Dunja Krause, Jan Wolfertz, Dona-Catalina Suarez, and Neysa Jacqueline Setiadi (2011), "2. WorldRiskIndex: Concept and results," *WorldRiskReport 2011*, Alliance Development Works, Berlin, Germany, 2011, pgs 13-42.

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

Welle,Torsten, Jorn Birkmann, Jakob Rhyner, Maximilian Witting, and Jan Wolfertz (2012), "2. WorldRiskIndex 2012: Concept, updating and results," *WorldRiskReport 2012*, Alliance Development Works, Berlin, Germany, 2012, pgs 11-23.

2.2.1 Indicator: IDPs/Refugees

While IDPs (Internally Displaced Persons) and refugees have both been forced to leave their homes, there are different definitions and classifications established by international humanitarian agencies and laws.

IDPs are described in the Guiding Principles on Internal Displacement (1998) as: "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border." The involuntary nature of their departure and the fact that they remain in their own country are the two major elements determining IDP status (ISIM Georgetown 2007). Many IDPs are women and children, tend to remain close to conflict zones, and suffer higher rates of mortality than the general population (OHCHR 2016). They are also at a higher risk of physical attack, sexual assault and abduction, and are often deprived of adequate shelter, food, and health services (OHCHR). IDPs, unlike refugees, are not as directly protected by international law or eligible to receive many types of aid (USA for UNHCR 2016).

Conversely, the 1951 Refugee Convention has established a definition and series of guaranteed rights to refugees. According to this convention, a "refugee" is a person who, "owing to well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable, or owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it" (OHCHR). In order to be designated a “refugee,” the person must have crossed an international border; otherwise, they are an IDP.

PACOM specifies that metrics should include: the number of displaced persons [baseline set at 20]; percentage of population that are IDPs/refugees; percentage of IDPs/refugees who remain in camps; percentage of IDPs/refugees who are elderly, ill, or children/adolescents; perception among IDPs/refugees that security conditions are unsuitable for return or resettlement; and perception among IDPs/refugees that conditions for meeting basic needs in their place of origin are unsuitable for return or resettlement.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

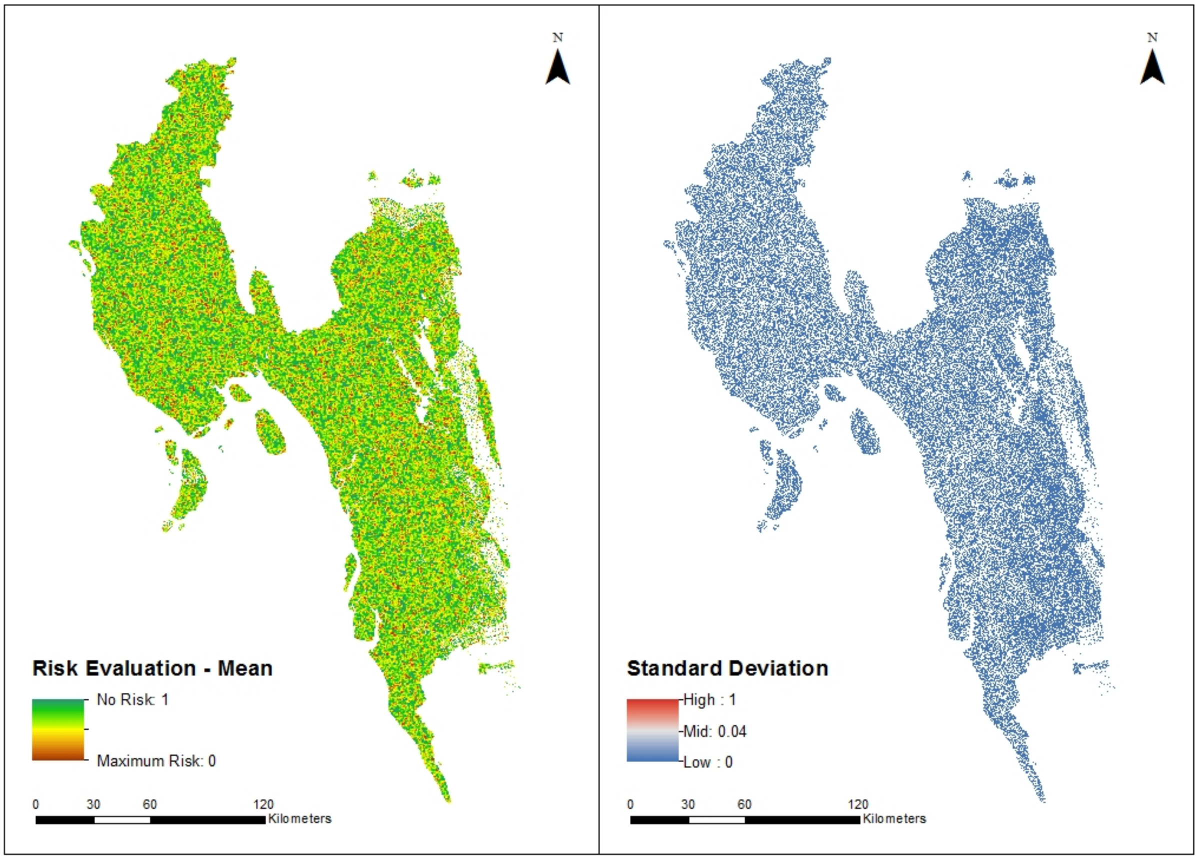
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

IDPs/Refugees Indicator



References

Institute for the Study of International Migration (ISIM) at Georgetown University (2007). “Internal Displacement Frequently Asked Questions.” Guiding Principles on Internal Displacement. Accessed at http://www.law.georgetown.edu/idp/english/id_faq.html on 30 Dec 2016.

United Nations Human Rights Office of the High Commissioner (OHCHR) (2016). “Questions and Answers about IDPs.” Accessed at http://www.ohchr.org/EN/Issues/IDPersons/Pages/Issues.aspx#1 on 30 Dec 2016.

United States for the Office of the United Nations High Commissioner for Refugees (USA for UNHCR) (2016). “What is a refugee?” Accessed at http://www.unrefugees.org/what-is-a-refugee/ on 30 Dec 2016.

2.2.2 Indicator: Undernourished Population

Despite the title, this indicator accounts for current and historical data on both the malnourished and undernourished populations.

The World Food Programme (WFP) defines malnutrition as “A condition resulting when a person’s diet does not provide adequate nutrients for growth and maintenance or when a person is not able to adequately utilize the food consumed due to illness” (WFP 2017). This include both undernutrition (too thin, micronutrient deficiencies, etc.) and overnutrition (overweight and obesity). Undernourishment is defined as “An indicator of inadequate dietary energy intake (based on FAO’s definition of hunger, characterized as consuming less than a minimum level of kilocalories) that is assessed at the population level using national food balance sheets to determine the supply of dietary energy available to a given population and modeling of how that energy is distributed across the population” (WFP 2017).

PACOM specifies that metrics should include: percentage of population that is malnourished or undernourished; and number of children with acute malnutrition (compared with historical data).

Metric Weighting Logic

“PerceivedIssueFood”, which asks respondents whether access to safe and nutritional food is a serious issue within their community from the VPS survey, most directly addresses the indicator’s goals in a broad, regional sense. While “ChildEatYesterday”, which asks respondents if their child ate yesterday from the DHS survey, can capture information on household-level food security. As such, they are both constraining metrics to the indicator which ensure that the indicator’s risk value is as high as either metric. And thus are weighted both a minimum and maximum value of 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueFood (2.2.2.1)	1.0	1.0
PerceivedEffortFood (2.2.2.2)	0.35	0.75
ChildEatYesterday (2.2.2.3)	1.0	1.0

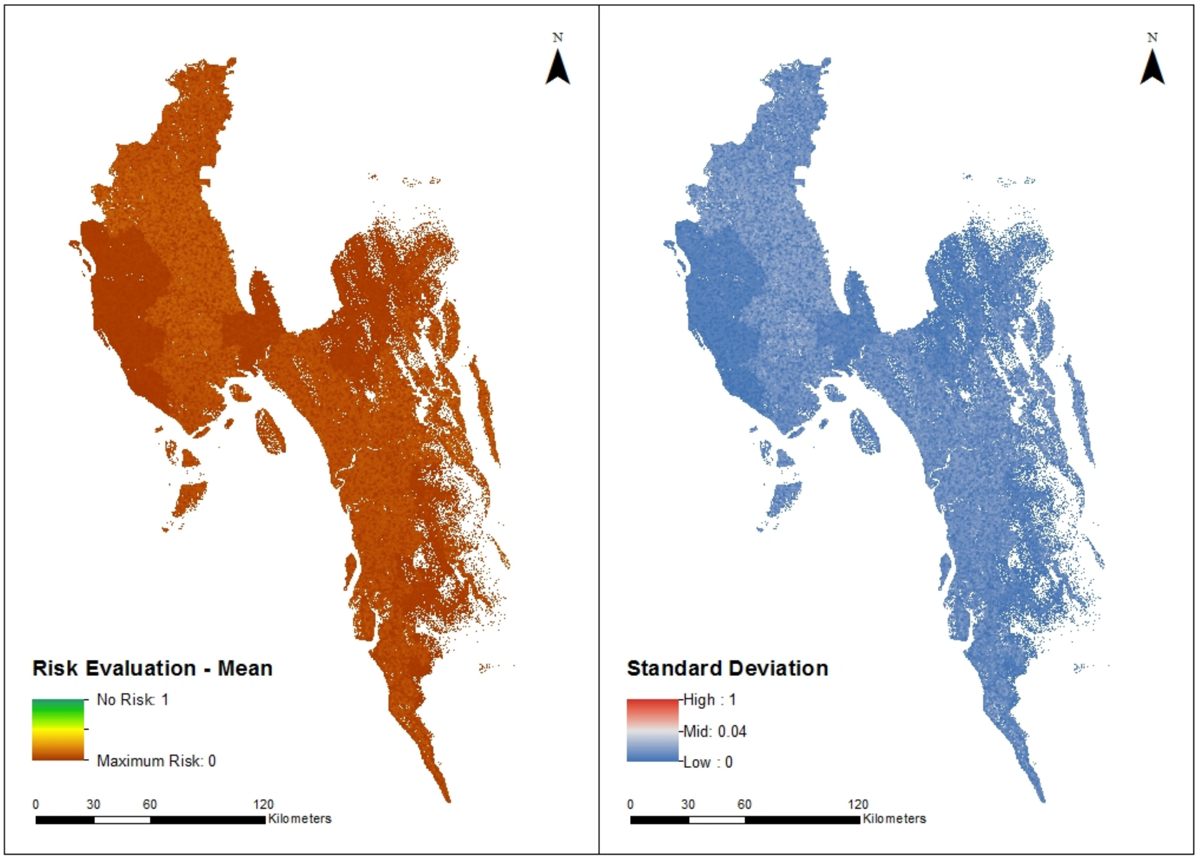
Uncertainty Values

While current metrics somewhat address the presence of malnourished and undernourished populations, they do not include quantitative numbers and percentages as specified by PACOM.

Indicator Uncertainty Min: 0.4
Indicator Uncertainty Max: 0.6

Example Outcome

Undernourished Population Indicator



References

World Food Programme (WFP) (2017). Hunger Glossary. Accessed at https://www.wfp.org/hunger/glossary on 3 Jan 2017.

2.2.2.1 Metric: PerceivedIssueFood

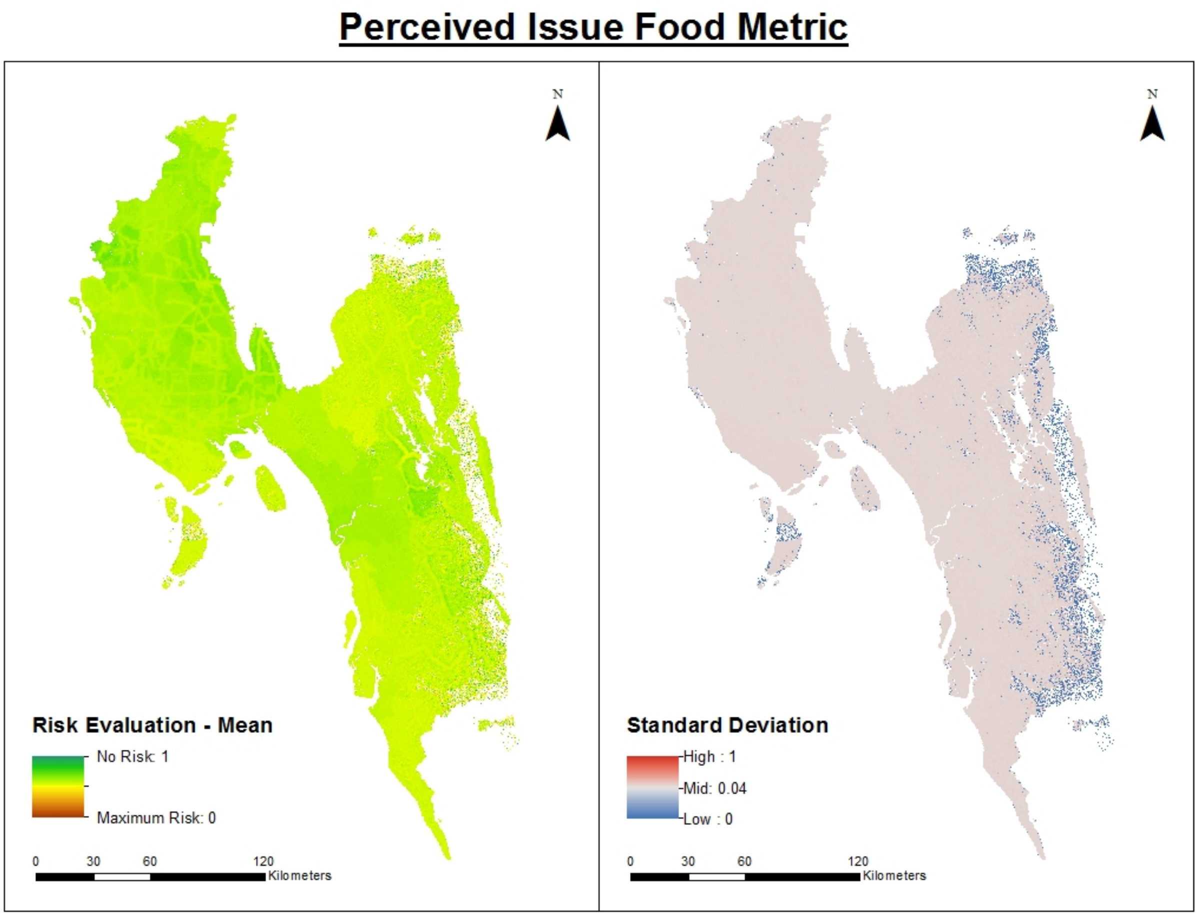
Indicator: Undernourished Population
Factor: Vulnerable Groups
Condition: Human Behavioral Impact
Metric Assigned Values: NotIssue (min: 1.0, max: 1.0)
LessSerious (min: 0.25, max: 0.9)
MoreSerious (min: 0.07, max: 0.5)
Survey: VPS
Survey Date: 2011
Other Data Sources:

Logic: This metric consists of answers to the question “Can you tell me whether access to safe and nutritious food is more or less serious in your community than in the rest of Bangladesh?”

Answers of “Not an Issue” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, ½^{1}). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, ½^{2}) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, ½^{1}). The ranges of risk impact are larger due to the subjective nature of the question. Maps will range from high risk to no risk.

This metric is weighted with both a minimum and maximum value of 1.0 as it is the only metric that addresses access to food at the local community level (versus the household or national level).

Example Realization Metric Map

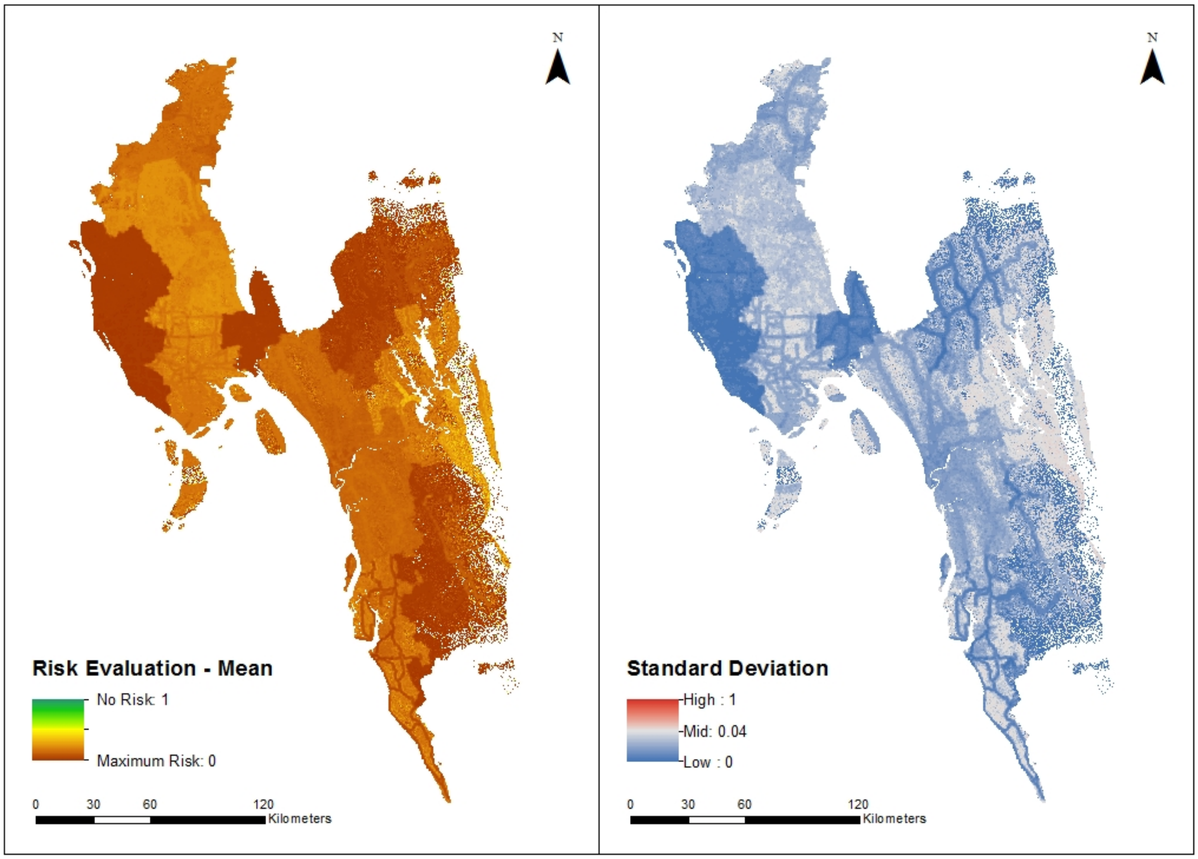


2.2.2.2 Metric: PerceivedEffortFood

Indicator:	Undernourished Population
Factor:	Vulnerable Groups
Condition:	Human Behavioral Impact
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe it working hard to improve the access to safe and nutritious food in Bangladesh today?” “Yes” answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $\frac{1}{2}^{1}$). “No” answers are given a minimum value of 0.25 (medium risk, $\frac{1}{2}^{2}$) and a maximum value of 0.98 (minimal risk). As the question is subjective, the “No” answer could merely reflect a lack of knowledge about organizations and individuals working to improve food access, and not a lack of presence or actual effort. This is why the risk ranges from medium to very minimal risk. Maps will range from medium risk to no risk.

Example Realization Metric Map

Perceived Effort Food Metric



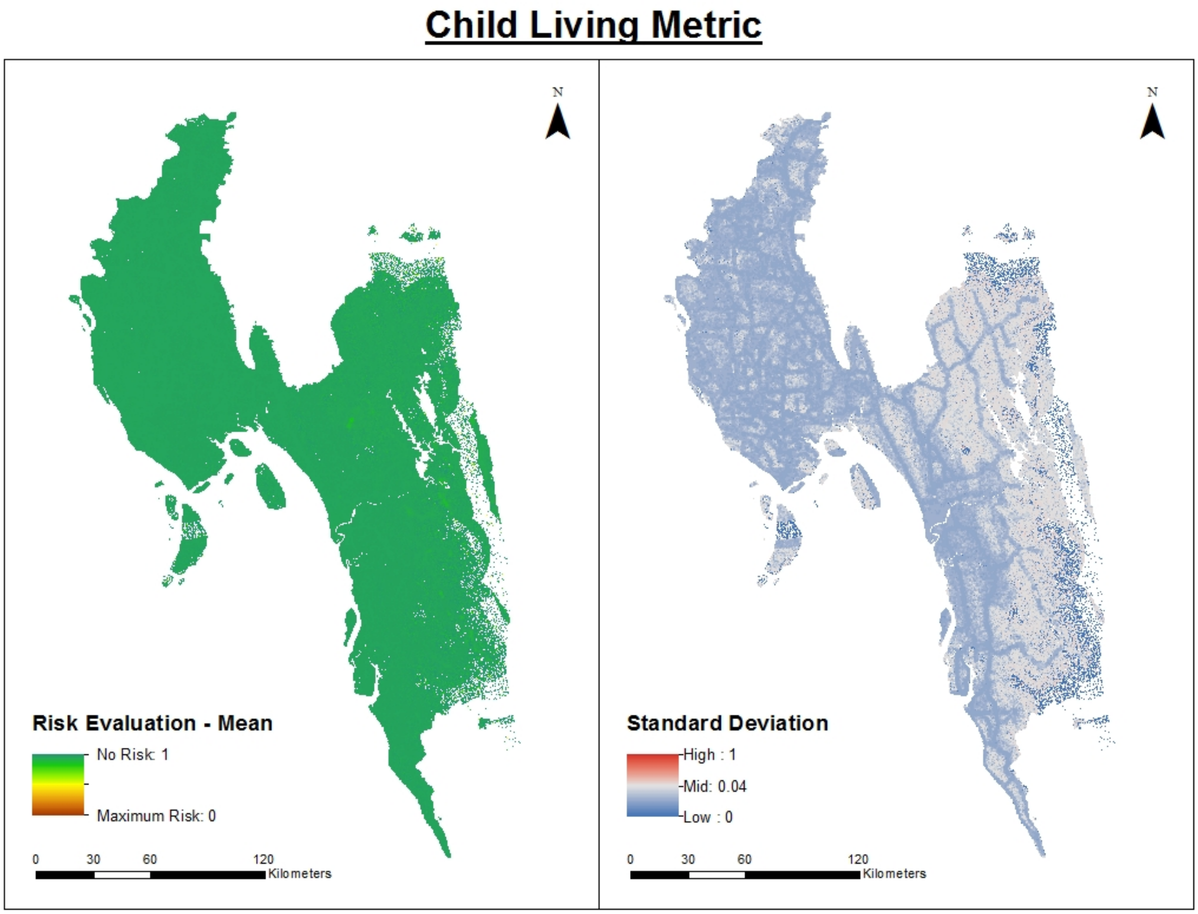
2.2.2.3 Metric: ChildEatYesterday

Indicator:	Undernourished Population
Factor:	Vulnerable Groups
Condition:	Human Behavioral Impact
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.0625, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Did child eat any solid, semi-solid, or soft foods yesterday?"

"Yes" answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). "No" answers are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). As this question directly addresses household-level access to food, the "No" answers are given a slightly smaller range of risk, and the metric as a whole is weighted higher than the previous "PerceivedEffortFood" metric. Maps will range from extreme risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



2.2.3 Indicator: Casualties, Injured, Sick

This indicator accounts for casualties, injuries, and sicknesses stemming from a particular singular event, such as an act of terrorism, a natural disaster, a disease outbreak, etc.

PACOM specifies that metrics should include: number of event-related deaths; number of event-related injuries or illnesses; and number of event-related injuries or illnesses among elderly, children/adolescents, or IDPs/refugees.

Metric Weighting Logic

As there is currently only one metric within the indicator, it is automatically the most constraining. Therefore, it is given both a minimum and maximum weight of 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
ChildLiving (2.2.3.1)	1.0	1.0

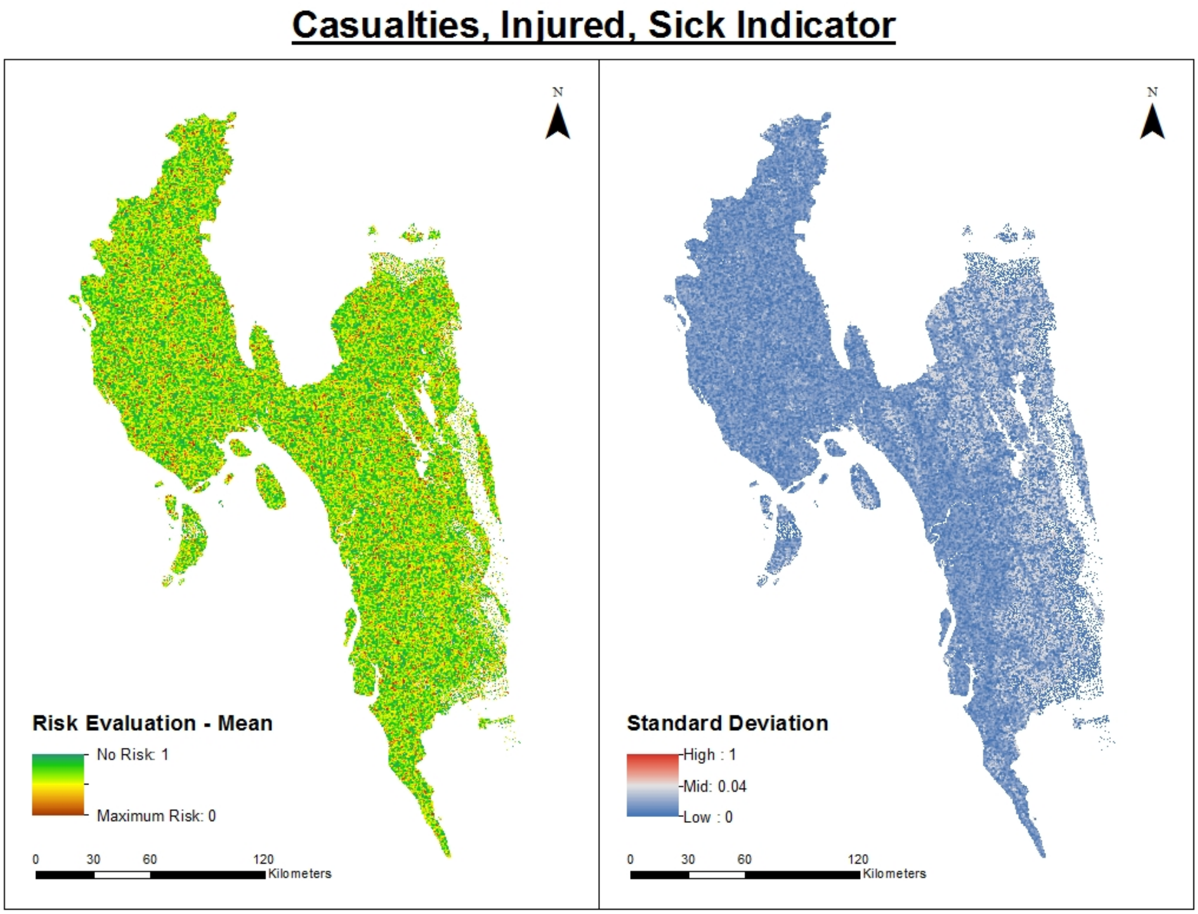
Uncertainty Values

The addition of metrics that actually address what PACOM specifies would decrease the high uncertainty values. The current metric only asks if someone’s child (children) is alive.

Alternatively, if the indicator was renamed something like “Child Mortality” or “Children/Adolescent Well-being”, it would provide better representation through phase zero to phase five, better reflect the existing metrics (and other available Urban Security data), and could lower the uncertainty values from 0.1 to 0.3.

Indicator Uncertainty Min: 0.90
Indicator Uncertainty Max: 0.95

Example Outcome



2.2.3.1 Metric: ChildLiving

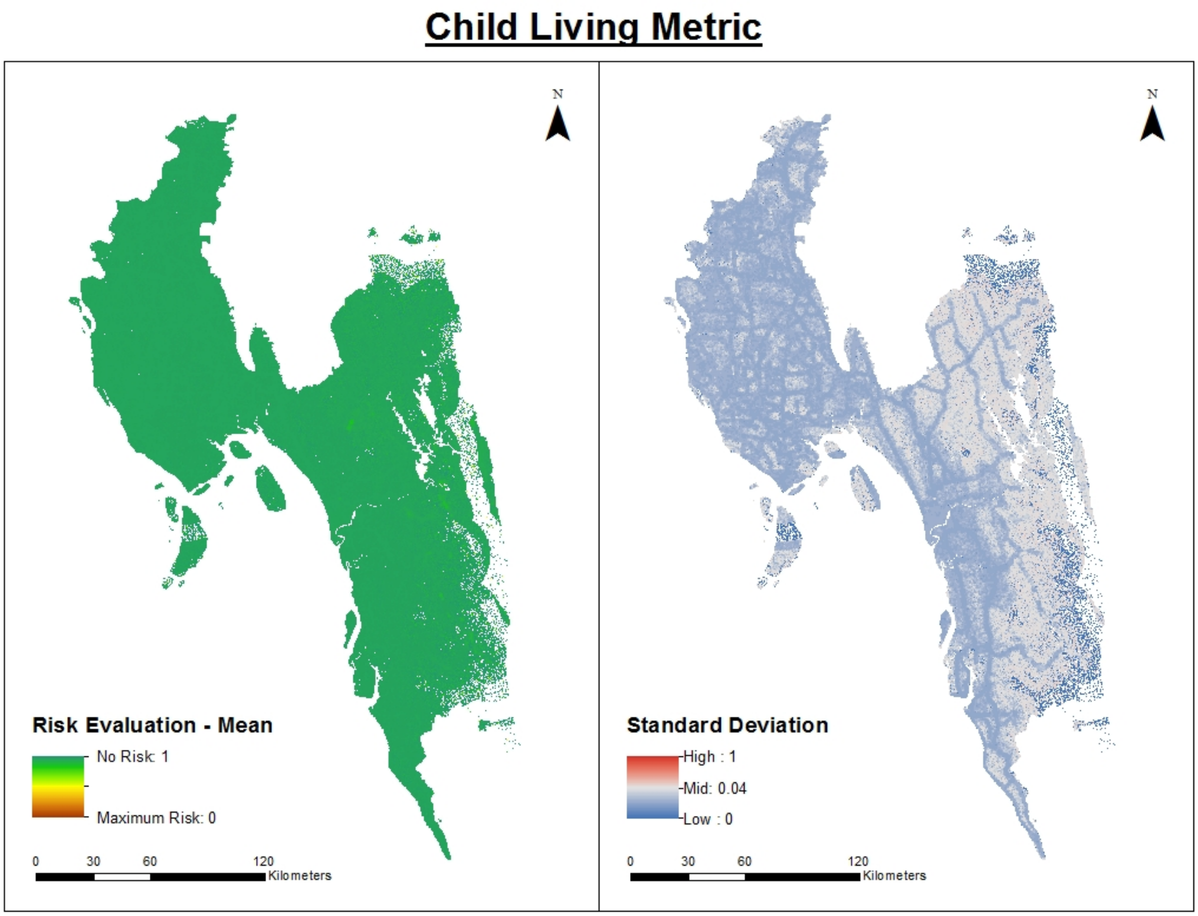
Indicator:	Casualties, Injured, Sick
Factor:	Vulnerable Groups
Condition:	Human Behavioral Impact
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.2, max: 0.8)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Is child living?" in the DHS survey.

The logic behind both the minimum and maximum values of 1.0 (minimal risk with no impact on risk, $½^0$) for the "Yes" response is simple: a live child does not impact overall risk for the indicator.

As this metric is under the factor "Vulnerable Groups," a "No" response (indicating that the child has passed away) does impact risk at both the indicator and the factor level. But as the cause of death is not specified in this particular question within the DHS survey, the actual risk impact, pointing to overall vulnerability, ranges from a medium risk level to a minimal risk level. Maps for this metric will range from medium risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



2.2.4 Indicator: Targeted Groups

This indicator accounts for acts of violence against individuals or groups targeted for their race, ethnicity, religion, gender, etc. These acts include hate crimes, genocides, and other group-identity based violence.

PACOM specifies that metrics should include: number of reported incidents of hate crimes, genocide, or other group-identity based violence (compared with historical data); number of casualties due to genocide or other group-identity based violence; and the crude mortality rate.

BTW, earlier VPS survey DID include questions asking whether people felt safe from violence. These questions were removed in their most recent surveys. Returning them would help complete PACOM frameworks.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

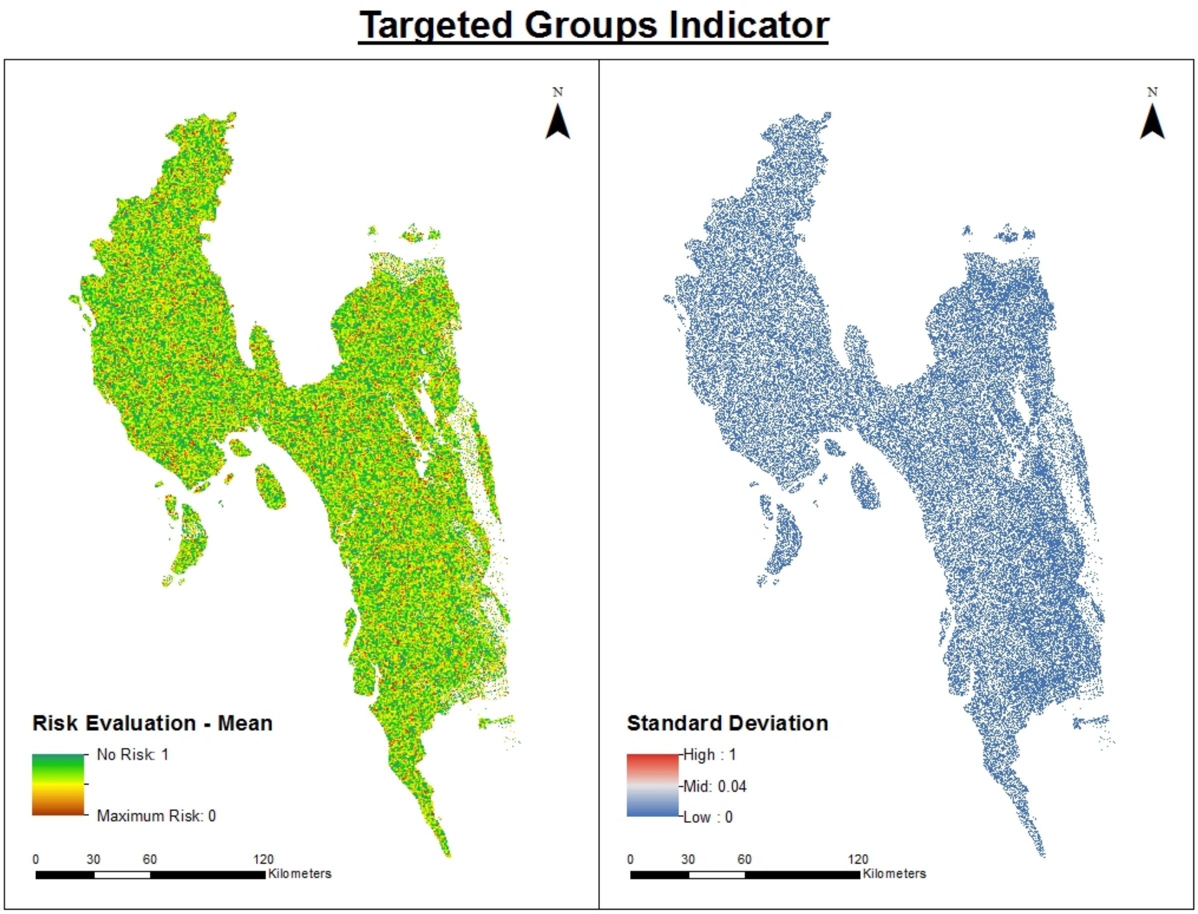
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



2.3 Substandard Human Conditions Factor Overview

This factor focuses on the negative human impacts on infrastructure, as well as living and working conditions. It is these indicators and metrics that most represent how the built environment can effect individual's quality of life.

Indicators within this factor include Civil Infrastructure Failure, Hazardous Working Conditions, Overcrowding and Dangerous Housing, and Polluted and Disease-Bearing Environment.

All of these indicators currently have available metric data.

Indicator Weighting Logic

As Hazardous Working Conditions, Overcrowded and Dangerous Housing, and Polluted and Disease-Bearing Environment would more significantly contribute to the cause of substandard conditions than Civil Infrastructure Failure, these three indicators are weighted a minimum of 0.75 and a maximum of 1.0. In this way, if any one of these indicators is given a high risk evaluation, the entire factor will be given a high risk evaluation.

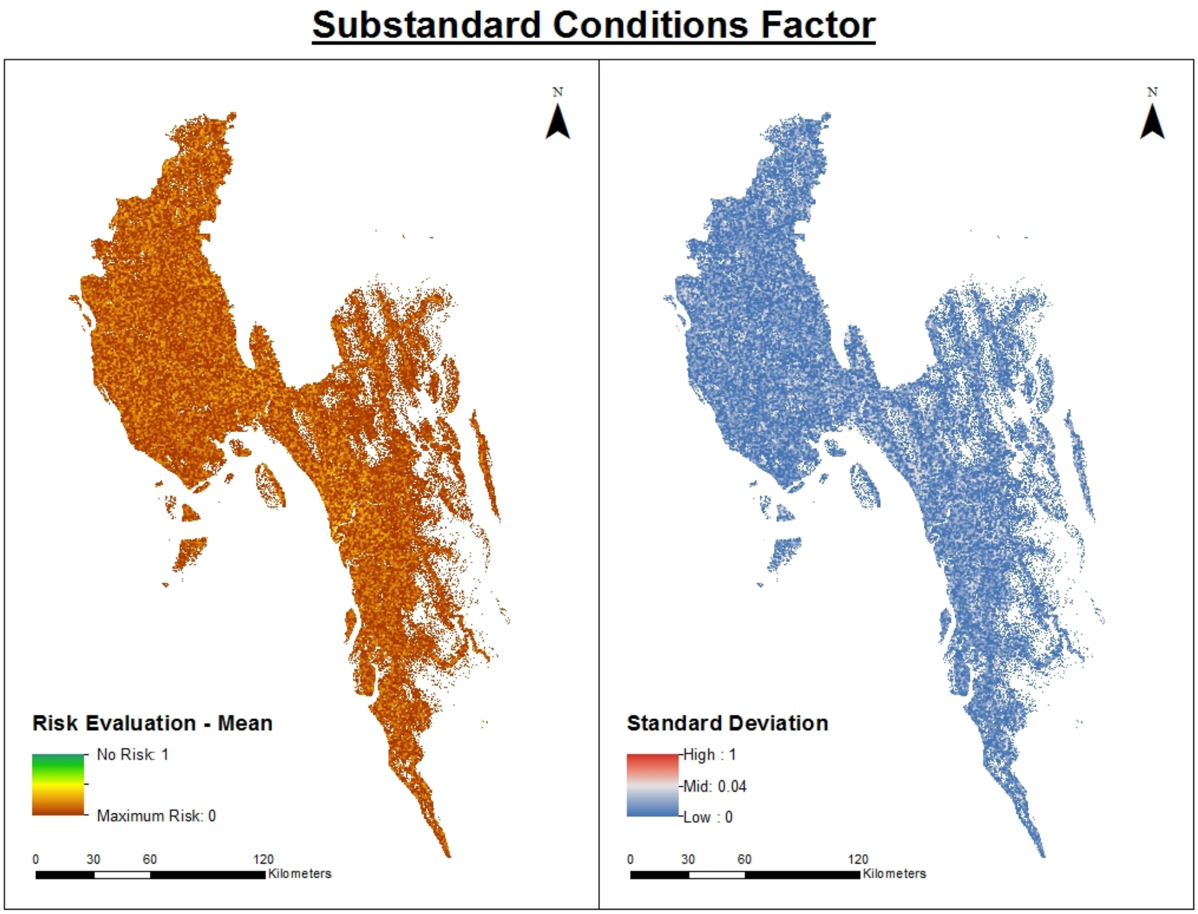
Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Civil Infrastructure Failure (2.3.1)	0.25	0.25
Hazardous Working Conditions (2.3.2)	0.75	1.0
Overcrowded and Dangerous Housing (2.3.3)	0.75	1.0
Polluted and Disease-Bearing Environment (2.3.4)	0.75	1.0

Uncertainty Values

This factor is given a range of uncertainty values from 0.1 to 0.2 because of the perceived ability of the existing indicators to fully address the themes of the factor. The addition of other indicators and metrics which measure physical aspects related to quality of life (i.e., adequate transportation infrastructure) could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.2

Example Outcome



2.3.1 Indicator: Civil Infrastructure Failure

Civil Infrastructure Failure accounts for infrastructure both at the macro-level (damns, levies, bridges, roads) and micro-level (households, residential and other buildings, etc.).

PACOM specifies that metrics should include: number of incidents involving failure of dams and levees (compared with historical data); number of incidents involving failure of bridges; percentage of bridges assessed as structurally unstable; percentage of buildings assessed as structurally unstable; and percentage of roads assessed as impassable or dangerous.

Metric Weighting Logic

The metric "HHType" (household type) from the IPUMS survey is the most constraining on this indicator, and is given the higher minimum value than the other metrics since it addresses building structure and materials.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HH Type (2.3.1.1)	0.4	0.5
HH Water Source (2.3.1.2)	0.2	0.5
HHTypeToilet (2.3.1.3)	0.2	0.5
HH Electrical (2.3.1.4)	0.2	0.5

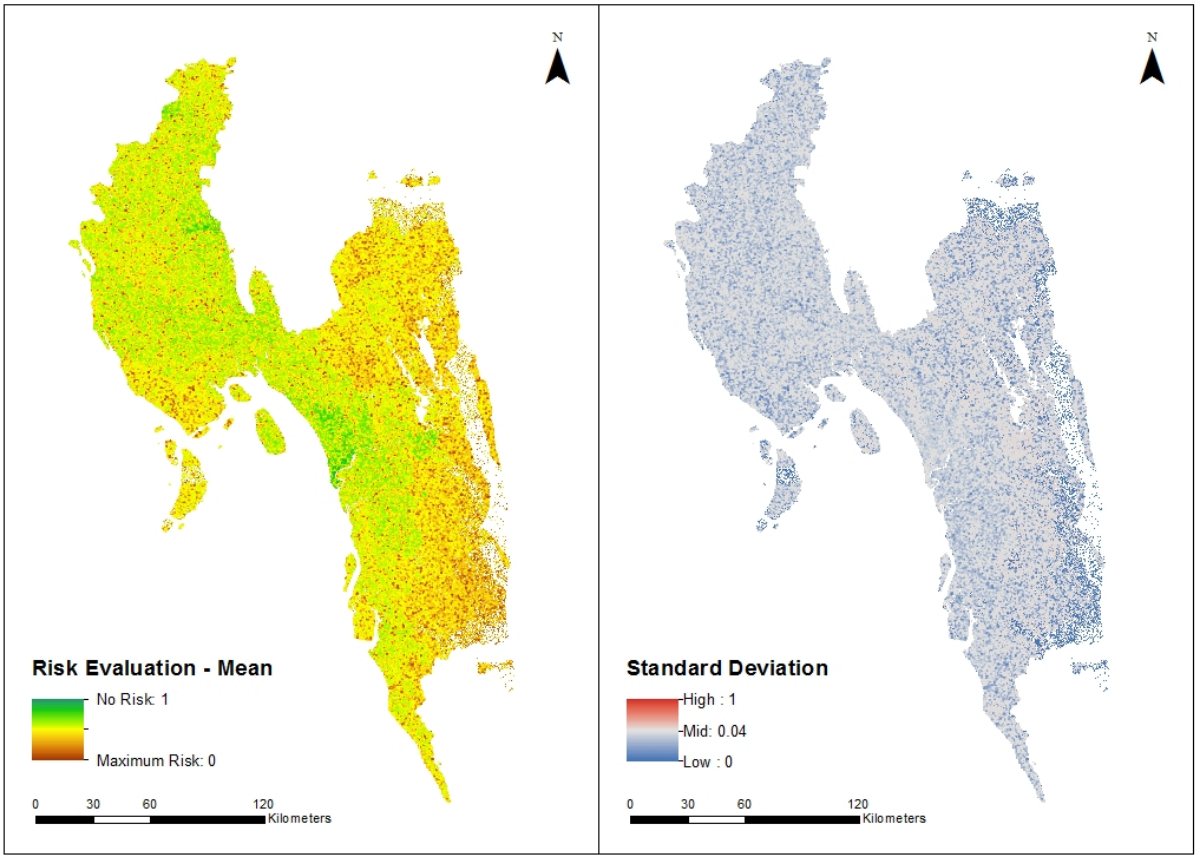
Uncertainty Values

Adding more data on large infrastructure failures or structural issues at the macro-level, such as the metrics PACOM specifies above, could decrease the uncertainty values. Current metrics only address household-level infrastructure.

Indicator Uncertainty Min: 0.4
Indicator Uncertainty Max: 0.6

Example Outcome

Civil Infrastructure Failure Indicator



2.3.1.1 Metric: HH Type

Indicator:	Civil Infrastructure Failure
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Pucka (min: 1.0, max: 1.0) Semi-Pucka (min: 0.4, max: 1.0) Kutcha (min: 0.125, max: 0.5) Jhupri (min: 0.0625, max: 0.25)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	http://theperfectslum.blogspot.com/2014/02/kacca-pucca-and-vernacular-architecture.html http://en.banglapedia.org/index.php?title=Housing

Logic:

This question addresses the type of household, based on construction materials, from the IPUMS 2011 survey.

Pucka, or pucca, homes are built with permanent and more durable materials such as brick, timber, stone, and concrete. These homes are often found in more urban areas. This answer receives both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

Semipucka houses have some elements of pucka homes (i.e., concrete foundation with a roof of organic materials). This answer is given a minimum value of 0.4 for those homes with straw walls or roof (slight risk) and a maximum value of 1.0 for those semipucka homes with solid wood instead of straw (minimal risk).

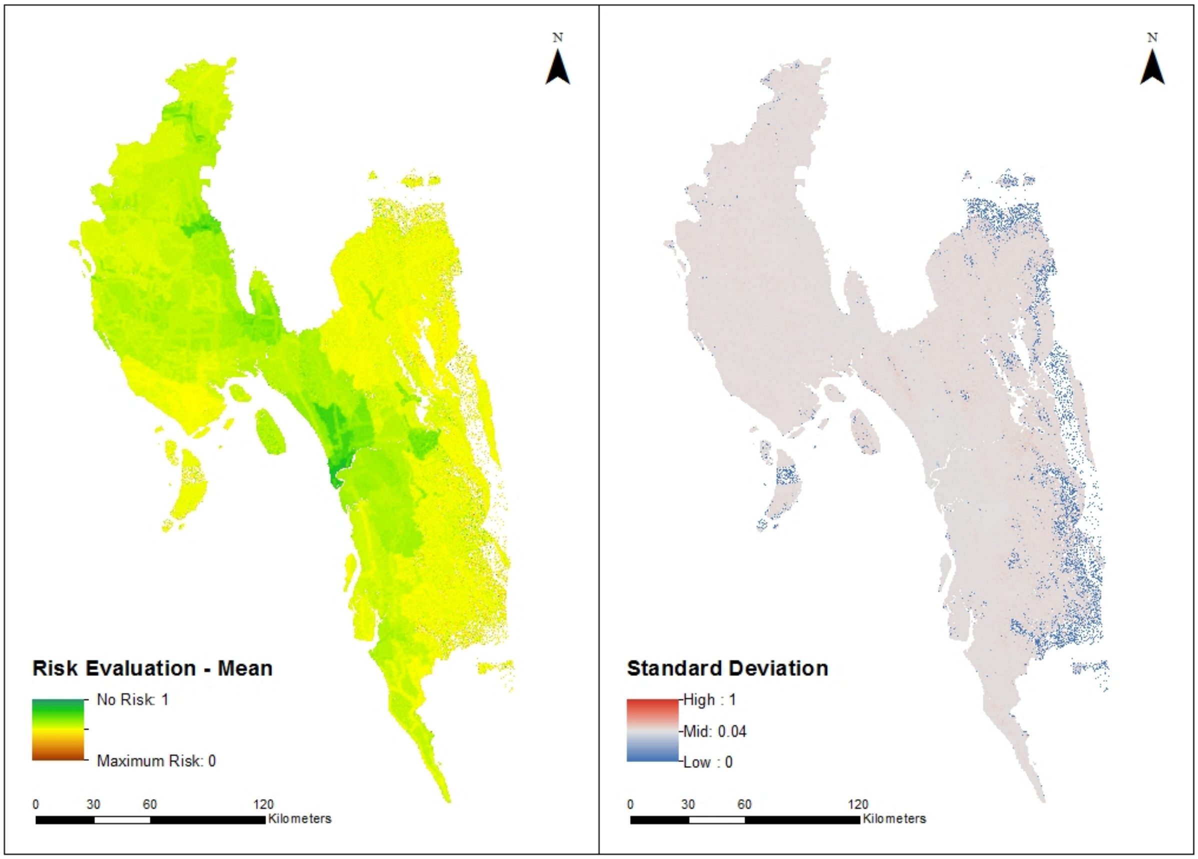
Kutcha, or kacca, homes are more temporary and built with earthen and organic materials. This answer is given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$).

Jhupri structures are shacks, made of jute sticks, tree leaves, jute sacks, and often are indicative of informal settlements. This answer receives a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.125 (high risk, $½^3$).

Maps will range from extreme risk to no risk.

Example Realization Metric Map

HH Type Metric



2.3.1.2 Metric: HHWaterSource

Indicator:	Civil Infrastructure Failure
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Tap (min: 1.0, max: 1.0) Tubewell (min: 0.5, max: 0.9) Other (min: 0.25, max: 0.8)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	http://www.wssinfo.org/definitions-methods/watsan-categories/

Logic:

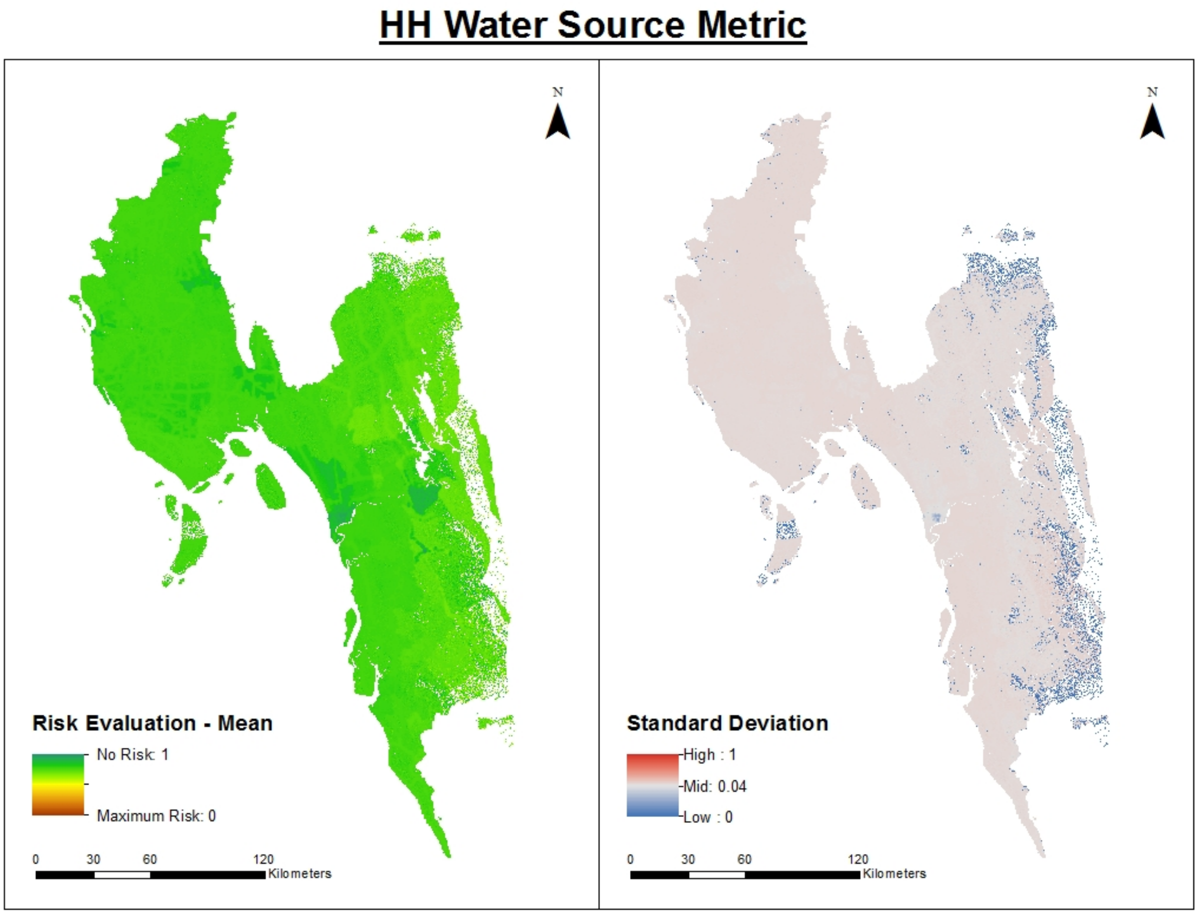
This metric consists on answers to the question of types of household water sources. “Tap” answers refer to a household connection to in-house plumbing. This answer is given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

“Tubewell” is a deep hole that has been driven, bored or drilled, with the purpose of reaching groundwater supplies. Water is delivered from a tubewell or borehole through a pump, which may be powered by human, animal, wind, electric, diesel or solar means. These answers are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk).

“Other” answers are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.8 (minimal risk).

Maps will range from slight risk to no risk.

Example Realization Metric Map



2.3.1.3 Metric: HHTypeToilet

Indicator:	Civil Infrastructure Failure
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	SanitaryWater (min: 1.0, max: 1.0) Sanitary (min: 0.8, max: 1.0) NonSanitary (min: 0.001, max: 0.25) None (min: 0.001, max: 0.125)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	Classifications come from the IPUMS survey metadata for the 2011 Bangladesh survey.

The toilet which is pit latrine with water sealed facility is called sanitary (water sealed). These answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

Pit latrine having no water sealed facility is called sanitary (Non water sealed). These answers are given a minimum value of 0.8 (minimal risk) and a maximum value of 1.0.

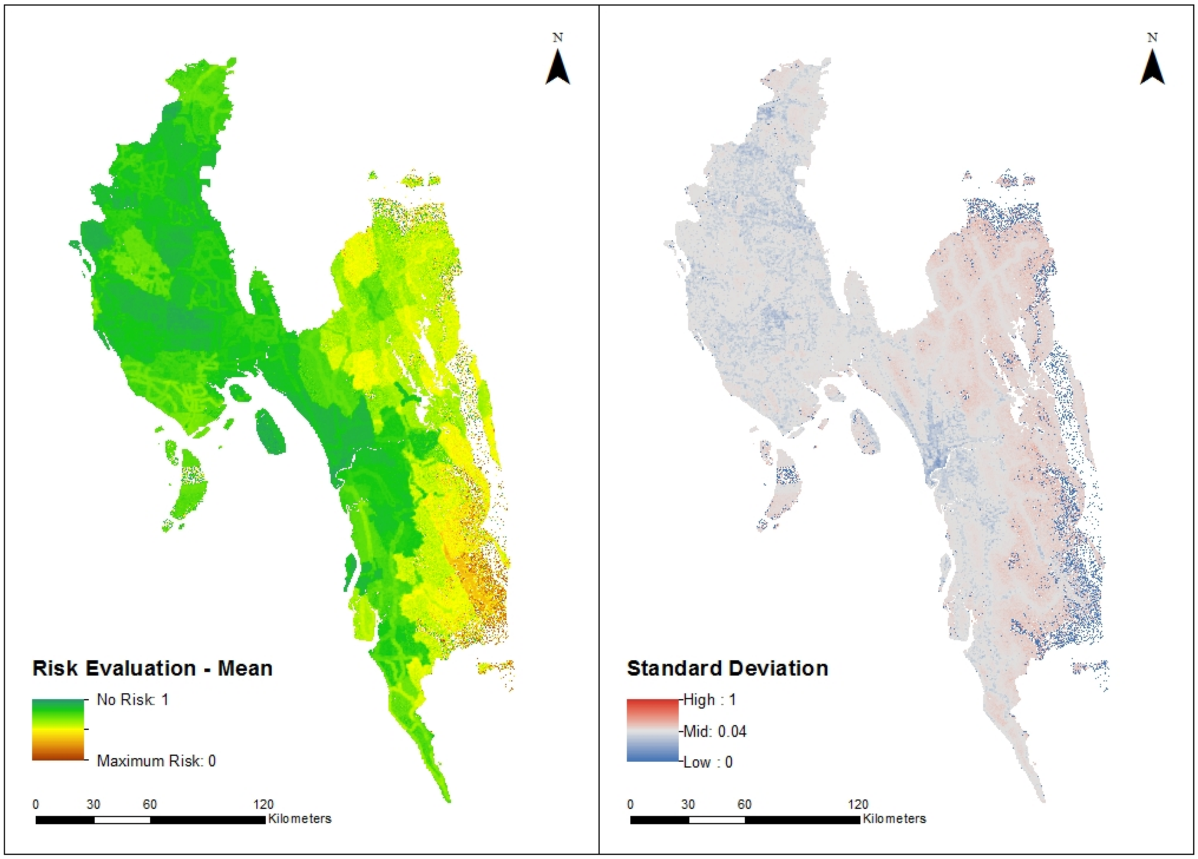
Toilets in pucca, semi-pucca or kutcha but having no facility to cover the discharge waste is called non-sanitary. Such type of toilet is not free from water and environment pollution. These answers are given a minimum value of 0.001 (extreme risk) and a maximum value of 0.25 (medium risk, $½^2$).

None means there is no toilet for the household usually uses to go bush, jungle or open space as and when necessary. These answers are given a minimum value of 0.001 (extreme risk) and a maximum value of 0.125 (high risk, $½^3$).

Maps will range from extreme risk to no risk.

Example Realization Metric Map

HH Toilet Type Metric

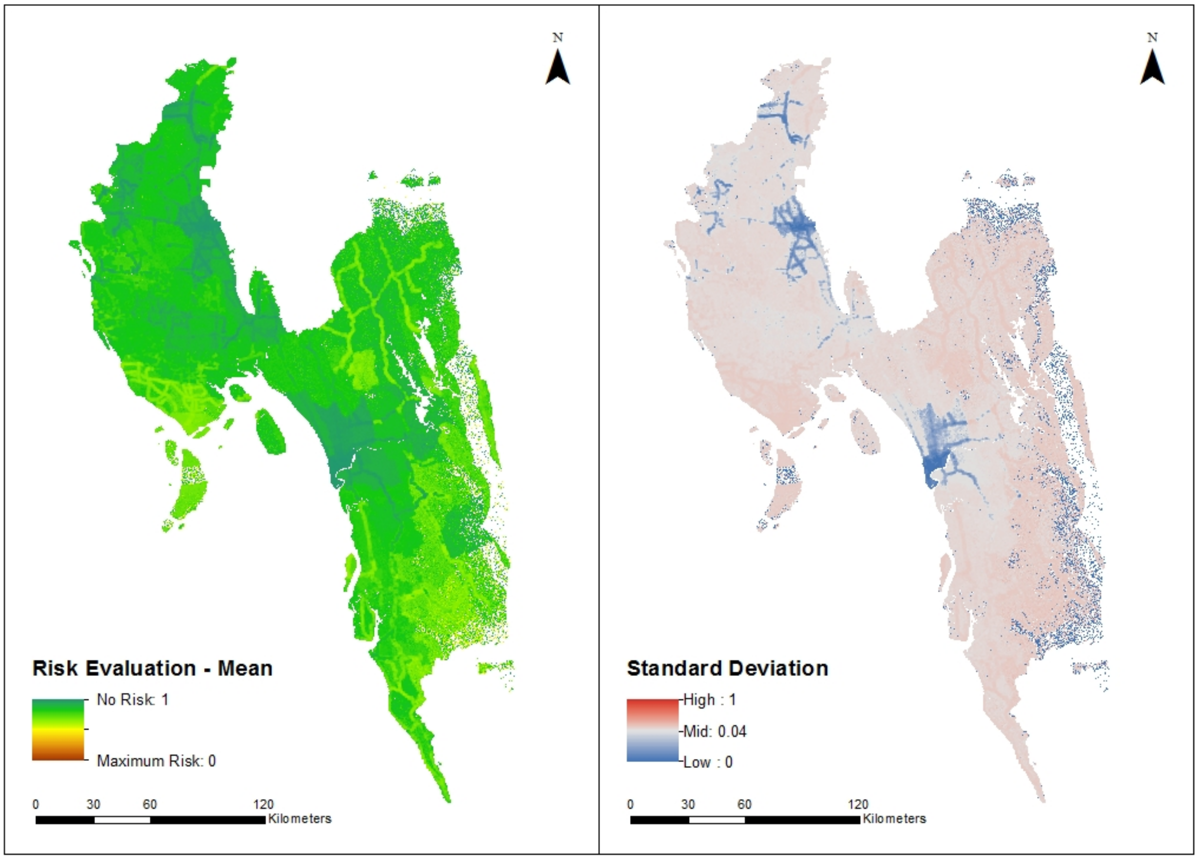


2.3.1.4 Metric: HHElectrical

Indicator:	Civil Infrastructure Failure
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.2, max: 0.8)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question of whether or not there is an electrical connection within the household. “Yes” answers are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). “No” answers are given a minimum value of 0.2 (medium risk) and a maximum value of 0.8 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

HH Electrical Metric



2.3.2 Indicator: Hazardous Working Conditions

This indicator accounts for dangerous working conditions, focusing specifically on the mining, agricultural, and industrial sectors.

PACOM specifies that metrics should include: percentage of works experiencing work-related health-conditions (acute and chronic, compared to historical data); percentage of workers experiencing work-related injuries; percentage of mines assessed as structurally unstable or unsafe; percentage of farms or other agricultural producers using pesticides or other chemicals hazardous to human health (e.g., carcinogenic, immunotoxic, endocrine disruption, organ system toxicity, developmental and reproductive toxicity, etc.); and appropriate fire safety mechanism in place for factory workers.

Metric Weighting Logic

As there is only one metric, it is given both a minimum and maximum weight of 1.0. Adding more metrics would likely decrease both metric ranges, since metrics focusing on the physical aspects of the workspace that could potentially be hazardous would be more constraining.

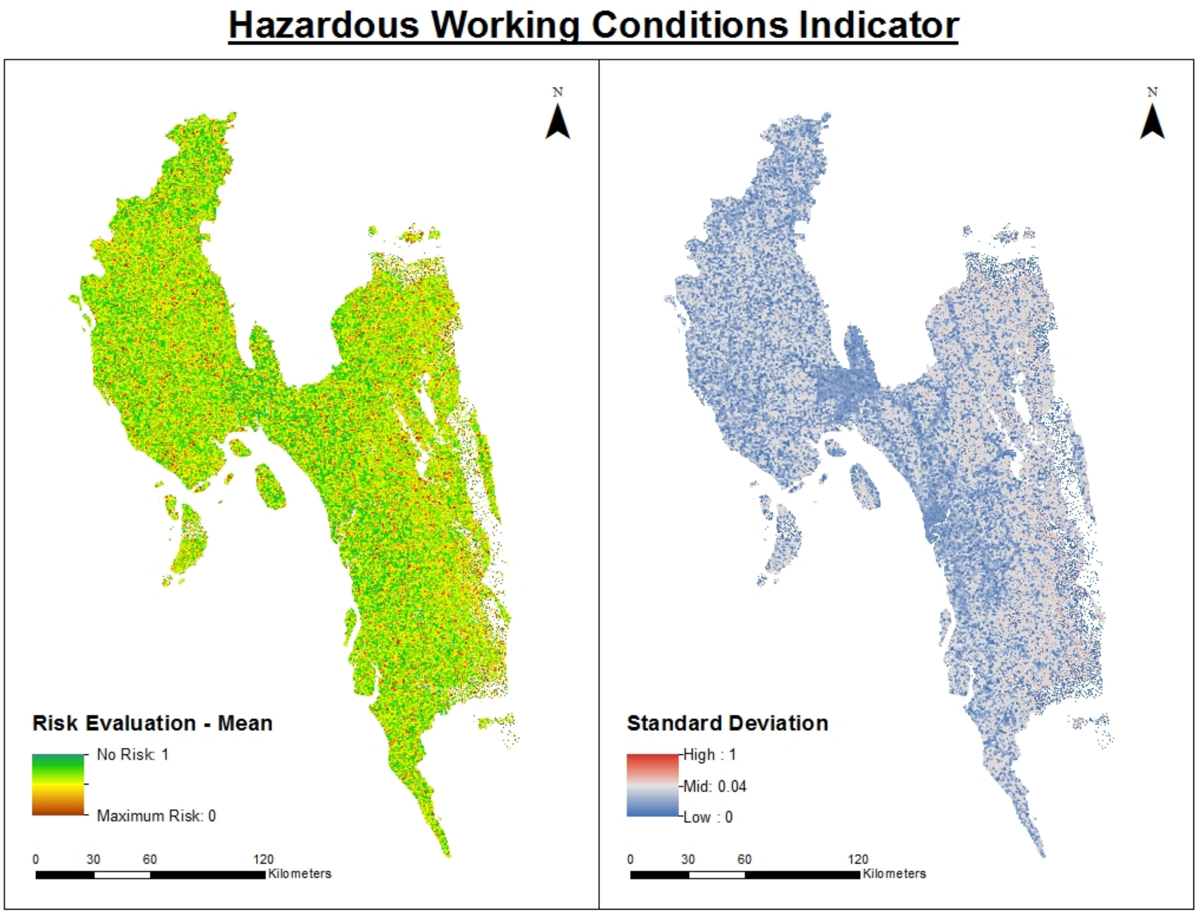
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
SocioeconomicStatus (2.3.2.1)	1.0	1.0

Uncertainty Values

Adding more data on physical work-related health and structural issues, such as those specified by PACOM, could decrease the uncertainty values.

Indicator Uncertainty Min: 0.8
Indicator Uncertainty Max: 0.9

Example Outcome

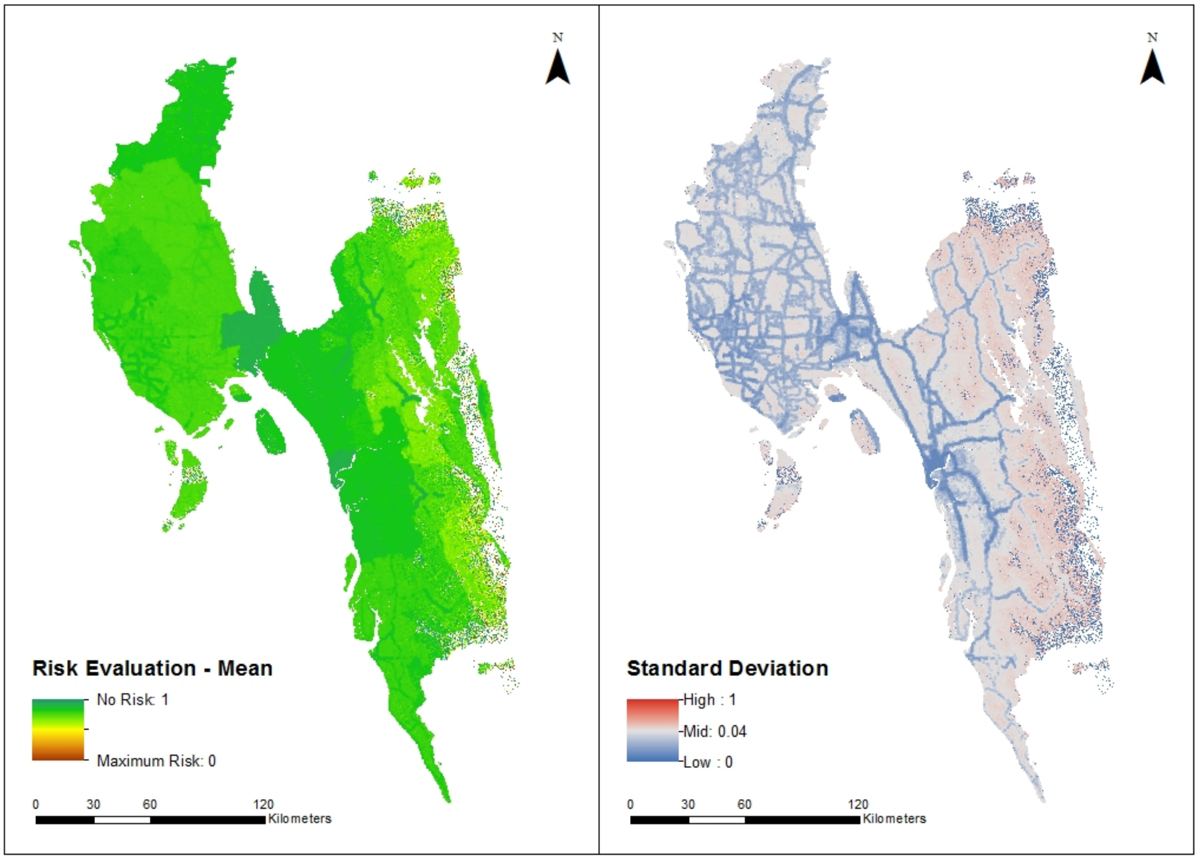


2.3.2.1 Metric: SocioEconomicStatus

Indicator:	Insufficient Loans/Debt Forbearance and Cancellation
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	A1 (businessmen with higher educational degrees) (min: 1.0, max: 1.0) A2 (businessmen with some higher education (no degrees)) (min: 1.0, max: 1.0) B1 (businessmen with HS degree) (min: 1.0, max: 1.0) B2 (businessmen with 5-9 years of school) (min: 1.0, max: 1.0) C (skilled with HS degree) (min: 0.5, max: 1.0) D (skilled with less than 9 years of school) (min: 0.25, max: 0.75) E1 (unskilled with less than 9 years of school) (min: 0.125, max: 0.5) E2 (unskilled illiterate) (min: 0.07, max; 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question in the VPS survey that asks that surveyor to record the socioeconomic status of the respondent. Answers of A1, A2, B1, and B2 are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers C are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 1.0. Answers of D are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.75 (minimal risk). Answers of E1 are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5. Answers of E2 are given a minimum value of 0.07 (high risk) and a maximum value of 0.5. Maps will range from high risk to no risk.

Example Realization Metric Map

Socioeconomic Status Metric



2.3.3 Indicator: Overcrowding and Dangerous Housing

As different cities, regions, and countries will have varying definitions of what defines overcrowded or dangerous housing, it is important for this indicator to obtain area-specific data to make up the metrics.

PACOM specifies that metrics should include: percentage of population living in overcrowded housing (inadequate living space); percentage of population living in structurally unstable or otherwise hazardous housing (e.g., chemical exposure, lead) – slums or otherwise; percentage of population living in what can be considered slums or similar; and number of cases of communicable diseases or conditions [baseline set at 20], including:

- Diphtheria
- Encephalitis
- Meningitis
- Mononucleosis
- Influenza
- Lice
- MMR (measles, mumps, rubella)
- SARS
- Smallpox
- Typhoid
- Tuberculosis

Metric Weighting Logic

The “PeoplePerHH metric” is logically the most constraining, as it directly addresses the theme of this indicator, and is therefore given a higher minimum weight value. As the presence of a roof and it’s material is more determinant of the overall structure of a house than the walls or floor, the “HHRoofMaterial” metric is given the second highest weighting schema.

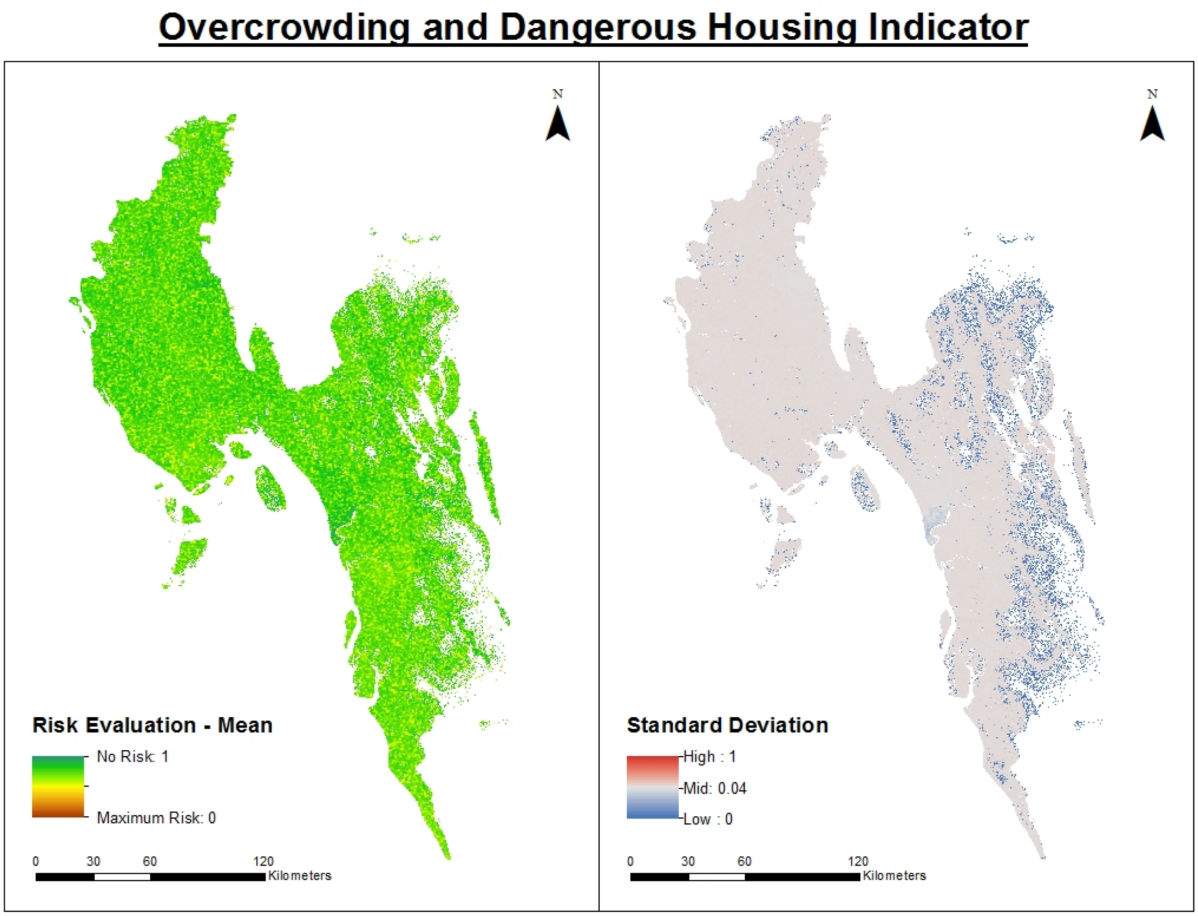
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PeoplePerHH (2.3.3.1)	0.75	1.0
HHFloorMaterial (2.3.3.2)	0.2	0.8
HHRoofMaterial (2.3.3.3)	0.3	0.9
HHExtWallMaterial (2.3.3.4)	0.1	0.4

Uncertainty Values

This range is due to the thoroughness of the existing metrics in addressing the topic of overcrowding and dangerous housing. Additional data on the presence and size of slums/informal settlements, especially compared to historical data, could further decrease the uncertainty values.

Indicator Uncertainty Min: 0.15
Indicator Uncertainty Max: 0.25

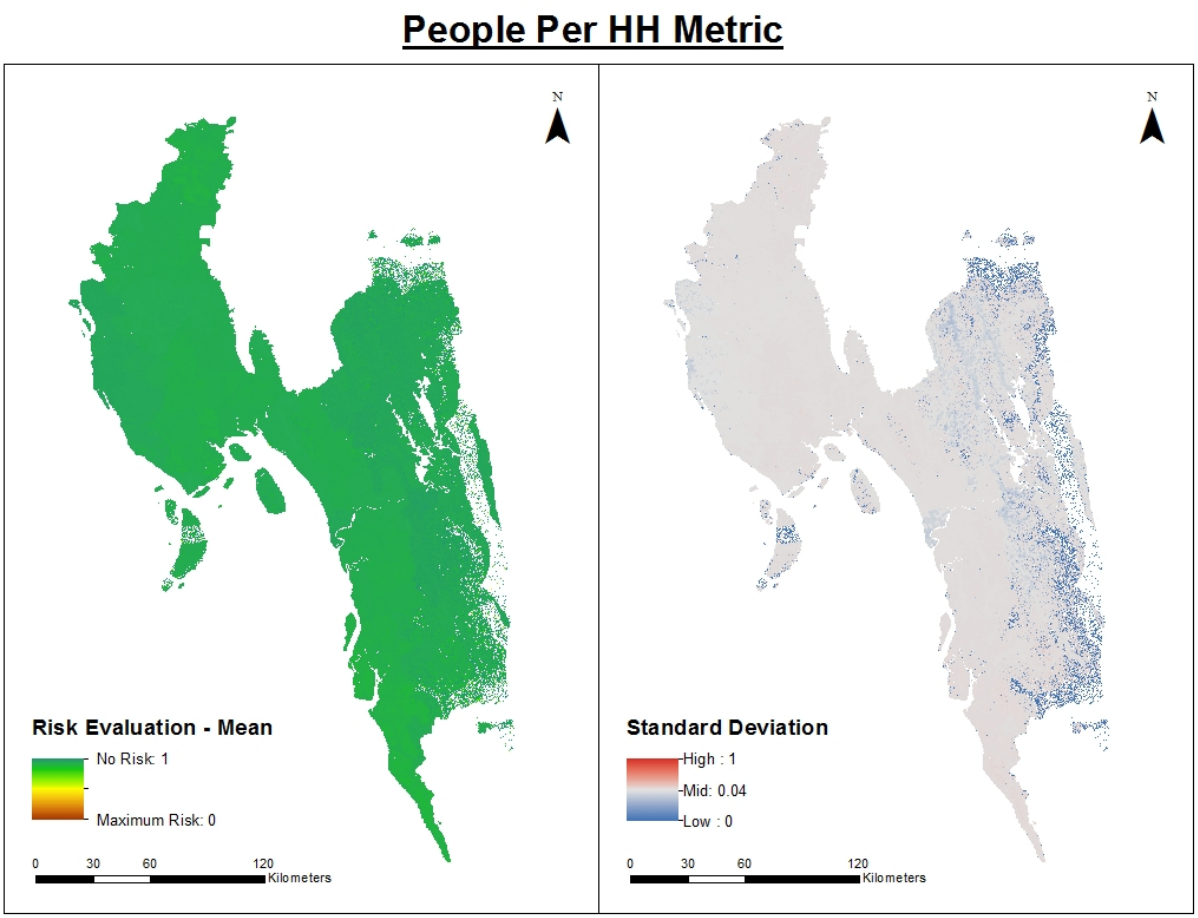
Example Outcome



2.3.3.1 Metric: PeoplePerHH

Indicator:	Overcrowding
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Framework:	Cholera
Metric Assigned Values:	1-6PeoplePerHousehold (min: 1.0, max: 1.0) 7-10PeoplePerHousehold (min: 0.5, max: 0.9) 11-20PeoplePerHousehold (min: 0.25, max: 0.75) 20+PeoplePerHousehold (min: 0.0625, max: 0.5)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of the number of people per household from the IPUMS survey. Ideally, this metric would take the number of people per household and divide it by the number of sleeping rooms (also from IPUMS); however, current computational capabilities does not allow for this. Answers of one to six people per household are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of seven to ten people per household are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers of eleven to twenty people per household are given a minimum value of (medium risk, $½^2$) and a maximum value of 0.75 (minimal risk). Answers of over twenty people per household are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from extreme risk to no risk.

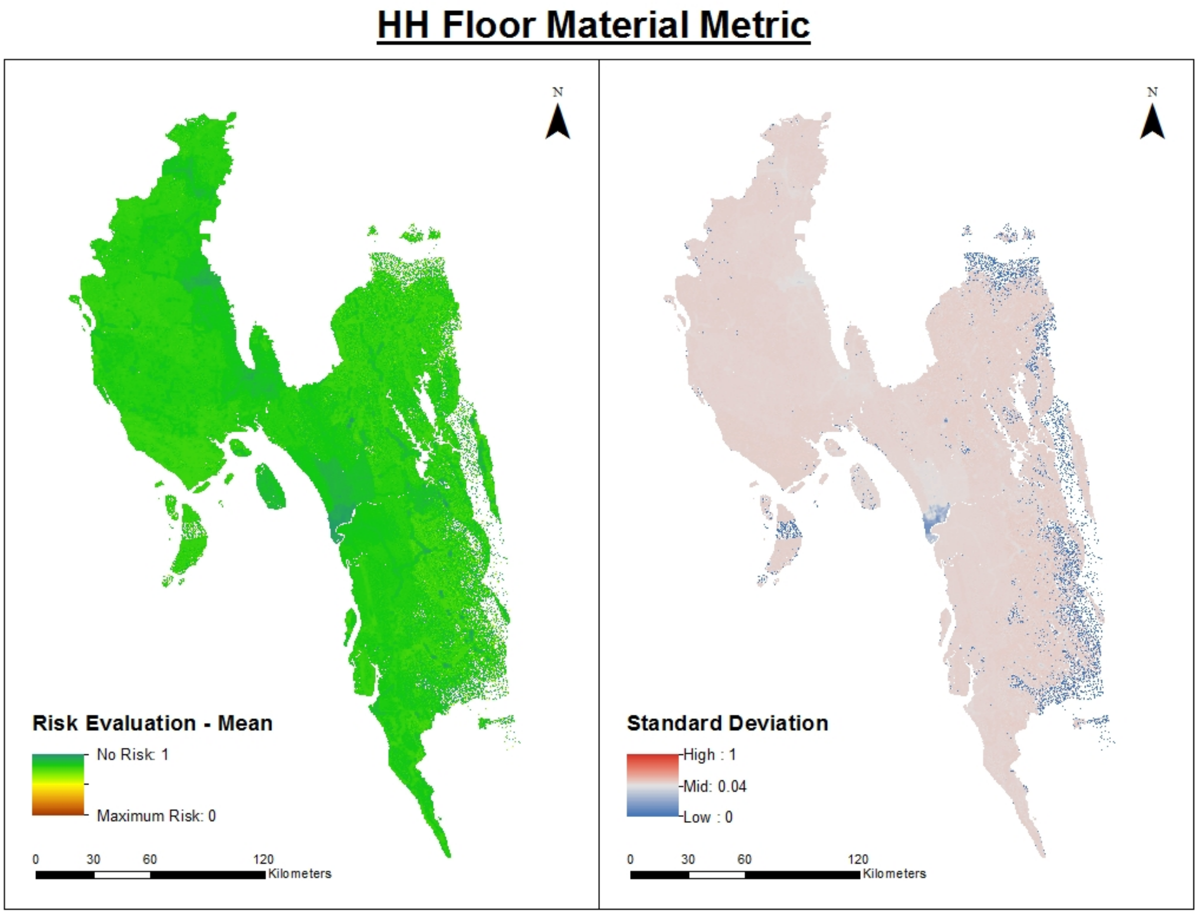
Example Realization Metric Map



2.3.3.2 Metric: HHFloorMaterial

Indicator:	Overcrowding and Dangerous Housing
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Finished (min: 1.0, max: 1.0) Natural (min: 0.4, max: 0.9) Rudimentary (min: 0.1, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to questions concerning household floor material. "Finished" floor answers are grouped from "parquet or polished wood," "vinyl or asphalt strips," "ceramic tiles," "cement," and "carpet." These answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). "Rudimentary" answers are grouped from "earth/sand" and "dung." These answers are given a minimum value of 0.1 (high risk) and a maximum value of 0.5 (slight risk, $½^1$) "Natural" answers are grouped from "wood planks" and "palm/bamboo." These answers are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9 (minimal risk). Maps will range from high risk to no risk.

Example Realization Metric Map



2.3.3.3 Metric: HHRoofMaterial

Metric:	HHRoofMaterial
Indicator:	Overcrowding and Dangerous Housing
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Finished (min: 1.0, max: 1.0) Natural (min: 0.1, max: 0.5) Rudimentary (min: 0.4, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

Logic: This metric consists of answers to the question concerning observation of household roofing material. "Finished answers" are grouped from "metal," "wood," "calamine/cement fiber," "ceramic tiles," "cement," and "roofing shingles." These answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

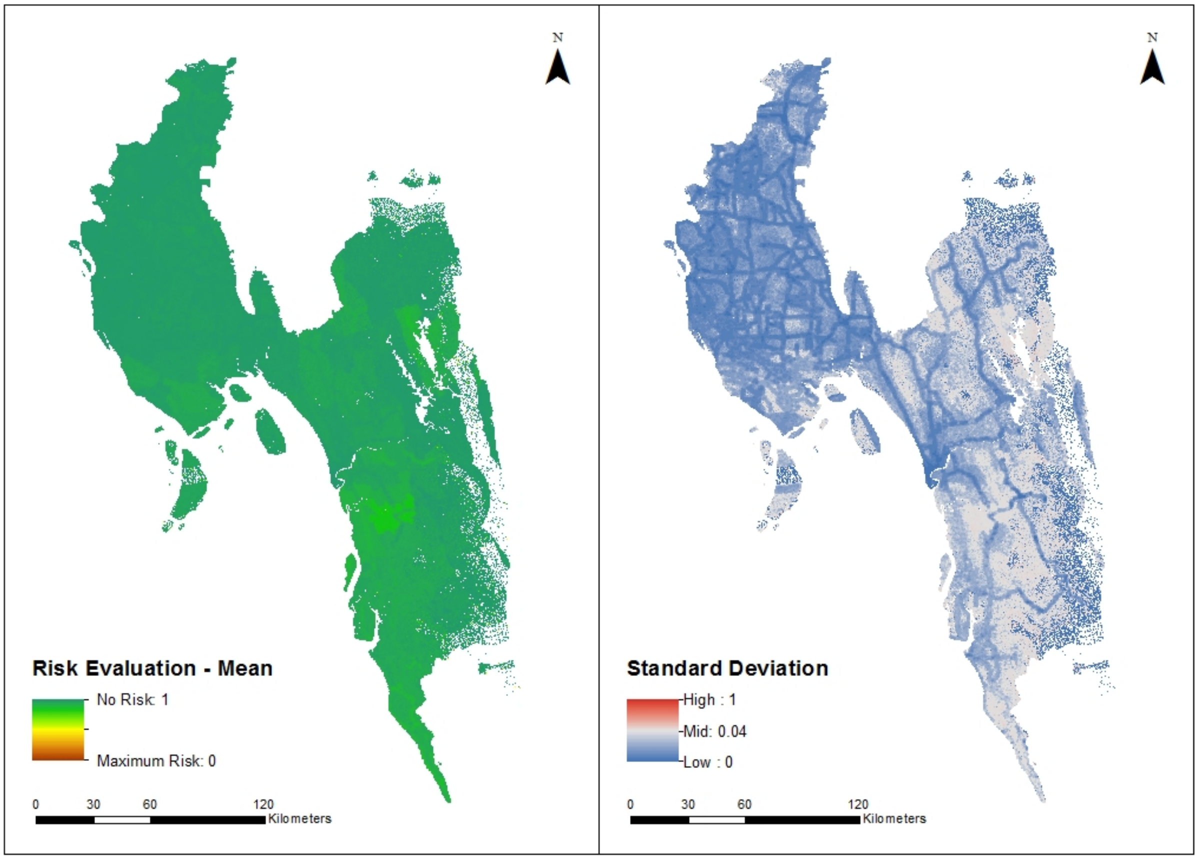
"Rudimentary" answers are grouped from "rustic mat," "palm/bamboo," "wood planks," "cardboard." These answers are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9 (minimal risk).

"Natural" answers are grouped from "no roof," "thatch/palm leaf," and "sod." These answers are given a minimum value of 0.1 (high risk) and a maximum value of 0.5 (slight risk, $½^1$).

Maps will range from high risk to no risk.

Example Realization Metric Map

HH Roof Material Metric



2.3.3.4 Metric: HHExtWallMaterial

Indicator:	Overcrowding and Dangerous Housing
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Finished (min: 1.0, max: 1.0) Natural (min: 0.1, max: 0.5) Rudimentary (min: 0.4, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

Logic:

This metric consists of answers to the question concerning observation of household exterior wall material. “Finished answers” are grouped from “cement,” “stone with lime/cement,” “bricks,” “cement blocks,” “covered adobe,” and “wood planks/shingles.” These answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

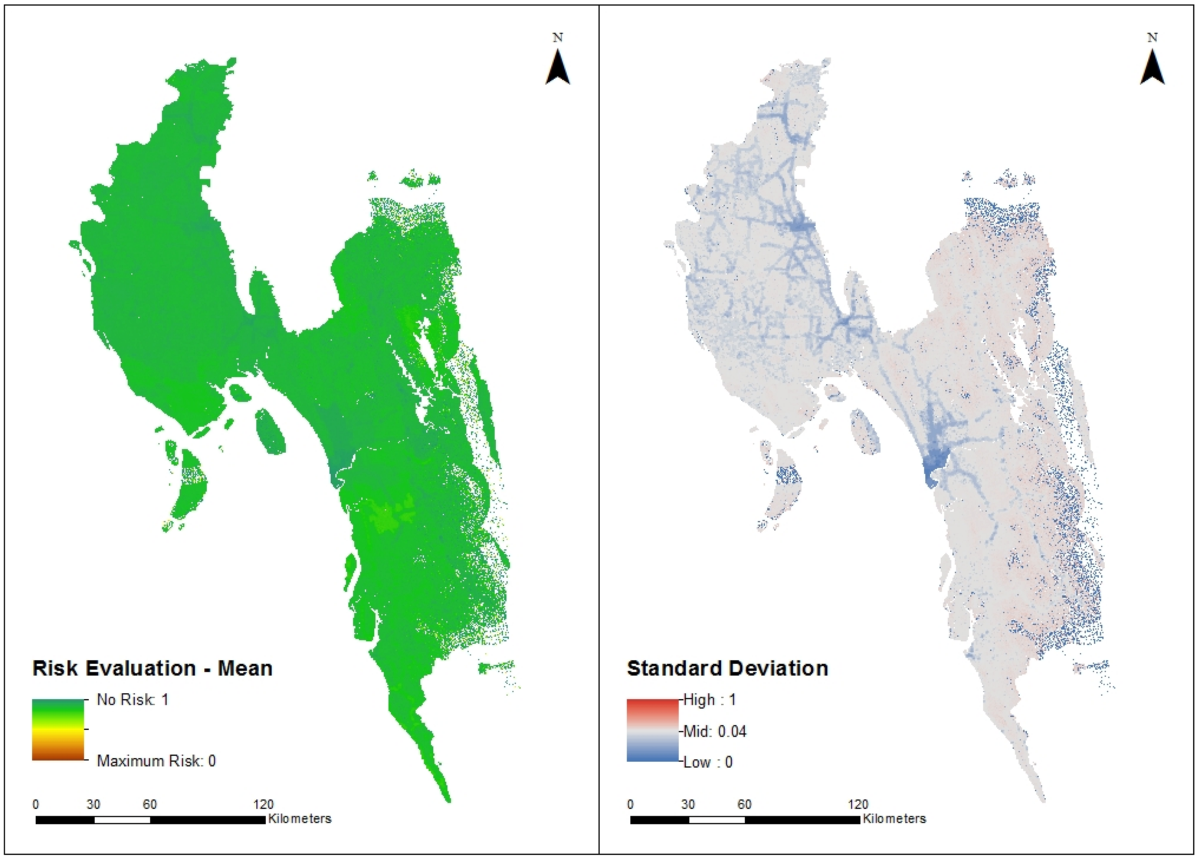
“Rudimentary” answers are grouped from “bamboo with mud,” “stone with mud,” “uncovered adobe,” “plywood,” “cardboard,” and “reused wood.” These answers are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9 (minimal risk).

“Natural” answers are grouped from “no walls,” “cane/palm/trunks,” and “dirt.” These answers are given a minimum value of 0.1 (high risk) and a maximum value of 0.5 (slight risk, $½^1$).

Maps will range from high risk to no risk.

Example Realization Metric Map

HH Exterior Wall Material Metric



2.3.4 Indicator: Polluted and Disease-Bearing Environment

This indicator should account for the potential for water-borne and other communicable and vector-borne diseases to spread, as well as historical data and trends on these diseases. The PACOM literature specifies the following diseases as potential metrics, measured per capita:

- Malaria
- Amebiasis
- Cholera
- Dengue fever
- Hepatitis A
- Lyme disease
- Tetanus
- E. coli infection
- Tick-borne encephalitis
- Ebola
- West Nile
- Yellow Fever

Metric Weighting Logic

The metrics "Vaccinated" and "IllDiarrhea" are the most constraining on this indicator, and are both weighted the highest. While the data that makes up the "Vaccinated" metric is broad, it potentially addresses several of the diseases listed above – including Tetanus, Hepatitis A, and Yellow Fever – which the other metrics do not. Likewise, the presence of a mosquito net has been shown to greatly help prevent the contraction of malaria and other insect-borne diseases.

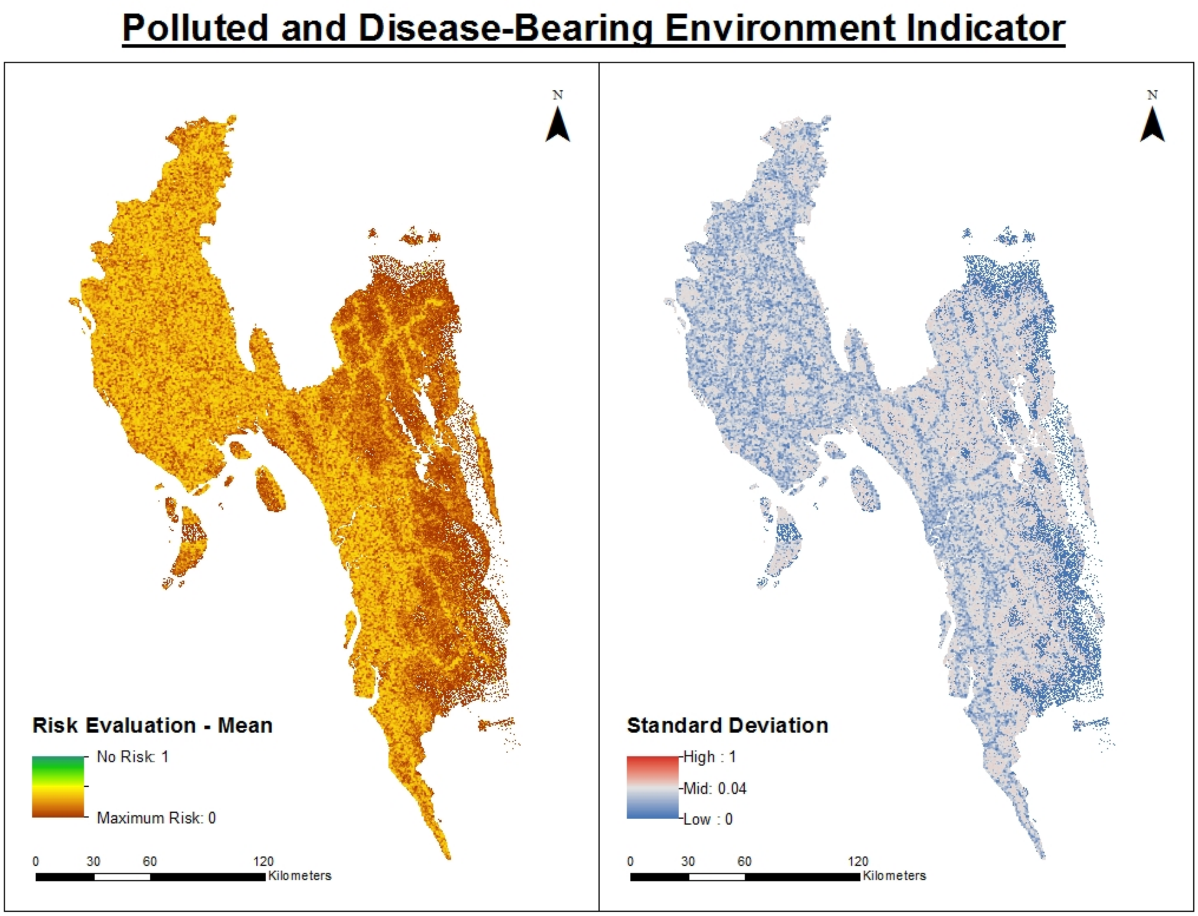
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
IllIntestinalWorm (2.3.4.1)	0.15	0.2
IllDiarrhea (2.3.4.2)	0.25	0.3
IllFever (2.3.4.3)	0.15	0.2
IllRespiratory (2.3.4.4)	0.15	0.2
Vaccinated (2.3.4.5)	0.3	0.5

Uncertainty Values

This reflects the overall accuracy and relevancy of the current metrics to the indicator, but also points to the need for more data on both vector-borne and non-vector-borne diseases. Currently, the metrics only address more generic, viral illnesses. In addition, metrics which look for the causes of diseases, rather than whether a child was sick in the past two weeks with a generic symptom of multiple diseases, would decrease the uncertainty of this indicator. Additional data on pollution (specifically, for Bangladesh, arsenic levels in ground water) could also decrease indicator uncertainty.

Indicator Uncertainty Min: 0.45
Indicator Uncertainty Max: 0.55

Example Outcome



2.3.4.1 Metric: IllIntestinalWorm

Indicator:	Polluted and Disease-Bearing Environment
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.2, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

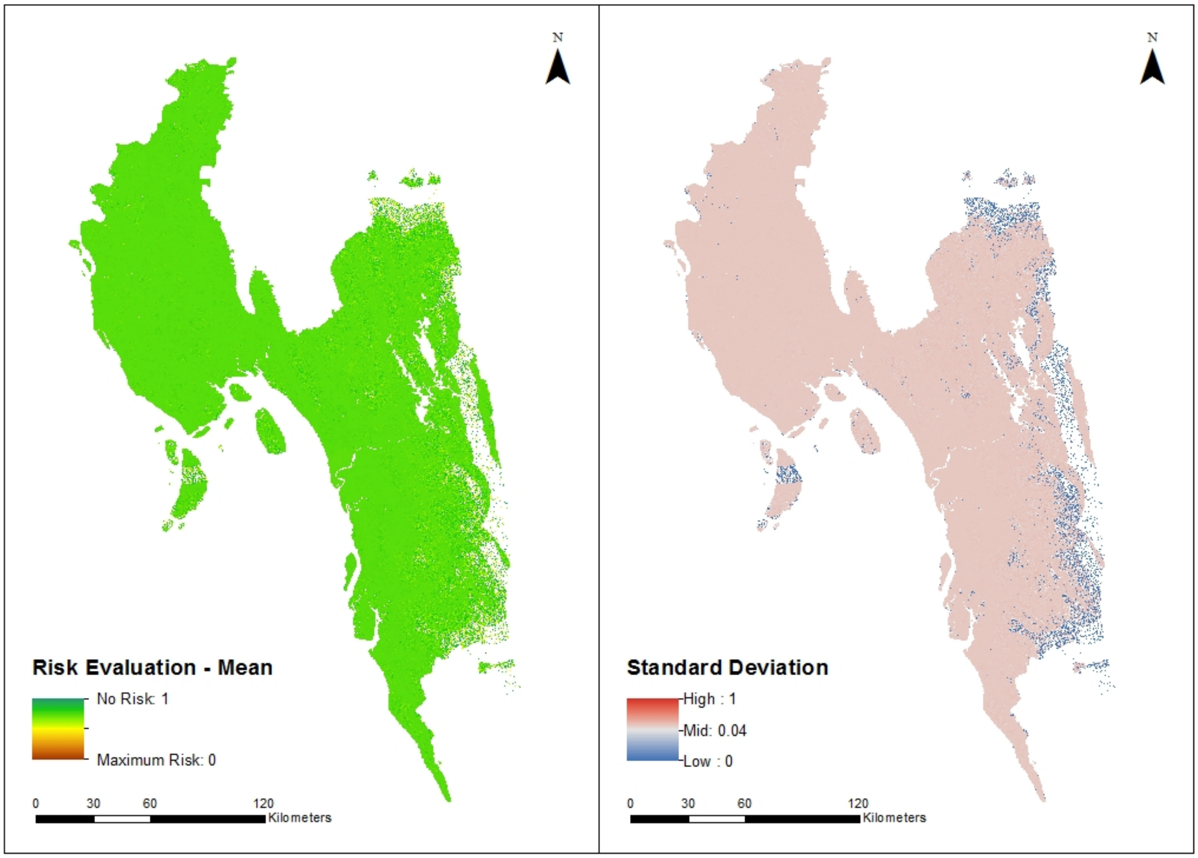
Logic:

This metric consists of answers to the question "Was (name of child) given any drug for intestinal worms in the last six months?" from the women's portion of the DHS survey. "Yes" answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, ½^0)."No" answers are given a minimum value of 0.2 (medium risk) and a maximum value of 0.9 (minimal risk). Maps will range from medium risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Maps:

III Intestinal Worm Metric



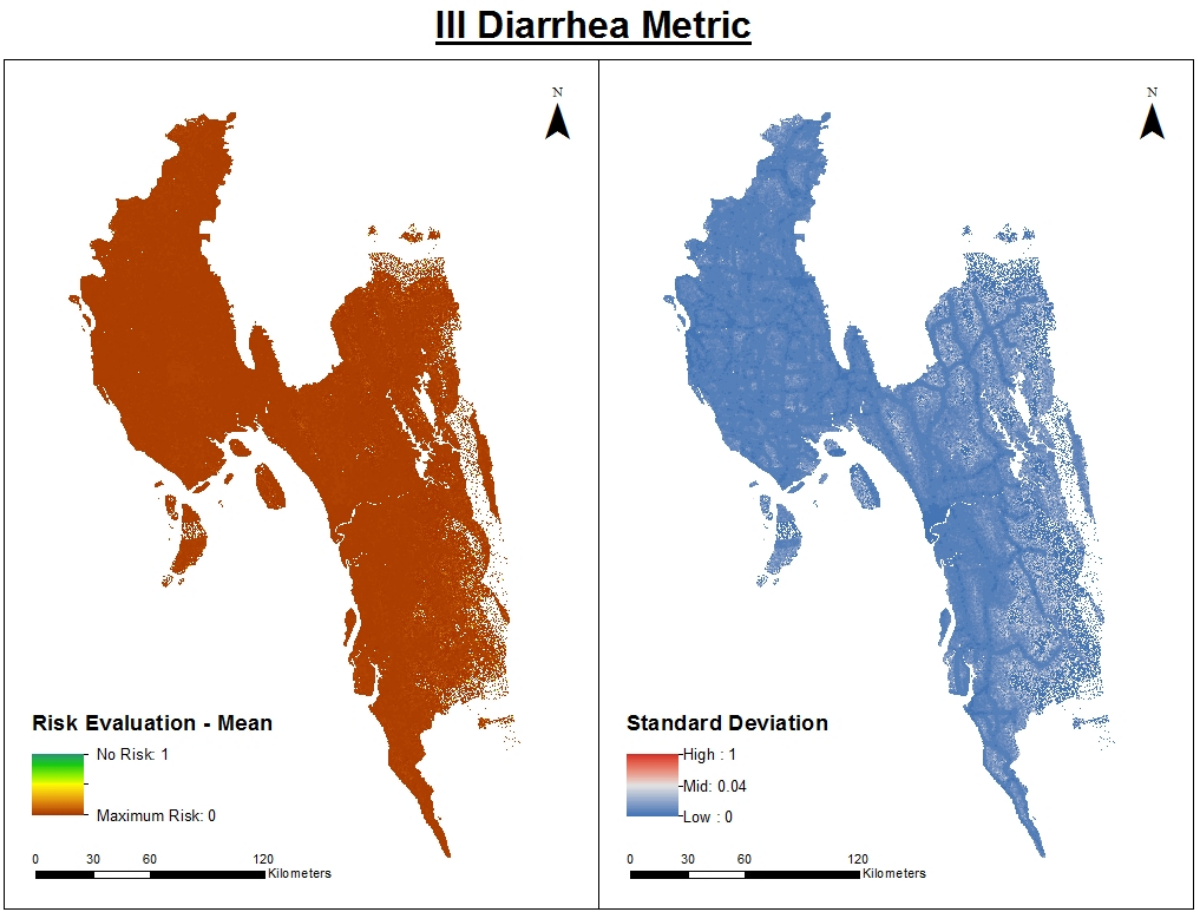
2.3.4.2 Metric: IllDiarrhea

Indicator: Polluted and Disease-Bearing Environment
Factor: Substandard Conditions
Condition: Human Behavioral Impact
Metric Assigned No (min: 1.0, max: 1.0)
Values: Yes (min: 0.2, max: 0.9)
Survey: DHS
Survey Date: 2011
Other Data Sources:

Logic: This metric consists of answers to the question “Has (name of child) had diarrhea in the last 2 weeks?” from the women’s portion of the DHS survey. “No” answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}).”Yes” answers are given a minimum value of 0.2 (medium risk) and a maximum value of 0.9 (minimal risk). Maps will range from medium risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



2.3.4.3 Metric: IllFever

Indicator:	Polluted and Disease-Bearing Environment
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned	No (min: 1.0, max: 1.0)
Values:	Yes (min: 0.2, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

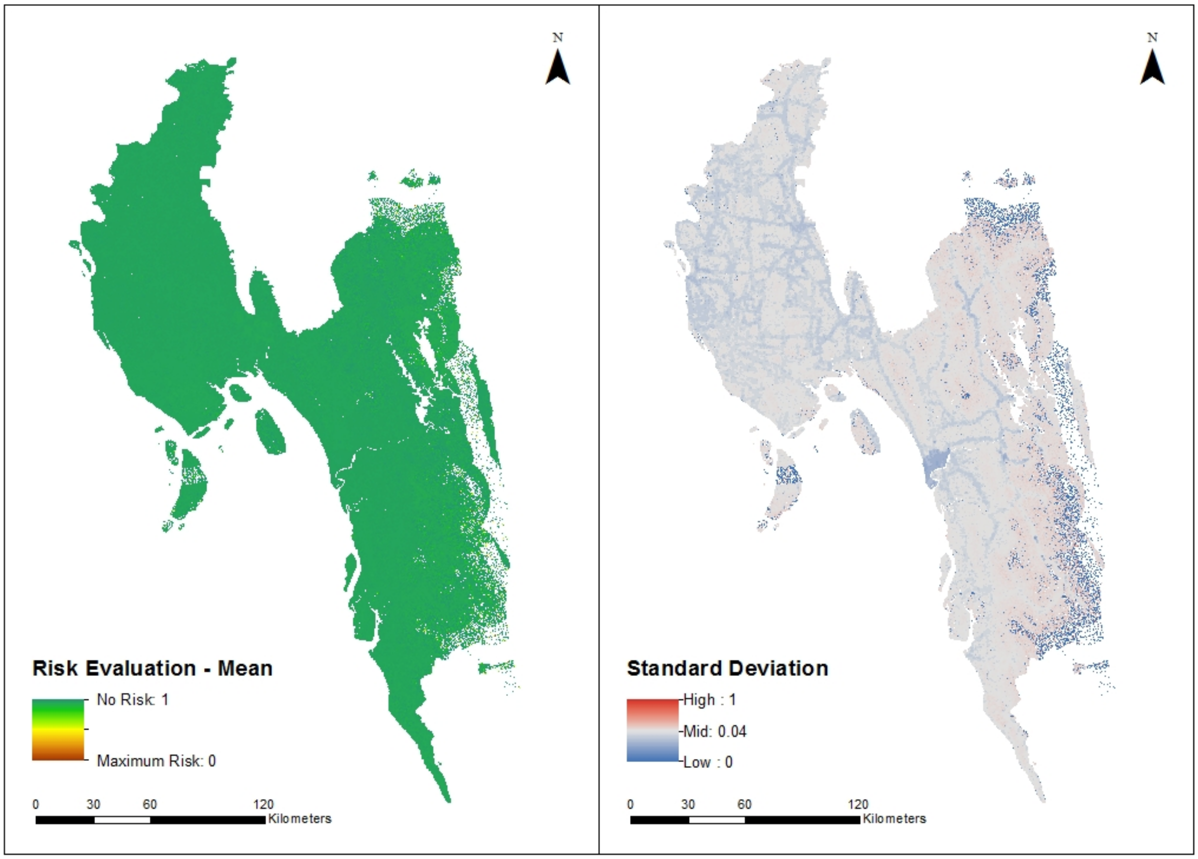
Logic:

This metric consists of answers to the question “Has (name of child) been ill with a fever at any time in the last 2 weeks?” from the women’s portion of the DHS survey. “No” answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).”Yes” answers are given a minimum value of 0.2 (medium risk) and a maximum value of 0.9 (minimal risk). Maps will range from medium risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

Ill Fever Metric



2.3.4.4 Metric: IllRespiratory

Indicator:	Polluted and Disease-Bearing Environment
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned	No (min: 1.0, max: 1.0)
Values:	Yes (min: 0.2, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

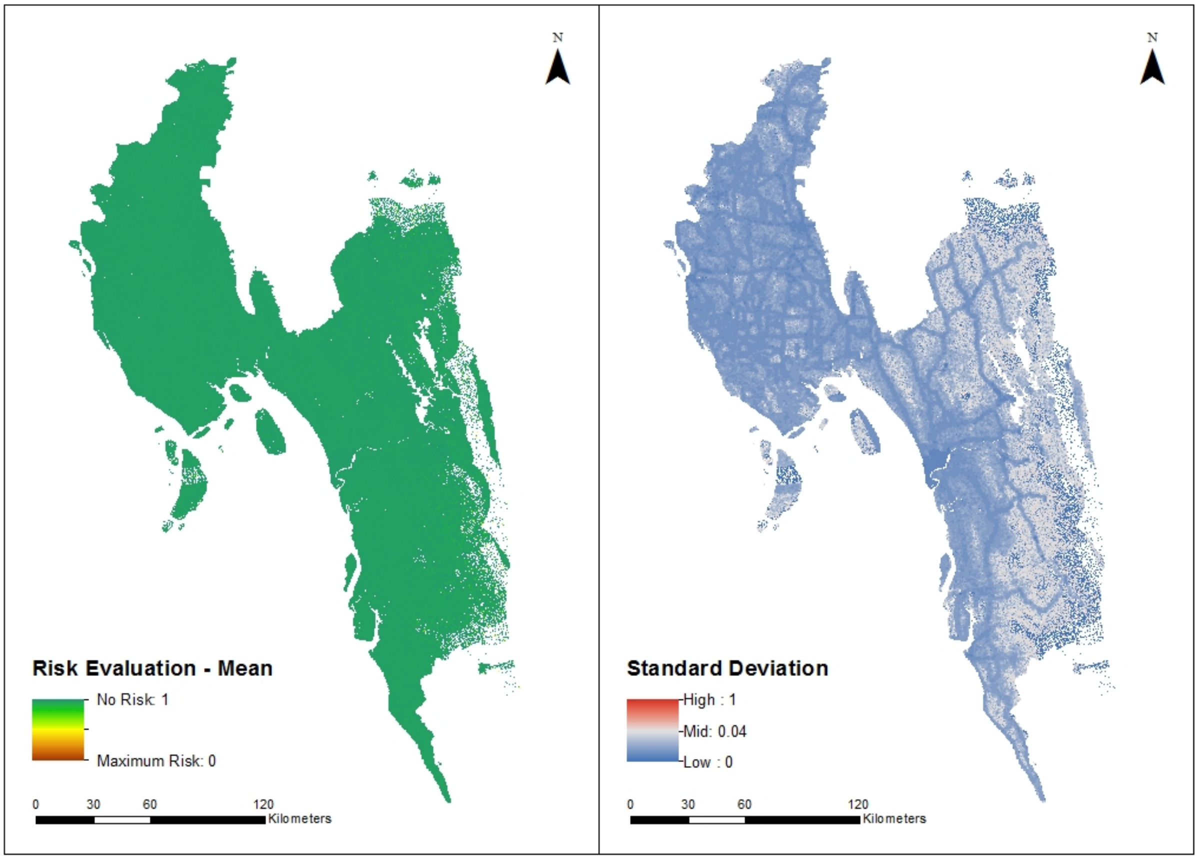
Logic:

This metric consists of answers to the question "Has (name of child) had an illness with a cough at any time in the last 2 weeks?" from the women's portion of the DHS survey. "No" answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$)."Yes" answers are given a minimum value of 0.2 (medium risk) and a maximum value of 0.9 (minimal risk). Maps will range from medium risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

Ill Respiratory Metric



2.3.4.5 Metric: Vaccinated

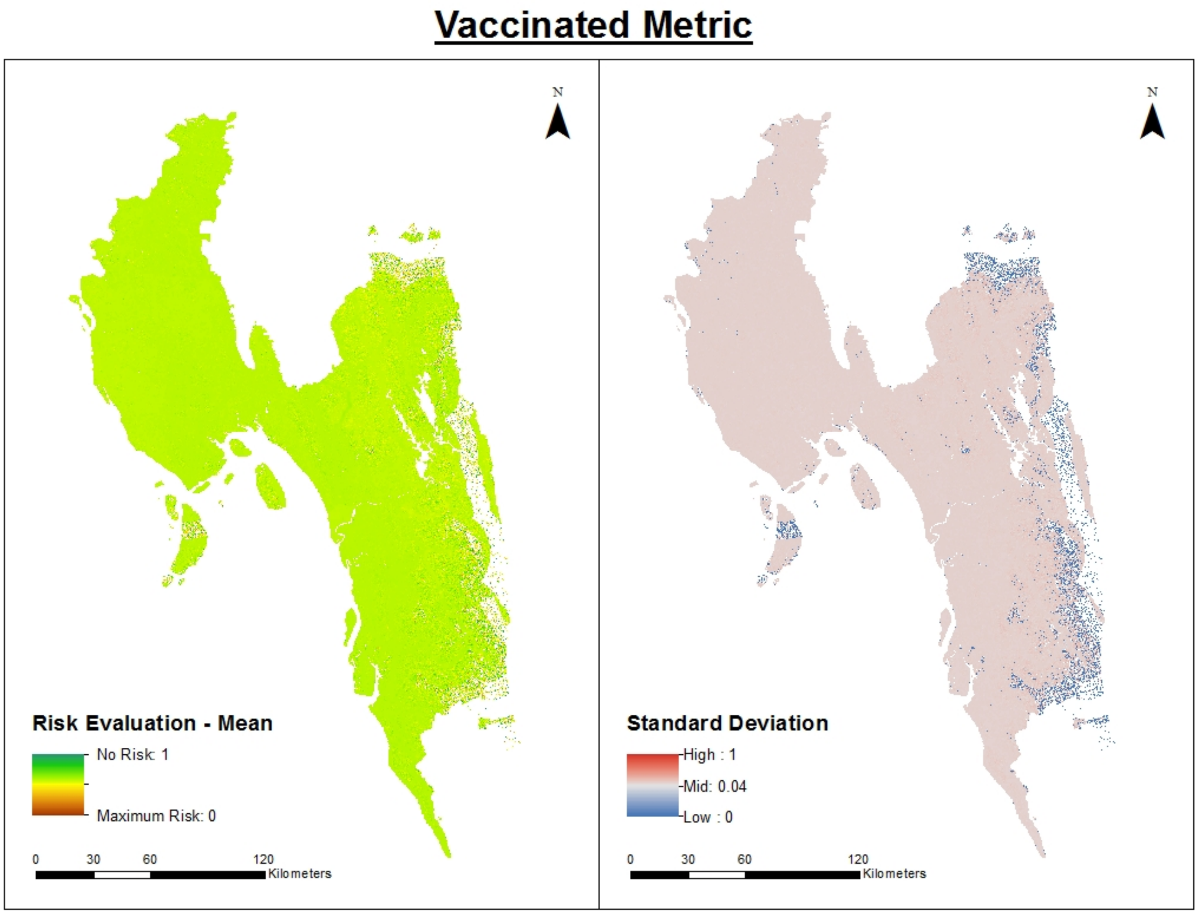
Indicator:	Polluted and Disease-Bearing Environment
Factor:	Substandard Conditions
Condition:	Human Behavioral Impact
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.0625, max: 0.500)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	N/A

Logic:

This metric consists of answers to the question “Have you ever had a vaccination?” from the DHS survey. The “No” response is given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.500 (slight risk, $½^1$). The “Yes” response is given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Maps will range from extreme risk to no risk.

This is the same question and answer series from the “Vaccinated” metric under the “Epidemics/Pandemics” indicator.

Example Realization Metric Map



3 Service Failure Condition Overview

This condition focuses on failures within multiple governance systems – the legal and policing systems, health and medical systems, and public infrastructure.

All factors currently have available metric and indicator data.

Factor Weighting Logic

All factors are given both a minimum and maximum weight of 0.333, as they are contributing equally with the condition risk potentially higher than an individual factor's risk level.

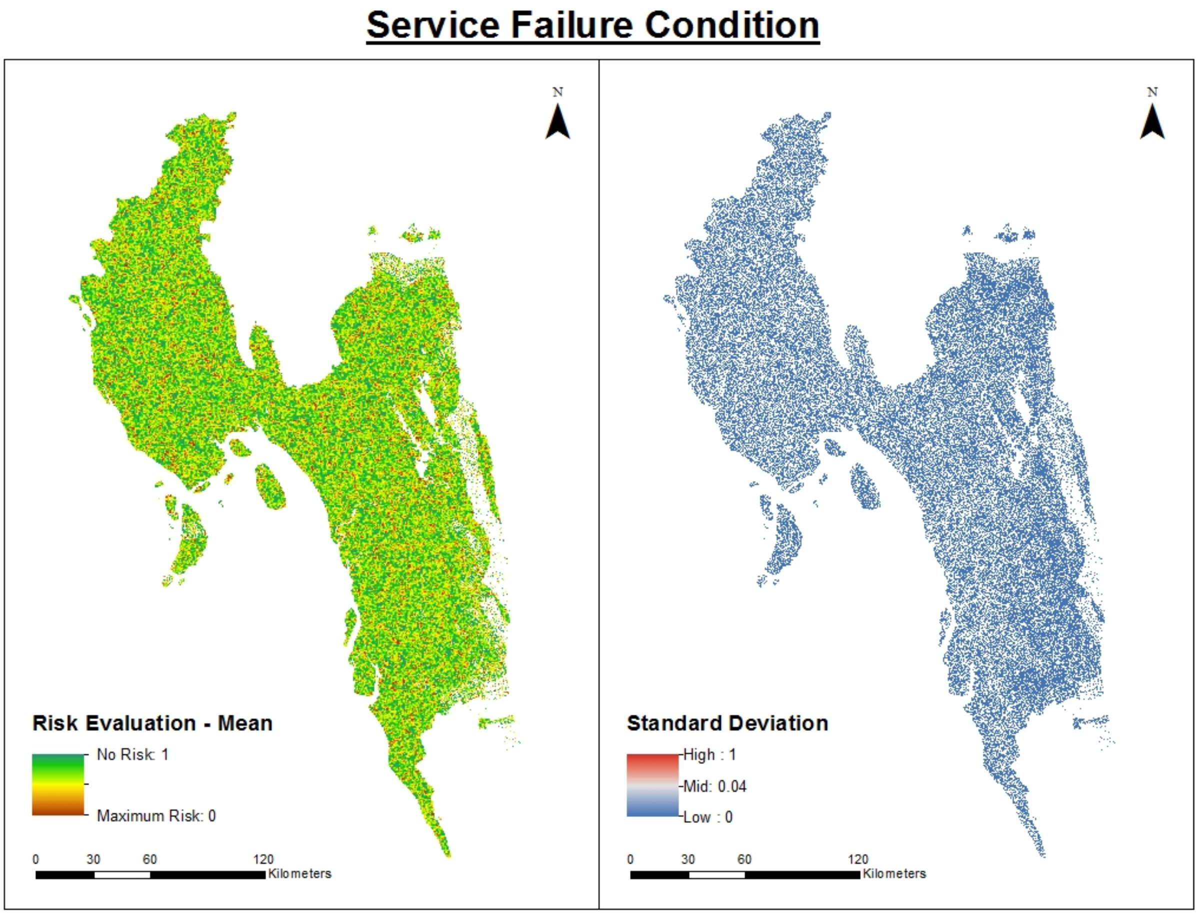
Factor (heading number)	Weight Minimum Value	Weight Maximum Value
Law Enforcement/Policing Deficiencies (3.1)	0.333	0.333
Health and Medical Service Insufficiencies (3.2)	0.333	0.333
Utilities Disruption (3.3)	0.333	0.333

Uncertainty Values

While the factors do encompass multiple aspects of civil service failures, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Condition Uncertainty Min: 0.1
Condition Uncertainty Max: 0.3

Example Outcome



3.1 Law Enforcement/Policing Deficiencies Factor Overview

This factor focuses on the systematic failure of existing judicial and policing efforts, where the indicators all point to law enforcement service failures. This could be due to lack of resources, dissatisfaction with the services, and/or corruption.

A functioning police and military has been shown to be extremely helpful with humanitarian assistance post-disaster when there is established dialogue and interaction with civilians (ECHO, OCHA 2013).

This factor also relates to the United Nation's Sustainable Development Goal 16: promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels (UN-DSD, 2016).

Indicators for this factor include Policing/Patrol Deficits, Inadequate Investigations and Prosecution, Prisons and Jails, and Inadequate Facilities/Property Protection.

Only the Policing/Patrol Deficits and the Inadequate Investigations and Prosecution indicators currently have any available metric data. Other indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All four indicators within the factor are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Policing/Patrol Deficits (3.1.1)	0.25	0.25
Inadequate Investigations and Prosecution (3.1.2)	0.25	0.25
Prisons and Jails (3.1.3)	0.25	0.25
Inadequate Facilities/Property Protection (3.1.4)	0.25	0.25

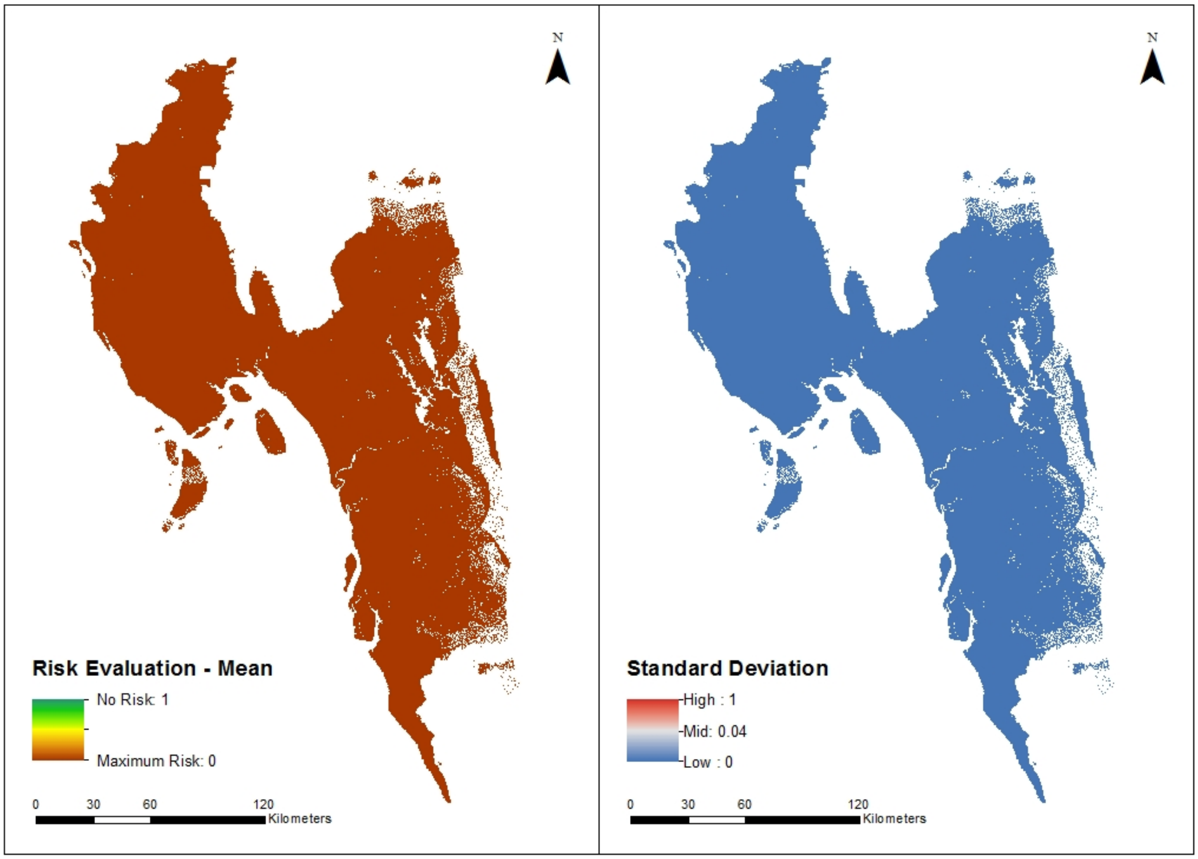
Uncertainty Values

The addition of other indicators pointing to law and order failures, such as judicial backlog, perception of bias in the legal system, etc., could further decrease the uncertainty value.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Law Enforcement Factor



References

United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2013). OCHA on Message: Civil-Military Coordination. Accessed at https://docs.unocha.org/sites/dms/Documents/OOM_CMCoord_11November2013_eng.pdf on 3 Jan 2017.

United Nations Division for Sustainable Development (DSD) (2016). "Sustainable Development Goal 16." Accessed at https://sustainabledevelopment.un.org/sdg16 on 3 Jan 2017.

3.1.1 Indicator: Policing/Patrol Deficits

This indicator focuses on policing service failures both in terms of quantities (numbers of officers, number of police training programs, etc.) and qualities (i.e., civilian satisfaction with police).

PACOM specifies that metrics should include: available police force; number of active-duty officers on patrol; number of training exercises per year; and satisfaction with policing/patrolling.

Metric Weighting Logic

As "PerceivedPoliceEffortsPositive" (which asks respondents their confidence level that the police will make a positive contribution to the maintenance of law and order in their community, from the VPS survey) most directly addresses the PACOM-specified metrics, it is given the highest maximum weight.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedPoliceEffortsPositive (3.1.1.1)	0.25	0.7
PerceivedIssueSafety (3.1.1.2)	0.25	0.5
PerceivedVisiblePolicingEffect (3.1.1.3)	0.25	0.6
PerceivedCrimeNonReportingReason (3.1.1.4)	0.25	0.6

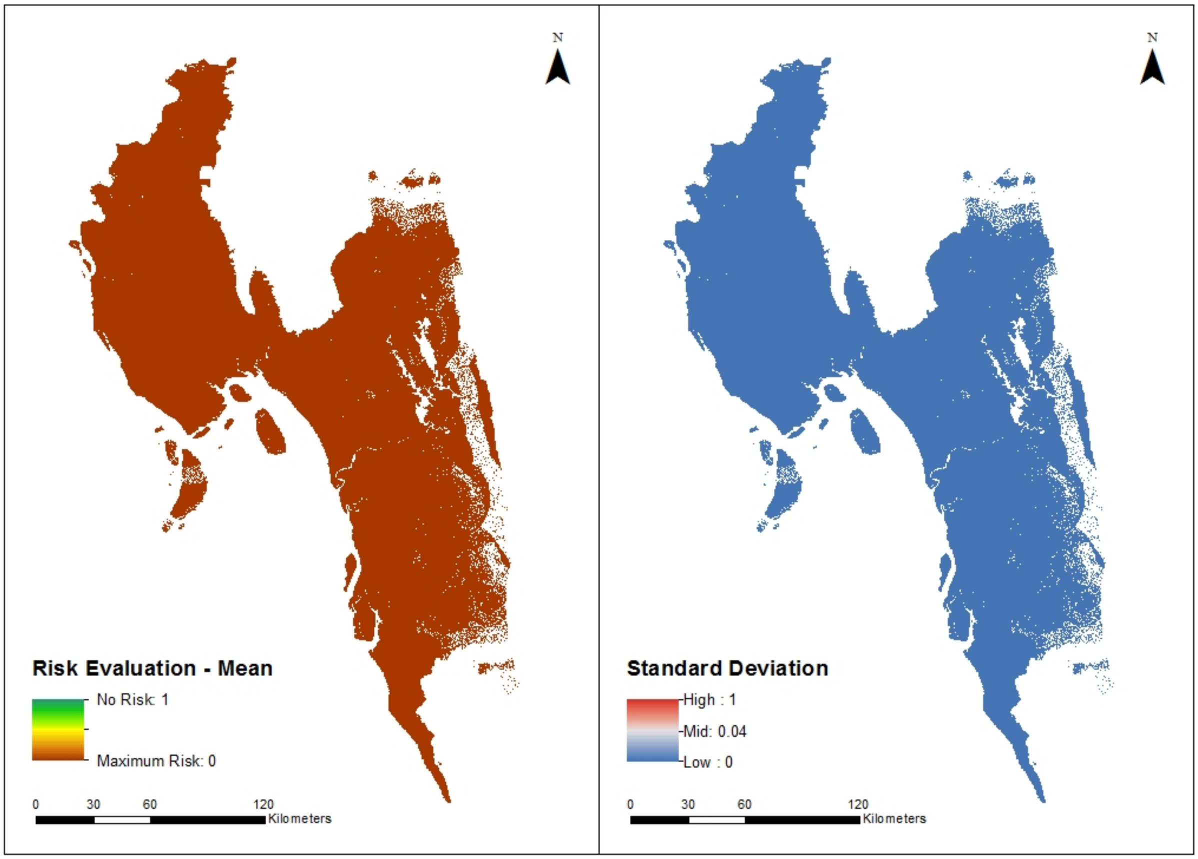
Uncertainty Values

Adding more quantitative data (i.e., proportion of active-duty officers per person) could decrease these uncertainty values, as current metrics consist of surveyed opinion measures.

Indicator Uncertainty Min: 0.70
Indicator Uncertainty Max: 0.75

Example Outcome

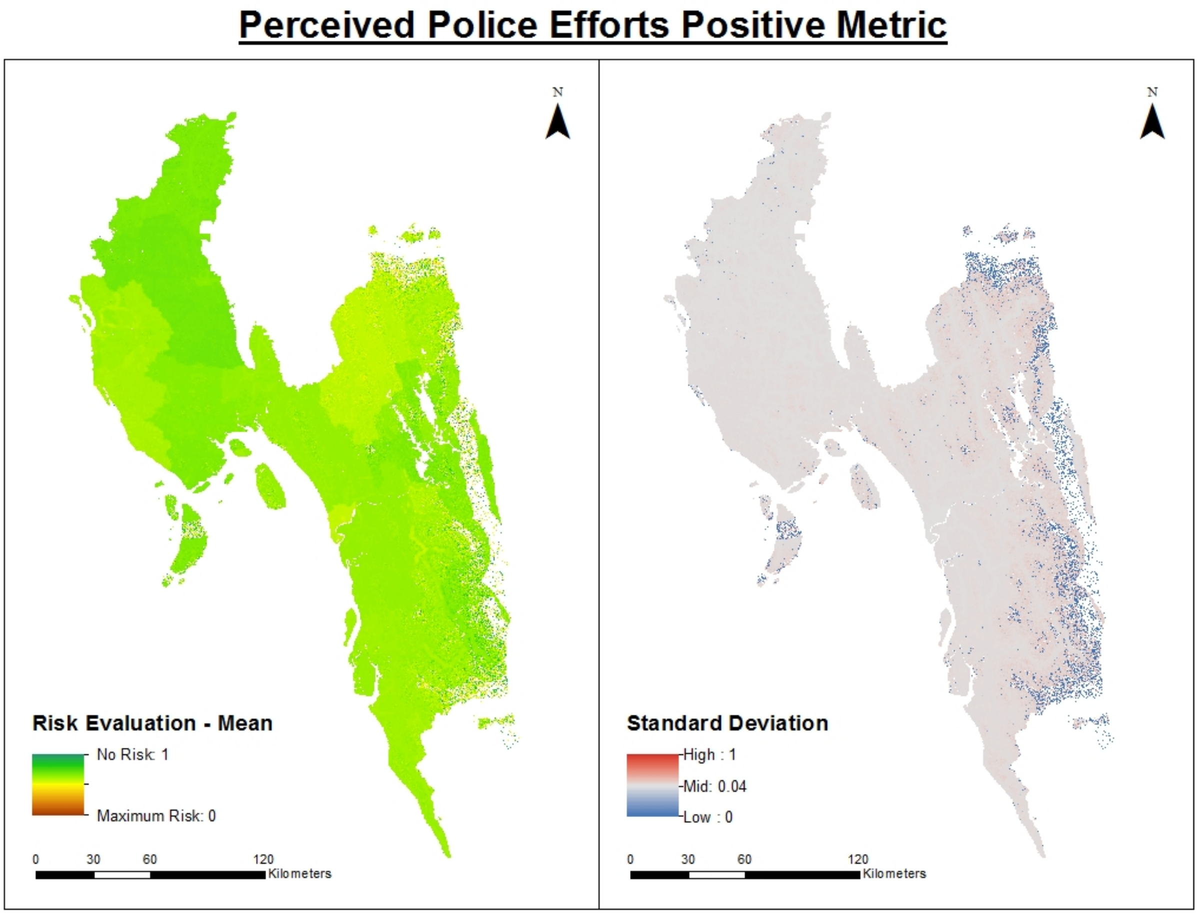
Policing Patrol Deficit Indicator



3.1.1.1 Metric: PerceivedPoliceEffortsPositive

Indicator:	Policing/Patrol Deficits
Factor:	Law Enforcement/Policing Deficiencies
Condition:	Service Failure
Metric Assigned Values:	Very Confident (min: 1.0, max: 1.0) Confident (min: 0.9, max: 1.0) Neither (Neither Confident nor Unconfident) (min: 0.3, max: 0.8) Unconfident (min: 0.125, max: 0.5) Very Unconfident (min: 0.0625, max: 0.3)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “How confident are you that the police will make a positive contribution to the maintenance of law and order in your community?” from the VPS survey. Answers of “Very Confident” are given both a minimum and a maximum number of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Confident” are given a minimum value of 0.9 (minimal risk) and a maximum value of 1.0. Answers of “Neither” are given a minimum value of 0.3 (slight risk) and a maximum value of 0.8 (minimal risk). Answers of “Unconfident” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of “Very Unconfident” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.3. Maps will range from extreme risk to no risk.

Example Realization Metric Map

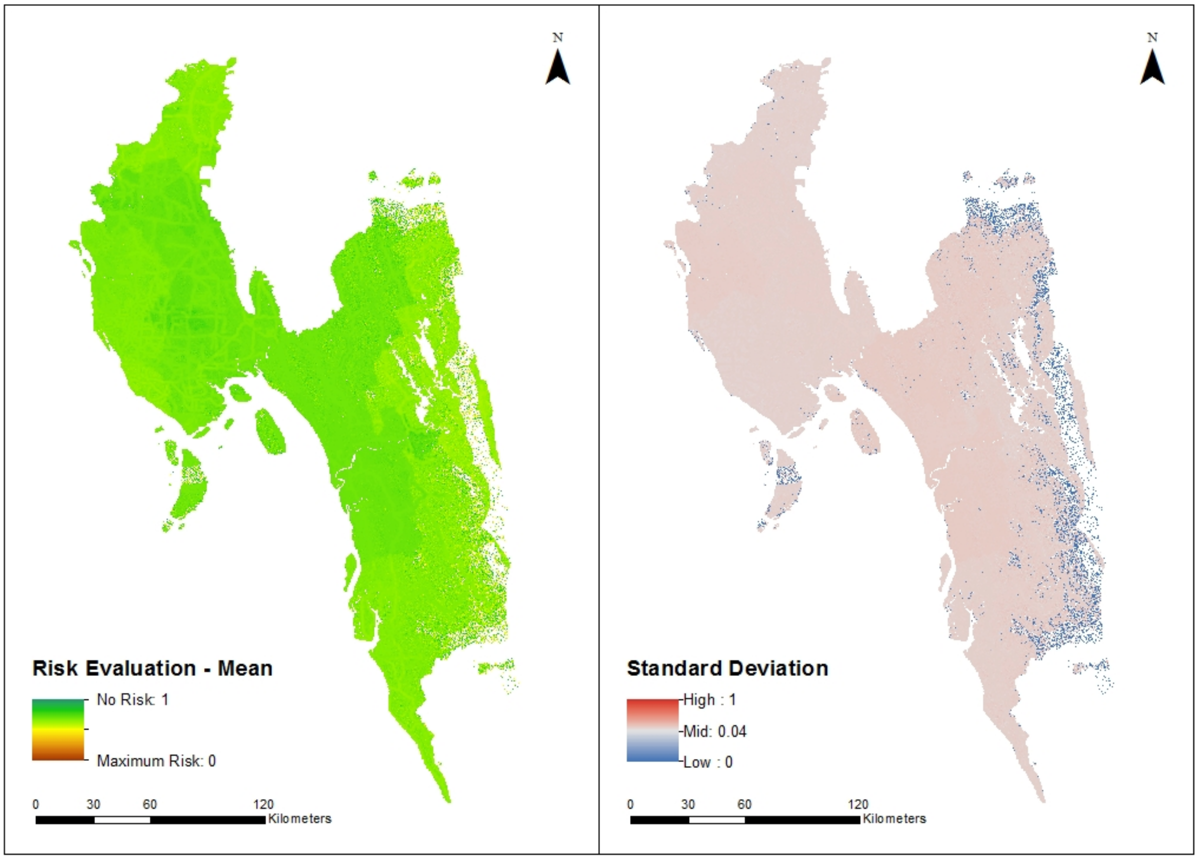


3.1.1.2 Metric: PerceivedIssueSafety

Indicator:	Policing/Patrol Deficits
Factor:	Law Enforcement/Policing Deficiencies
Condition:	Service Failure
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) Less Serious (min: 0.25, max: 0.9) More Serious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether safety and security is more or less serious in your community than in the rest of Bangladesh?” from the VPS survey. Answers of “Not Issue” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

Perceived Issue Safety Metric

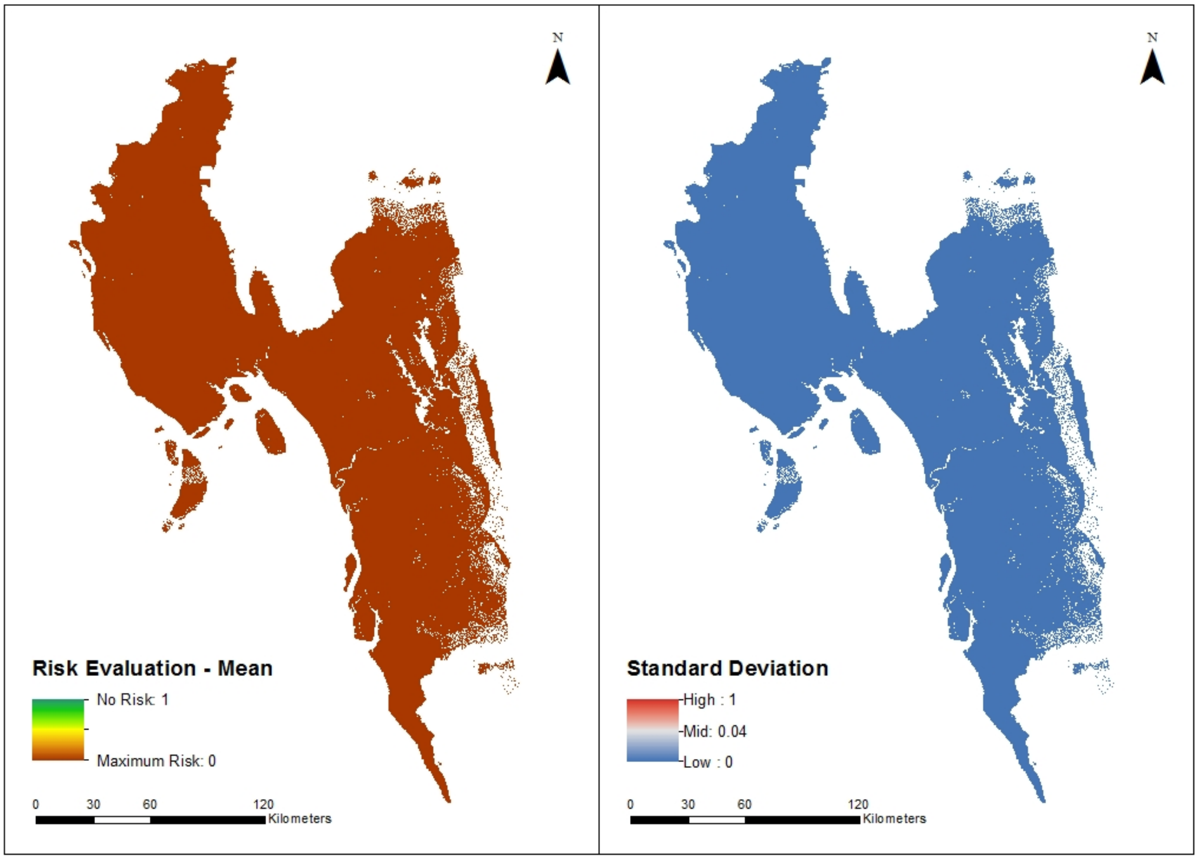


3.1.1.3 Metric: PerceivedVisiblePolicingEffort

Indicator:	Policing/Patrol Deficits
Factor:	Law Enforcement/Policing Deficiencies
Condition:	Service Failure
Metric Assigned Values:	More Safe (min: 1.0, max: 1.0) Neither (min: 0.25, max: 0.9) Less Safe (min: 0.07, max: 0.25)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you feel less or more safe when security forces are visibly present in your community?” from the VPS survey. Answers of “More Safe” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Neither” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “Less Safe” are given a minimum value of 0.07 (high risk) and a maximum value of 0.25 (slight risk, $½^2$). Maps will range from high risk to no risk.

Example Realization Metric Map

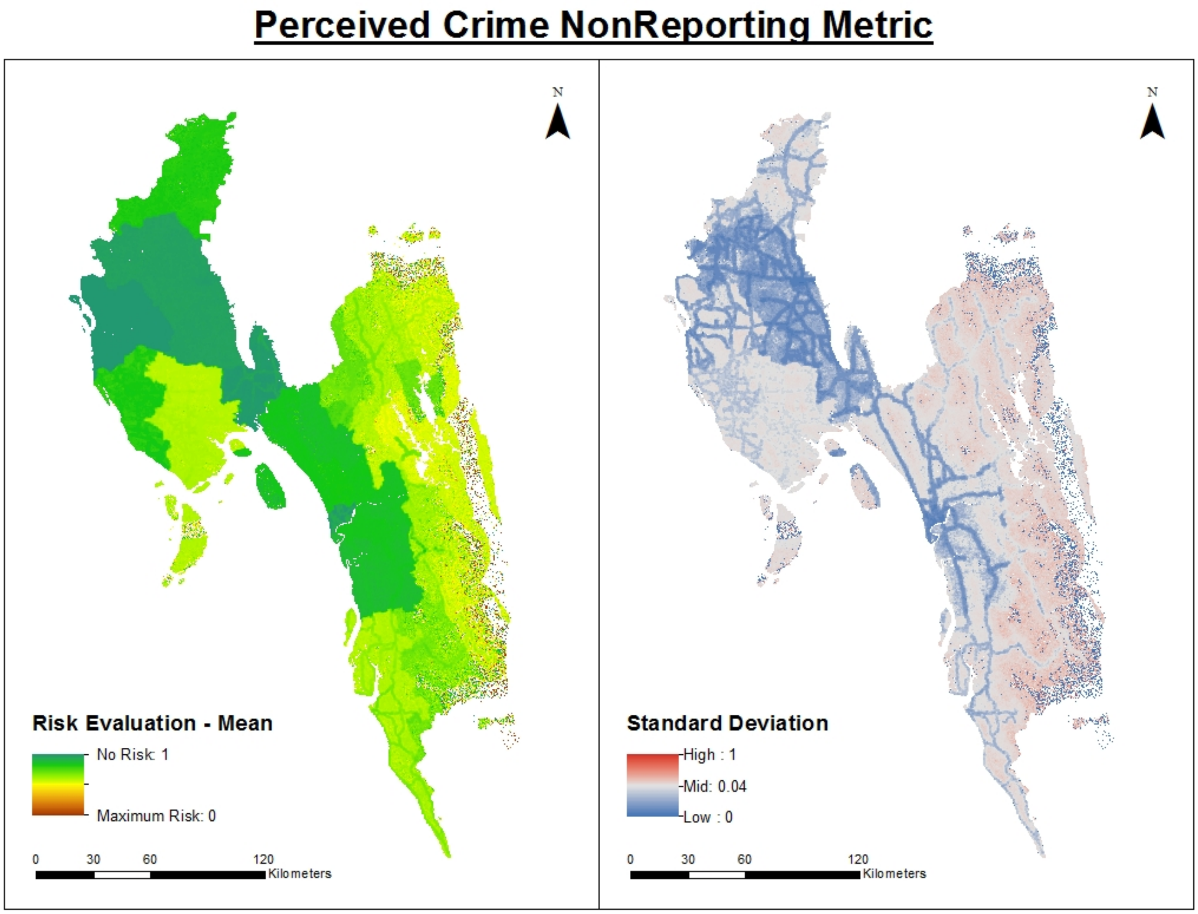
Perceived Visible Policing Metric



3.1.1.4 Metric: PerceivedCrimeNonreportingReason

Indicator:	Policing/Patrol Deficits
Factor:	Law Enforcement/Policing Deficiencies
Condition:	Service Failure
Metric Assigned Values:	PoliceNonCatch (police won't catch the criminals) (min: 0.0625, max: 0.35) LegalNonPunish (legal system won't punish criminals) (min: 0.0625, max: 0.4) CriminalHarmReporter (criminals will cause harm to those who reported the crime) (min: 0.0625, max: 0.25) NoCrime (no crime in my area to report) (min: 1.0, max: 1.0) CrimeReported (everyone in my area reports crimes) (min: 1.0, max: 1.0)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Why do you think people don't report crimes?” from the VPS survey. Answers of “PoliceNonCatch” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.35 (medium risk). Answers of “LegalNonPunish” are given a minimum value of 0.0625 and a maximum value of 0.4 (slight risk). Answers of “CriminalHarmReporter” are given a minimum value of 0.0625 and a maximum value of 0.25. Answers of “NoCrime” and “CrimeReported” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Maps will range from extreme risk to no risk.

Example Realization Metric Map



3.1.2 Indicator: Inadequate Investigations and Prosecution

This indicator accounts for failures in law and order, or within the judicial system within the study area.

PACOM specifies that metrics should include: number of reported investigations for violent crimes (murder, rape, robbery, aggravated assault); and number of prosecutions for violent crimes compared with historical data.

Metric Weighting Logic

As there is currently only one metric within this indicator, it is automatically the most constraining with both a minimum and maximum weight of 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedJudicialEffortsPositive (3.1.2.1)	1.0	1.0

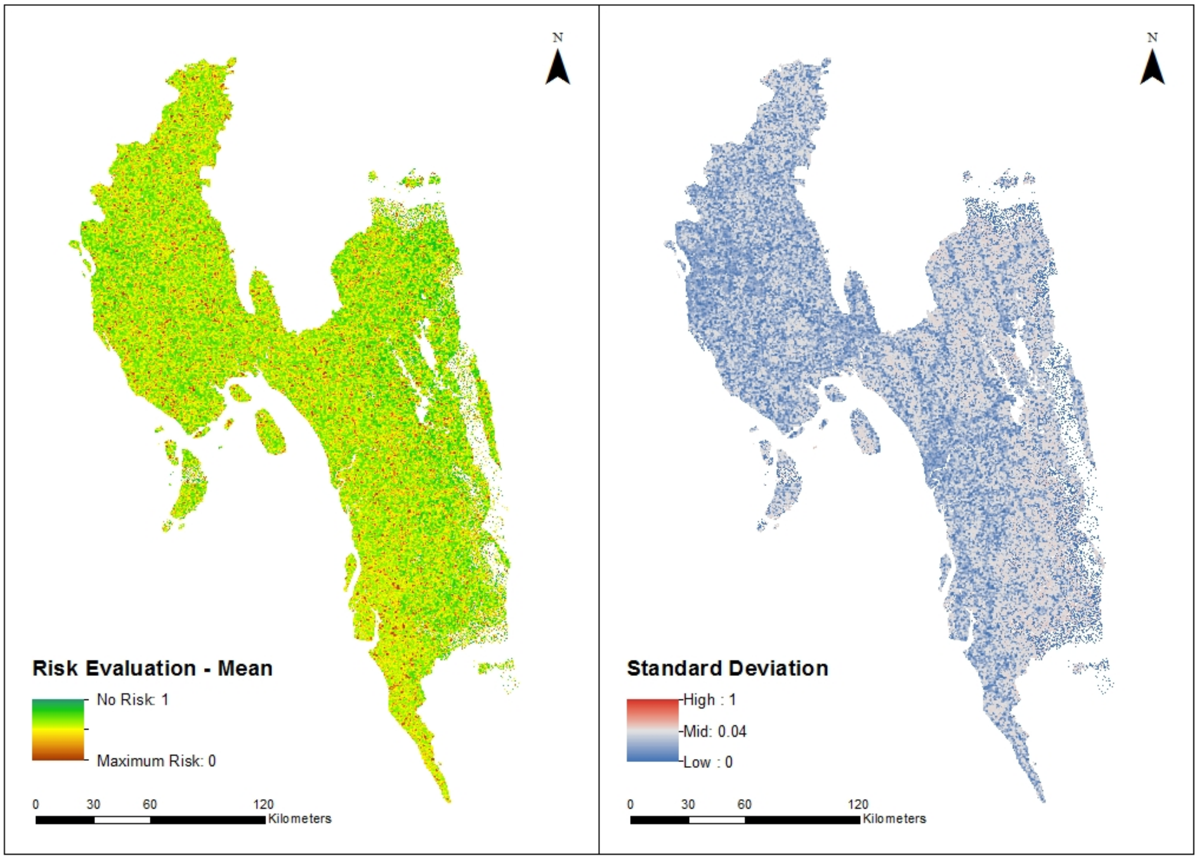
Uncertainty Values

Adding more quantitative data that PACOM specifies could decrease these uncertainty values, as current metrics consist of surveyed opinion measures.

Indicator Uncertainty Min: 0.70
Indicator Uncertainty Max: 0.75

Example Outcome

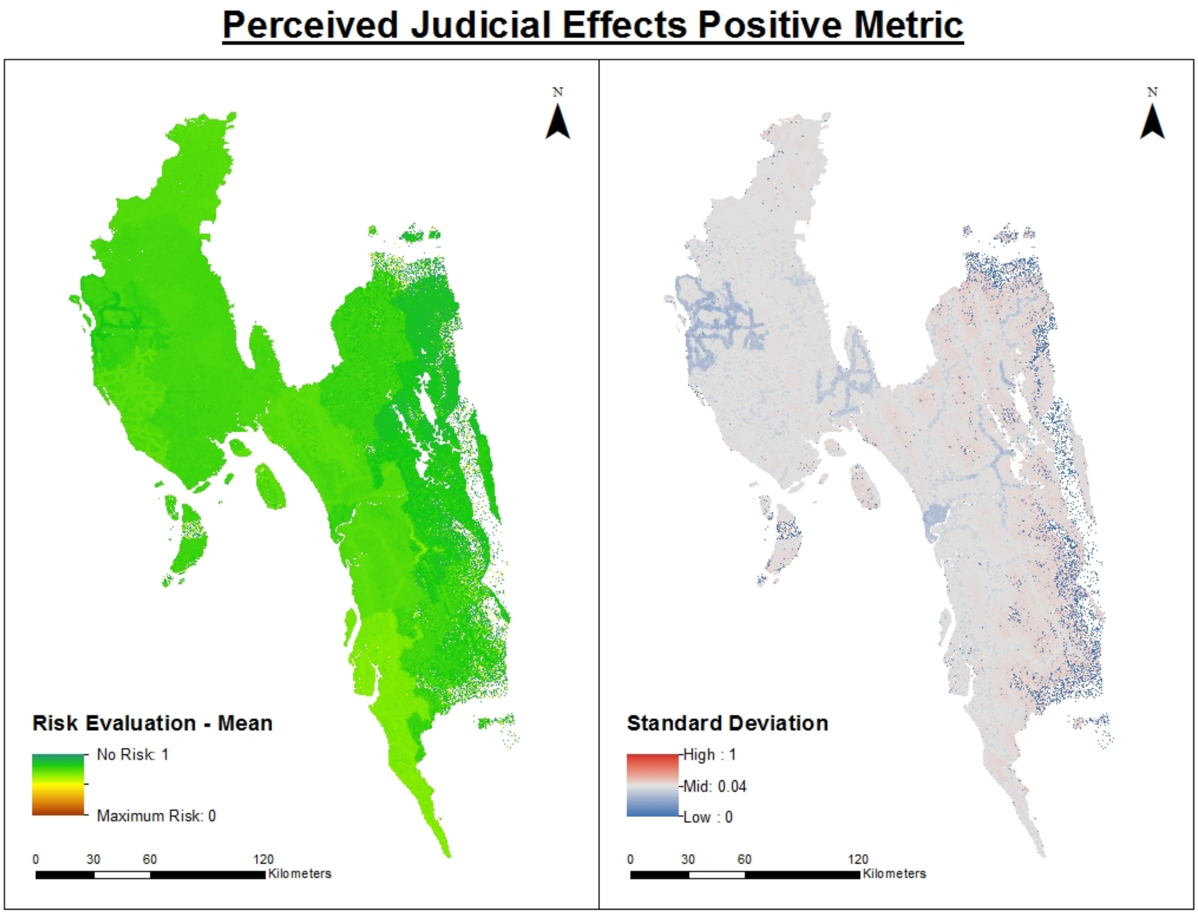
Inadequate Investigations and Prosecution Indicator



3.1.2.1 Metric: PerceivedJudicialEffortsPositive

Indicator:	Inadequate Investigations and Prosecution
Factor:	Law Enforcement/Policing Deficiencies
Condition:	Service Failure
Metric Assigned Values:	Very Confident (min: 1.0, max: 1.0) Confident (min: 0.9, max: 1.0) Neither (Neither Confident nor Unconfident) (min: 0.3, max: 0.8) Unconfident (min: 0.125, max: 0.5) Very Unconfident (min: 0.0625, max: 0.3)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "How confident are you that the national judicial system will make a positive contribution to the maintenance of law and order in your local community?" from the VPS survey. Answers of "Very Confident" are given both a minimum and a maximum number of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Confident" are given a minimum value of 0.9 (minimal risk) and a maximum value of 1.0. Answers of "Neither" are given a minimum value of 0.3 (slight risk) and a maximum value of 0.8 (minimal risk). Answers of "Unconfident" are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of "Very Unconfident" are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.3. Maps will range from extreme risk to no risk.

Example Realization Metric Map



3.1.3 Indicator: Prisons and Jails

This indicator accounts for, not necessarily for the presence of prisons and jails, but rather for the lack of capacity for the prison system to handle the influx and out flux of criminals.

PACOM specifies that metrics should include: number of prison/jail facilities per capita (compare with historical and cross-national data); number of cells available per capita; and jail occupancy levels.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

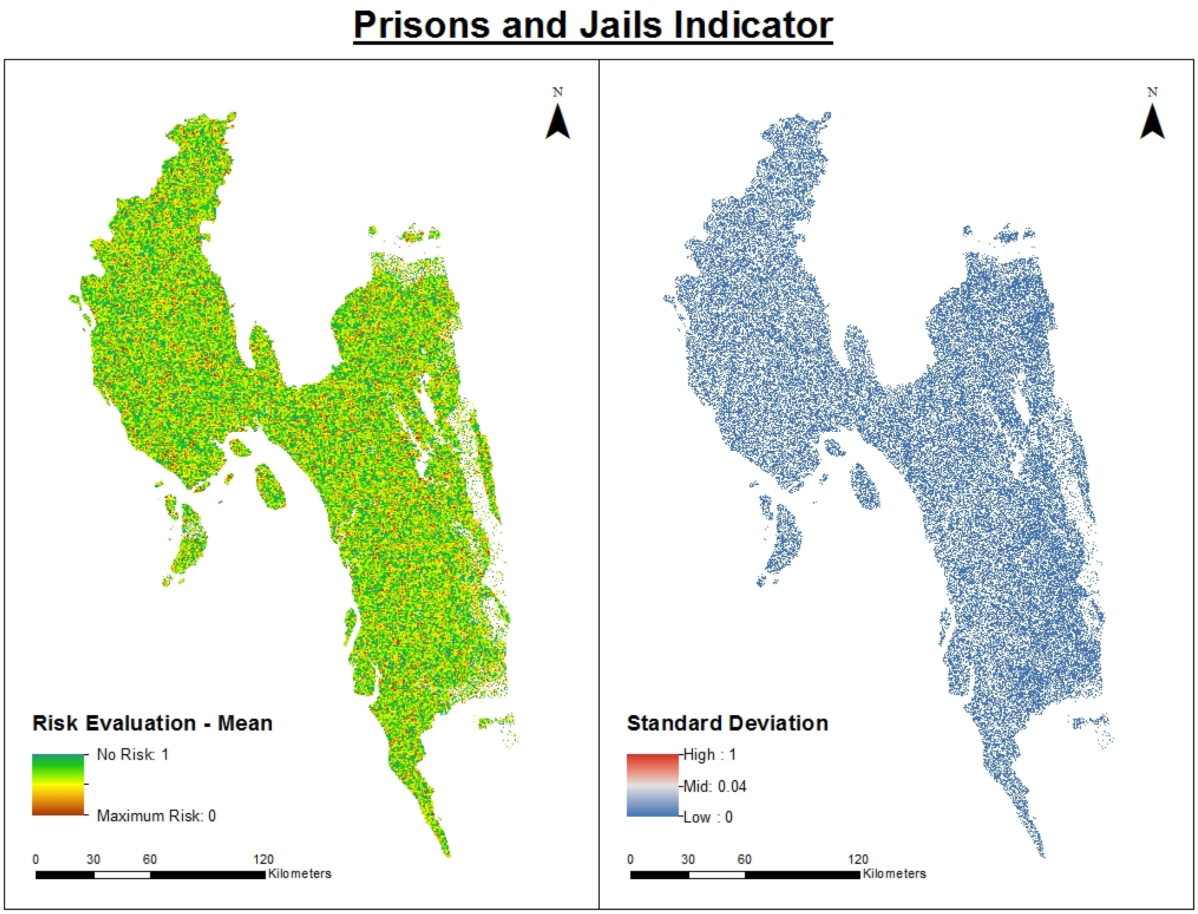
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



3.1.4 Indicator: Inadequate Facilities/Property Protection

This indicator accounts for the lack of protection of both private and public properties.

PACOM specifies that metrics should include: number of officers assigned to patrol/protect business facilities (compare with historical data).

3.1.4.1 Region-Specific Note

As the data called for by PACOM is difficult to obtain, especially in the Bangladesh context, it is likely that this indicator will have no metrics and therefore no effect on the overall risk of this factor.

If this indicator was renamed to reflect physical damage to private property and facilities, especially following a crisis (i.e., looting, arson), metrics may be easier to find. This would allow for better quantification of risk and a decrease in uncertainty values.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

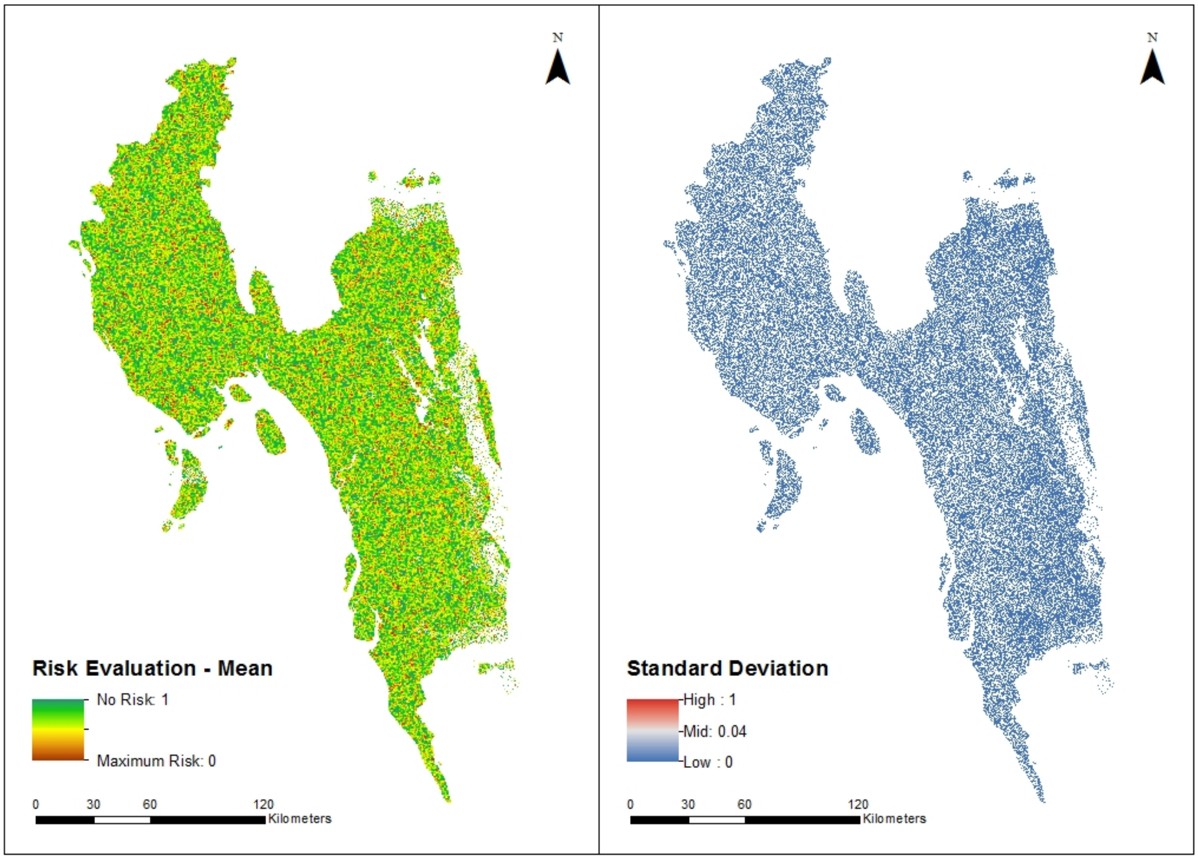
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Inadequate Facilities/Property Protection Indicator



3.2 Health and Medical Service Insufficiencies Factor Overview

This factor accounts for service failures in the health and medical sectors within the study area. The efficacy of medical services during typical day-to-day operations will suggest their effectiveness in adapting to a crisis situation. “Medical Services” is one of 28 indicators in the World Risk Index under the heading of “coping capacity” (Welle and Birkmann 2015). In other words, coping capacities point to the function of governance, disaster preparedness and early warning, medical services, and social and economic security.

Indicators include Doctor and Access to Primary Care, Hospitals/Clinics and Secondary Care, Availability of Pharmaceuticals, and Delayed or Deficient Mortuary Affairs.

Except for the Delayed or Deficient Mortuary Affairs indicator, all of the indicators currently have available metric data.

Indicator Weighting Logic

All four indicators within the factor are given both a minimum and a maximum value of 0.25. Because all of the indicator weights add up to 1.0, none of the indicators alone determine the factor’s overall risk. As such, they are contributing equally with the factor risk potentially higher than an individual indicator’s risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Doctor and Access to Primary Care (3.2.1)	0.25	0.25
Hospital/Clinics and Secondary Care (3.2.2)	0.25	0.25
Availability of Pharmaceuticals (3.2.3)	0.25	0.25
Delayed or Deficient Mortuary Affairs (3.2.4)	0.25	0.25

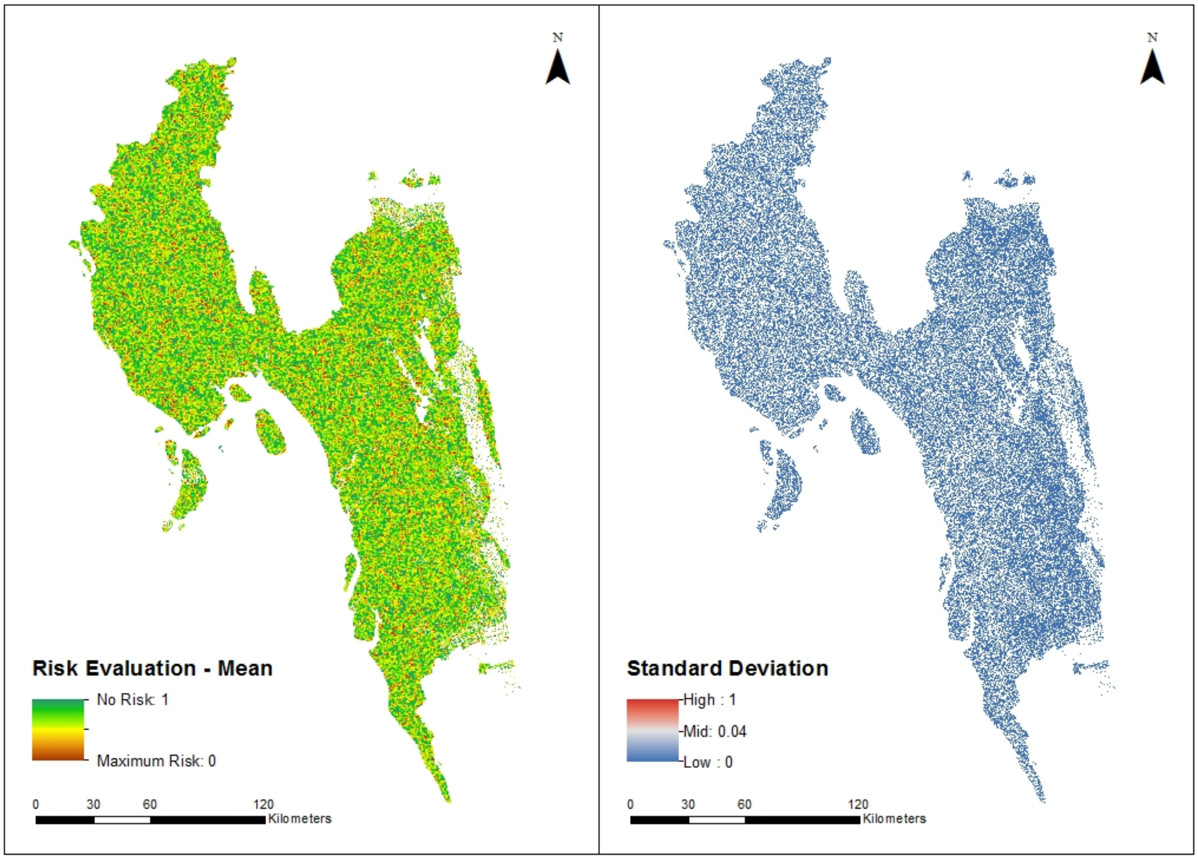
Uncertainty Values

The addition of indicators measuring the relation between and regulation of public and private healthcare, the efficiency of medical services post disaster (i.e., triage), etc., could further reduce the uncertainty factor.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Health Medical Factor



References

Welle, Torsten and Joern Birkmann (2015). "The World Risk Index – An Approach to Assess Risk and Vulnerability on a Global Scale." J Extreme Events, Vol. 2, No. 1 (2015) 1550003 (34 pages).

3.2.1 Indicator: Doctor and Access to Primary Care[1]

According to the John Hopkins Primary Care Policy Center:

> Primary care is the level of a health services system that provides entry into the system for all new needs and problems, provides person-focused (not disease-oriented) care over time, provides care for all but very uncommon or unusual conditions, and coordinates or integrates care, regardless of where the care is delivered and who provides it. It is the means by which the two main goals of a health services system, optimization and equity of health status, are approached (John Hopkins).

It is important to note that the above definition was written and is applicable within a Western context, while this particular application of the PACOM HC framework focuses on Bangladesh. As such, medical needs that may be considered more secondary care in the West (i.e., antenatal and postnatal care) could be found at a primary care clinic and/or addressed by a general physician.

PACOM specifies that metrics should include: number of healthcare professionals per capita (compared with historical and cross-national data); number of primary healthcare facilities per capita; satisfaction with the amount of time required to reach primary care facilities; satisfaction with ability to obtain an appointment for primary care concern; and perceived quality of healthcare services delivered by primary care professional (if applicable).

Metric Weighting Logic

As “PerceivedIssueHealthcare” (whether availability of health care is more or less serious in respondent’s community than in the rest of Bangladesh from VPS survey) and “PerceivedDistanceHealthcare” (asks if distance to the health facility a big problem from DHS survey) most directly cover the metrics called for by PACOM, they are the most constraining on the indicator and are given the highest minimum and maximum weights.

[1] Note: The top-down structure and creation process of the PACOM Humanitarian Crisis framework requires that metrics be found to fit into the established indicator/factor/condition framework. As such, the names of indicators are unchangeable. However, based on 1) increasing the ease of application within non-Western contexts and 2) allowing for metrics and metric metadata to bets fit into a singular indicator, the research team would prefer for the indicator “Doctor and Access to Primary Care” to be named “Access to Health Care Facilities”; and for the indicator “Hospitals/Clinics and Secondary Care” to be named “Access to Health Care Professionals and Specialists.”

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueHealthcare (3.2.1.1)	0.3	0.7
PerceivedEffortHealthcare (3.2.1.2)	0.125	0.3
AntenatalCareBegin (3.2.1.3)	0.2	0.5
AntenatalCareFrequency (3.2.1.4)	0.2	0.5
HealthStaffPostDelivery (3.2.1.5)	0.2	0.5
HealthInsuranceCoverage (3.2.1.6)	0.2	0.5
PerceivedDistanceHealthcare (3.2.1.7)	0.3	0.7

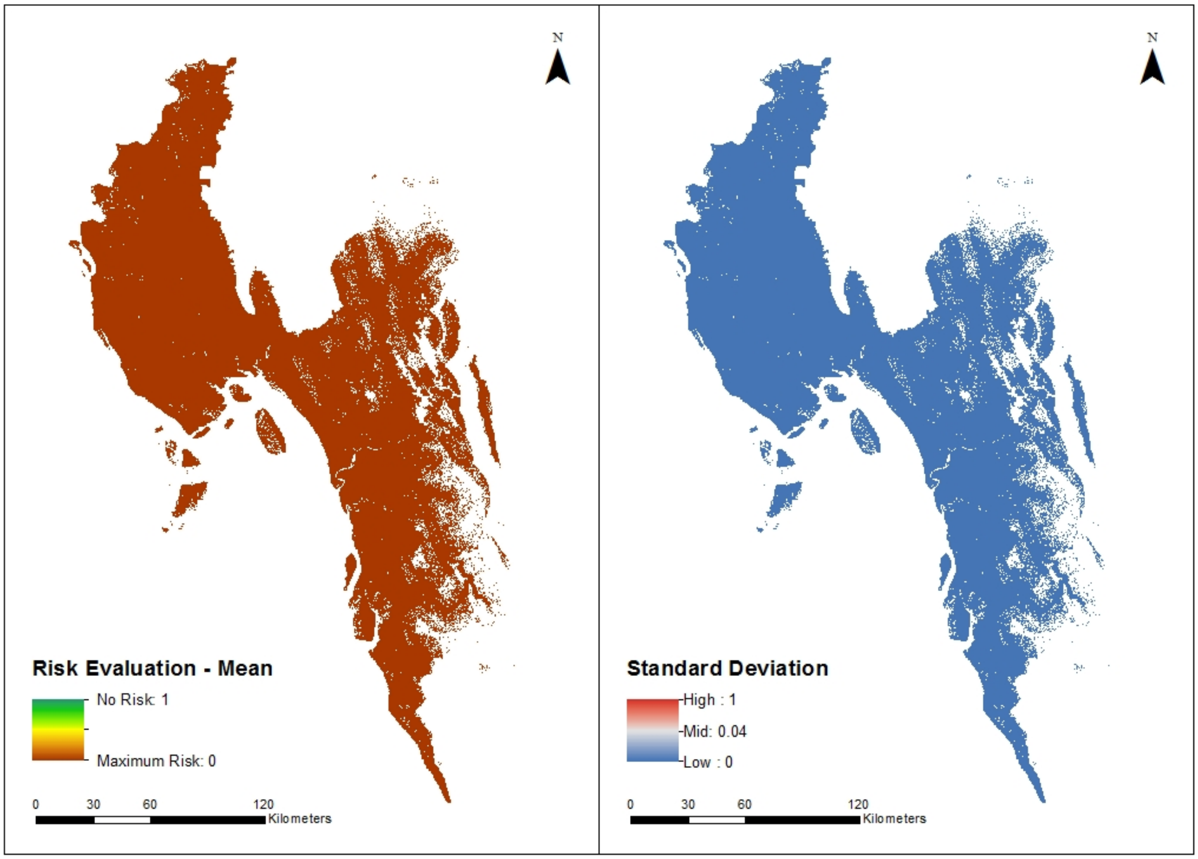
Uncertainty Values

Adding more quantitative data as suggested by PACOM could decrease these uncertainty values, as current metrics consist mostly of surveyed measures focusing on antenatal and postnatal care.

Indicator Uncertainty Min: 0.5
Indicator Uncertainty Max: 0.6

Example Outcome

Doctor and Access to Primary Care Indicator



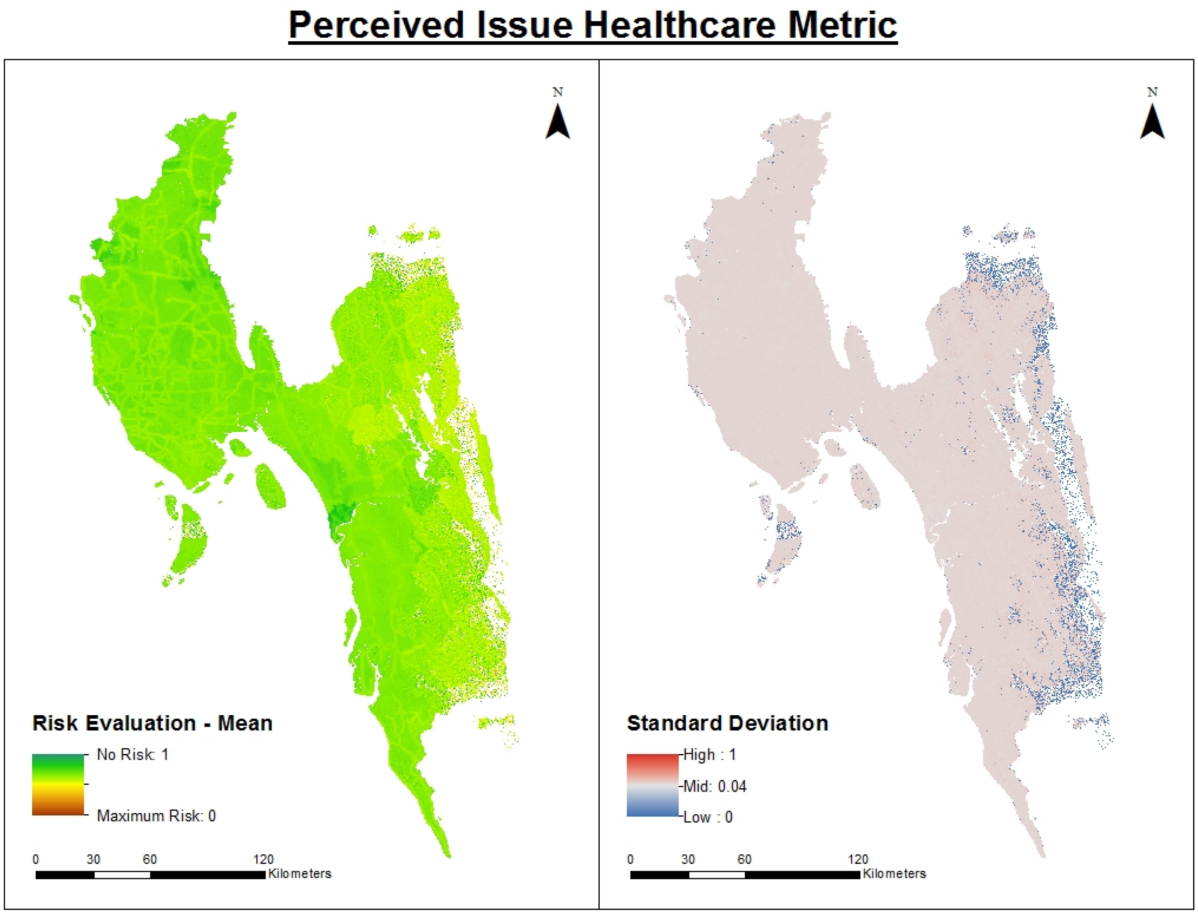
References

John Hopkins Primary Care Policy Center. "Definitions." John Hopkins Bloomberg School of Public Health. Accessed at http://www.jhsph.edu/research/centers-and-institutes/johns-hopkins-primary-care-policy-center/definitions.html on 3 Jan 2017.

3.2.1.1 Metric: PerceiveIssueHealthcare

Indicator:	Doctor and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether availability of health care is more or less serious in your community than in the rest of Bangladesh?” from the VPS survey. Answers of “Not Issue” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

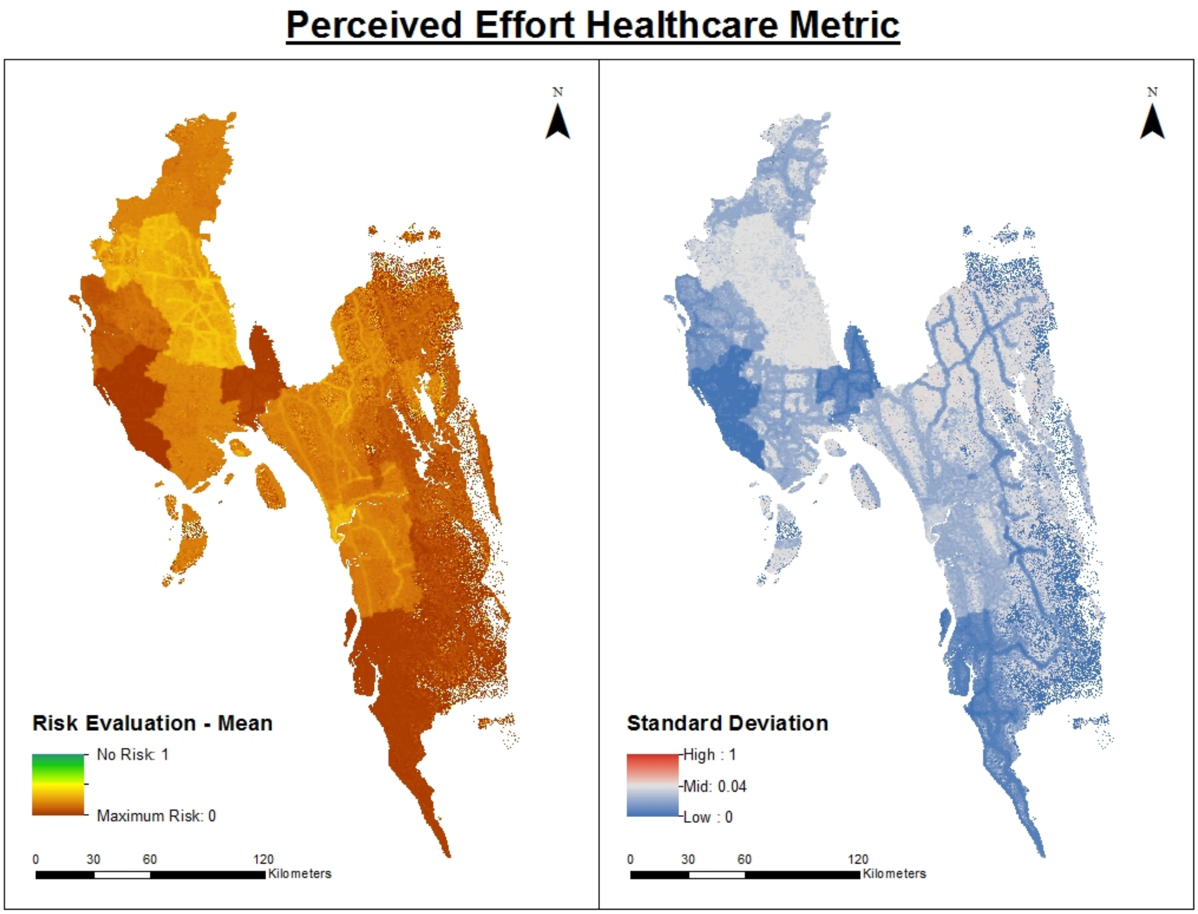
Example Realization Metric Map



3.2.1.2 Metric: PerceivedEffortHealthcare

Indicator:	Doctors and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe it working hard to improve the availability of health care in Bangladesh today?” from the DHS survey. Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

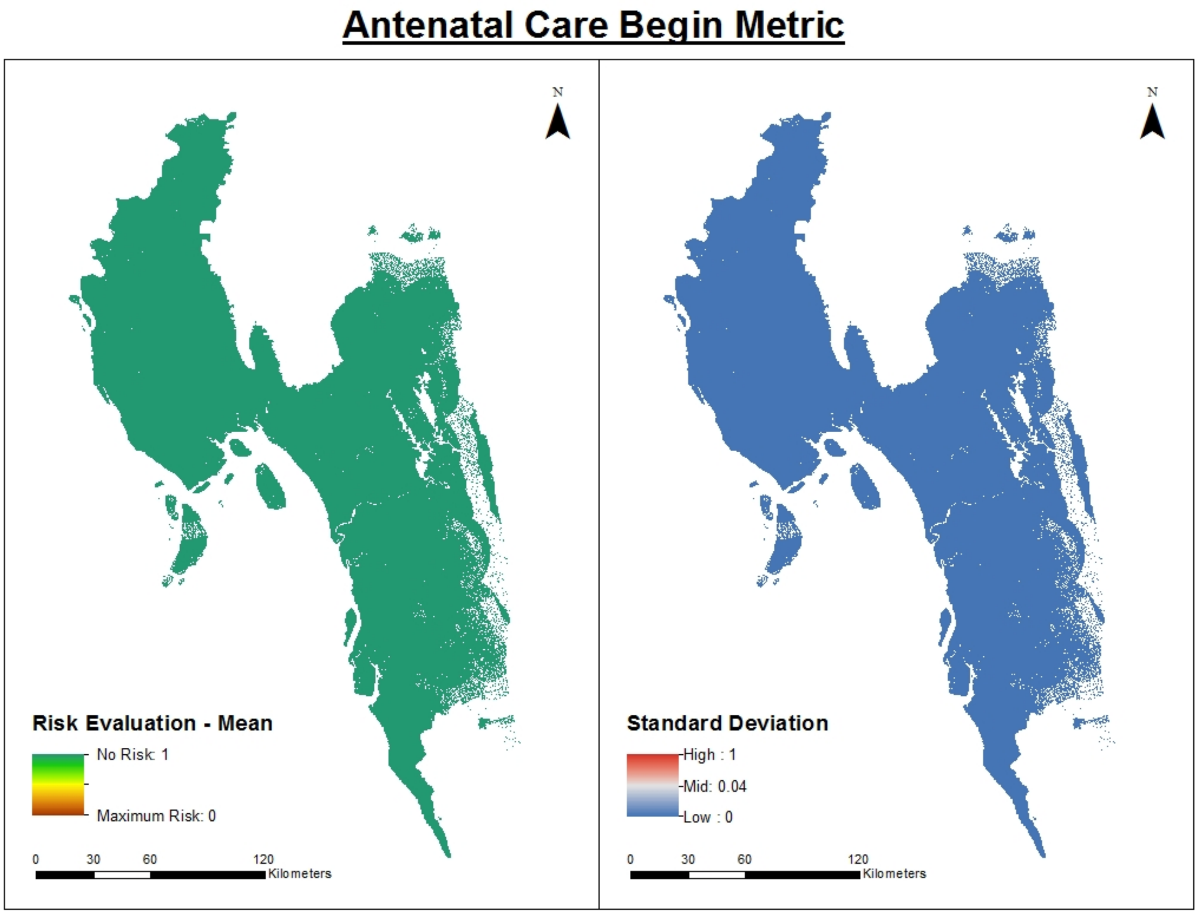
Example Realization Metric Map



3.2.1.3 Metric: AntenatalCareBegin

Indicator:	Doctor and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	0to3Month (min: 1.0, max: 1.0) 3to9Month (min: 0.3, max: 0.8) Unknown (min: 0.3, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “How many months pregnant were you when you first received antenatal care?” from the DHS survey. Answers of “0 to 3 months” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “3 to 9 months” are given a minimum value of 0.3 (slight risk) and a maximum value of 0.8 (minimal risk). Answers of “Unknown” are given a minimum value of 0.3 and a maximum value of 0.9 (minimal risk). Maps will range from slight risk to no risk. It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



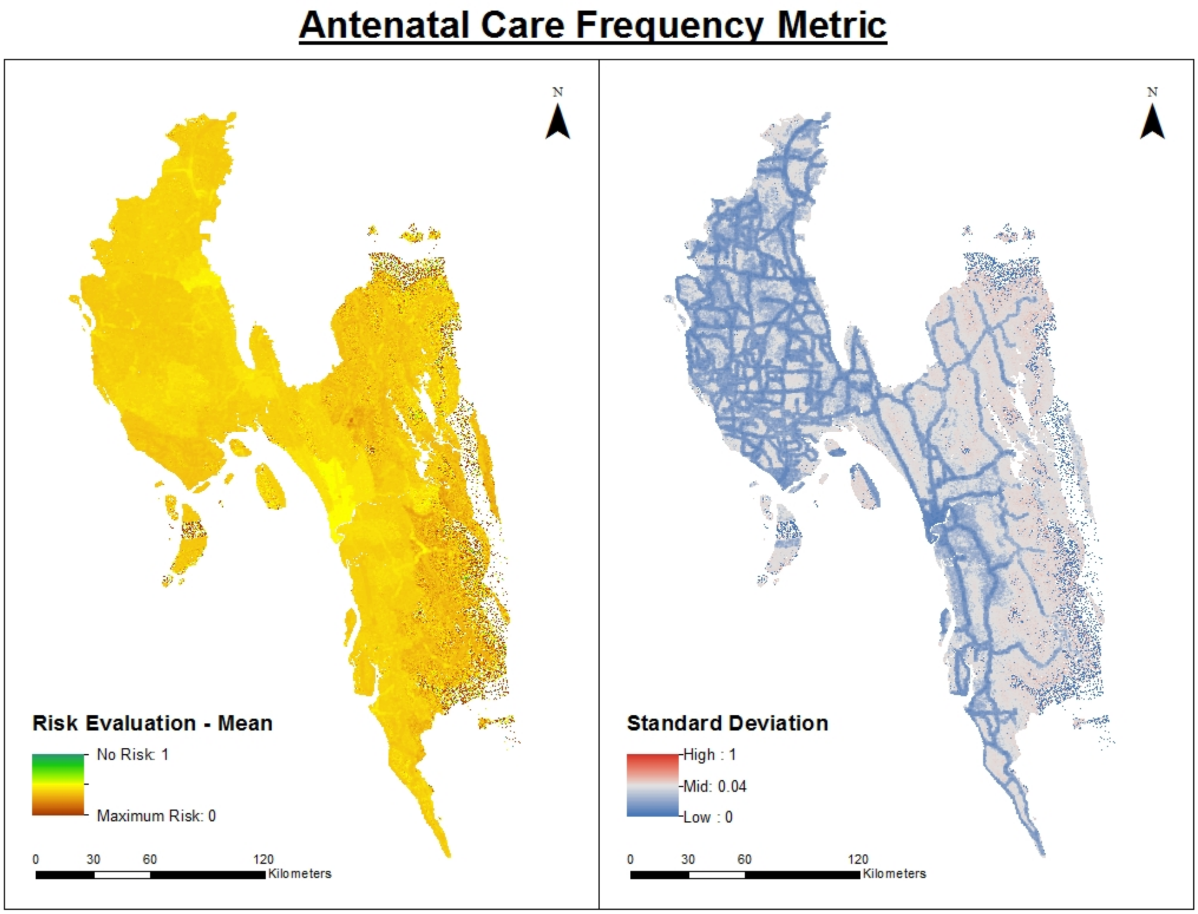
3.2.1.4 Metric: AntenatalCareFrequency

Indicator:	Doctor and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	1to3Times (min: 0.3, max: 0.5) 4to10Times (min: 1.0, max: 1.0) 11PlusTimes (min: 1.0, max: 1.0) Unknown (min: 0.3, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "How many times did you receive antenatal car during your pregnancy?" from the DHS survey.

Answers of "1 to 3 times" are given a minimum value of 0.3 (slight risk) and a maximum value of 0.5 (slight risk, $½^1$). Answers of "4 to 10 times" and "11 plus times" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Unknown" are given a minimum value of 0.3 and a maximum value of 0.9 (minimal risk). Maps will range from slight risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

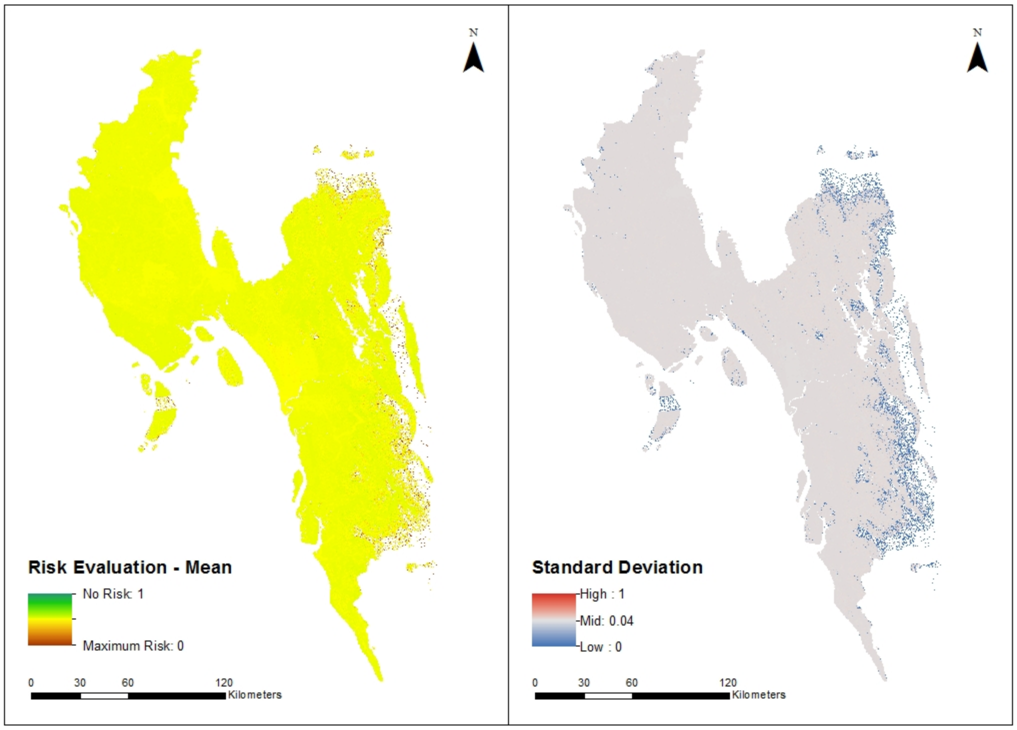


3.2.1.5 Metric: HealthStaffPostDelivery

Indicator:	Doctor and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	Health Professional (min: 1.0, max: 1.0) Other Person (Health Related) (min: 0.5, max: 0.9) Other (write in) (min: 0.3, max: 0.5) None (min: 0.2, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the questions “Who checked on your health after you left the delivery facility?” and “Did anyone check on your health after you gave birth?” from the DHS survey. If participants answered “Yes” to the latter question, they were only then asked the former question. Answers of “Health Professional” to the question “Who checked on your health after you left the delivery facility?” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Other Person (Health Related)” are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers of “Other (write in)” are given a minimum value of 0.3 (slight risk) and a maximum value of 0.5. For those participants that answered “No” to the question “Did anyone check on your health after you gave birth?”, their answers are given a minimum value of 0.2 (high risk) and a maximum value of 0.5. Maps will range from high risk to no risk. It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

Health Staff Post Delivery Metric

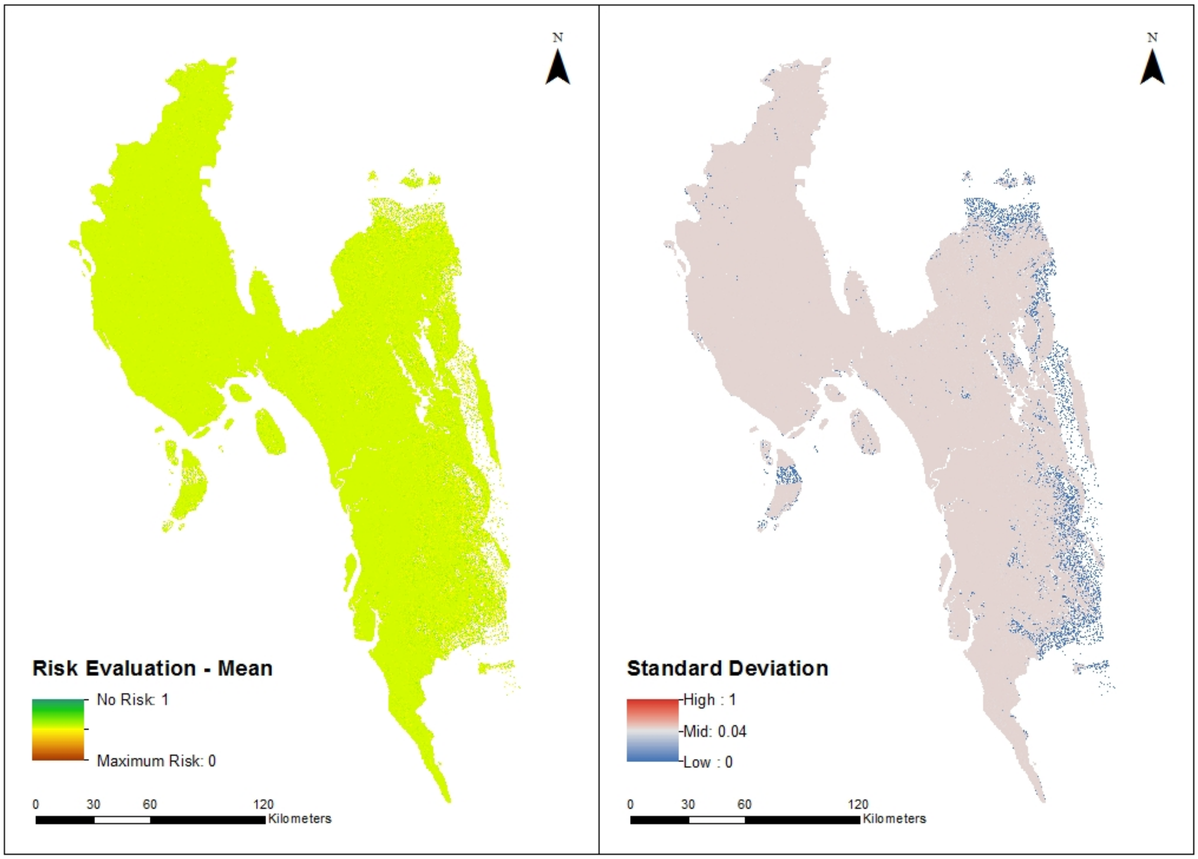


3.2.1.6 Metric: HealthInsuranceCoverage

Indicator:	Doctor and Access to Primary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.2, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Are you covered by health insurance?” from the DHS survey. “Yes” answers are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^{0}$). “No” answers are given a minimum value of 0.2 (high risk) and a maximum value of 0.5 (slight risk, $½^{1}$). Maps will range from high risk to no risk.

Example Realization Metric Map

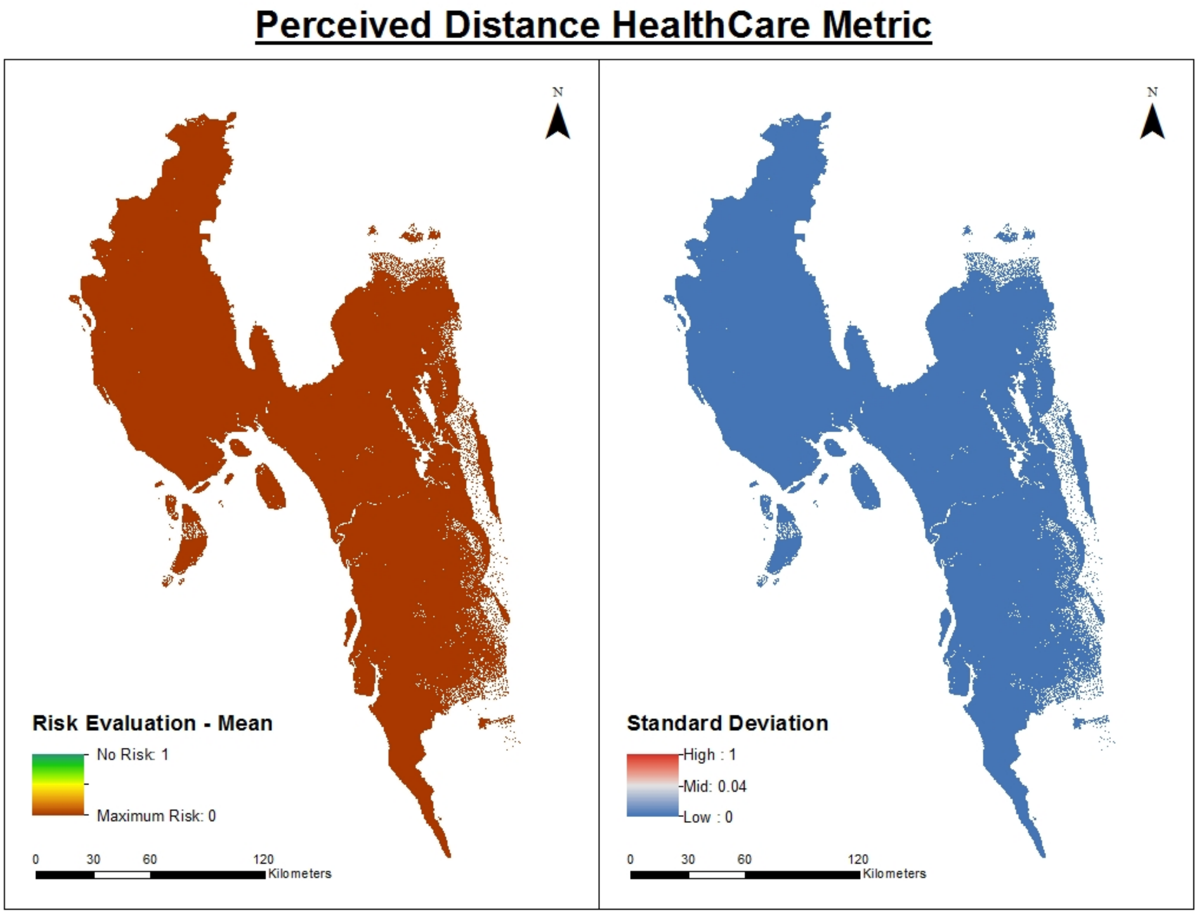
Health Insurance Coverage Metric



3.2.1.7 Metric: PerceivedDistanceHealthcare

Indicator:	Hospitals/Clinic and Secondary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	BigProblem (min: 0.125, max: 0.3) NotBigProblem (min: 1.0, max: 1.0)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Is distance to the health facility a big problem?” from the DHS survey. Answers of “Big Problem” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.3 (slight risk). Answers of “Not a Big Problem” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Maps will range from high risk to no risk.

Example Realization Metric Map



3.2.2 Indicator: Hospitals/Clinics and Secondary Care

Secondary care happens with referrals from primary care physicians, encompassing specialists and medical consultants that work outside the realm of general physical care. Psychologists, obstetricians/gynecologists, and gastroenterologists are all examples of secondary care physicians. These types of medical specialists are often found in hospitals and clinics.

It is important to note that the above definition was written and is applicable within a Western context, while this particular application of the PACOM HC framework focuses on Bangladesh. As such, medical needs that may be considered more secondary care in the West (i.e., antenatal and postnatal care) could be found at a primary care clinic and/or addressed by a general physician.

PACOM specifies that metrics should include: number of hospital beds per capita (compare with historical and cross-national data); number of acute care beds per capita; satisfaction with amount of time required to reach hospitals/clinics; satisfaction with amount of time required to reach secondary care facilities; satisfaction with ability to obtain an appointment with a medical specialist; perceived quality of healthcare services delivered by hospital/clinic (if applicable); perceived quality of healthcare services delivered by medical specialist (if applicable); public expenditure on health as a percentage of GDP; and private expenditure on health as percent of GDP.

Metric Weighting Logic

As the last two metrics - both which ask for the first source of medical care for diarrhea, fever, and cough from the DHS survey – most directly address the metrics specified by PACOM, they are the most constraining on the indicator and are therefore weighted the highest. As “BirthDeliveryLocation” (which asks respondents where they gave birth from the DHS survey) is the least relevant to the PACOM-specified metrics, it is weighted the lowest of all the metrics.

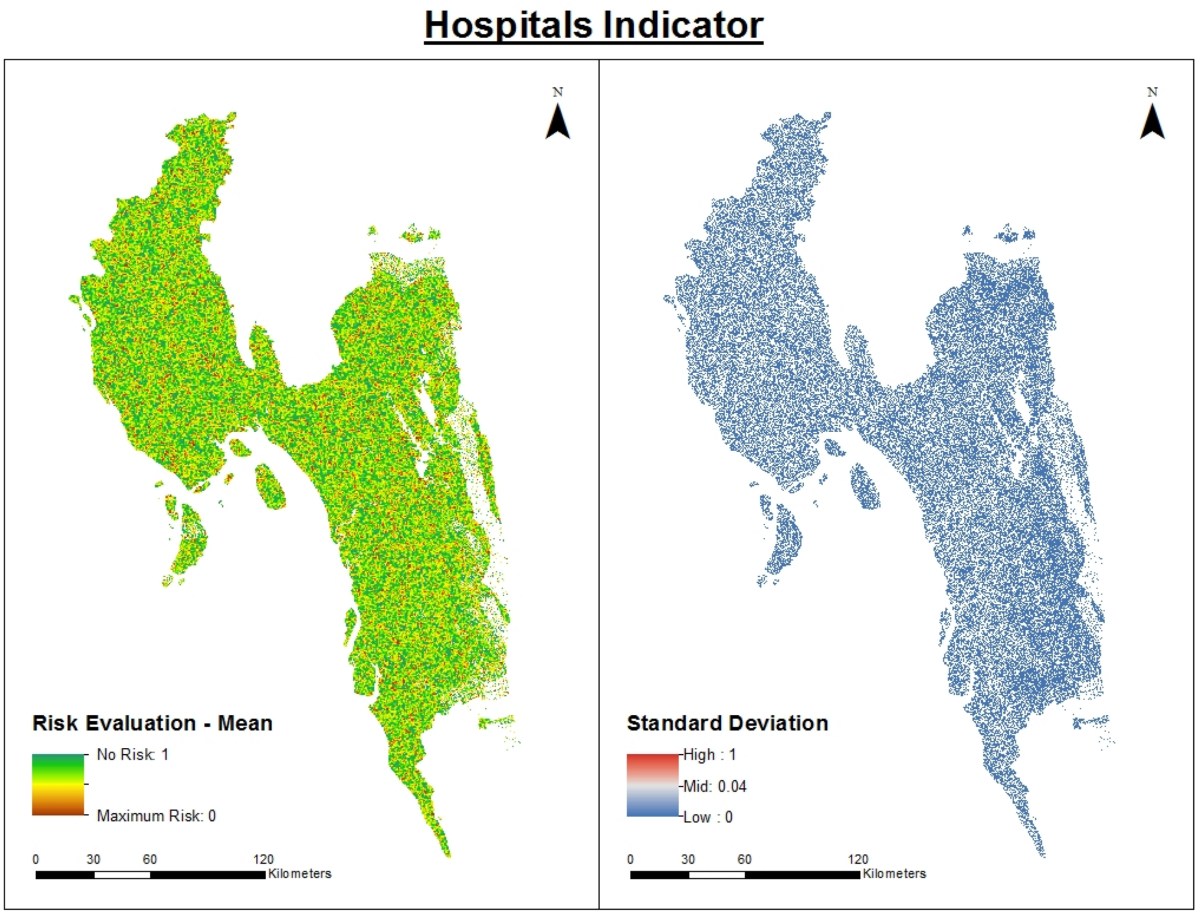
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HealthStaffFamilyPlanning (3.2.2.1)	0.2	0.3
BirthDeliveryLocation (3.2.2.2)	0.2	0.25
FirstSourceMedicalCareDiarrhea (3.2.2.3)	0.3	0.5
FirstSourceMedicalCareFeverCough (3.2.2.4)	0.3	0.5

Uncertainty Values

Adding more data on availability and accessibility of non-general physicians, clinics, hospitals would decrease the uncertainty levels.

Indicator Uncertainty Min: 0.5
Indicator Uncertainty Max: 0.6

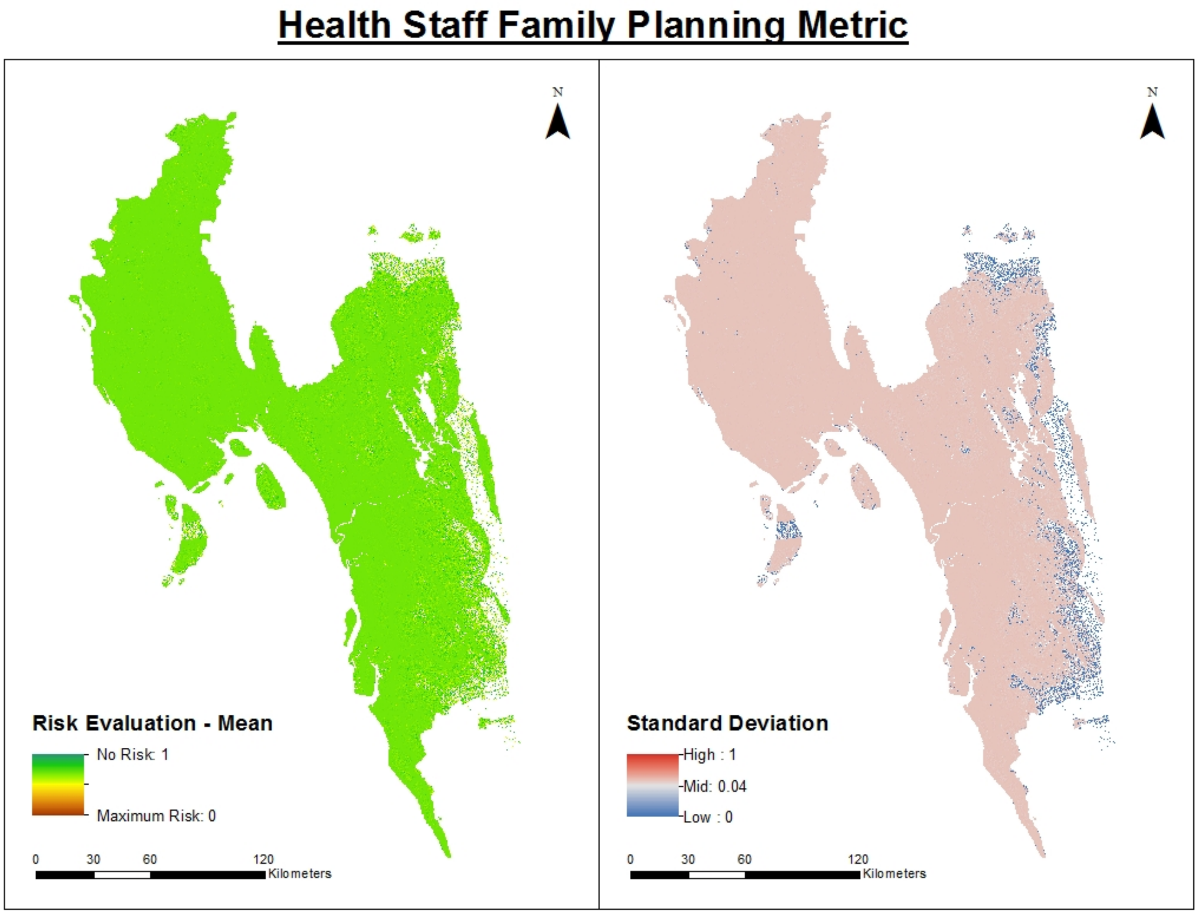
Example Outcome



3.2.2.1 Metric: HealthStaffFamilyPlanning

Indicator:	Hospitals/Clinics and Secondary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.3, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Did any staff member at the health facility speak to you about family planning methods?” from the DHS survey. “Yes” answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). “No” answers are given a minimum value of 0.3 (slight risk) and a maximum value of 0.9 (minimal risk). Maps will range from slight risk to no risk. It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



3.2.2.2 Metric: BirthDeliveryLocation

Indicator:	Hospitals/Clinic and Secondary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	Home (min: 0.6, max: 0.9) PublicSector (min: 1.0, max: 1.0) PrivateMedicalSector (min: 1.0, max: 1.0) Other (min: 0.4, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

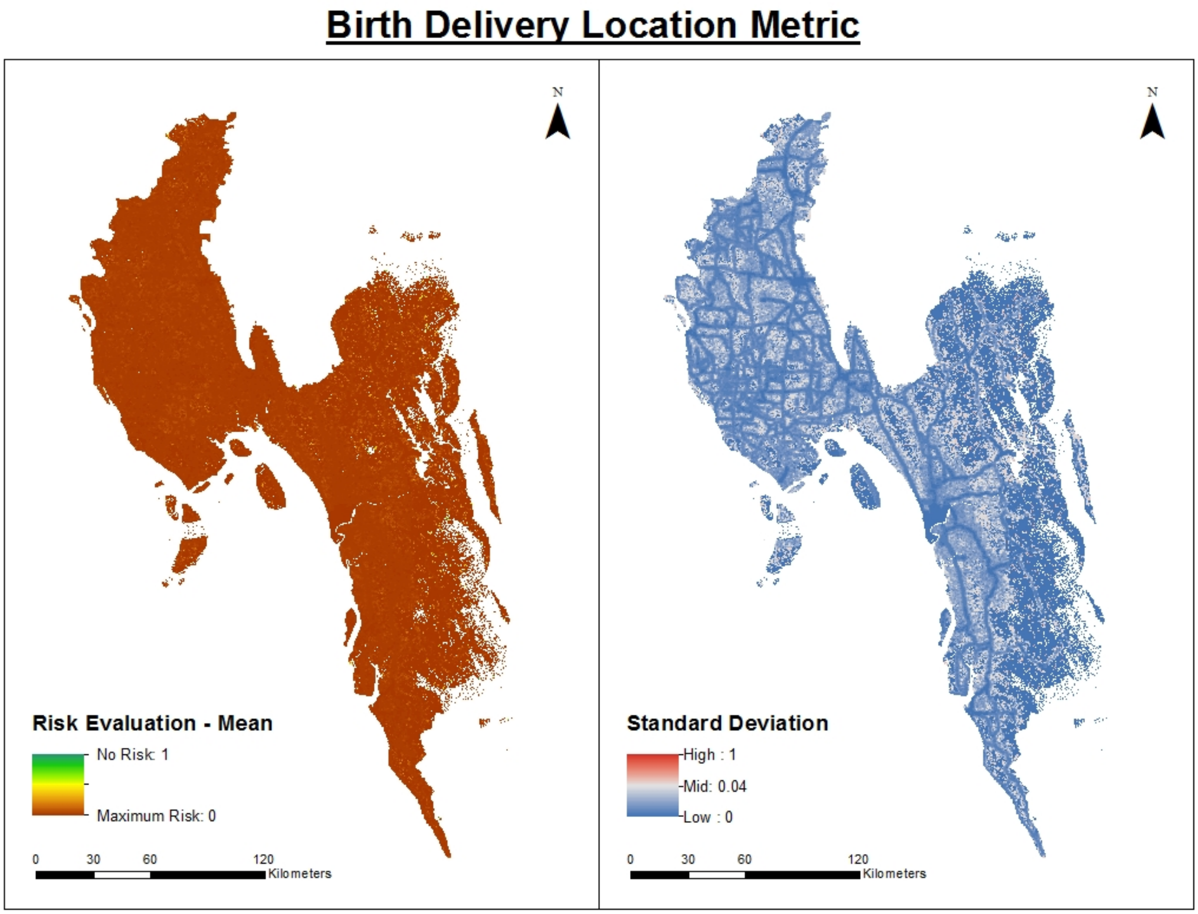
Logic: This metric consists of answers to the question “Where did you give birth?” from the DHS survey.

Answers of “Home” are given a minimum value of 0.6 (minimal risk) and a maximum value of 0.9 (minimal risk). Answers of “Public Sector” and “Private Medical Sector” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Answers of “Other” are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9. Here, hospital births (whether private or public) carry less risk than home births or births that occurred elsewhere.

Maps will range from slight risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

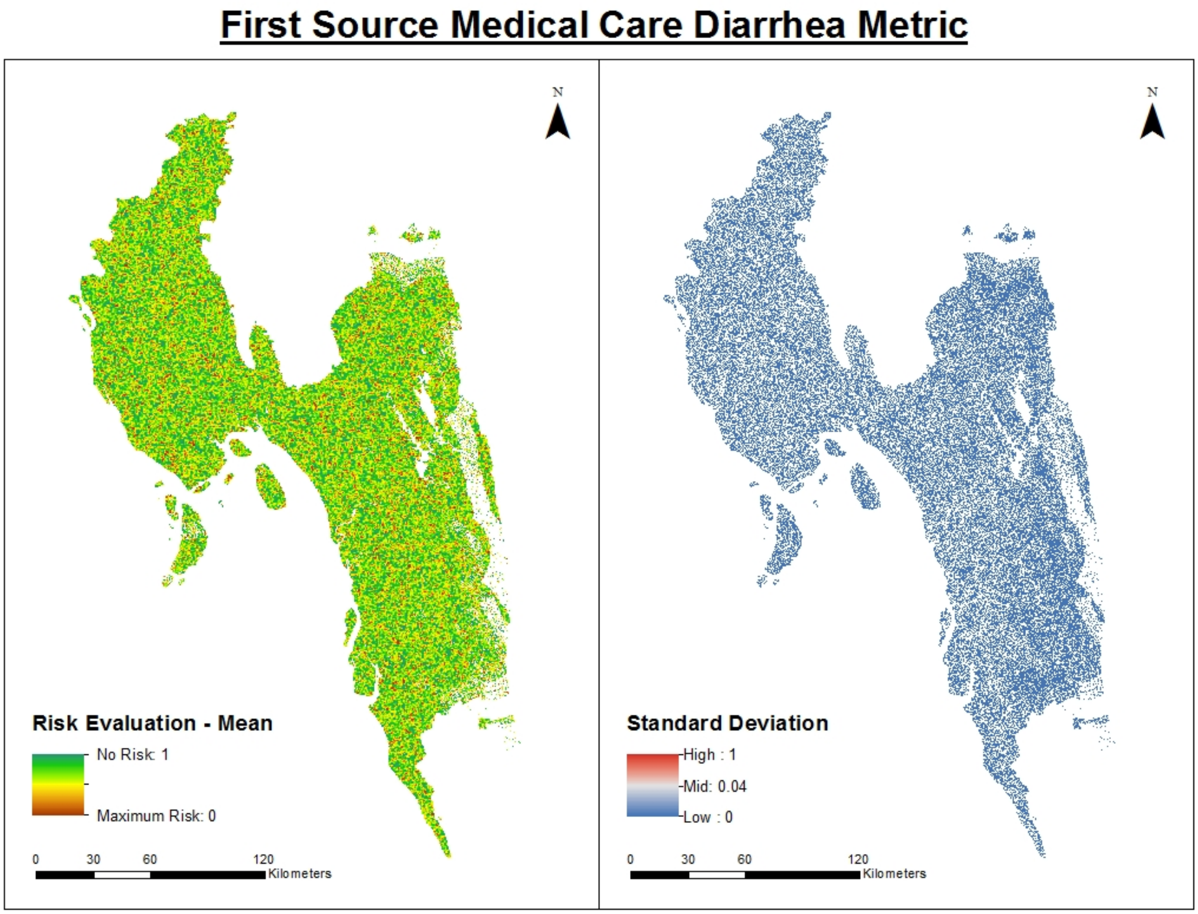
Example Realization Metric Map



3.2.2.3 Metric: FirstSourceMedicalCareDiarrhea

Indicator:	Hospitals/Clinic and Secondary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	PublicSector (min: 1.0, max: 1.0) PrivateMedicalSector (min: 1.0, max: 1.0) Other (min: 0.4, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Where do you first seek medical advice or treatment?" concerning cases of diarrhea in children from the DHS survey. Answers of "Public Sector" and "Private Medical Sector" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Answers of "Other" are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9. Maps will range from slight risk to no risk. It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

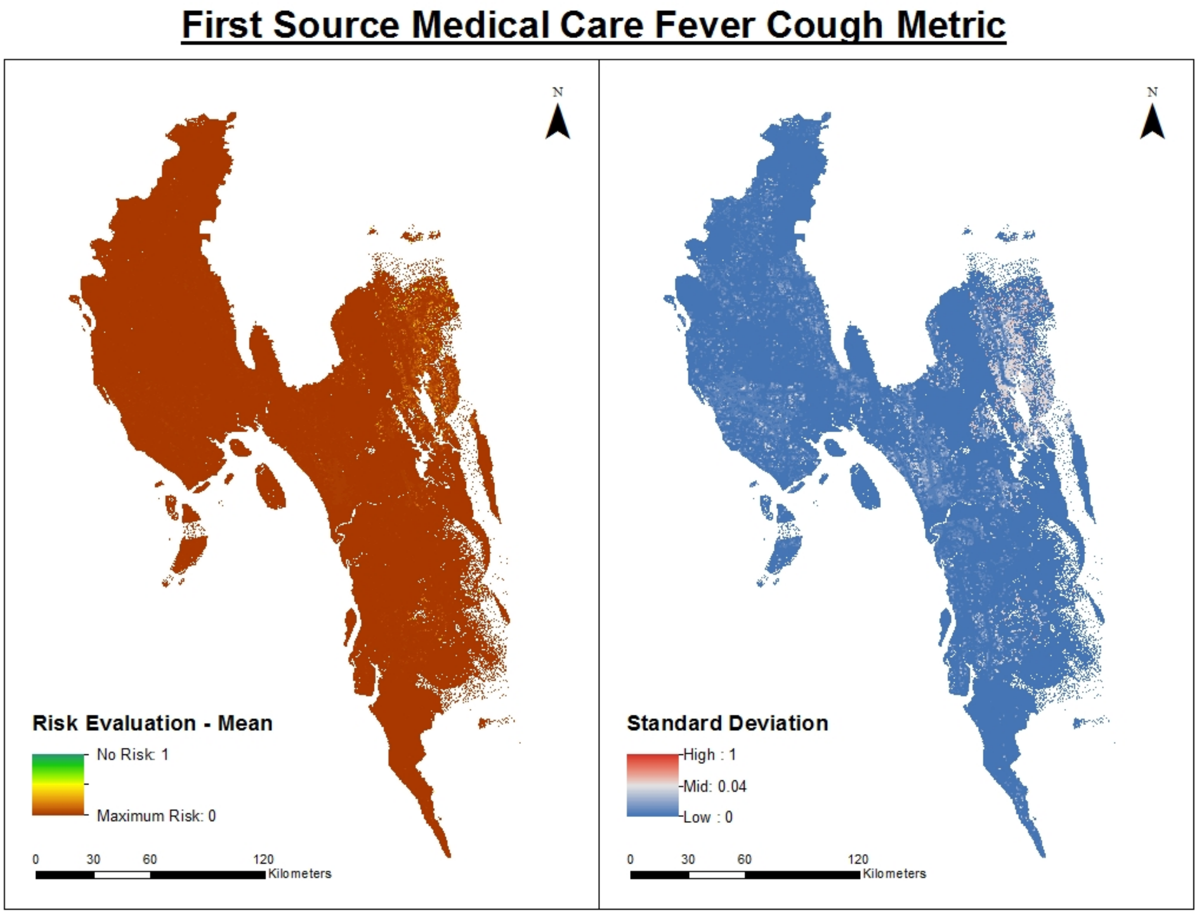
Example Realization Metric Map



3.2.2.4 Metric: FirstSourceMedicalCareFeverCough

Indicator:	Hospitals/Clinic and Secondary Care
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	PublicSector (min: 1.0, max: 1.0) PrivateMedicalSector (min: 1.0, max: 1.0) Other (min: 0.4, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Where do you first seek medical advice or treatment?” concerning cases of fever and cough in children from the DHS survey. Answers of “Public Sector” and “Private Medical Sector” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Other” are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9. Maps will range from slight risk to no risk. It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women’s portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map



3.2.3 Indicator: Availability of Pharmaceuticals

Access to essential pharmaceuticals and medicines are increasingly viewed as a fundamental human right on the international stage (Cullet 2003). This indicator focuses on all measure related to pharmaceuticals (particularly antibiotics) – not just their availability. Cohen (2005) lists five key processes (post-manufacturing), all of which need to function optimally so that the system as a whole offers good-quality, cost-effective, safe and efficacious medicines: Registration, Selection, Procurement, Distribution, and Service Delivery (Figure 2).

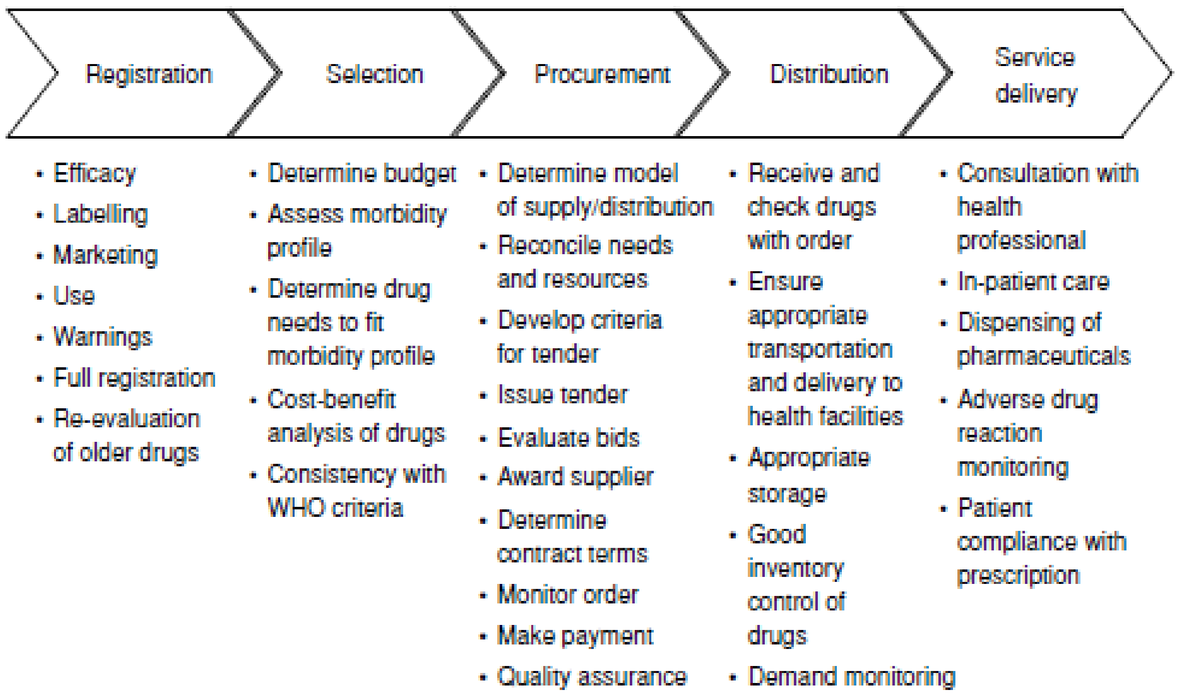


Figure 2: Key processes in the selection and delivery of pharmaceutical products. Source: Cohen 2005.

PACOM specifies that metrics should include: number of pharmacies per capita (compare with historical data); manufacture, import, or receipt of donations of broad-spectrum antibiotics used to treat frequently occurring bacterial infections OR other pharmaceuticals targeted to the specific malady/maladies resulting from the humanitarian crisis; appropriate channels in place to enable access and distribution of antibiotics and other pharmaceuticals (e.g., chemical antidotes, antitoxins, etc.), including temperature-controlled supply chain; pharmaceutical supplies determined on the basis of risk assessments and analyzes; pharmaceuticals readily available in sufficient quantities; pharmaceuticals are periodically inspected to ensure that inappropriate or expired items are disposed of in accordance with guidelines; appropriate maintenance and inventory procedures in place; procedure exists for acquisition of specialized pharmaceuticals not on basic supply list; and appropriate mechanisms in place to facilitate pharmaceutical donations/meet necessary criteria, including:

- Well matched to needs
- Familiar to recipients
- Registered for use in recipient country
- Properly labeled in locally accessible language
- Up to quality standards and not expired
- Consistent with normal administrative procedures, and
- Without unintended financial impacts such as storage fees or high import taxes.

Metric Weighting Logic

As the "TypeDrugsTakenIllness" metric most directly addresses the availability of various kinds of pharmaceuticals, it is given the highest maximum weight value.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PharmacyProvidedBirthControl (3.2.3.1)	0.33	0.4
TetanusShotDuringPregnancy (3.2.3.2)	0.33	0.6
TypeDrugsTakenIllness (3.2.3.3)	0.33	0.8

Uncertainty Values

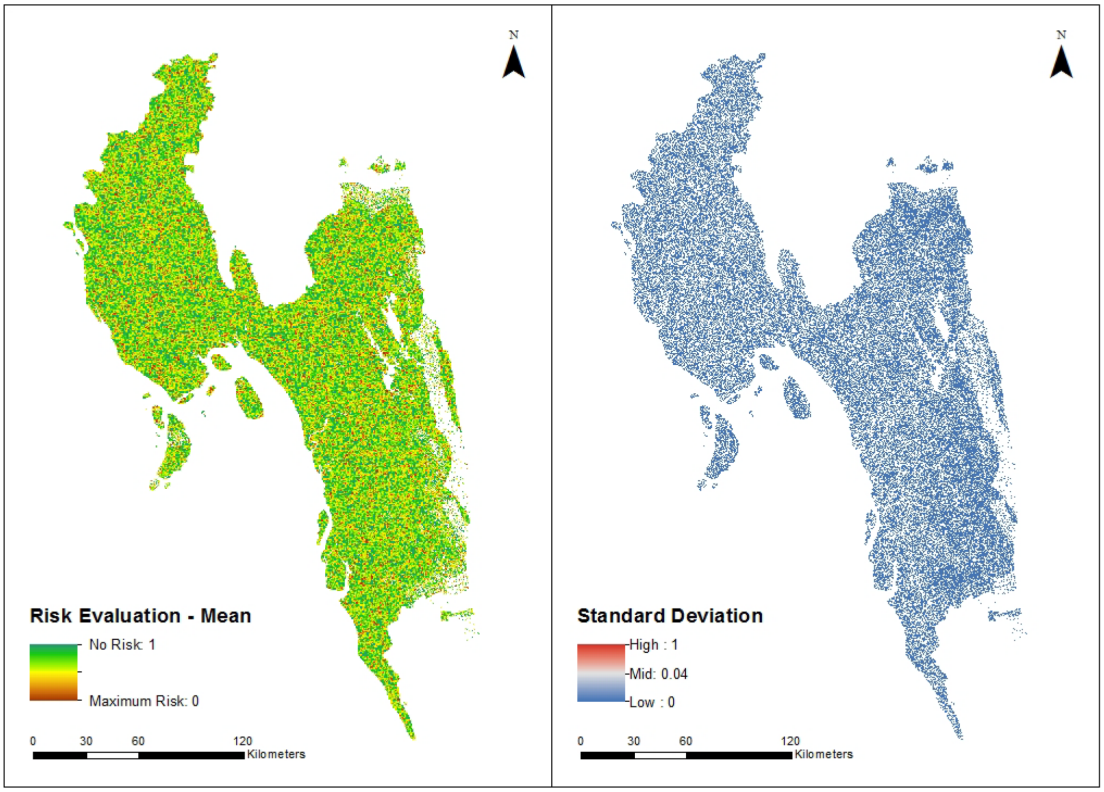
The values are on the higher end of the uncertainty scale due to the lack of metrics focusing on the efficiency and regulating of the pharmaceutical system as a whole. Adding more data about number of pharmacies, drug effectiveness, prescription rates, drug costs, etc., like those specified by PACOM, could decrease the uncertainty values.

As most of the data specified by PACOM is difficult to obtain for Bangladesh, especially at regional and neighborhood levels, this indicator essentially has very little effect on overall risk of the factor and has high uncertainty values. However, if this indicator was renamed to more adequately reflect access to pharmaceuticals – including vaccinations – then the metrics that are currently implemented here would better match the asks of the indicator. This would also lower the uncertainty values to a minimum of 0.1 and a maximum of 0.3.

Indicator Uncertainty Min: 0.8
Indicator Uncertainty Max: 0.9

Example Outcome

Availability of Pharmaceuticals Indicator



References

Cohen, Jillian Clare (2005). *Pharmaceuticals and corruption: a risk assessment*. World Bank. Accessed at http://www1.worldbank.org/publicsector/anticorrupt/corecourse2007/Pharmaceuticals.pdf on 5 Jan 2017.

Cullet, Philippe (2003). 'Patents and Medicines: the Relationship between TRIPS and the Human Right to Health'. International Affairs 79(1).

3.2.3.1 Metric: PharmacyProvidedBirthControl

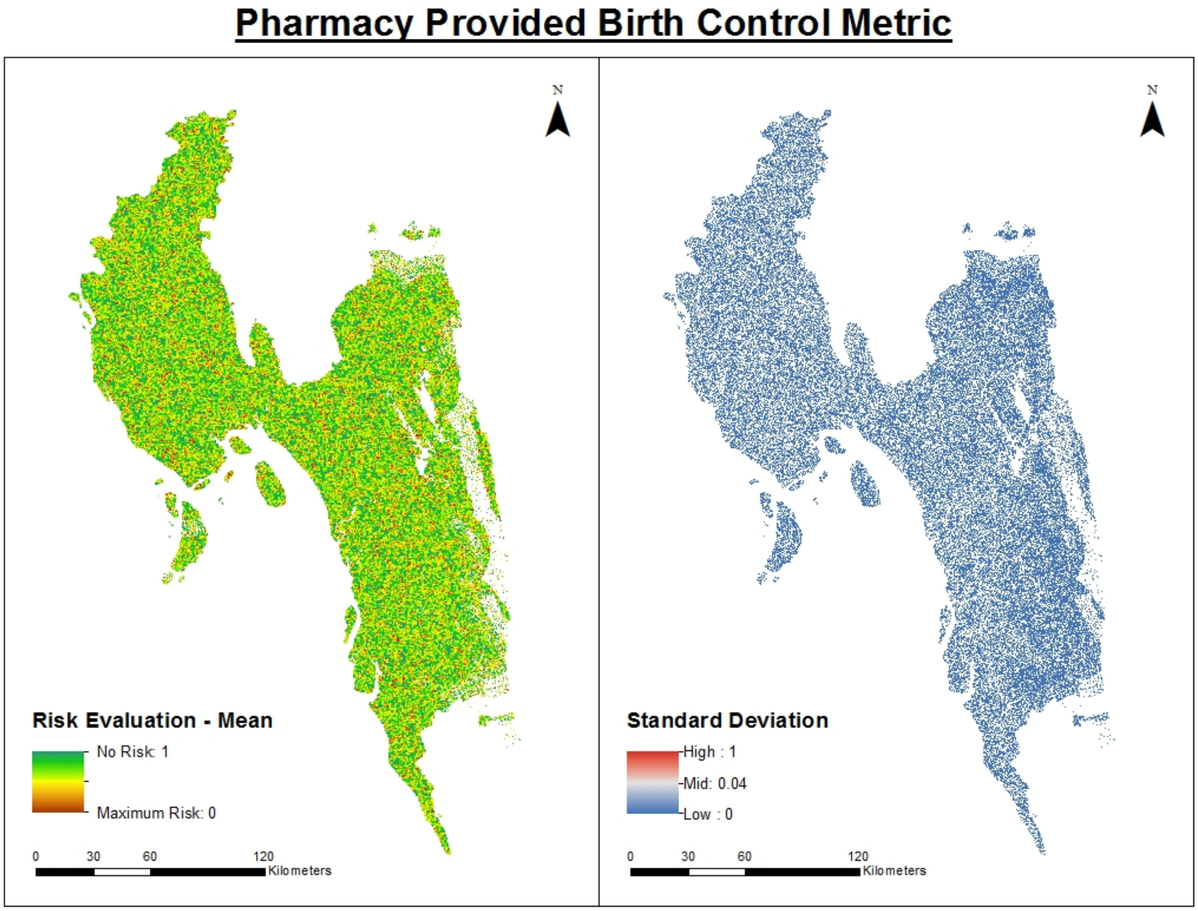
Indicator: Availability of Pharmaceuticals
Factor: Health and Medical Service Insufficiencies
Condition: Service Failure
Metric Assigned Values:
GovernmentClinicPharmacy (min: 1.0, max: 1.0)
GovernmentHomeCommunityDelivery (min: 0.9, max: 1.0)
NGO (min: 0.8, max: 1.0)
PrivateClinicDelivery (min: 0.8, max: 1.0)
Pharmacy (min: 1.0, max: 1.0)
ShopChurchFriend (min: 0.5, max: 0.9)
Other (min: 0.4, max: 0.9)
Unknown (min: 0.3, max: 0.9)
Survey: DHS
Survey Date: 2011
Other Data Sources:

Logic: This metric consists of answers to the question You first started using (current birth control method) in (date). Where did you get it at that time?" from the women's portion of the DHS survey.

Answers of "GovernmentClinicPharmacy" and "Pharmacy" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Answers of "GovernmentHomeCommunityDelivery" are given a minimum value of 0.9 (minimal risk) and a maximum value of 1.0. Answers of "NGO" and "PrivateClinicDelivery" are given a minimum value of 0.8 (minimal risk) and a maximum value of 1.0. As all of these answers involve more regulated and organized distribution of contraception, they are all given values of minimal risk.

Answers of "ShopChurchFriend" (3 different entities grouped into one) are given a minimum value of 0.5 (slight risk, ½^{1}) and a maximum value of 0.9 (minimal risk). Answers of "Other" are given a minimum value of 0.4 (slight risk) and a maximum value of 0.9. Answers of "Unknown" are given a minimum value of 0.3 (slight risk) and a maximum value of 0.9.

Maps will range from slight risk to no risk.


Pharmacy Provided Birth Control Metric
N
Risk Evaluation - Mean
No Risk: 1
Maximum Risk: 0
0 30 60 120 Kilometers
N
Standard Deviation
High : 1
Mid: 0.04
Low : 0
0 30 60 120 Kilometers

3.2.3.2 Metric: TetanusShotDuringPregnancy

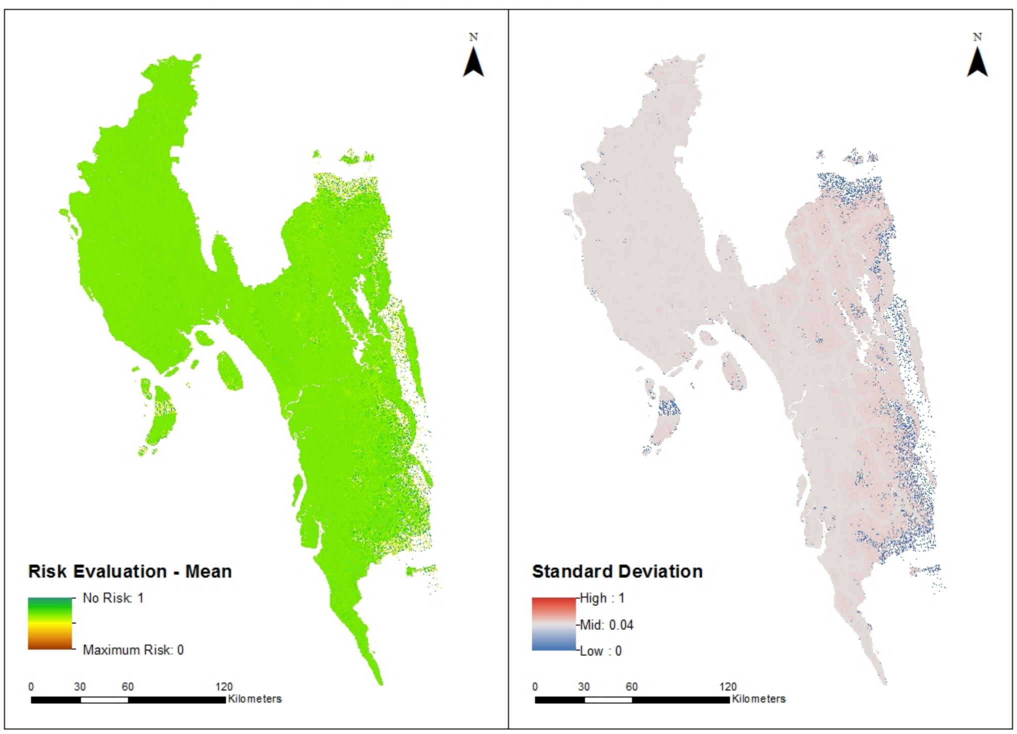
Indicator:	Availability of Pharmaceuticals
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	None (min: 0.125, max: 0.5) 1thru6Shots (min: 1.0, max: 1.0) 7PlusShots (min: 1.0, max: 1.0) Unknown (min: 0.3, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	http://www.cdc.gov/vaccines/pregnancy/hcp/guidelines.html http://www.who.int/reproductivehealth/publications/maternal_perinatal_health/immunization_tetanus.pdf http://www.searo.who.int/bangladesh/mnteliminationbangladesh/en/
Logic:	This metric consists of answers to the question “During this pregnancy, how many times did you get a tetanus injection?” from the women’s portion of the DHS survey. The CDC and WHO recommends every pregnant woman receive at least one dose of a tetanus vaccine (Tdap, DPT, Td, TT, etc.) during pregnancy, regardless of previous exposure to the vaccine (“Guidelines” 2016, WHO 2006). For women never exposed to a tetanus vaccine before pregnancy, the CDC and WHO recommend at least two, but ideally three vaccinations containing tetanus and reduced diphtheria toxoids (if a woman only receives two during pregnancy, the third vaccine should be received immediately after birth). For women of child-bearing age, lifetime protection is achieved after 5 doses of the tetanus vaccine. Bangladesh achieved MNT (maternal and neonatal tetanus) elimination status in 2008 (WHO Country Office for Bangladesh). Answers of “1-6 shots” and “7 plus shots” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Risk values are specific to Bangladesh. Each country’s metric values should be determined on whether tetanus shots are universally given (1.0 – 1.0 for 1thru6shots) or if there are high proportions of women not up to date on their tetanus shots. Answers of “None” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of “Unknown” are given a minimum

value of 0.3 (slight risk) and a maximum value of 0.9 (minimal risk). Maps will range from high risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4 (Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

Tetanus Shot During Pregnancy Metric



3.2.3.3 Metric: TypeDrugsTakenIllness

Indicator:	Availability of Pharmaceuticals
Factor:	Health and Medical Service Insufficiencies
Condition:	Service Failure
Metric Assigned Values:	Antimalarial (min: 1.0, max: 1.0) Antibiotics (min: 1.0, max: 1.0) Aspirin/Ibuprofen/Acetaminophen (min: 1.0, max: 1.0) Other (min: 0.5, max: 0.9) Unknown (min: 0.3, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	

Logic:

This metric consists of answers to the question "What drugs did (name of child) take?" in reference to a fever or cough-based illness from the women's portion of the DHS survey.

Answers of "Antimalarial Drugs" – including "sp/fansidar," "chloroquine," "amodiaquine," "quinine," "combination with artemisinin," and "other antimalarial" – are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Antibiotics" – including "pill/syrup" and "injection" – are given both a minimum and maximum value of 1.0. Answers of "aspirin," "ibuprofen," and "acetaminophen" (under the category of "Other Drugs" in the possible answers of the survey question) are also given both a minimum and a maximum value of 1.0. As all of these answers point to the availability of pharmaceuticals within the area, there is no overall impact on risk for this particular metric.

Answers of "Other" (write-in) are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers of "Unknown" are given a minimum value of 0.3 (slight risk) and a maximum value of 0.9.

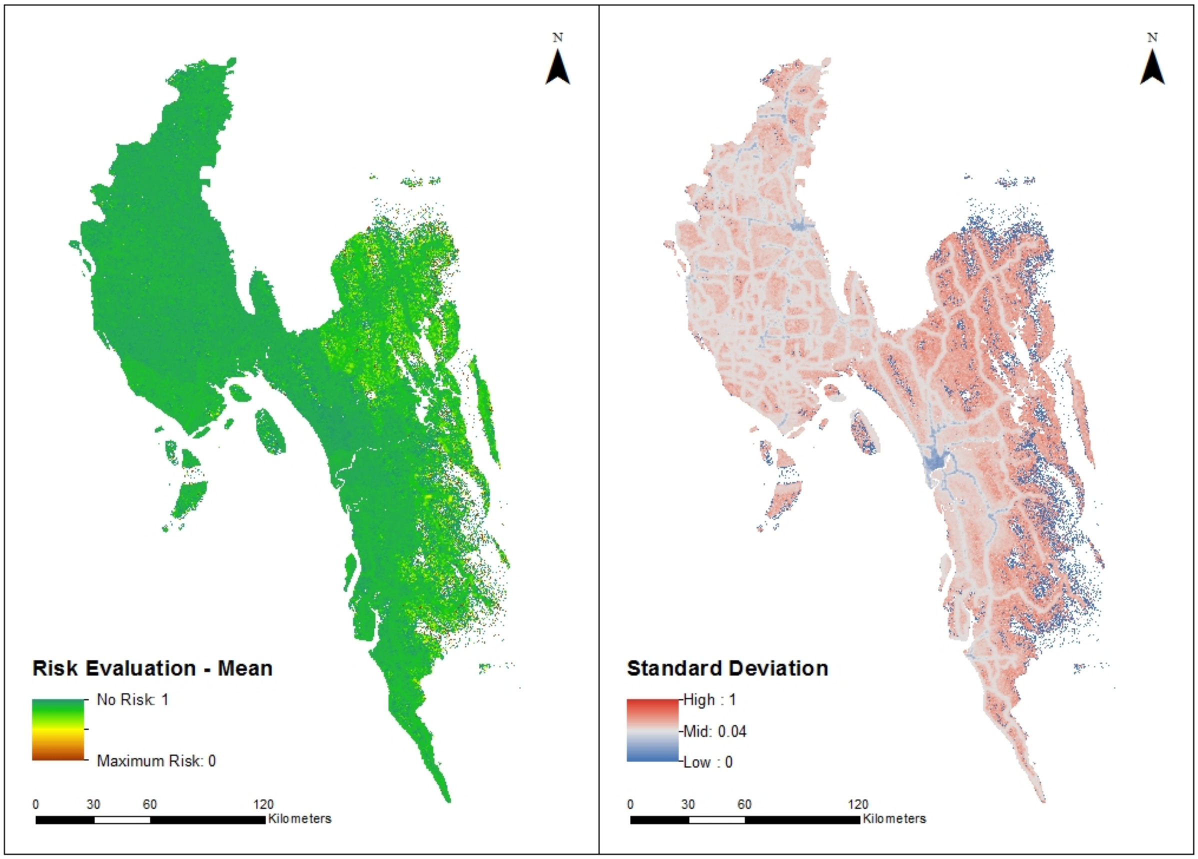
Maps will range from slight risk to no risk.

It should be noted that, as this version of the framework was constructed as a proof of research concept, only the results pertaining to the first child for whom answers were provided were used to create this metric. For questions under Section 2 (Reproduction) of the women's portion of the DHS Bangladesh survey, answers were allowed for up to 12 children. Results from these questions will only contain answers for the eldest child. For questions under Sections 4

(Pregnancy and Postnatal Care) and 5 (Child Immunization, Health, and Nutrition), answers were allowed for children from the last birth, the next-to-last birth, and the second next-to-last birth (i.e., the youngest three children of the female respondent). Results from these questions will only contain answers for the youngest child.

Example Realization Metric Map

Type Drugs Taken Metric



3.2.4 Indicator: Delayed or Deficient Mortuary Affairs

This indicator accounts for the ability of the existing mortuary system to function at both an every-day and/or a post-disaster capacity.

Each culture, region, and/or nation has different procedures and regulations for handling the deceased, and these should be clearly accounted for in determining and weighting metrics.

PACOM specifies that metrics should include: number of morgues per capita (compared with historical and cross-national data); number of mortuary personnel per capita; perception that removal of casualties occurred within an appropriate time frame; average latency to burying dead; and official capacity present to dispose of bodies.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

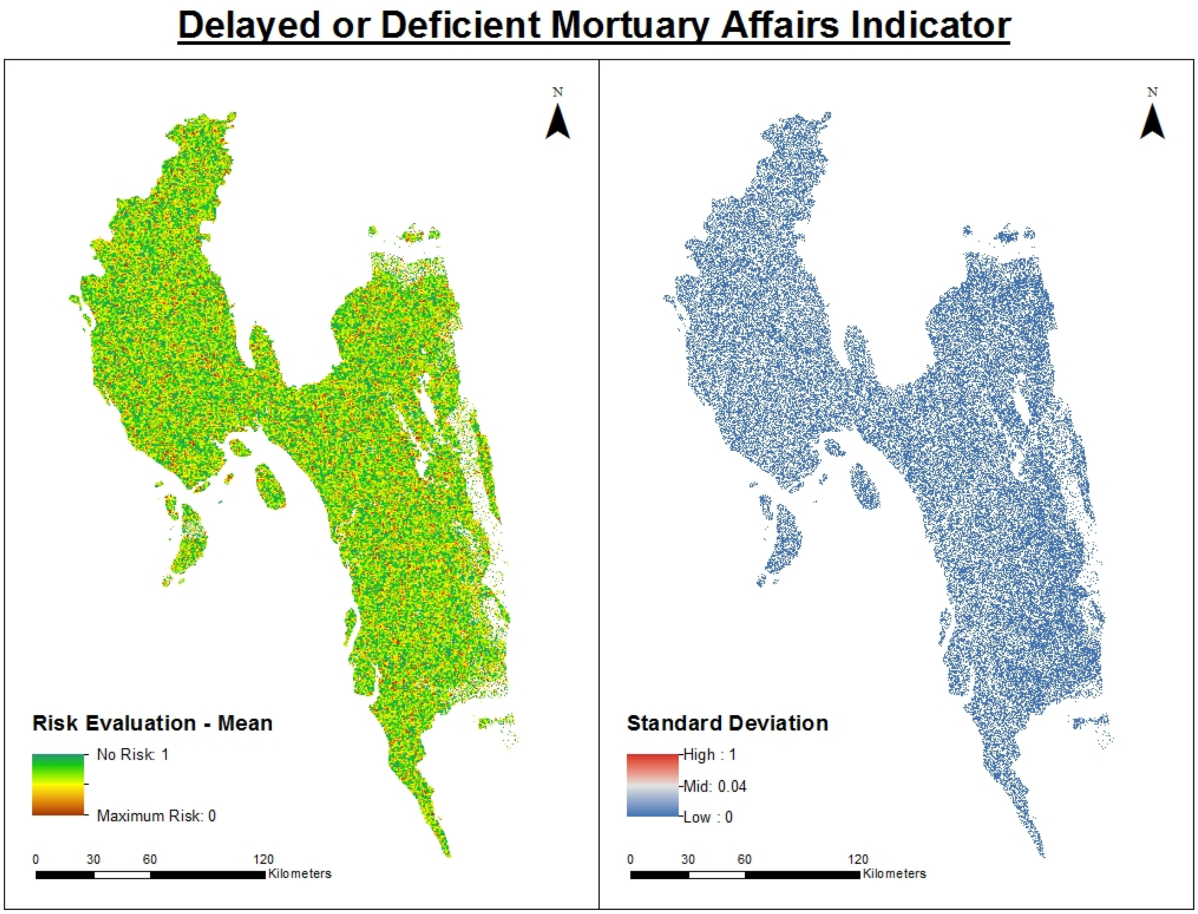
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



3.3 Utilities Disruption Factor Overview

This factor emphasizes the more conventional aspect of "service" failures, in terms of public infrastructure services often provided by a local, regional, or national government. These include sanitation, clean water, communications infrastructure (i.e., cell-phone and radio towers, broadband, etc.), and power/energy. Urban and rural patterns in if and how utilities are provided should be taken into account in both determining metrics and weighting indicators.

Metrics and indicators within this factor should specifically account for what utilities have been/are disrupted by a humanitarian crisis, and how badly they have been disrupted.

All of the indicators within this factor currently have available metric data.

Indicator Weighting Logic

All four indicators within the factor are given both a minimum and a maximum value of 0.25, for a sum of 1.0. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

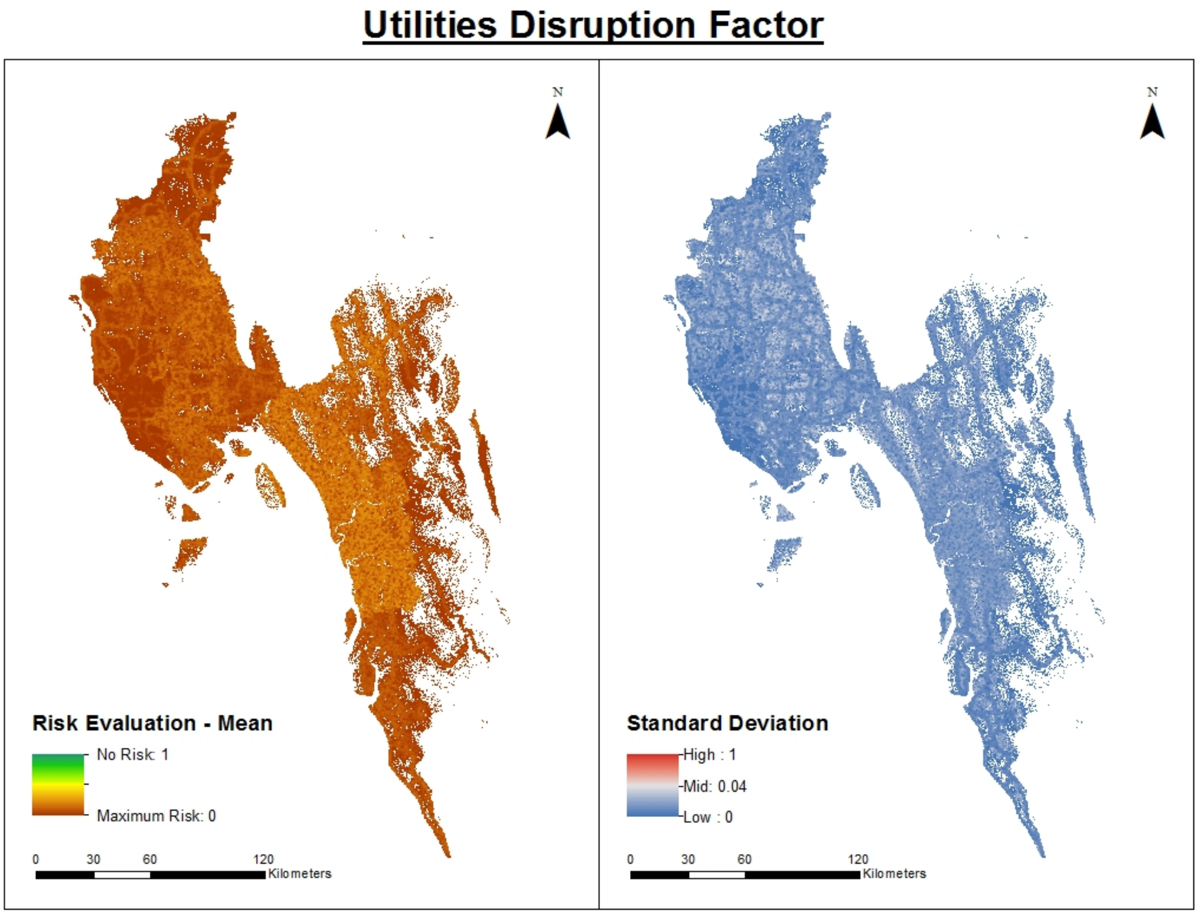
Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Inadequate Sanitation (3.3.1)	0.25	0.25
Water Shortfalls (3.3.2)	0.25	0.25
Lack of Communications Availability (3.3.3)	0.25	0.25
Energy Deficits (3.3.4)	0.25	0.25

Uncertainty Values

Taking into account other utilities indicators, such as trash removal or provision of household heating systems, and if there are government subsidies for these programs, could further decrease the uncertainty value.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.2

Example Outcome



3.3.1 Indicator: Inadequate Sanitation

According to the World Health Organization:

> Sanitation generally refers to the provision of facilities and services for the safe disposal of human urine and feces. Inadequate sanitation is a major cause of disease world-wide and improving sanitation is known to have a significant beneficial impact on health both in households and across communities. The word 'sanitation' also refers to the maintenance of hygienic conditions, through services such as garbage collection and wastewater disposal (“Sanitation” 2017).

It should be noted that while this indicator name implies that it measures the inadequacy of sanitation services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Adequate Sanitation.”

PACOM specifies that metrics should include: percentage of sanitation facilities damaged; percentage of population with access to sanitation (compared with historical data); and satisfaction with access to sanitation.

Metric Weighting Logic

As the “HHTypeToilet” (household toilet type from the IPUMS survey) is the most constraining metric, it is weighted both a minimum and maximum value of 1.0. As such, it is the most constraining metric to the indicator which ensure that the indicator’s risk value is as high as the metric. The “PerceivedEffortSanitation” metric consists of a qualitative question about organizations of public figures working to improve sanitation, which does not lend much information to measuring adequate sanitation. For this reason, it is weighted the lowest of the four metrics.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HHTypeToilet (3.3.1.1)	1.0	1.0
PerceivedIssueSanitation (3.3.1.2)	0.4	0.6
PerceivedEffortSanitation (3.3.1.3)	0.35	0.7
ToiletShared (3.3.1.4)	0.6	0.8

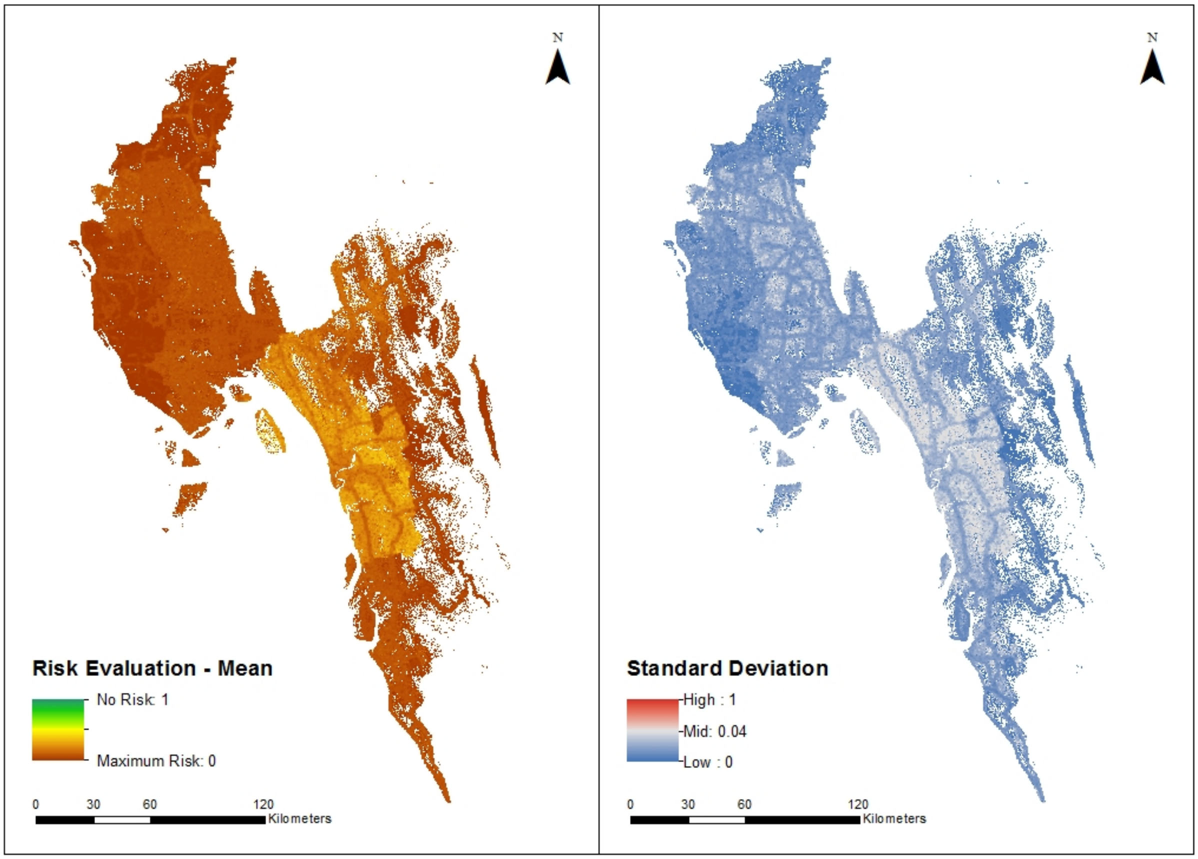
Uncertainty Values

The addition of data on city-wide sanitation system provisions and larger urban sanitation issues could further decrease the uncertainty values.

Indicator Uncertainty Min: 0.10
Indicator Uncertainty Max: 0.15

Example Outcome

Inadequate Sanitation Indicator



References

World Health Organization (WHO) (2017). "Sanitation." 2017. Accessed at http://www.who.int/topics/sanitation/en/ on 12 Jan 2017.

3.3.1.1 Metric: HHTypeToilet

Indicator:	Inadequate Sanitation
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	SanitaryWater (Sanitary with water seal) (min: 1.0, max: 1.0) Sanitary (no water seal) (min: 0.8, max: 1.0) NonSanitary (min: 0.001, max: 0.25) None (min: 0.001, max: 0.125)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	Classifications come from the IPUMS survey metadata for the 2011 Bangladesh survey.

The toilet which is pit latrine with water sealed facility is called sanitary (water sealed). These answers are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

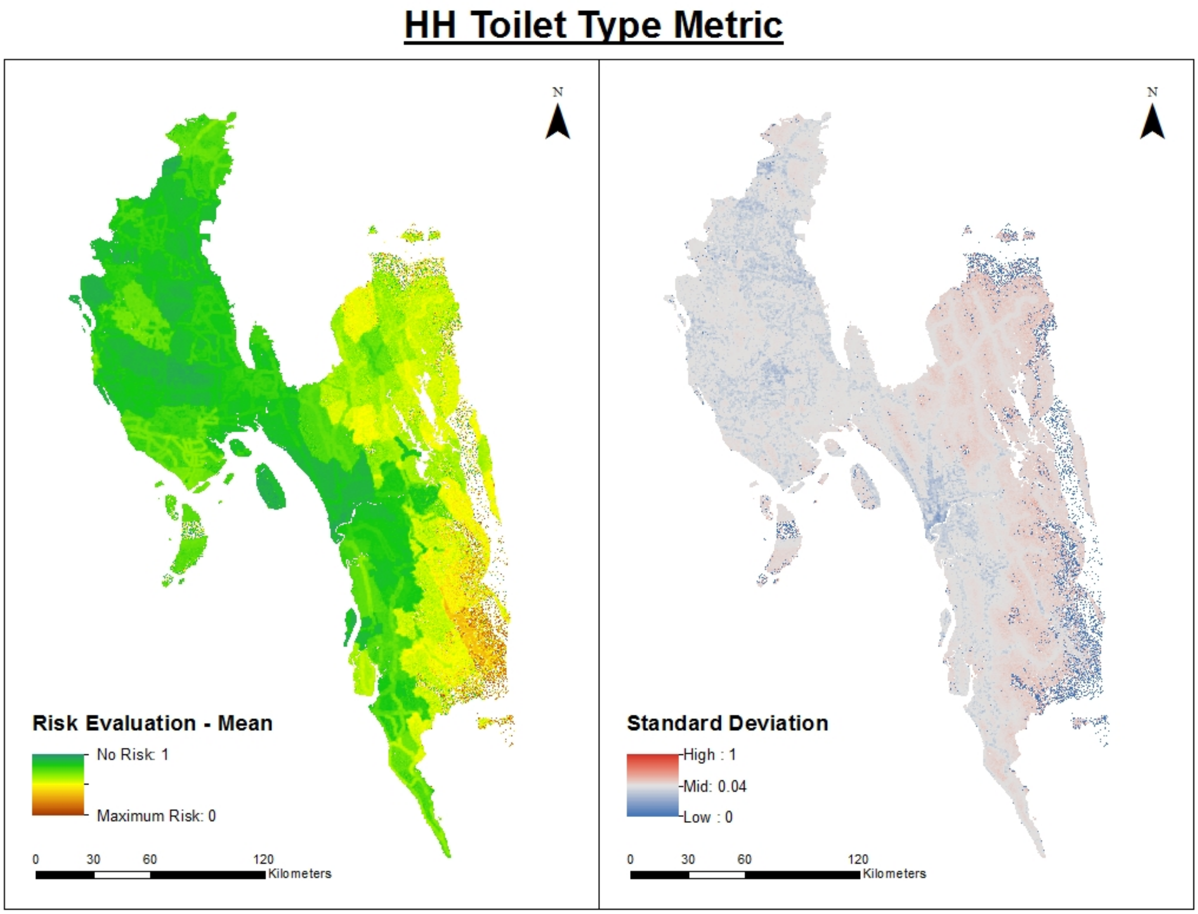
The latrine which is pit latrine but having no water sealed facility is called sanitary (Non water sealed). These answers are given a minimum value of 0.8 (minimal risk) and a maximum value of 1.0.

The toilet which may be pucca, semi-pucca or kutcha but having no facility to cover the discharge waste is called Non-sanitary. Such type of toilet is not free from water and environment pollution. These answers are given a minimum value of 0.001 (extreme risk) and a maximum value of 0.25 (medium risk, $½^2$).

None means there is no toilet for the household usually uses to go bush, jungle or open space as and when necessary. These answers are given a minimum value of 0.001 (extreme risk) and a maximum value of 0.125 (high risk, $½^3$).

Maps will range from extreme risk to no risk.

Example Realization Metric Map

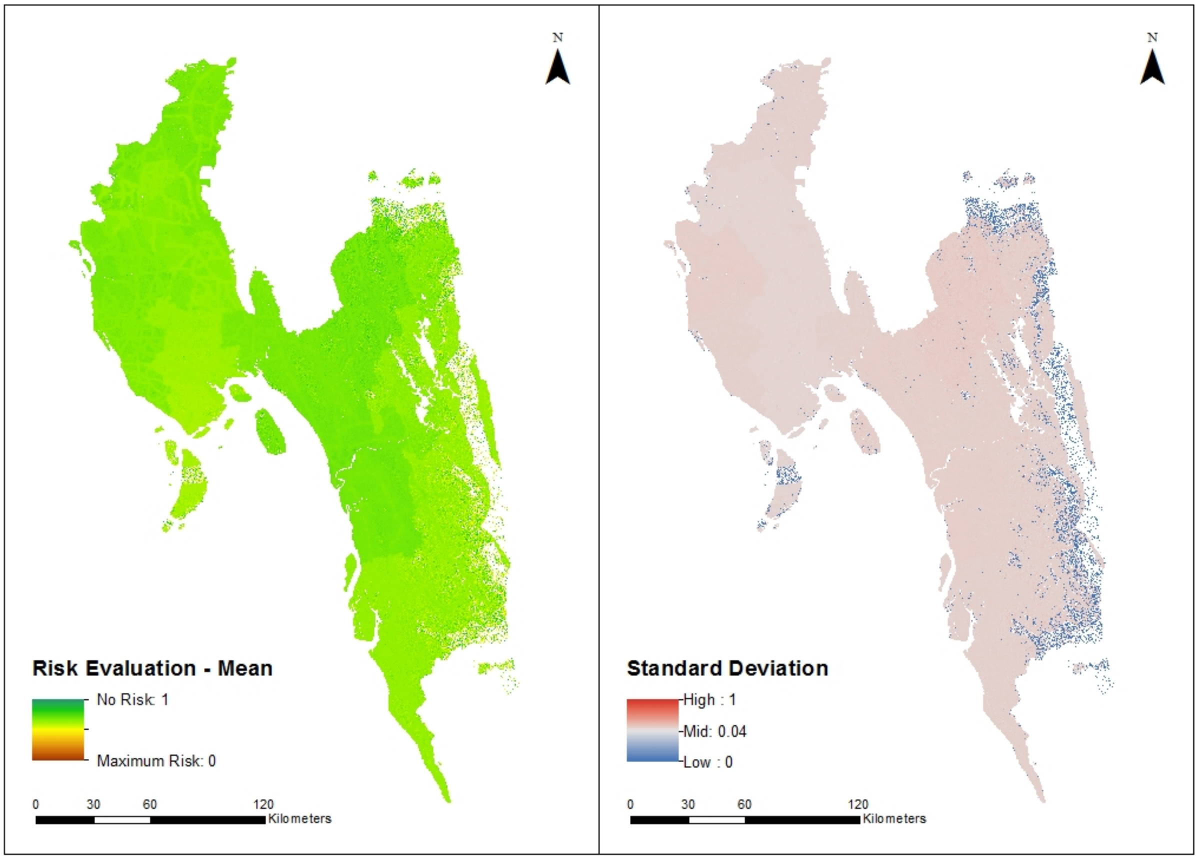


3.3.1.2 Metric: PerceivedIssueSanitation

Indicator:	Inadequate Sanitation
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether sanitation is more or less serious in your community than in the rest of Bangladesh?” Answers of “Not Issue” are given both a minimum value and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

Perceived Issue Sanitation Metric

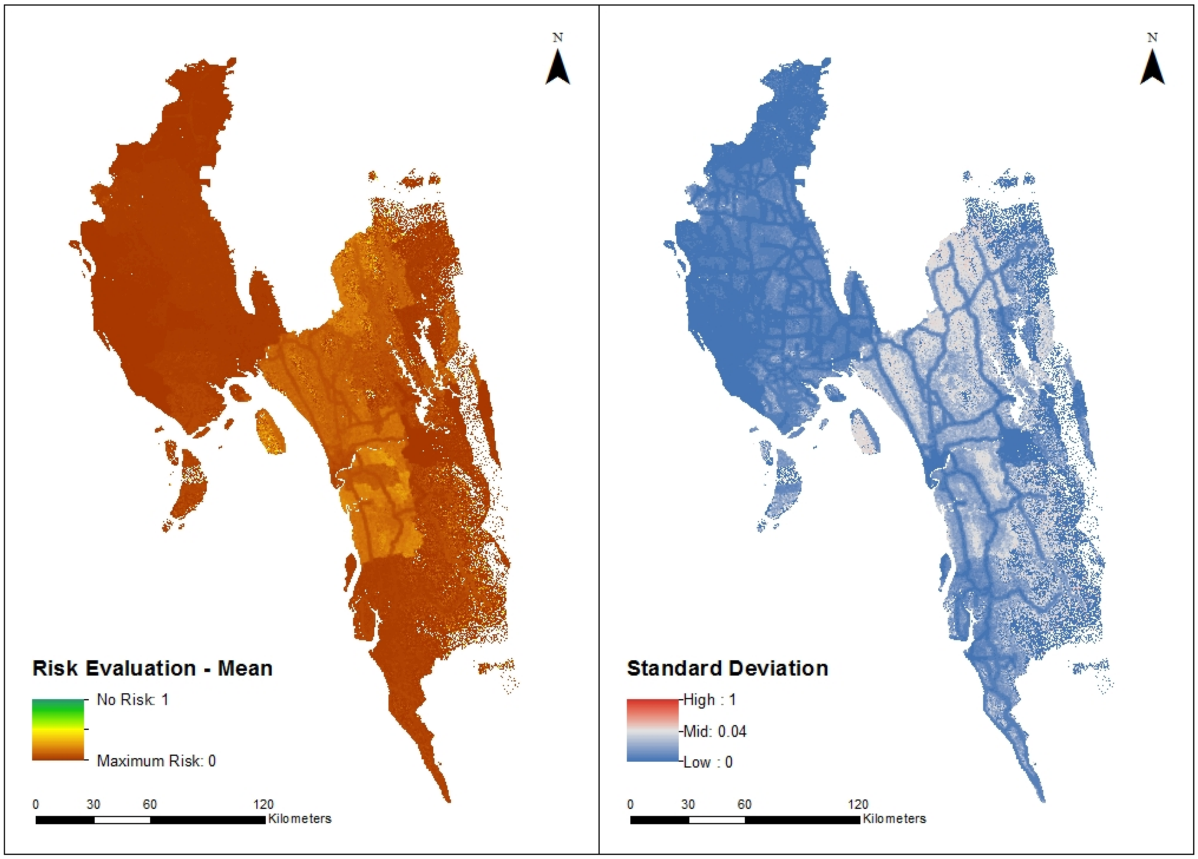


3.3.1.3 Metric: PerceivedEffortSanitation

Indicator:	Inadequate Sanitation
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve sanitation in Bangladesh today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

Perceived Effort Sanitation Metric

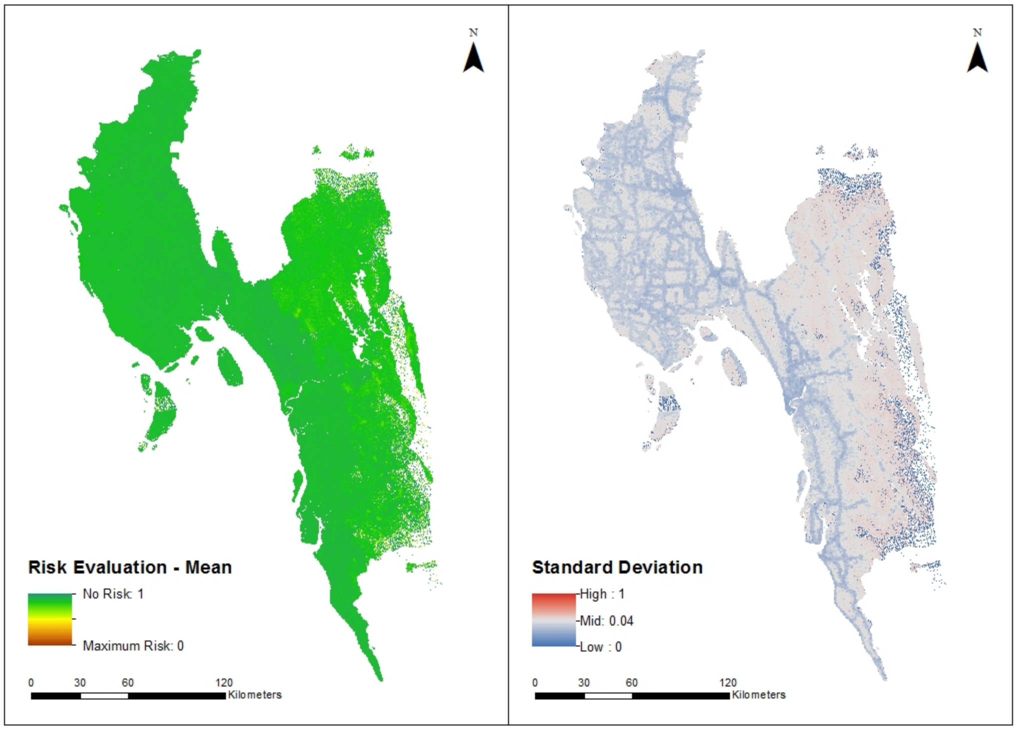


3.3.1.4 Metric: ToiletShared

Indicator:	Inadequate Sanitation
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 0.2, max: 0.75) No (min: 1.0, max: 1.0)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you share this toilet facility with other households?” Answers of “Yes” are given a minimum value of 0.2 (medium risk) and a maximum value of 0.75 (minimal risk). Answers of “No” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Maps will range from medium risk to no risk.

Example Realization Metric Map

Toilet Shared Metric



3.3.2 Indicator: Water Shortfalls

This indicator measures both general access to clean water (for drinking and other household uses), as well as how access and quality of water are negatively effected in the event of a crisis.

It should be noted that while this indicator name implies that it measures the lack of water services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Water Availability.”

PACOM specifies that metrics should include: percentage of water storage facilities (wells, water tanks) damaged by crisis; percentage of fresh water contaminated; percentage of population with access to potable water; and satisfaction with provision and supply of potable water.

Metric Weighting Logic

As the “SourceDrinkingWater” (household drinking water source from the IPUMS survey) is the most constraining metric, it is weighted both a minimum value of 0.8 and maximum value of 1.0. The “AdditiveForDrinkingWater” metric is the least relevant in terms of measuring quality and access to clean water, it is weighted the lowest of all metrics.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
SourceDrinkingWater (3.3.2.1)	0.8	1.0
PerceivedIssueWater (3.3.2.2)	0.4	0.6
PerceivedEffortWater (3.3.2.3)	0.35	0.7
WaterSourceLocation (3.3.2.4)	0.25	0.7
AdditiveForDrinkingWater (3.3.2.5)	0.25	0.35

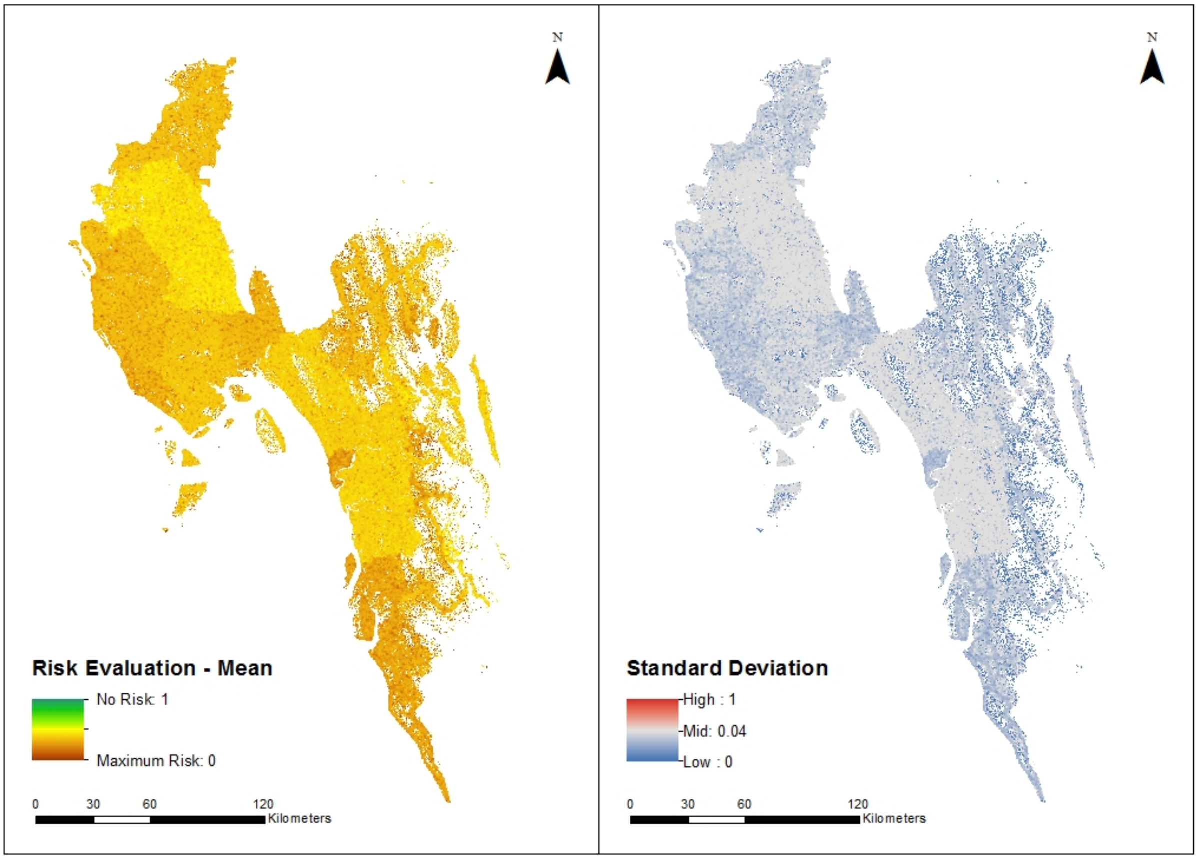
Uncertainty Values

The addition of data on city-wide clean water system provisions and larger urban water access issues could further decrease the uncertainty values, as would data measuring water utility disruptions in crisis situations.

Indicator Uncertainty Min: 0.1
Indicator Uncertainty Max: 0.15

Example Outcome

Water Shortfalls Indicator



3.3.2.1 Metric: SourceDrinkingWater

Indicator:	Water Shortfalls
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Tap (min: 1.0, max: 1.0) Tubewell (min: 0.5, max: 0.9) Other (min: 0.7, max: 0.8)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	http://www.wssinfo.org/definitions-methods/watsan-categories/

Logic:

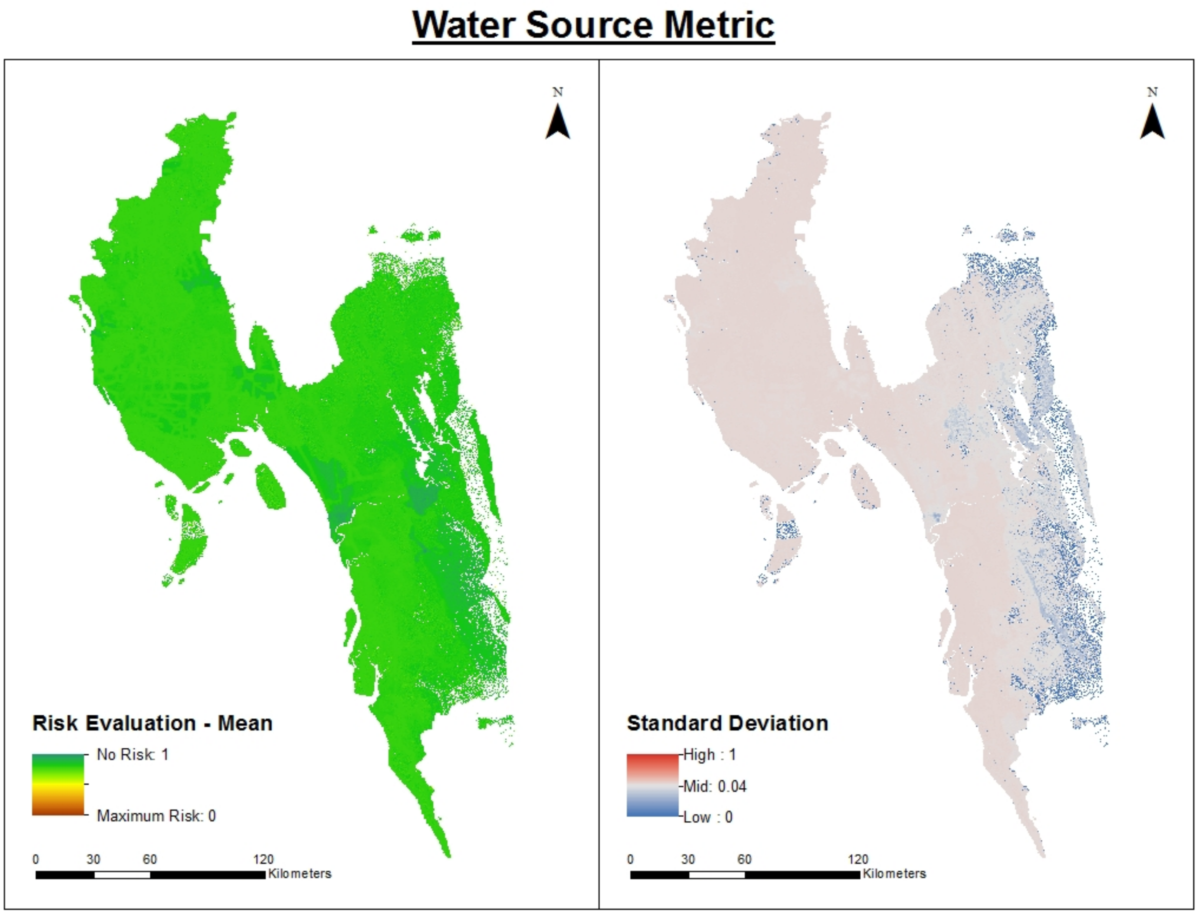
This metric consists on answers to the question of types of household drinking water sources (which is different from the more generic IPUMS survey question on household water sources, see metric "HHWaterSource"). "Tap" answers refer to a household connection to in-house plumbing. This answer is given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

"Tubewell" is a deep hole that has been driven, bored or drilled, with the purpose of reaching groundwater supplies. Water is delivered from a tubewell or borehole through a pump, which may be powered by human, animal, wind, electric, diesel or solar means. These answers are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk).

"Other" answers are given a minimum value of 0.7 (minimal risk) and a maximum value of 0.8 (minimal risk).

Maps will range from slight risk to no risk.

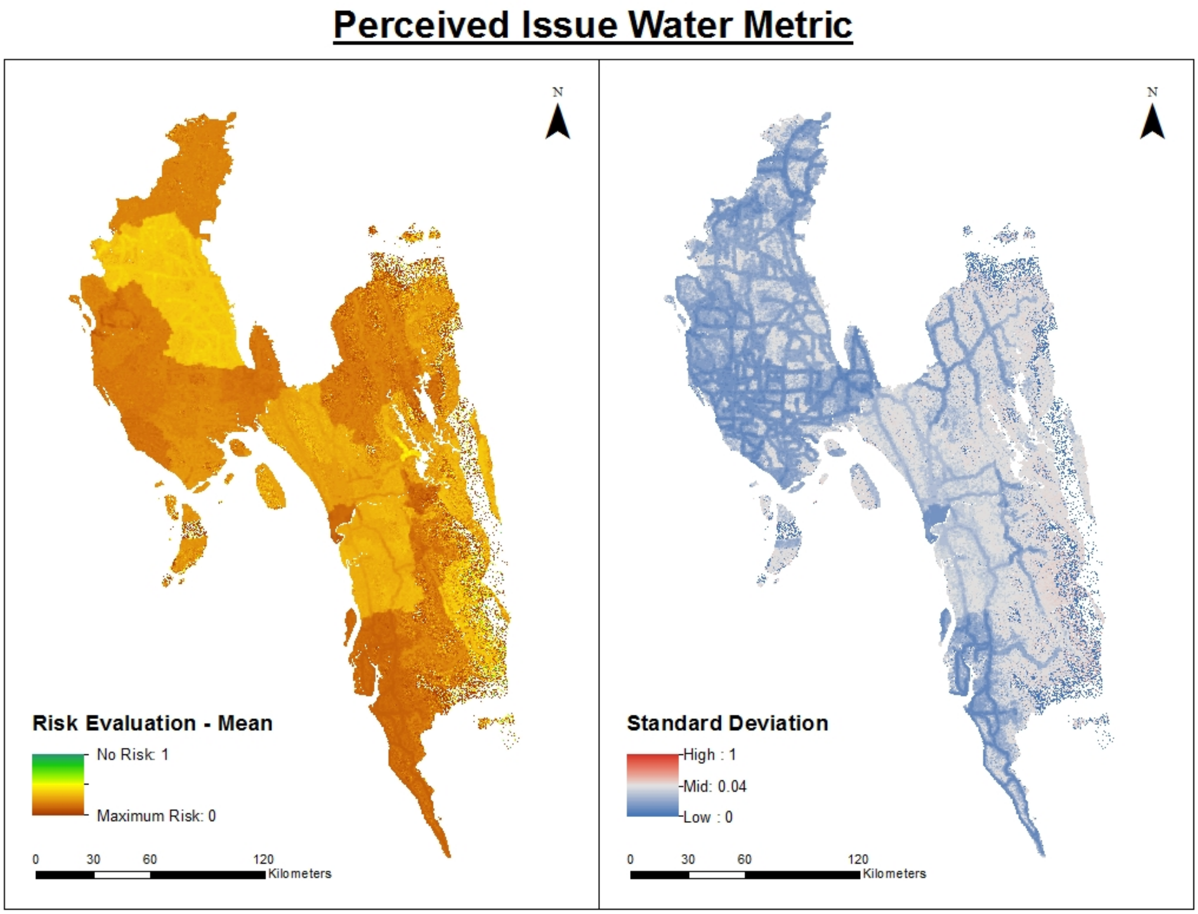
Example Realization Metric Map



3.3.2.2 Metric: PerceivedIssueWater

Indicator:	Water Shortfalls
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether availability of fresh water is more or less serious in your community than in the rest of Bangladesh?” Answers of “Not Issue” is given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

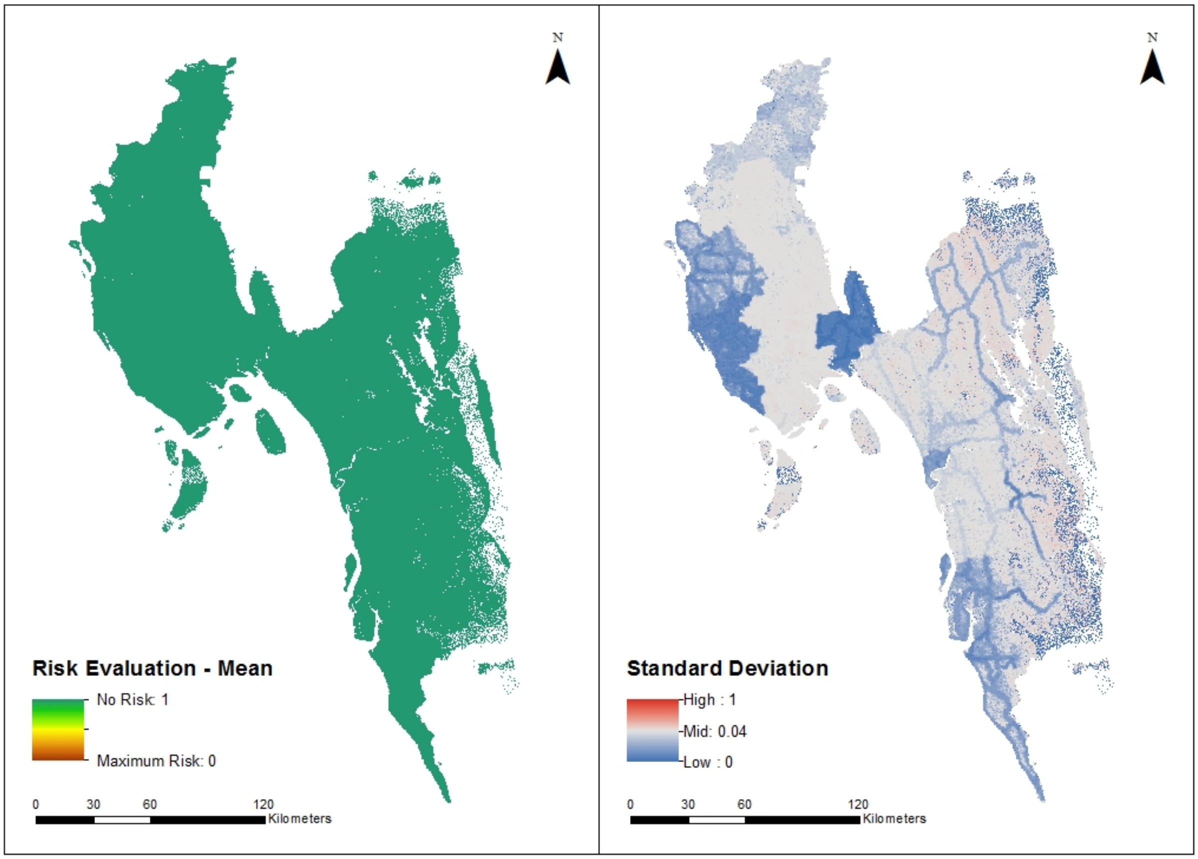


3.3.2.3 Metric: PerceivedEffortWater

Indicator:	Water Shortfalls
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe it working hard to improve the availability of fresh water in Bangladesh today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

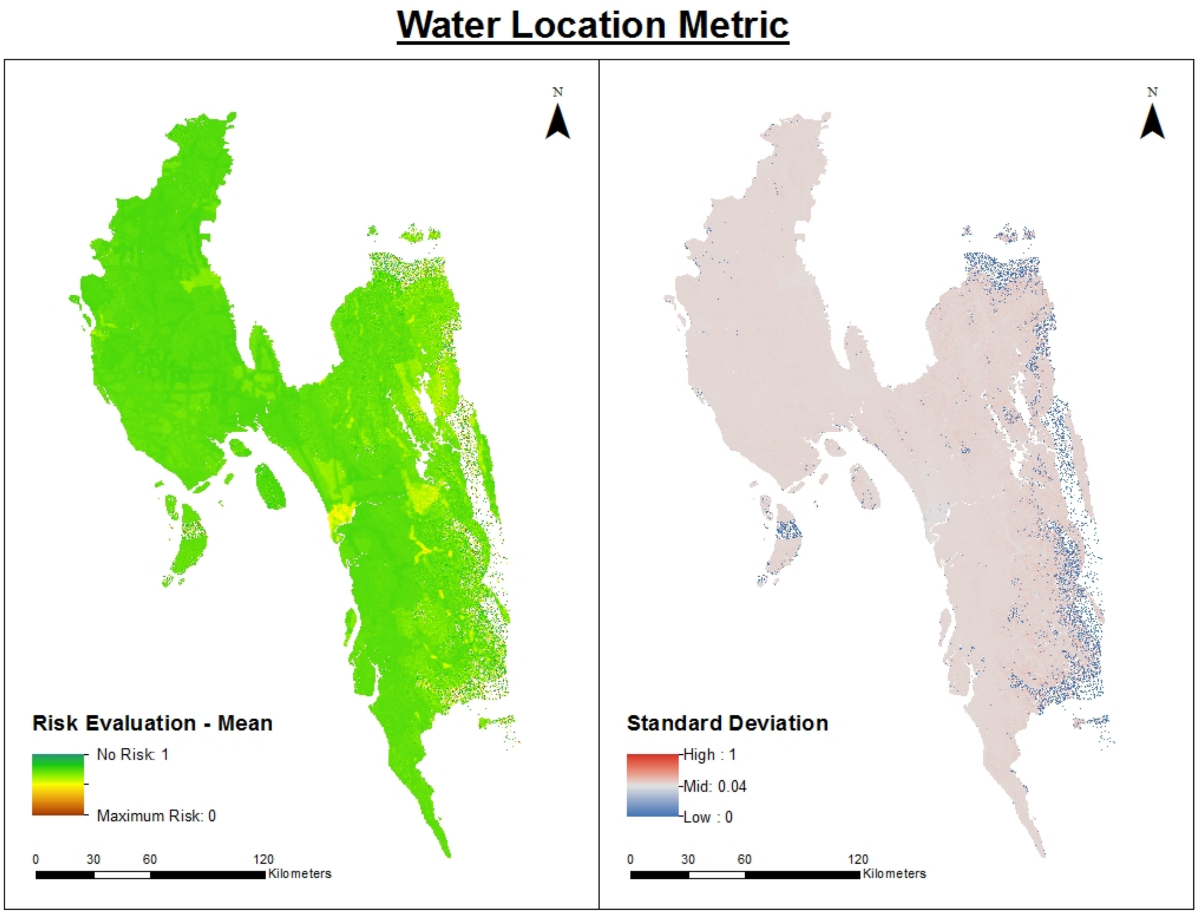
Perceived Effort Water Metric



3.3.2.4 Metric: WaterSourceLocation

Indicator:	Water Shortfalls
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Dwelling (in own dwelling) (min: 1.0, max: 1.0) Yard (in own yard) (min: 0.6, max: 0.95) Other (Elsewhere) (min: 0.07, max: 0.75)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Where is that water source located?” Answers of “Dwelling” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^{0}$). Answers of “Yard” are given a minimum value of 0.6 (minimal risk) and a maximum value of 0.95 (minimal risk). Answers of “Other” are given a minimum value of 0.07 (high risk) and a maximum value of 0.75 (minimal risk). Maps will range from high risk to no risk.

Example Realization Metric Map

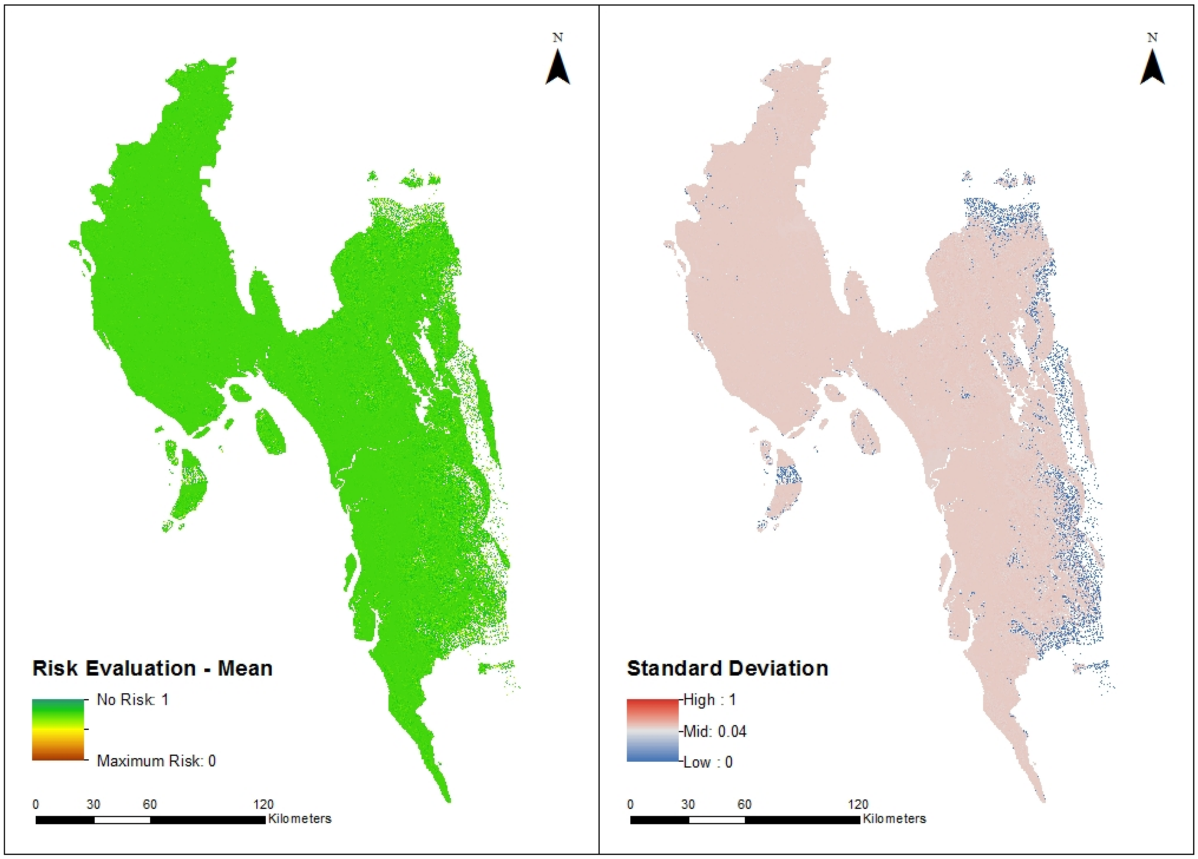


3.3.2.5 Metric: AdditiveForDrinkingWater

Indicator:	Water Shortfalls
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 0.4, max: 1.0) No (min: 0.3, max: 1.0) Unknown (min: 0.3, max: 0.8)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you do anything to the water to make it safe to drink?” Answers of “Yes” are given a minimum value of 0.4 (slight risk) and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Answers of “No” are given a minimum risk of 0.3 (slight risk) and a maximum value of 1.0. Answers of “Unknown” are given a minimum value of 0.3 and a maximum value of 0.8 (minimal risk). Maps will range from slight risk to no risk.

Example Realization Metric Map

Water Additive Metric



3.3.3 Indicator: Lack of Communications Availability

In the event of a crisis, communications access immediately becomes the one of the most important concerns for both victims and responders. Bidirectional telecommunications allow for the quick dissemination of information and warnings, which greatly determines the effectiveness of the response effort (Woodworth 2005). Townsend and Moss (2005) emphasize the importance of a functioning multi-media communications infrastructure at all stages of a disaster – not just immediate response, but in prevention as well. Recent crises such as the 2015 Nepal earthquake and the 2014-2015 Ebola outbreak point to the significance of communications infrastructure across mediums (Sigdel and Kafle 2015, Smout 2015).

It should be noted that while this indicator name implies that it measures the lack of communication services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Communications Availability."

PACOM specifies that metrics should include: percentage of communication towers, DSL and fiber optic lines disabled by crisis; percentage of population with access to communication (radio, television, cell phones, internet, newspapers) (compared with historical data); and satisfaction with access to communication.

Metric Weighting Logic

Each of these metrics are weighted based on the communication mediums' ability to quickly and accurately spread information, especially when that information is time-sensitive i.e., during a crisis. As such, radio and mobile phones (with or without internet) are weighted the highest, newspapers are weighted the lowest, and access as a whole is weighted higher than ownership.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HHOwnRadio (3.3.3.1)	0.2	0.8
HHOwnTV (3.3.3.2)	0.2	0.8
HHOwnMobilePhone (3.3.3.3)	0.2	0.8
HHOwnNonMobilePhone (3.3.3.4)	0.2	0.8
TVAccess (3.3.3.5)	0.2	0.8
RadioAccess (3.3.3.6)	0.5	1.0
NewspaperAccess (3.3.3.7)	0.2	0.5
InternetAccess (3.3.3.8)	0.2	0.8
MobilePhoneAccess (3.3.3.9)	0.5	1.0
MobilePhonewithInternetAccess (3.3.3.10)	0.5	1.0

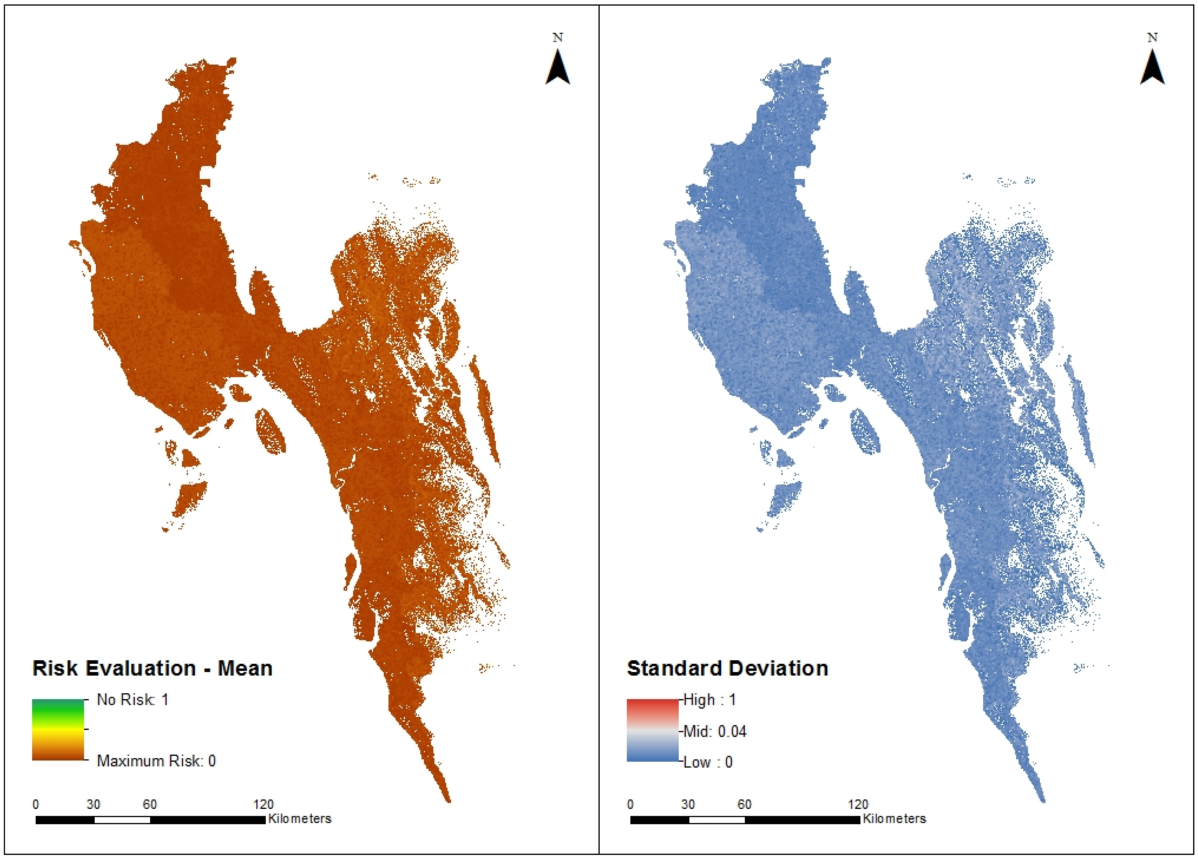
Uncertainty Values

The addition of metrics pointing to communications infrastructure at a larger scale (i.e., presence of cell towers, cables, etc.) could further decrease the uncertainty values.

Indicator Uncertainty Min: 0.25
Indicator Uncertainty Max: 0.30

Example Outcome

Lack of Communications Availability Indicator



References

Sigdel, K.R. and Dol Raj Kafle (2015). "Nepal needs better communication infrastructure to respond to disaster." *WACC Global*. 11 May 2015. Accessed at http://waccglobal.org/articles/nepal-needs-better-communication-infrastructure-to-respond-to-disaster on 12 Jan 2017.

Smout, Elizabeth (2015). "Communicating in a crisis like Ebola: Facts and figures." SciDevNet. 29 Apr 2015. Accessed at http://www.scidev.net/global/ebola/feature/communicating-crisis-ebola-facts-figures.html on 12 Jan 2017.

Townsend, Anthony M. and Mitchell L. Moss (2005). Telecommunications Infrastructure in Disasters: Preparing Cities for Crisis Communications. Center for Catastrophe Preparedness and Response & Robert F. Wagner Graduate School of Public Service. New York University. Apr 2005. Accessed at https://www.nyu.edu/ccpr/pubs/NYU-DisasterCommunications1-Final.pdf on 12 Jan 2017.

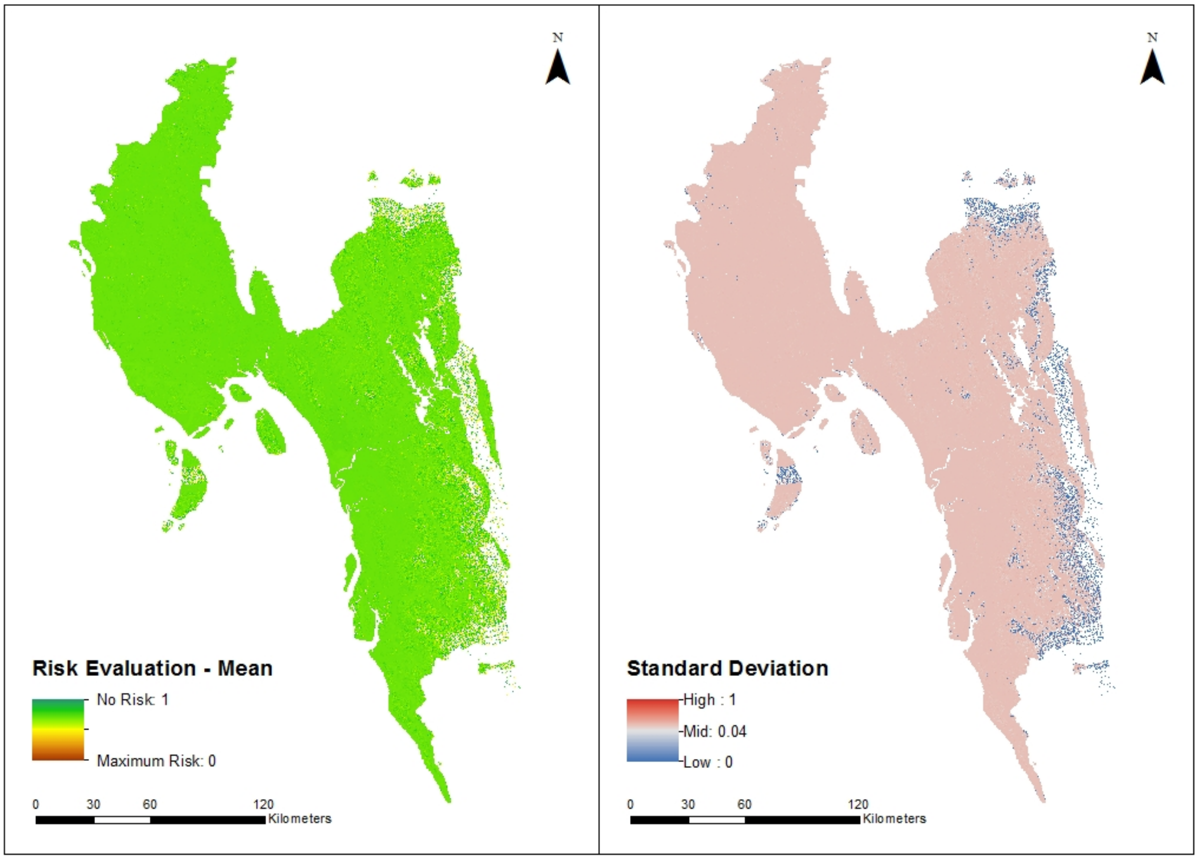
Woodworth, Brent (2005). "The Importance of Information Technology and Telecommunications support in Crisis Management." 1 May 2005. Accessed at http://apps.who.int/hac/events/tsunamiconf/presentations/2_18_logistics_it_telecoms_woodworth_doc.pdf on 12 Jan 2017.

3.3.3.1 Metric: HHOwnRadio

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.126, max: 0.95)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Does your household have a radio?” from the household portion of the DHS survey. Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). This large gap between the minimum and maximum values exists because ownership may not reflect access. Maps will range from medium risk to no risk.

Example Realization Metric Map

Own Radio Metric

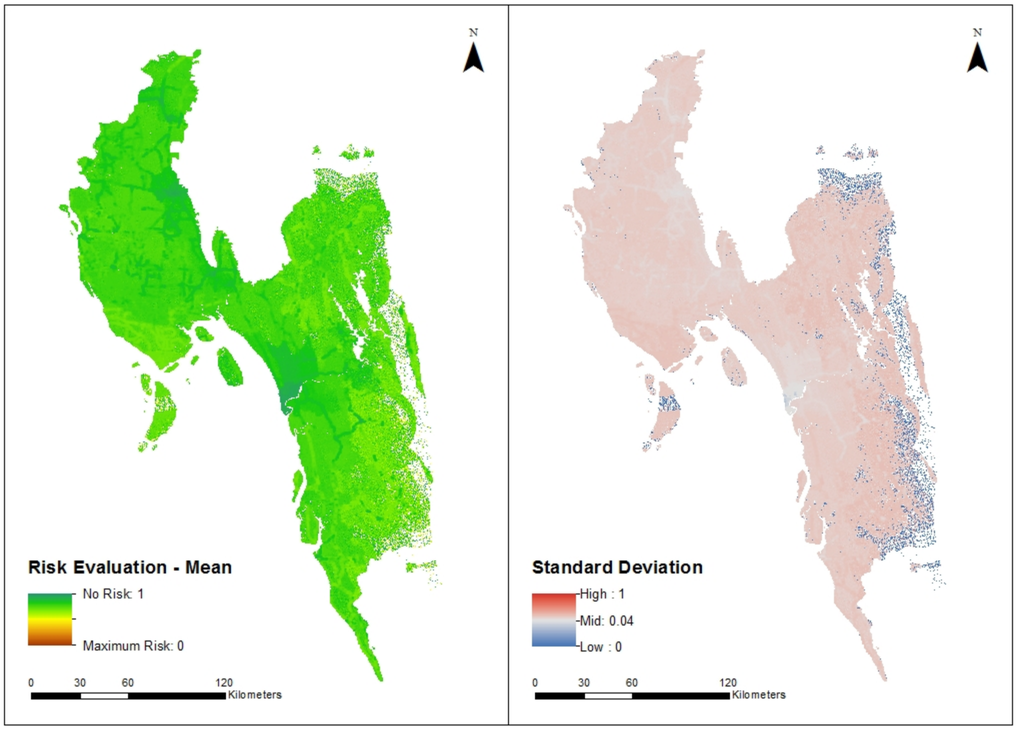


3.3.3.2 Metric: HHOwnTV

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.126, max: 0.95)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Does your household have a television?" from the household portion of the DHS survey. Answers of "Yes" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "No" are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). This large gap between the minimum and maximum values exists because ownership may not reflect access. Maps will range from medium risk to no risk.

Example Realization Metric Map

Own TV Metric

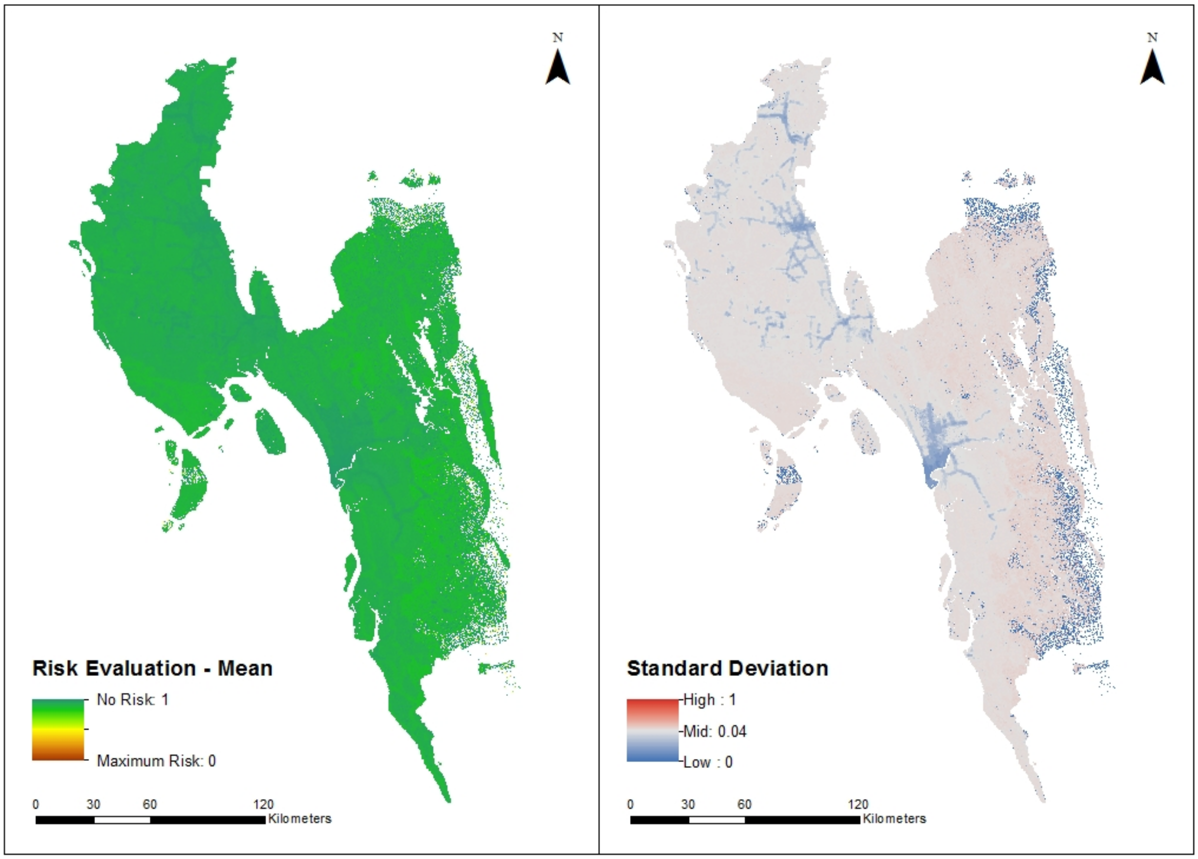


3.3.3.3 Metric: HHOwnMobilePhone

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.126, max: 0.95)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Does your household have a mobile telephone?” from the household portion of the DHS survey. Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). This large gap between the minimum and maximum values exists because ownership may not reflect access. Maps will range from medium risk to no risk.

Example Realization Metric Map

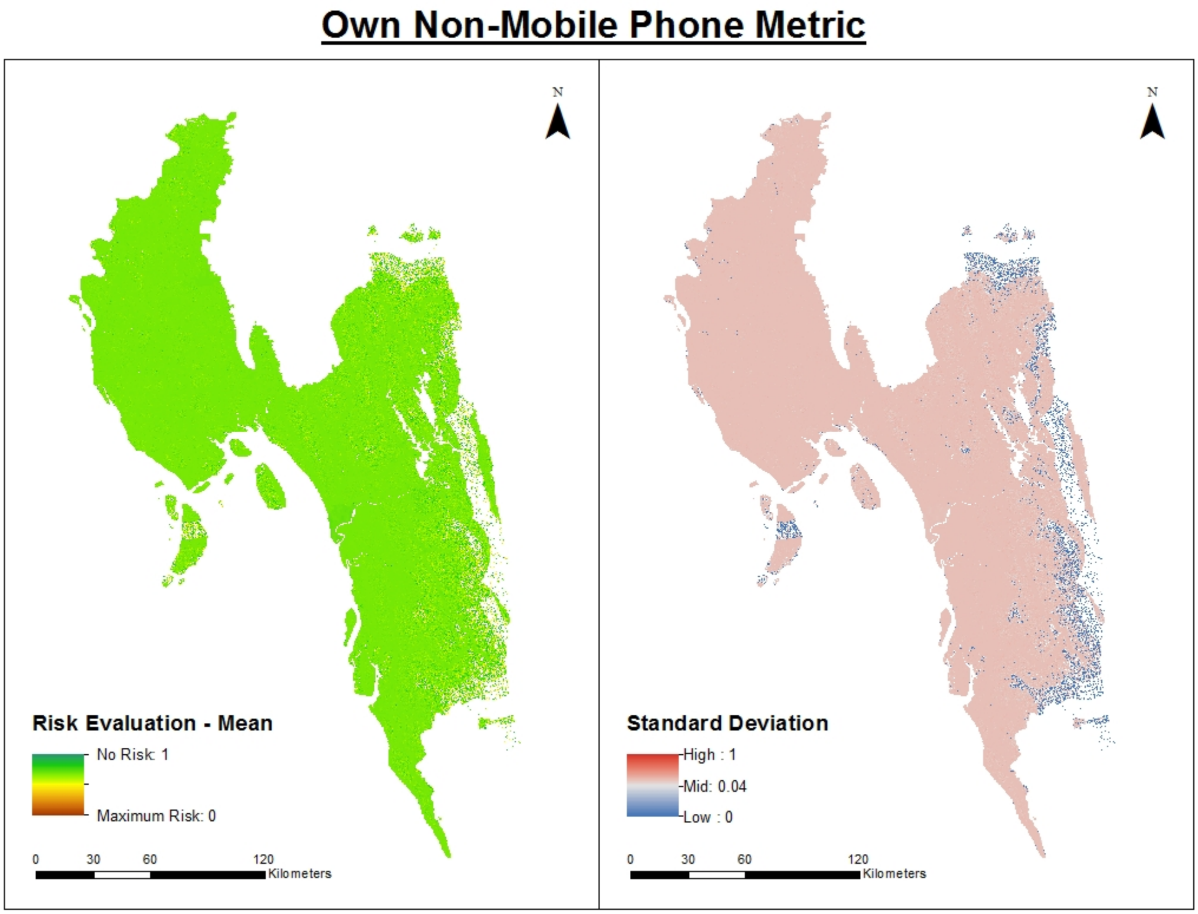
Own Mobile Phone Metric



3.3.3.4 Metric: HHOwnNonMobilePhone

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.126, max: 0.95)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Does your household have a non-mobile telephone?" from the household portion of the DHS survey. Answers of "Yes" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "No" are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). This large gap between the minimum and maximum values exists because ownership may not reflect access. Maps will range from medium risk to no risk.

Example Realization Metric Map



3.3.3.5 Metric: TVAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	0.1thru4.4Hours (min: 0.5, max: 0.95) 4.5thru10.9Hours (min: 0.85, max: 1.0) 11thru169Hours (min: 1.0, max: 1.0) Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.9)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	

Logic:

This metric consists of answers to the questions "Thinking about your activities over the last 7 days, approximately how many hours did you spend: watching TV?" and (if the respondent answers 0 hours to the previous question) "Do you have access to a television?"

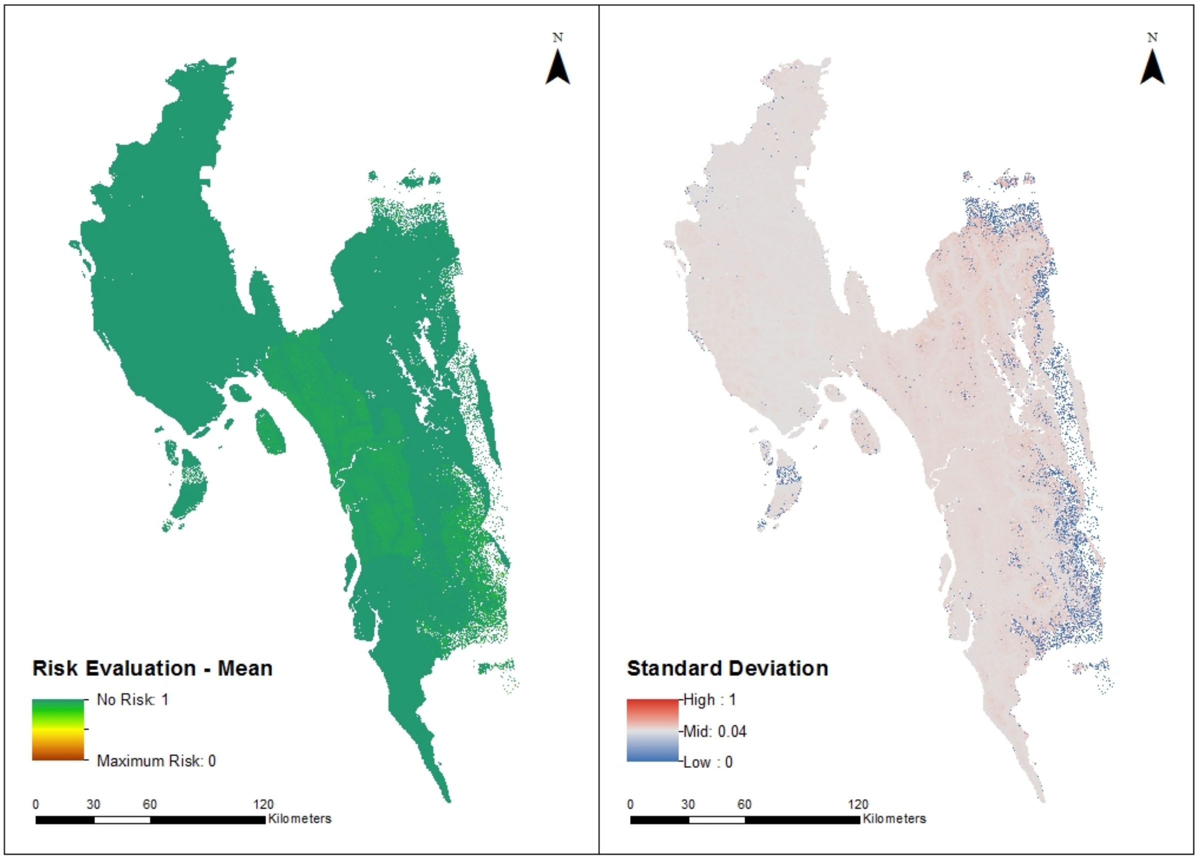
Hourly answer groupings are based on natural breaks within the survey answer data. Any answers between 0.1 and 4.4 hours are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.95 (minimal risk). Answers between 4.5 and 10.9 hours are given a minimum value of 0.85 (minimal risk) and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers between 11 and 169 hours are given both a minimum and a maximum value of 1.0.

If the respondent says they spent 0 hours in the last week watching TV, but answer "Yes" that they do have access to a television, their answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0. Answers of "No" are given a minimum value of 0.126 (medium risk) and a maximum value of 0.9 (minimal risk).

Maps will range from medium risk to no risk.

Example Realization Metric Map

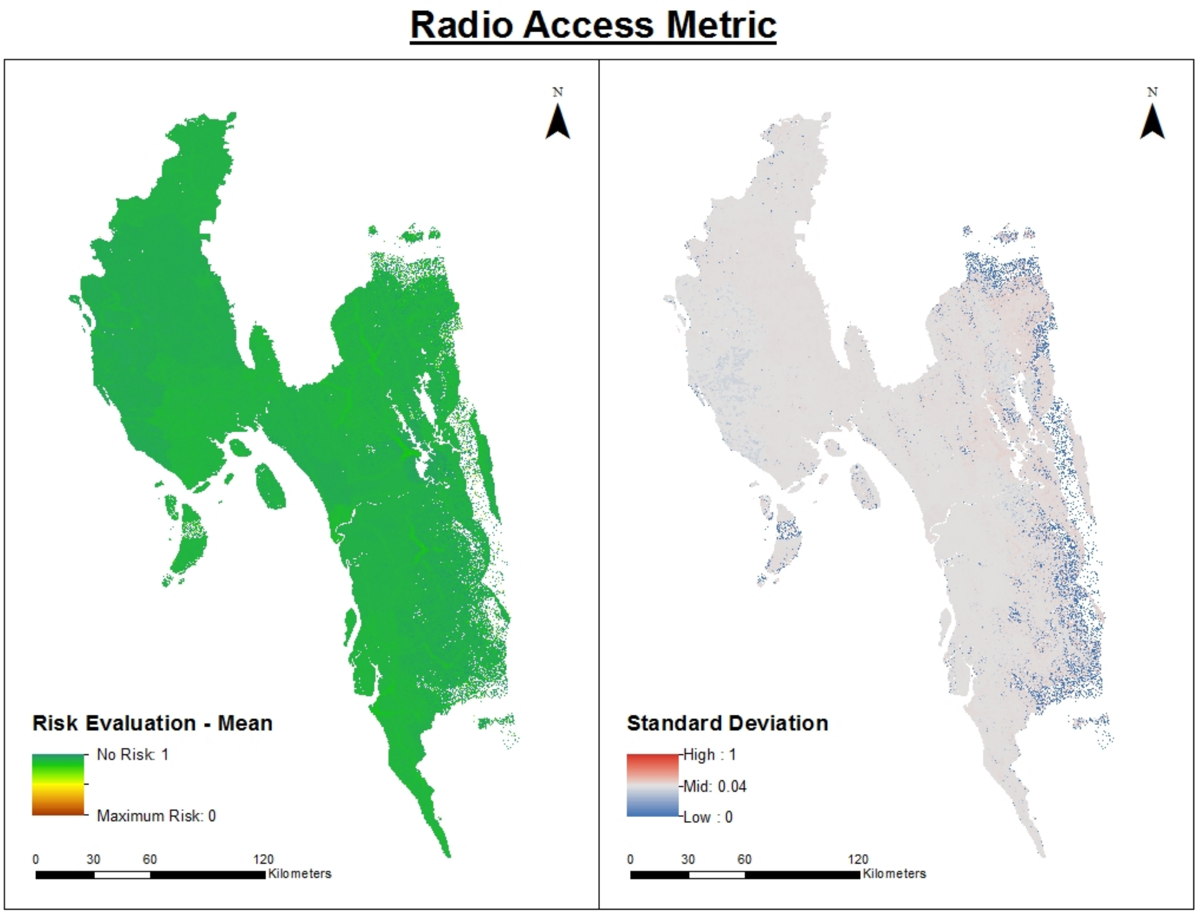
TV Access Metric



3.3.3.6 Metric: RadioAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	0.1thru4.4Hours (min: 0.5, max: 0.9) 4.5thru10.9Hours (min: 0.625, max: 0.95) 11thru169Hours (min: 1.0, max: 1.0) Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.95)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the questions “Thinking about your activities over the last 7 days, approximately how many hours did you spend: Listening to the radio?” and (if the respondent answers 0 hours to the previous question) “Do you have access to a radio?” Hourly answer groupings are based on natural breaks within the survey answer data. Any answers between 0.1 and 4.4 hours are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers between 4.5 and 10.9 hours are given a minimum value of 0.625 (minimal risk) and a maximum value of 0.95 (minimal risk). Answers between 11 and 169 hours are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). If the respondent says they spent 0 hours in the last week listening to the radio, but answer “Yes” that they do have access to a radio, their answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0. Answers of “No” are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map



3.3.3.7 Metric: NewspaperAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	0.1thru1.5Hours (min: 0.5, max: 0.9) 1.6thru8Hours (min: 0.625, max: 0.95) 8.1thru169Hours (min: 1.0, max: 1.0) Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.95)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the questions “Thinking about your activities over the last 7 days, approximately how many hours did you spend: Reading a newspaper?” and (if the respondent answers 0 hours to the previous question) “Do you have access to a newspaper?”

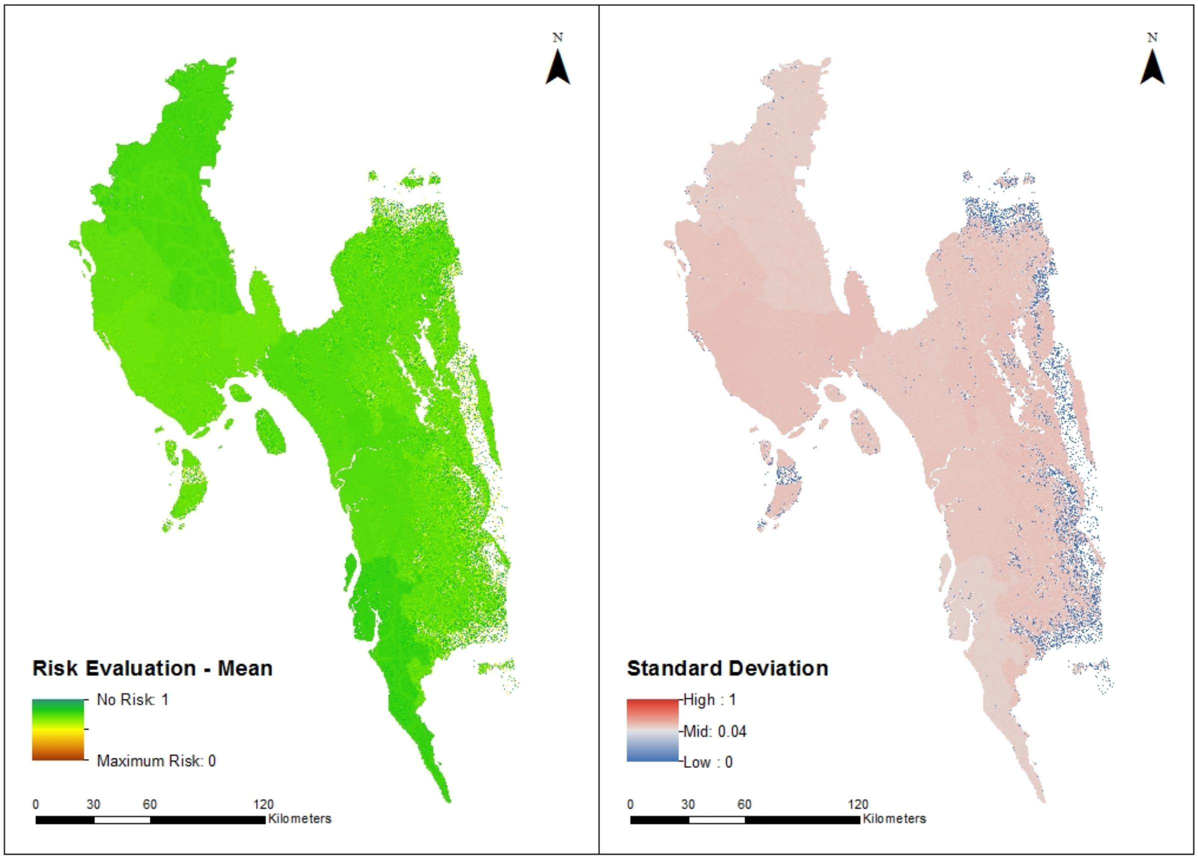
Hourly answer groupings are based on natural breaks within the survey answer data. Any answers between 0.1 and 1.5 hours are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers between 1.6 and 8 hours are given a minimum value of 0.625 (minimal risk) and a maximum value of 0.95 (minimal risk). Answers between 8.1 and 169 hours are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$).

If the respondent says they spent 0 hours in the last week reading the newspaper, but answer “Yes” that they do have access to a newspaper, their answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0. Answers of “No” are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk).

Maps will range from medium risk to no risk.

Example Realization Metric Map

Newspaper Access Metric

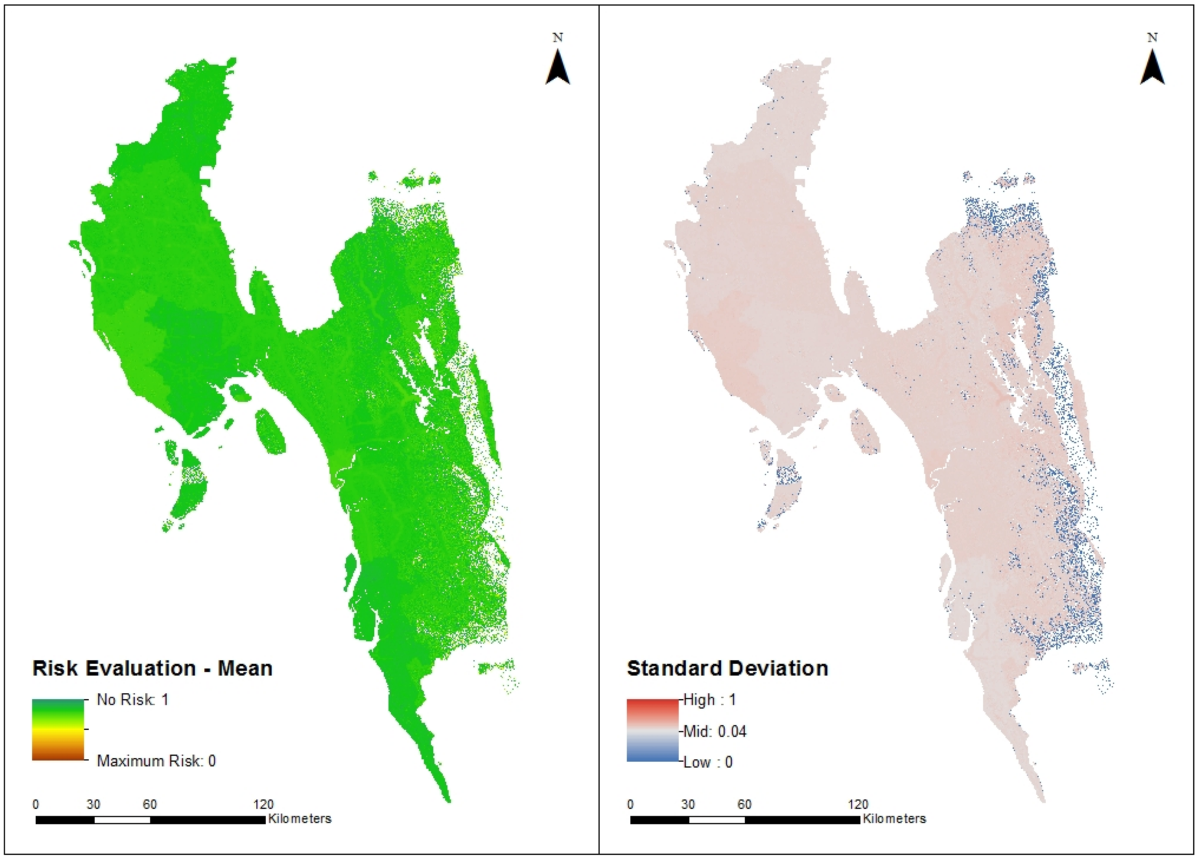


3.3.3.8 Metric: InternetAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	0.1thru3.5Hours (min: 0.5, max: 0.9) 3.6thru17.9Hours (min: 0.625, max: 0.95) 18thru169Hours (min: 1.0, max: 1.0) Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.95)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the questions "Thinking about your activities over the last 7 days, approximately how many hours did you spend: On the internet?" and (if the respondent answers 0 hours to the previous question) "Do you have access to the internet?" Hourly answer groupings are based on natural breaks within the survey answer data. Any answers between 0.1 and 3.5 hours are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers between 3.6 and 17.9 hours are given a minimum value of 0.625 (minimal risk) and a maximum value of 0.95 (minimal risk). Answers between 18 and 169 hours are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). If the respondent says they spent 0 hours in the last week on the internet, but answer "Yes" that they do have access to the internet, their answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0. Answers of "No" are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

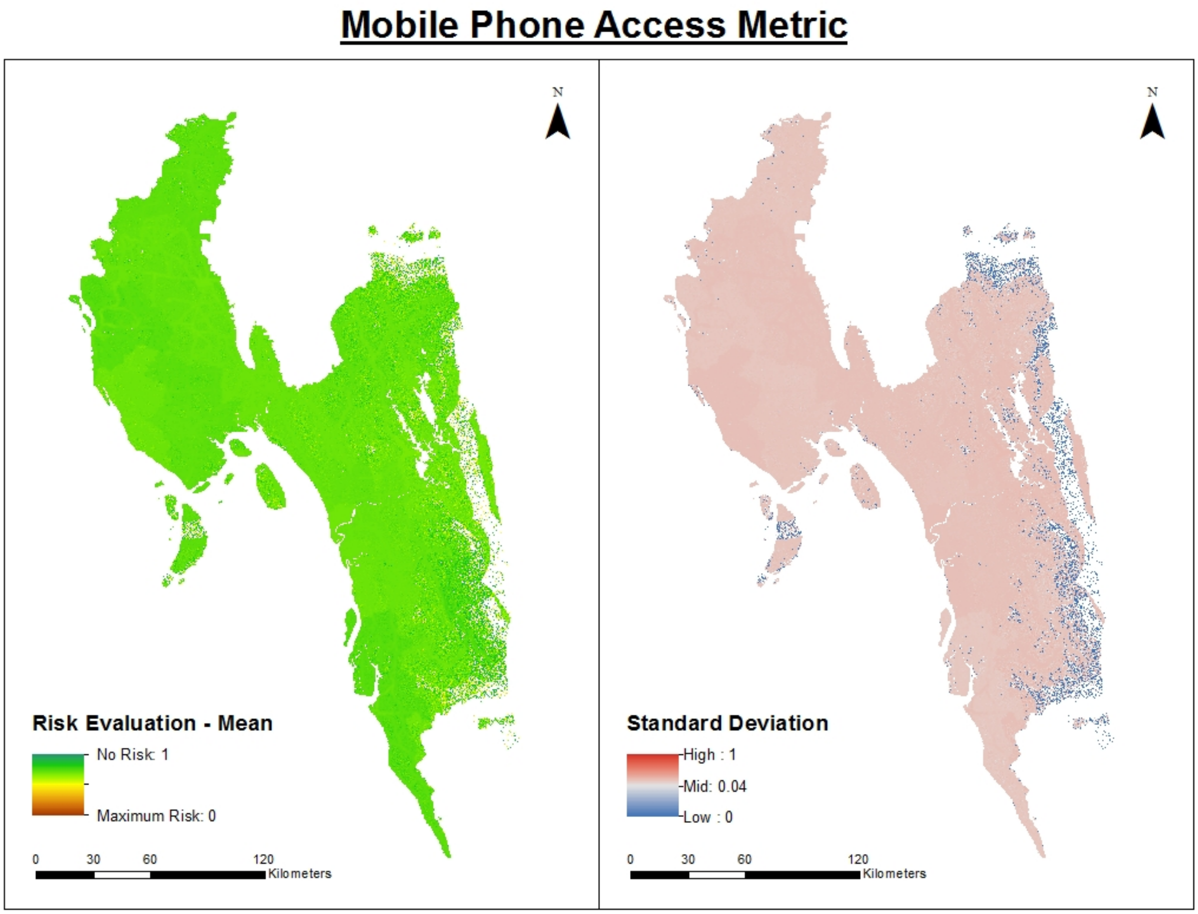
Internet Access Metric



3.3.3.9 Metric: MobilePhoneAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	0.1thru3.5Hours (min: 0.5, max: 0.9) 3.6thru10.9Hours (min: 0.625, max: 0.95) 11thru169Hours (min: 1.0, max: 1.0) Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.95)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the questions "Thinking about your activities over the last 7 days, approximately how many hours did you spend: Using a mobile phone?" and (if the respondent answers 0 hours to the previous question) "Do you have access a mobile phone?" Hourly answer groupings are based on natural breaks within the survey answer data. Any answers between 0.1 and 3.5 hours are given a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 (minimal risk). Answers between 3.6 and 10.9 hours are given a minimum value of 0.625 (minimal risk) and a maximum value of 0.95 (minimal risk). Answers between 11 and 169 hours are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). If the respondent says they spent 0 hours in the last week using a mobile phone, but answer "Yes" that they do have access to a mobile phone, their answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0. Answers of "No" are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

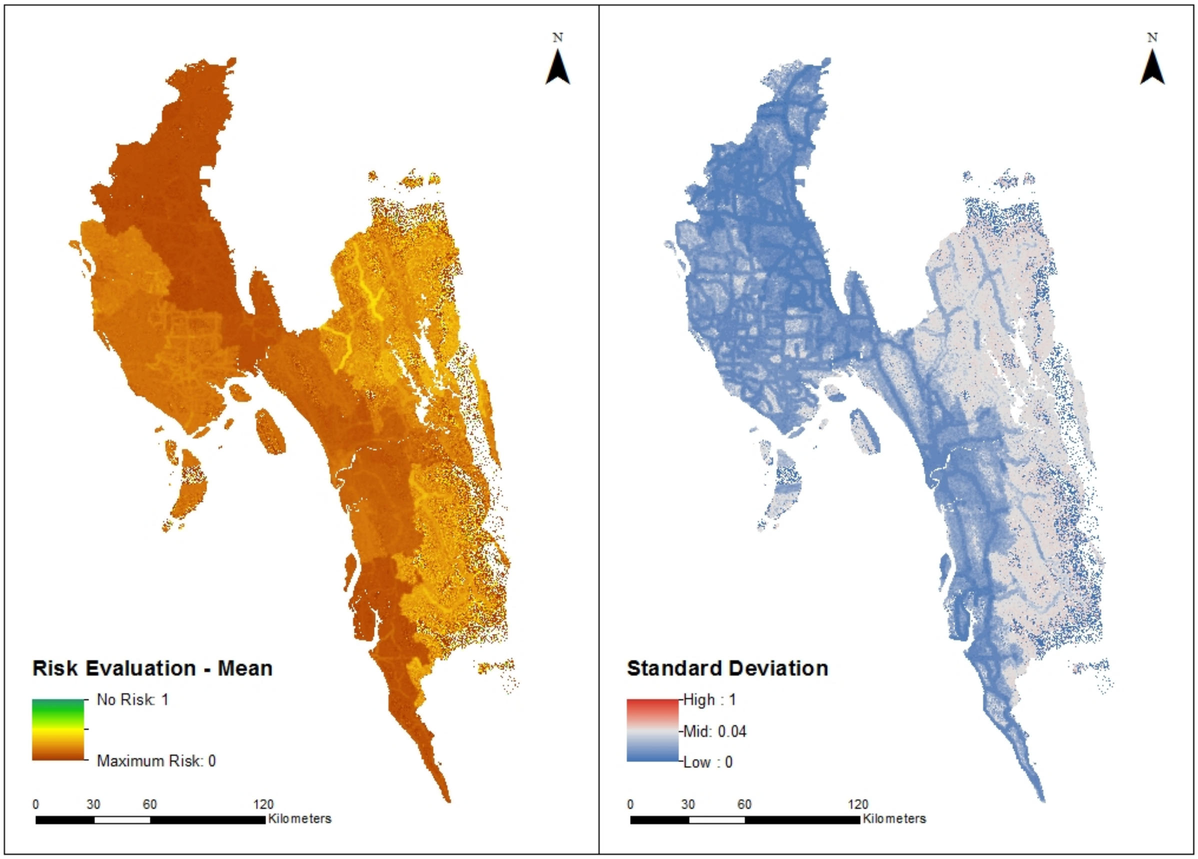


3.3.3.10 Metric: MobilePhonewithInternetAccess

Indicator:	Lack of Communications Availability
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (has access) (min: 0.625, max: 1.0) No (does not have access) (min: 0.126, max: 0.95)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you have access to a mobile phone that can access the internet?” “Yes” answers are given a minimum value of 0.625 (minimal risk) and a maximum value of 1.0 (minimal risk with no impact on risk, ½^{0}). Answers of “No” are given a minimum value of 0.126 (medium risk) and a maximum value of 0.95 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

Mobile Phone with Internet Access Metric



3.3.4 Indicator: Energy Deficits

The term “energy” here is meant to encompass not just energy in its final form (i.e., electricity within the household, interior heating and cooling systems, etc.), but also the fuel and natural resources that produce energy. The provision of energy is considered to be both a primary critical facility as well as a crucial emergency service (UNISDR 2009).

Fuel and energy shortages can be extremely constraining within protracted humanitarian crises (FAO 2016, OCHA 2015). In a Western context, the oil and gas shortage in the United States in the 1970’s could be considered a wide-ranging energy deficit.

It should be noted that while this indicator name implies that it measures the lack of energy services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Energy Accessability.”

PACOM specifies that metrics should include: percentage of power plants offline; KWH of electricity produced (compare with historical data); load shedding practice (i.e., energy shortages resulting in rolling blackouts); tons of coal mined; barrels of oil produced and in reserve; percentage of population with access to electricity; expenditure on electricity; perception of availability of electricity; perception of affordability of electricity; percentage of population with access to heating fuel; expenditure on heating fuel; perception of availability of heating fuel; and perception of affordability of heating fuel.

Metric Weighting Logic

As the “PerceivedEffortElectrical” metric (whether an individual or organization is working to improve access to electricity from the VPS survey) provides the least relevant information in terms of the indicator’s ask, it is weighted with the lowest minimum and maximum value.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HHAccessElectrical (3.3.4.1)	0.4	0.8
PerceivedIssueElectrical (3.3.4.2)	0.4	0.8
PerceivedEffortElectrical (3.3.4.3)	0.35	0.7

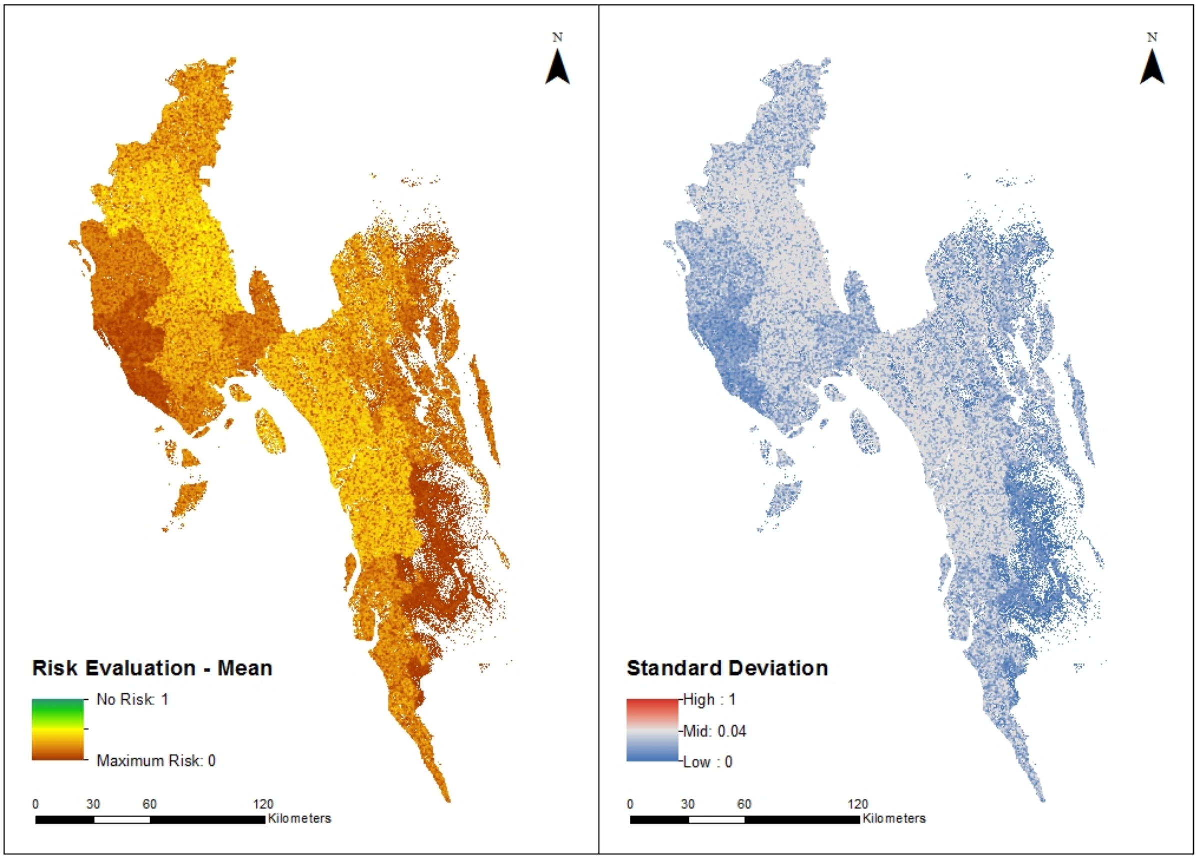
Uncertainty Values

The addition of metrics relating to the production and reserve of fuel and power sources, load shedding, power plants, and historical trends on these topics could decrease the uncertainty value. However, the minimum is kept at a relatively low uncertainty value, since existing metrics have the potential to speak to broader electricity issues.

Indicator Uncertainty Min: 0.25
Indicator Uncertainty Max: 0.60

Example Outcome

Energy Deficits Indicator



References

Food and Agricultural Organization of the United Nations (FAO) (2016). *Guidance Note: Meeting Fuel and Energy Needs in Protracted Crises – The SAFE Approach.* 2016. Accessed at http://www.fao.org/3/a-i6633e.pdf on 13 Jan 2017.

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

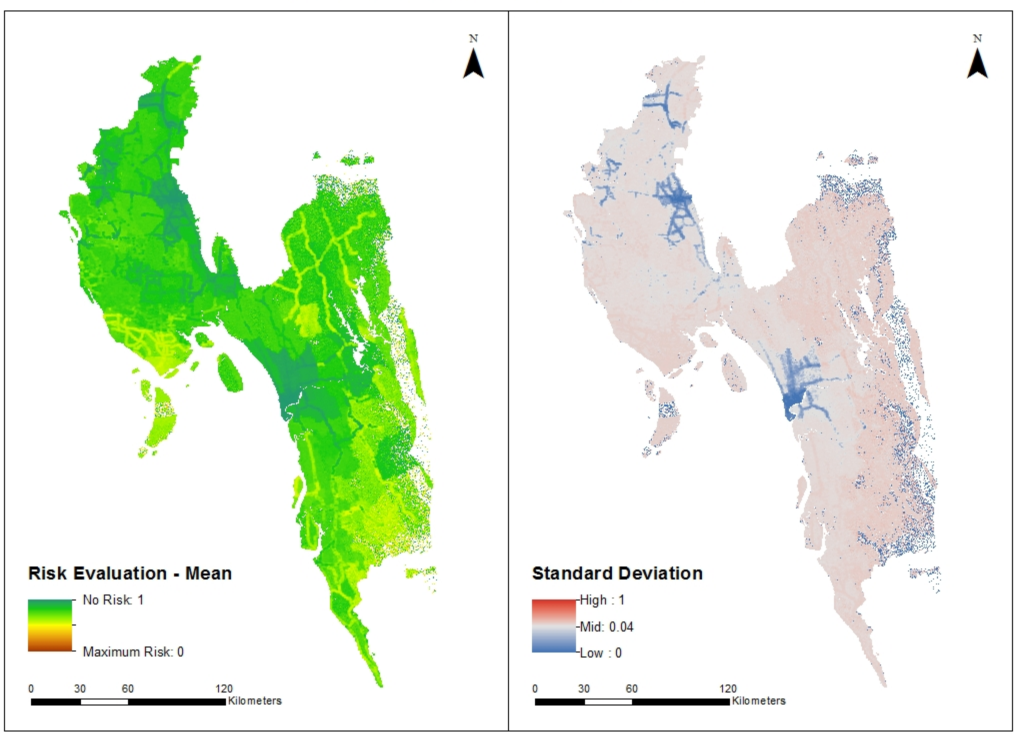
United Nations Office for the Coordination of Humanitarian Affairs (OCHA) (2015). "The Humanitarian Impact of Gaza's Electricity and Fuel Crisis." July 2015. Accessed at http://gaza.ochaopt.org/2015/07/the-humanitarian-impact-of-gazas-electricity-and-fuel-crisis/ on 13 Jan 2017.

3.3.4.1 Metric: HHAccessElectrical

Indicator:	Energy Deficits
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.0625, max: 0.6)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question of whether or not a household has an electrical connection. “Yes” answers are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). “No” answers are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.6 (minimal risk). Maps will range from extreme risk to no risk.

Example Realization Metric Map

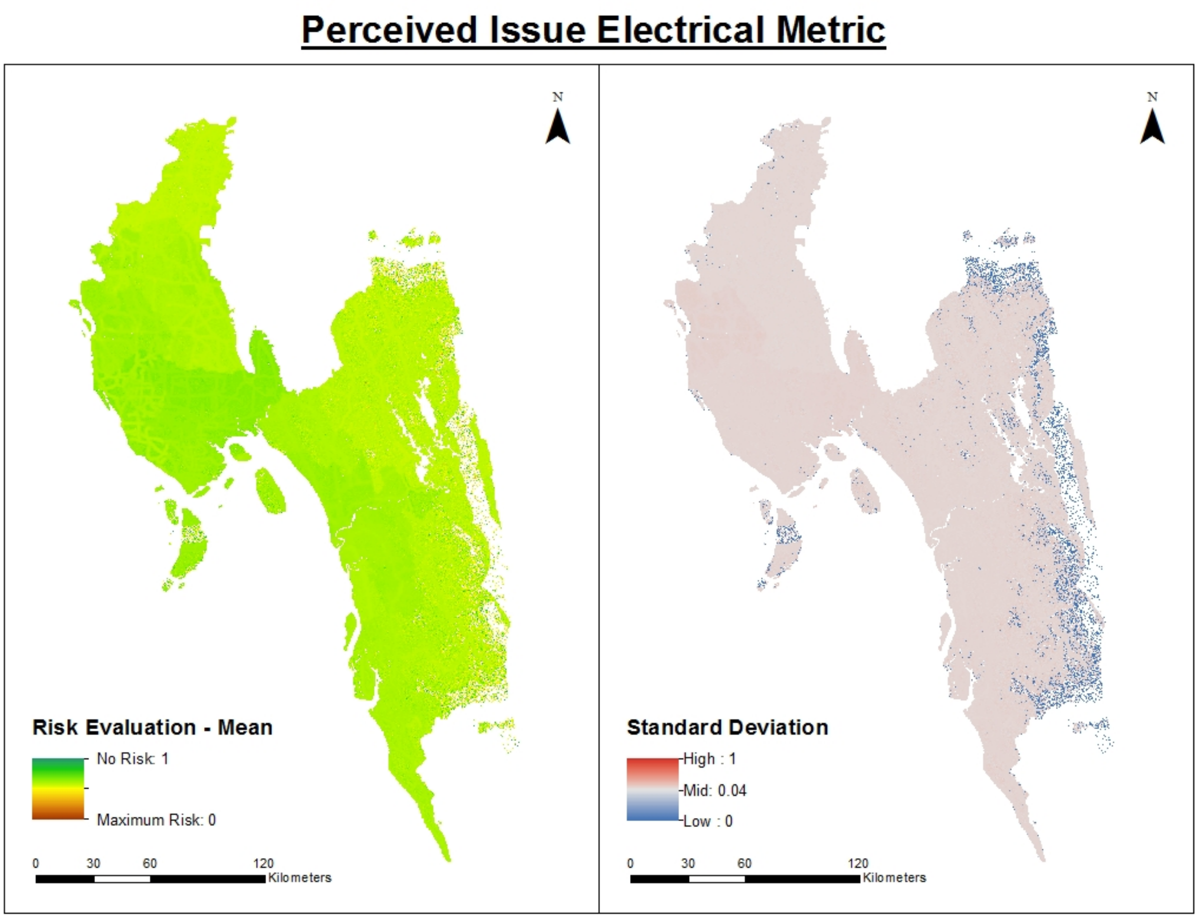
HH Access Electrical Metric



3.3.4.2 Metric: PerceivedIssueElectrical

Indicator:	Energy Deficits
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question "Can you tell me whether access to electricity is more or less serious in your community than the rest of Bangladesh?" Answers of "Not Issue" and given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Less Serious" are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of "More Serious" are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

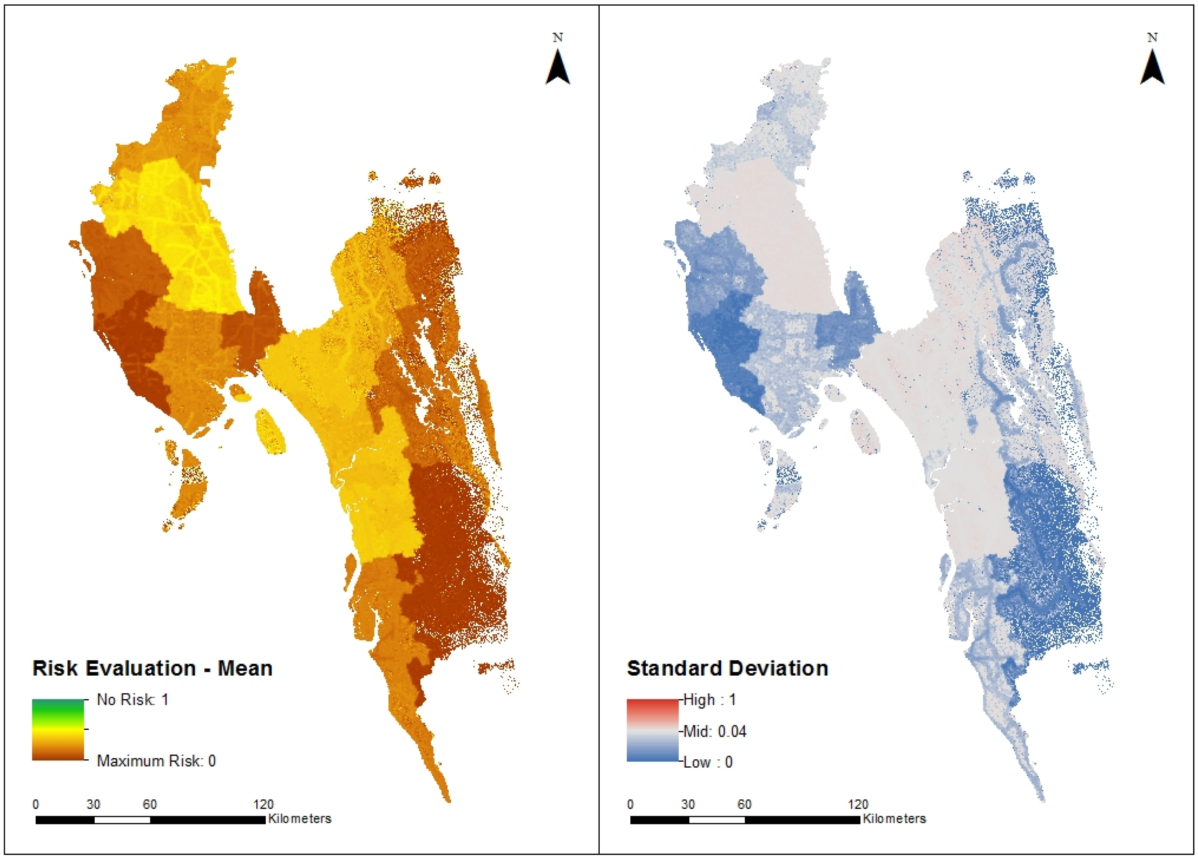


3.3.4.3 Metric: PerceivedEffortElectrical

Indicator:	Energy Deficits
Factor:	Utilities Disruption
Condition:	Service Failure
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve Bangladeshis' access to electricity today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^{0}$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^{2}$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

Perceived Effort Electricity Metric



4 Readiness and Response Inadequacy Condition Overview

This condition focuses on structural systematic capacities to prepare for crises. The related term "readiness" describes the ability to quickly and appropriately respond when required (UNISDR 2009, pg. 21). These factors and indicators would ideally measure phases one through three.

It should be noted that while this indicator name implies that it measures the inadequacy of readiness and response services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Readiness and Response Capacity."

Only the factor Lack of Preparation and Warning currently has any available metric and indicator data.

Factor Weighting Logic

All factors are given both a minimum and maximum weight of 1.0, as it is equally as constraining on the condition as the other factors.

Note: This weighting schema may, and should, be altered once metric data is inserted into the indicators.

Factor (heading number)	Weight Minimum Value	Weight Maximum Value
Lack of Preparation and Warning (4.1)	1.0	1.0
Emergency Response Shortfalls (4.2)	1.0	1.0
Civil/Military Authority Failures (4.3)	1.0	1.0

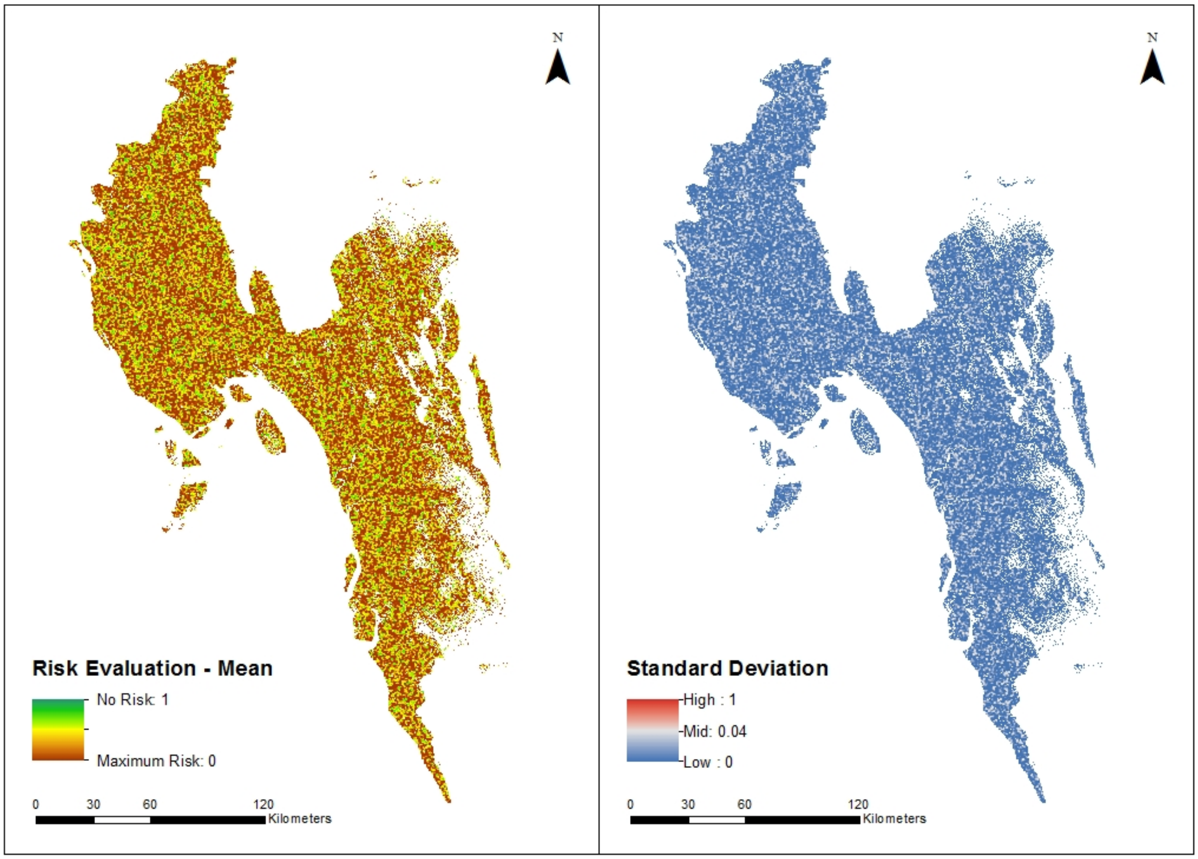
Uncertainty Values

While the factors do encompass multiple aspects of readiness and response failures, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Condition Uncertainty Min: 0.1
Condition Uncertainty Max: 0.3

Example Outcome

Readiness & Response Inadequacy Condition



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

4.1 Lack of Preparation and Warning Factor Overview

The United Nations defines "preparedness" as:

> "The knowledge and capacities developed by governments, professional response and recovery organizations, communities and individuals to effectively anticipate, respond to, and recover from, the impacts of likely, imminent or current hazard events or conditions.
>
> Comment: Preparedness action is carried out within the context of disaster risk management and aims to build the capacities needed to efficiently manage all types of emergencies and achieve orderly transitions from response through to sustained recovery. Preparedness is based on a sound analysis of disaster risks and good linkages with early warning systems, and includes such activities as contingency planning, stockpiling of equipment and supplies, the development of arrangements for coordination, evacuation and public information, and associated training and field exercises. These must be supported by formal institutional, legal and budgetary capacities." (UNISDR 2009, pg 21)

In a similar fashion to the Service Failure factor, indicators and metrics within this factor should account for missing or ineffective elements that would contribute to crisis/disaster preparedness in a phase 0 situation.

It should be noted that while this indicator name implies that it measures the lack of preparation and warning, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Preparation and Warning Capacity."

Indicators for this factor include pre-positioning supplies; hazard plans, personnel training, and exercises; established detection sensors; and dissemination/alert broadcast deficits.

Only the Dissemination/Alert Broadcast Deficits indicator currently has available metric data. Other indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All four indicators within the Substandard Conditions factor are given both a minimum and a maximum value of 0.25, as no one indicator is constraining on the factor. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Pre-positioning Supplies (4.1.1)	0.25	0.25
Hazard Plans, Personnel Training, and Exercises (4.1.2)	0.25	0.25
Established Detection Sensors (4.1.3)	0.25	0.25
Dissemination/Alert Broadcast Deficits (4.1.4)	0.25	0.25

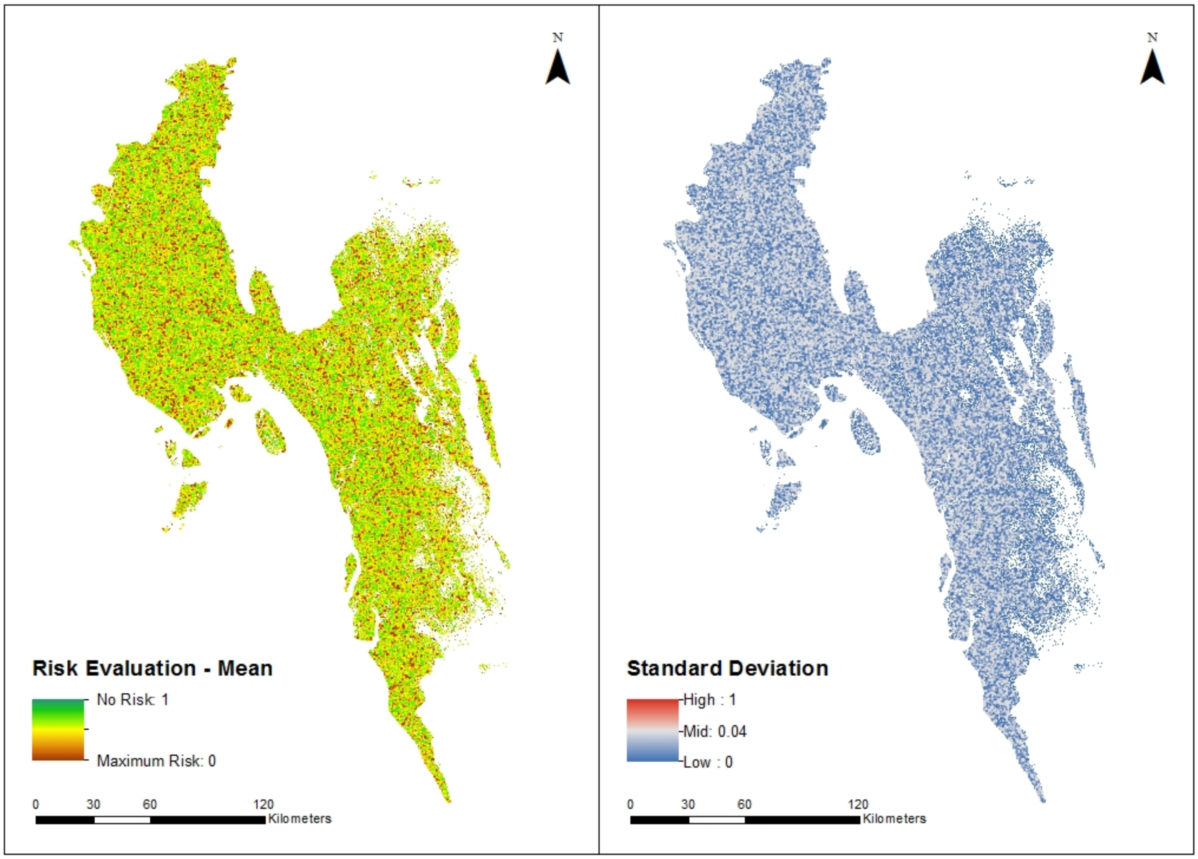
Uncertainty Values

The addition of indicators measuring the institutions behind preparedness and warning dissemination (both their existence and their effectiveness) could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Lack of Preparation and Warning Factor



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

4.1.1 Indicator: Pre-Positioning Supplies

This indicator covers the “stockpiling of equipment and supplies” section of the UNISDR definition of preparedness. The availability, procurement, and distribution of supplies before a disaster should be examined at multiple levels of governance as well as region-active NGO’s, such as UNICEF.

PACOM specifies that metrics should include:

- Availability of government and NGO stock-piled supplies, including:
  - Medical supplies and equipment
  - Generators
  - Water
  - Food
  - Building/Shelter Supplies
- Number of vehicles and personnel available to transport supplies
- Number of personnel available for on-site deployment

<u>Metric Weighting Logic</u>

As there are currently no metrics, this indicator produces a random map.

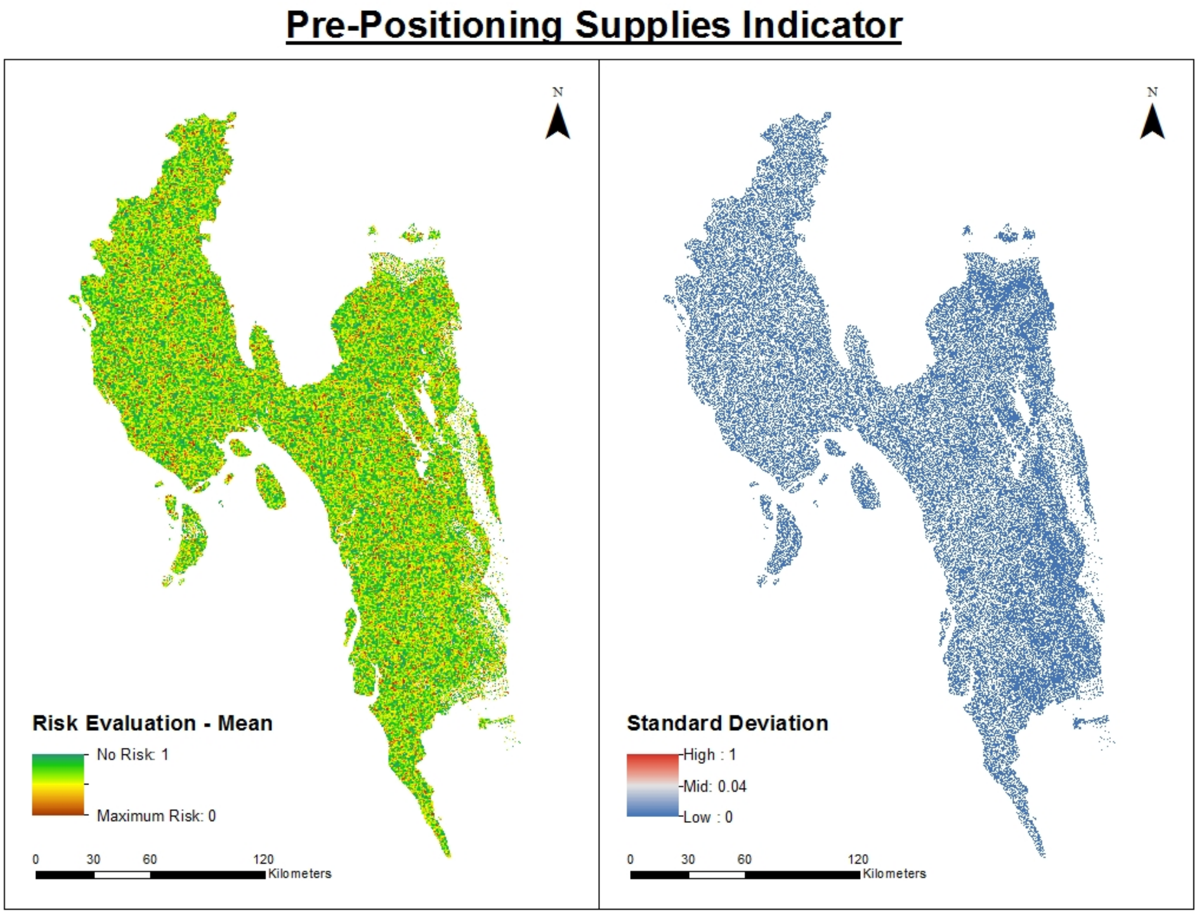
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

<u>Uncertainty Values</u>

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



4.1.2 Indicator: Hazard Plans, Personnel Training, and Exercises

This indicator accounts for the "contingency planning … the development of arrangements for coordination … and associated training and field exercises" portions of the UNISDR definition of preparedness.

PACOM specifies that metrics should include: if there is a government hazard plan established; if there are personnel training programs in place; and number of emergency training exercises conducted every year.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

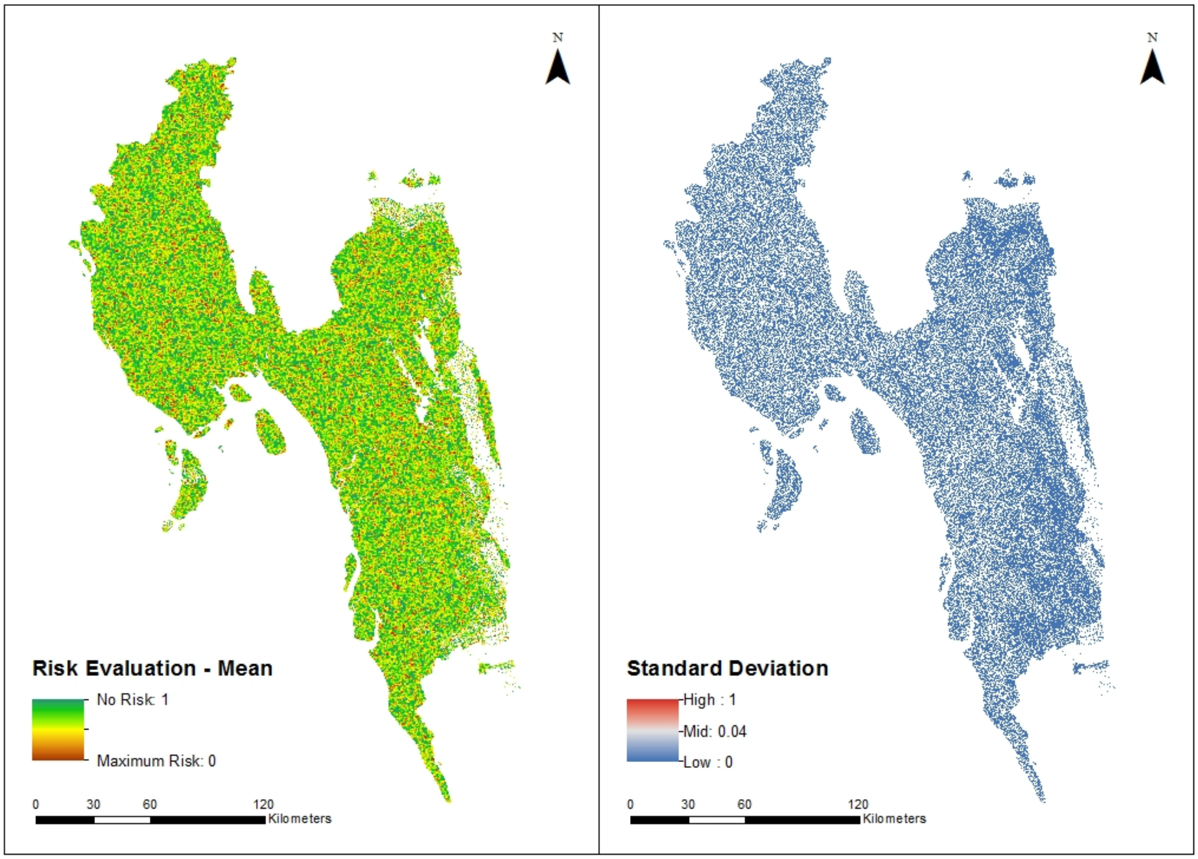
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Hazard Plans, Personnel Training, and Exercises Indicator



4.1.3 Indicator: Established Detection Sensors

This indicator addresses the "early warning systems" aspect of the UNISDR definition of preparedness. According to the PACOM framework developers, metrics should account for a wide variety of detection sensors, categorized under the factors and indicators within the "Natural Hazards" condition:[2]

Geophysical

- Earthquake warning system
- Acoustic monitoring system (landslides)
- Thermal monitoring (volcanoes)
- Remote sensing (volcanoes)

Climatological

- Buoys
- Meteorological and hydrological monitoring system

Ecosystem

- Early protection protocol in place (epidemics/pandemics)
- Percentage of population inoculated (epidemics/pandemics)
- Number of ground-based visual and non-visual systems (wildfires)
- Manned and unmanned aircraft (wildfires)
- Satellites (wildfires)

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

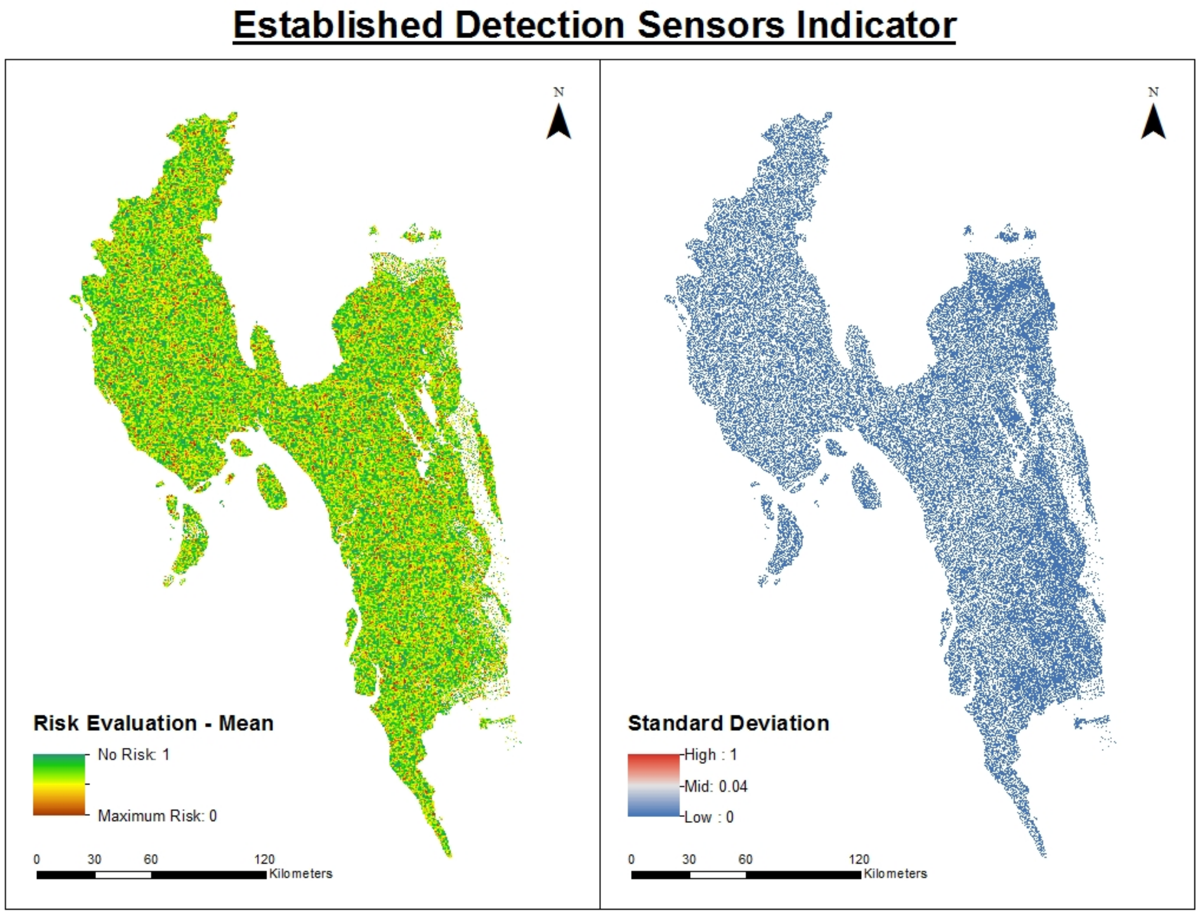
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

[2] Note: The top-down structure and creation process of the PACOM Humanitarian Crisis framework requires that metrics be found to fit into the established indicator/factor/condition framework. As such, the names of indicators are unchangeable. However, the research team believes that this indicator should be included in the "Natural Hazards" condition; in such a way that the detection system is logically correlated with and explicitly represented by its respective hazard.

Example Outcome



4.1.4 Indicator: Dissemination/Alert Broadcast Deficits

This indicator addresses the “evacuation and public information” portion of the UNISDR definition of preparedness. Like the “Lack of Communications Availability” indicator under the “Utilities Disruption” factor, this indicator should account for all forms of media communication.

It should be noted that while this indicator name implies that it measures the lack of dissemination and alert broadcasts, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Capacity of Dissemination/Alert Broadcasts.”

PACOM specifies that metrics should include: establishment of cell phone dissemination; establishment of FM subsidiary communication system (special users); establishment of radio broadcasting system; establishment of public electronic billboards system; number of mobile media TVs in taxis, buses, and subways; establishment of warning calls systems; and number of dedicated emergency phone lines.

Metric Weighting Logic

As with the “Lack of Communications Availability” indicator, each of these metrics are weighted based on the communication mediums’ ability to quickly and accurately spread information, especially when that information is time-sensitive i.e., during a crisis. As such, radio and television listening/watching frequency are weighted higher than newspaper reading. It is also important to take disabilities into account, as being unable to see, hear, and/or read a warning significantly decreases its effectiveness.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
NewspaperReadFrequency (4.1.4.1)	0.25	0.5
RadioListenFrequency (4.1.4.2)	0.5	1.0
TVWatchFrequency (4.1.4.3)	0.5	1.0
ReadingAbility (4.1.4.4)	0.125	0.5
TypeDisability (4.1.4.5)	0.125	0.5

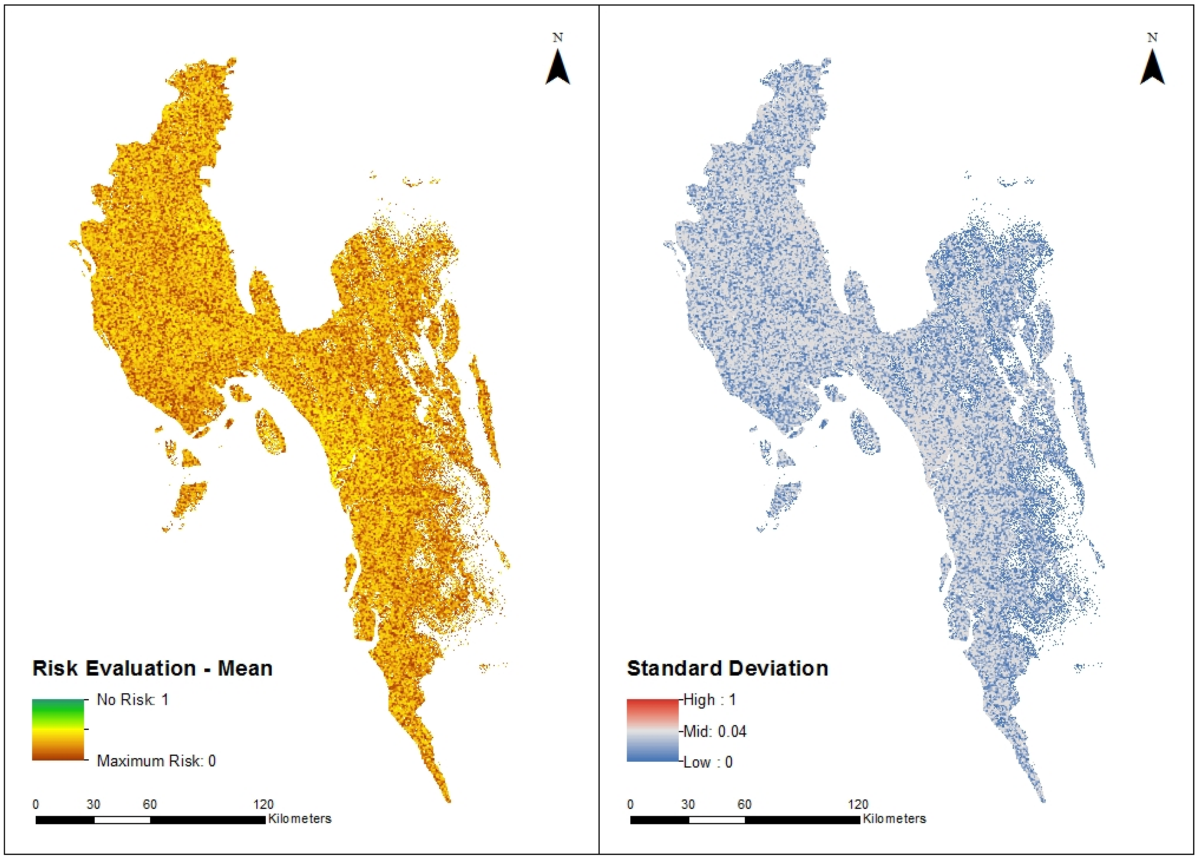
Uncertainty Values

The addition of metrics detailing the capacity of larger communication broadcasting systems, as described above, could decrease the overall uncertainty.

Indicator Uncertainty Min: 0.6
Indicator Uncertainty Max: 0.8

Example Outcome

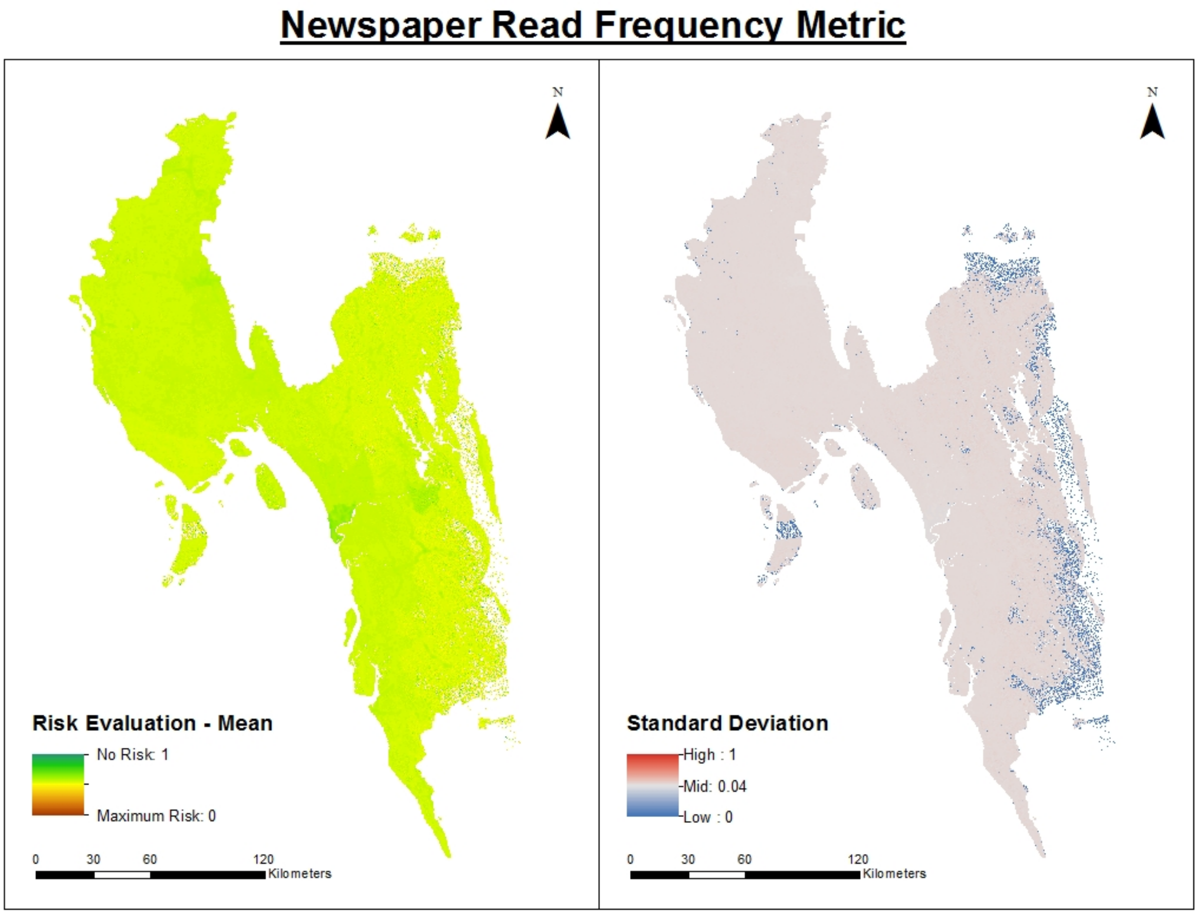
Dissemination/Alert Broadcast Deficits Indicator



4.1.4.1 Metric: NewspaperReadFrequency

Indicator:	Dissemination/Alert Broadcast Deficits
Factor:	Lack of Preparation and Warning
Condition:	Readiness and Response Inadequacy
Metric Assigned Values:	At least once a week (min: 1.0, max: 1.0) Less than once a week (min: 0.25, max: 0.6) Not at all (min: 0.125, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you read a newspaper or magazine at least once a week?” from the men’s and women’s portions of the DHS survey. Answers of “at least once a week” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “less than once a week” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.6 (minimal risk). Answers of “Not at all” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

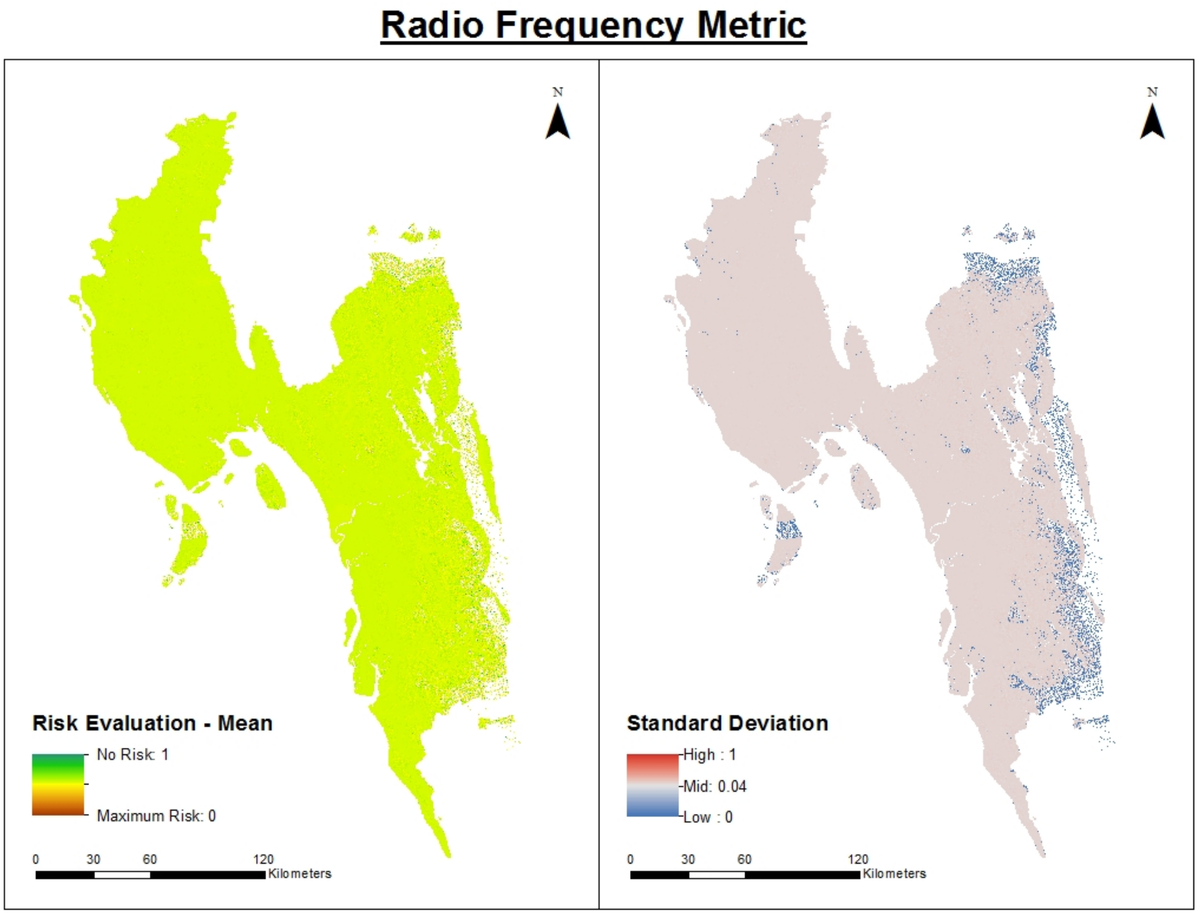
Example Realization Metric Map



4.1.4.2 Metric: RadioListenFrequency

Indicator:	Dissemination/Alert Broadcast Deficits
Factor:	Lack of Preparation and Warning
Condition:	Readiness and Response Inadequacy
Metric Assigned Values:	At least once a week (min: 1.0, max: 1.0) Less than once a week (min: 0.25, max: 0.6) Not at all (min: 0.125, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you listen to the radio at least once a week?” from the men’s and women’s portions of the DHS survey. Answers of “at least once a week” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “less than once a week” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.6 (minimal risk). Answers of “Not at all” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk. This metric is weighted higher because Radio and Television are more responsive and accessible for disseminating alerts than newspapers.

Example Realization Metric Map

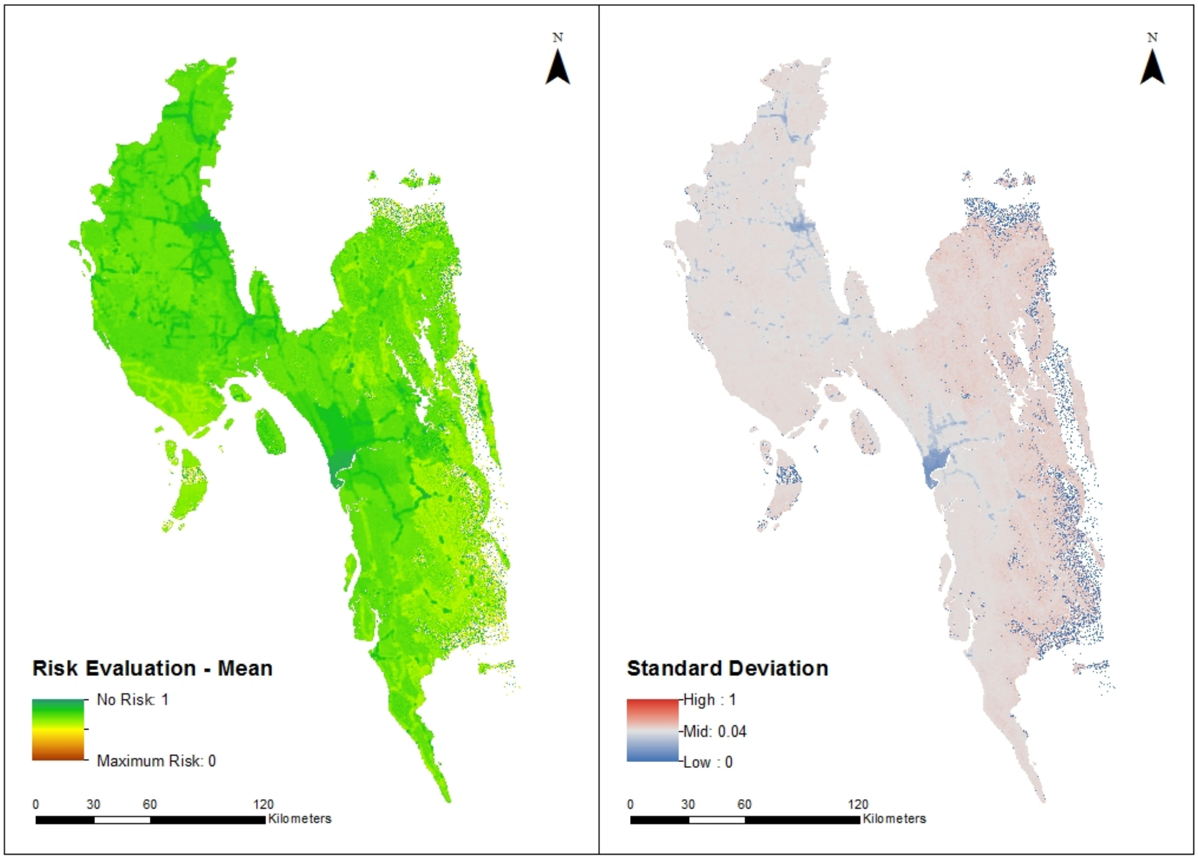


4.1.4.3 Metric: TVWatchFrequency

Indicator:	Dissemination/Alert Broadcast Deficits
Factor:	Lack of Preparation and Warning
Condition:	Readiness and Response Inadequacy
Metric Assigned Values:	At least once a week (min: 1.0, max: 1.0) Less than once a week (min: 0.25, max: 0.6) Not at all (min: 0.125, max: 0.5)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Do you watch TV at least once a week?” from the men’s and women’s portions of the DHS survey. Answers of “at least once a week” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “less than once a week” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.6 (minimal risk). Answers of “Not at all” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk. This metric is weighted higher because Radio and Television are more responsive and accessible for disseminating alerts than newspapers.

Example Realization Metric Map

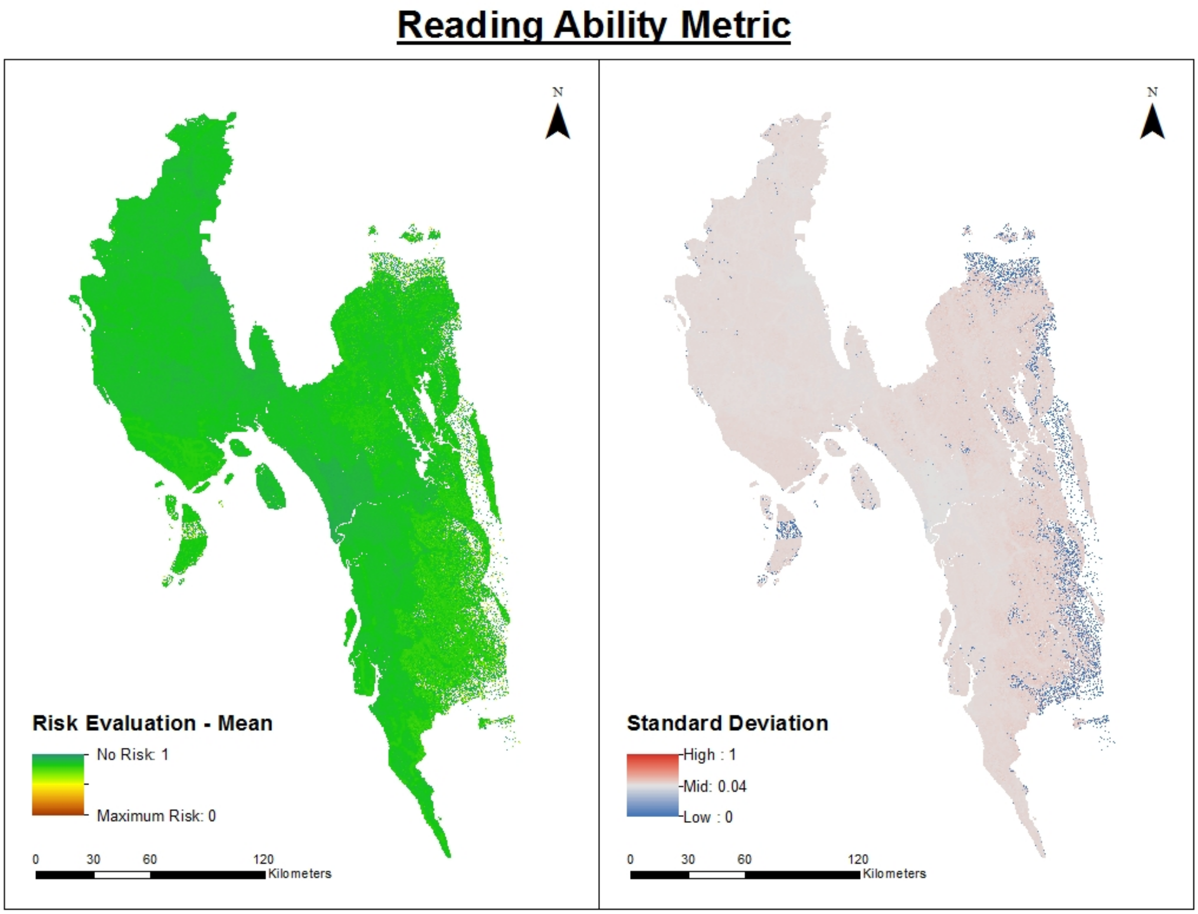
TV Watch Frequency Metric



4.1.4.4 Metric: ReadingAbility

Indicator:	Dissemination/Alert Broadcast Deficits
Factor:	Lack of Preparation and Warning
Condition:	Readiness and Response Inadequacy
Metric Assigned Values:	Cannot read at all (min: 0.125, max: 0.9) Able to read some (min: 0.5, max: 0.9) Able to read all (min: 1.0, max: 1.0) Different Language (no card with required language) (min: 0.125, max: 0.9) Blind/Visually Impaired (min: 0.125, max: 0.9)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of surveyor coding of responses to asking survey takers to read a card with a sentence on it. If the respondent cannot read, cannot read the provided language, or are visually impaired, a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.9 (minimal risk) is given. If the respondent is able to read some of the sentence, a minimum value of 0.5 (slight risk, $½^1$) and a maximum value of 0.9 is given. If the respondent can read all of the card, both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Maps will range from high risk to no risk. There is a large gap between the minimum and maximum value for “cannot read at all,” “different language,” and “blind/visually impaired” because reading one sentence on a card does not necessarily indicate actual literacy rates or the overall ability of the respondent to read.

Example Realization Metric Map

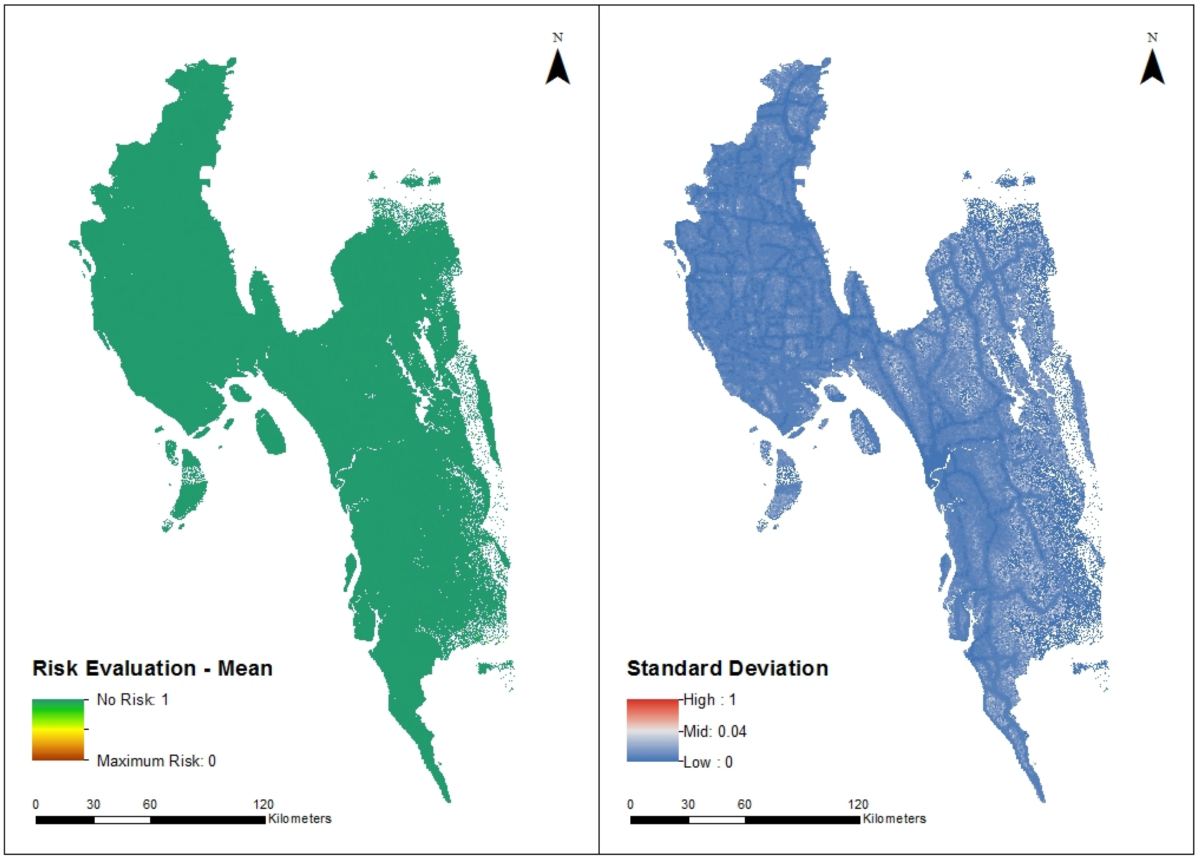


4.1.4.5 Metric: TypeDisability

Indicator:	Dissemination/Alert Broadcast Deficits
Factor:	Lack of Preparation and Warning
Condition:	Readiness and Response Inadequacy
Metric Assigned Values:	None (min: 1.0, max: 1.0) Speech (min: 0.125, max: 1.0) Vision (min: 0.125, max: 0.9) Hearing (min: 0.125, max: 0.9) Physical (min: 0.125, max: 1.0) Mental (min: 0.125, max: 1.0) Autistic (min: 0.125, max: 1.0)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of the surveyor asking the respondent is there anybody in this household who is having trouble in speaking, seeing, listening, physical or mental. According to Disabled Welfare Act 2010 person who is by born or cause of others physically unable or completely/partly handicapped or mentally retarded is considered as Disabled. In the IPUMS census, as per recommendation of the Washington Group, disabled has been categorized into six categories. Answers of “None” (no disability) are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Speech,” “Vision,” “Hearing,” “Physical,” “Mental,” and “Autistic” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.9 (minimal risk). Maps will range from high risk to no risk.

Example Realization Metric Map

Type Disability Metric



4.2 Emergency Response Shortfalls Factor Overview

This factor concerns the “response” phase of emergency and disaster planning, which occurs immediately after the disaster. Metrics and indicators should take into consideration both large-scale natural hazard response (i.e., earthquake, flood) and smaller-scale emergencies (i.e., apartment or factory fire), and account for personnel, equipment, and institutional shortfalls.

It should be noted that while this indicator name implies that it measures the inadequacy of emergency response services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Emergency Response Capacity.”

None of these indicators are available from Phase Zero Assessment of Urban Security Threats research, as there is no metric data for any of them. Some indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All four indicators within the factor are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator’s risk level.

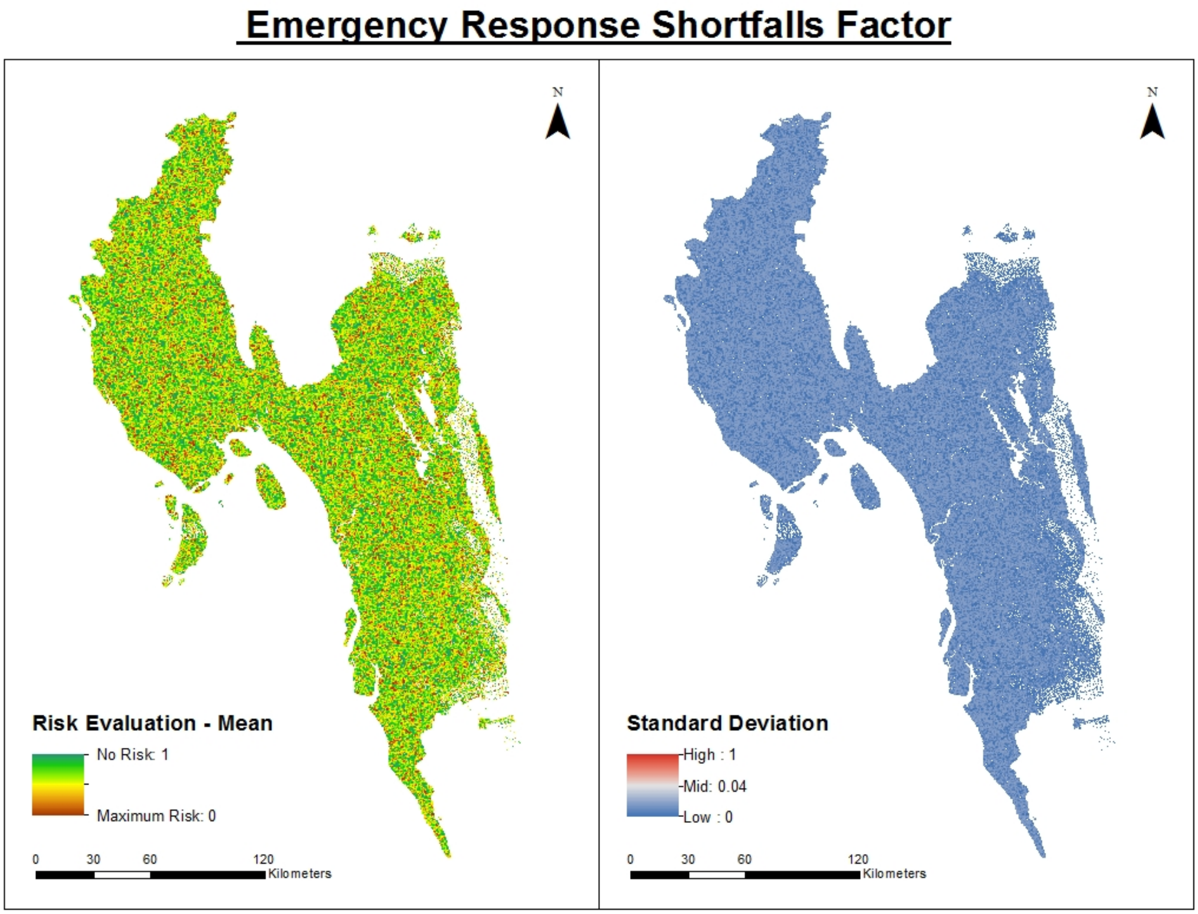
Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Inadequate Fire and EMS Services (4.2.1)	0.25	0.25
Extraction and Debris Removal (4.2.2)	0.25	0.25
Inadequate Search and Rescue (4.2.3)	0.25	0.25
Insufficient Lift/Evacuation, Transportation Capacity (4.2.4)	0.25	0.25

Uncertainty Values

The addition of indicators measuring institutional practices and regulations for emergency response, both in terms of local governmental organizations and NGOs, could further reduce the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome



4.2.1 Indicator: Inadequate Fire and EMS Services

This indicator accounts for local fire and EMS (emergency medical services) service capacity shortfalls. It should be noted that while this indicator name implies that it measures the inadequacy of fire and EMS services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Access to Fire and EMS Services."

PACOM specifies that metrics should include: percentage of fire-fighting equipment available (compare with historical data); percentage of fire-fighting personnel available; perception of adequacy of fire services; percentage of EMS equipment and personnel available; and perception of adequacy of EMS services.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

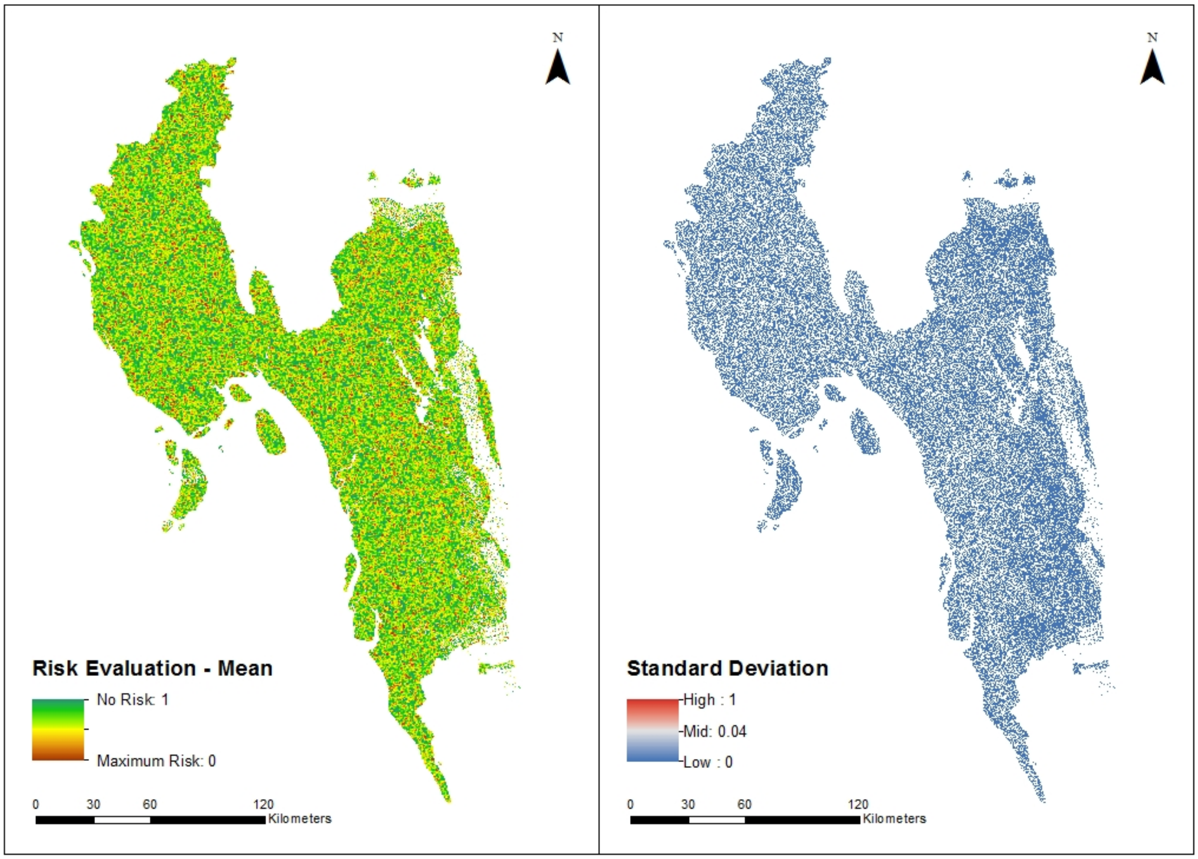
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Inadequate Fire and EMS Services Indicator



4.2.2 Indicator: Extraction and Debris Removal

Clearing away debris generated by crises is a critical part of relief and recovery efforts (UNDP 2013). But while debris removal should be completed as possible, proper disposal must be assured, as there is potential for debris to be used as post-disaster fuel, shelter, etc. (CARE International). As such, effective debris management in the response phase of disaster planning is crucial.

PACOM specifies that metrics should include: number of extraction and debris removal equipment available (compare with historical data); number of personnel available for extraction and debris removal; and perception of adequacy of extraction and debris removal.

Metric Weighting Logic

Metric (page number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

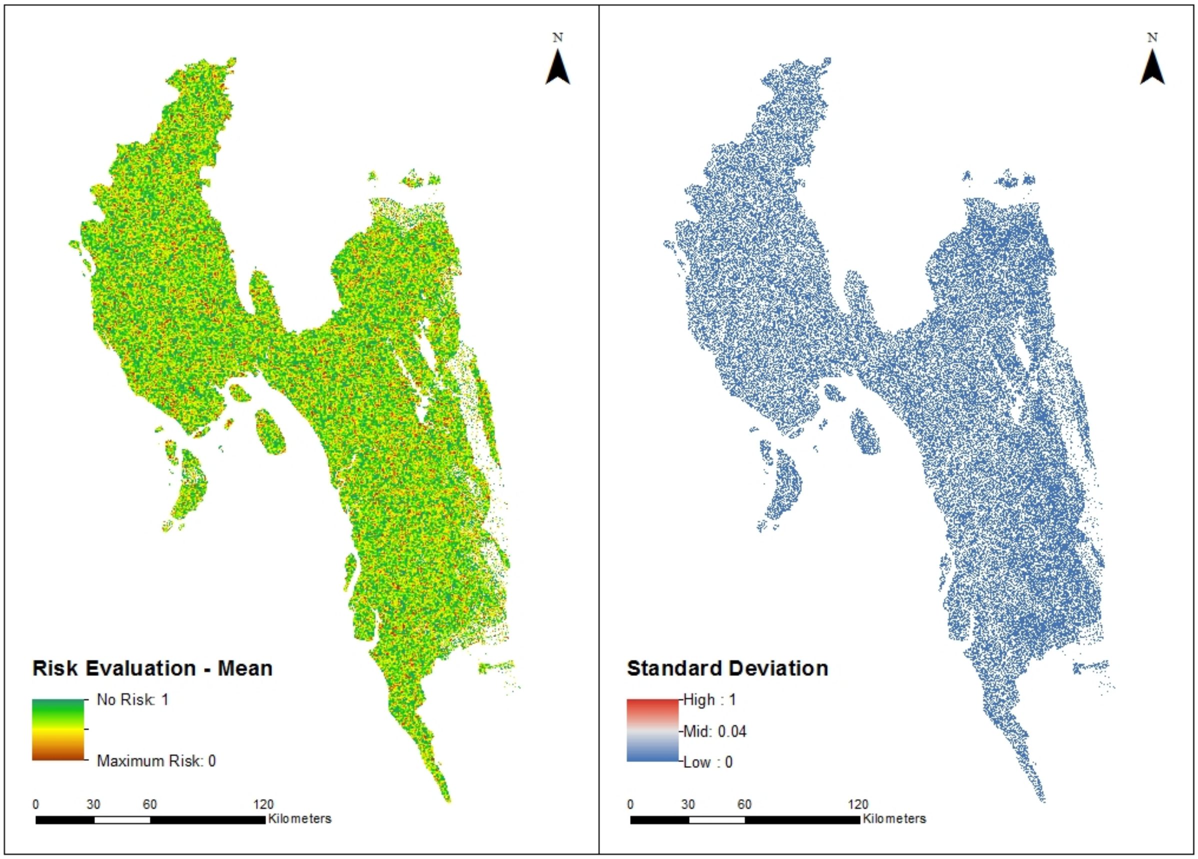
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Extraction and Debris Removal Indicator



References

CARE International and ProAct Network. Quick Guide: Post-Disaster Debris Management. Accessed at https://www.humanitarianresponse.info/system/files/documents/files/Quick%20guide%20post%20disaster%20debris%20management.pdf on 17 Jan 2017.

United Nations Development Programme (UNDP) (2013). Guidance Note – Debris Management. Accessed at http://www.undp.org/content/dam/undp/library/crisis%20prevention/SignatureProductGuidanceNoteDebrisManagement11012013v1.pdf on 17 Jan 2017.

4.2.3 Indicator: Inadequate Search and Rescue

Urban search and rescue (USAR or US&R) "involves the location, rescue (extrication), and initial medical stabilization of individuals trapped in confined spaces" following a disaster (FEMA 2016). According to the UNHCR, most USAR teams are multi-disciplinary and include personnel from police, fire and emergency medical services; and most USAR responders have basic training in structural collapse and the dangers associated with live wires, broken gas lines, and other hazards (UNHCR 2017).

USAR missions consist of three parts: assessment, search, and rescue (UNHCR 2017). The latter may involve triage and/or the use of equipment to remove victims.

It should be noted that while this indicator name implies that it measures the inadequacy of search and rescue services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Provision of Search and Rescue Services."

PACOM specifies that metrics should include: number of personnel available for search and rescue (compare with historical data); number of emergency vehicles available for search and rescue; and perception of adequacy of search and rescue.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

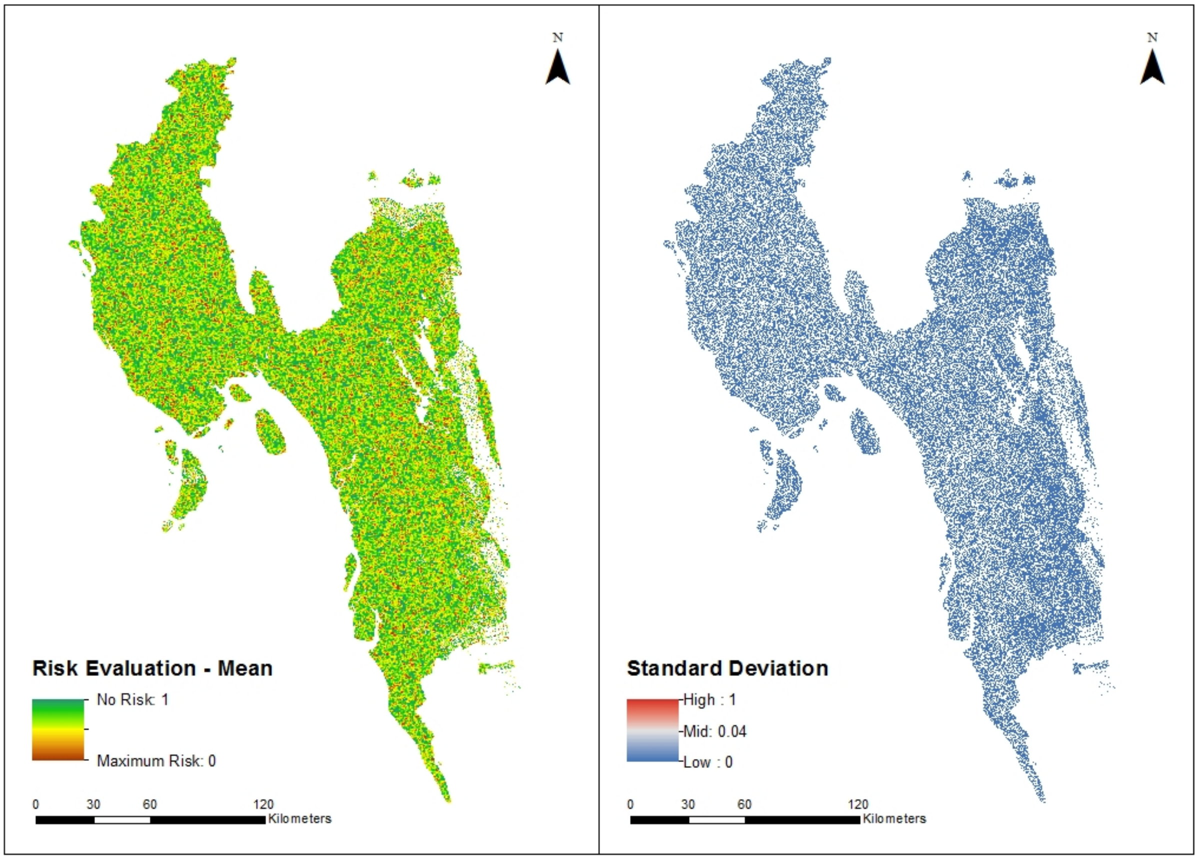
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Inadequate Search and Rescue Indicator



References

Federal Emergency Management Agency (FEMA) (2016). "Urban Search and Rescue." 24 Jun 2016. Accessed at https://www.fema.gov/urban-search-rescue on 17 Jan 2017.

United Nations High Commissioner for Refugees (UNHCR) (2017). "Search and rescue response and coordination (natural disasters)." Accessed at https://emergency.unhcr.org/entry/51487/search-and-rescue-response-and-coordination-natural-disasters on 17 Jan 2017.

4.2.5 Indicator: Insufficient Lift/Evacuation, Transportation Capacity

This indicator focuses on the capabilities of existing response services to lift, evacuate, and/or transport disaster survivors in the immediate aftermath. Obviously, there can be overlap with the previous indicators, specifically that of “Inadequate Search and Rescue”; but metrics within this indicator should attempt to explicitly measure vehicles and personnel used for removing people out of the disaster area.

It should be noted that while this indicator name implies that it measures the inadequacy of evacuation and transport services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Evacuation and Transportation Capacity.”

PACOM specifies that metrics should include: number of emergency vehicles and personnel available for lift/evacuation/transportation (compare with historical data); and perception of adequacy of lift/evacuation/transportation capacity.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

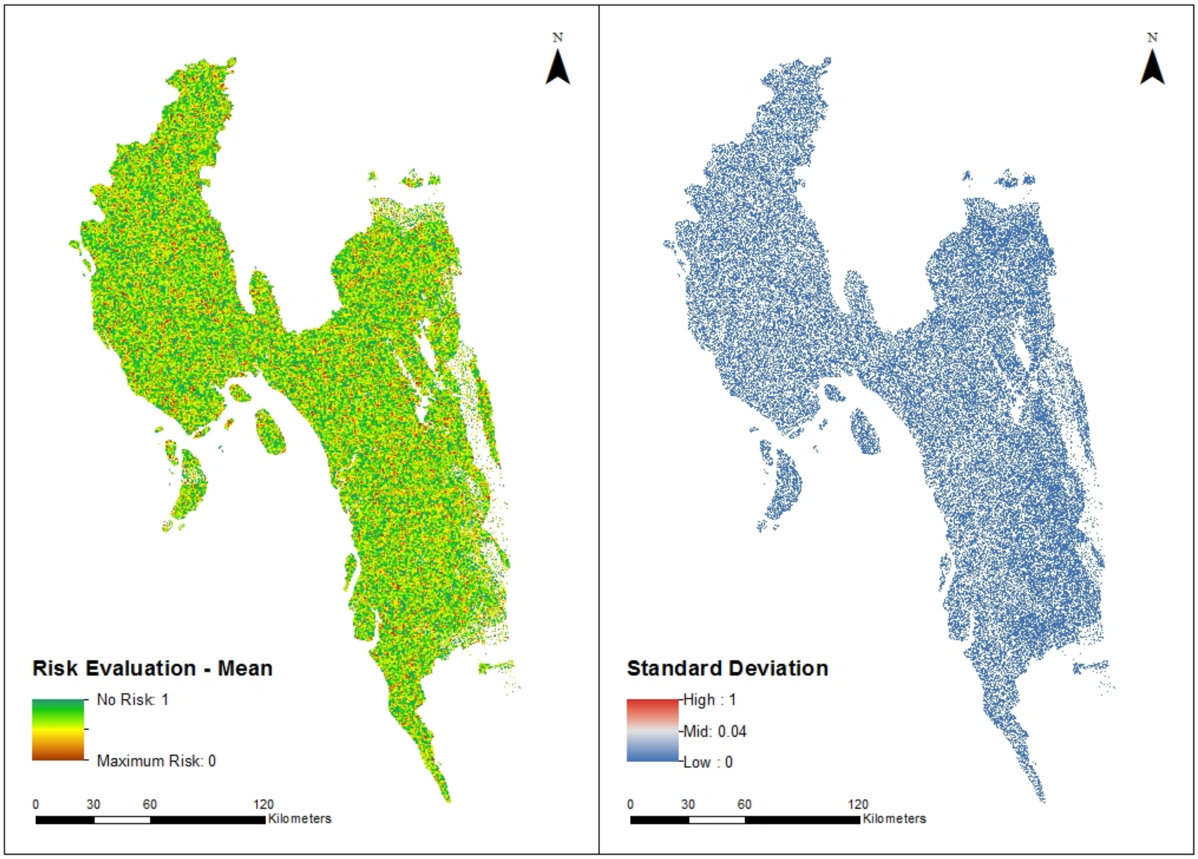
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Insufficient Lift/Evacuation, Transportation Capacity Indicator



4.3 Civil/Military Authority Failures Factor Overview

This factor measures the effectiveness of civil (government at all levels) and military infrastructure to manage and respond to humanitarian crises. The emphasis within this factor should be on "complex emergencies," defined as "a humanitarian crisis in a country, region or society where there is a total or considerable breakdown of authority resulting from internal or external conflict, and which requires an international response that goes beyond the mandate or capacity of any single agency and/or the ongoing UN country programme" (UNHCR 2001).

None of these indicators are available from Phase Zero Assessment of Urban Security Threats research, as there is no metric data for any of them. Some indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All four indicators within the factor are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading indicator)	Weight Minimum Value	Weight Maximum Value
(Lack of) Established/Delegated Authority (4.3.1)	0.25	0.25
Insufficient Interoperable Communications (4.3.2)	0.25	0.25
Lack of Technical/Functional Response Competency (4.3.3)	0.25	0.25
Breakdown of Situational Awareness (4.3.4)	0.25	0.25

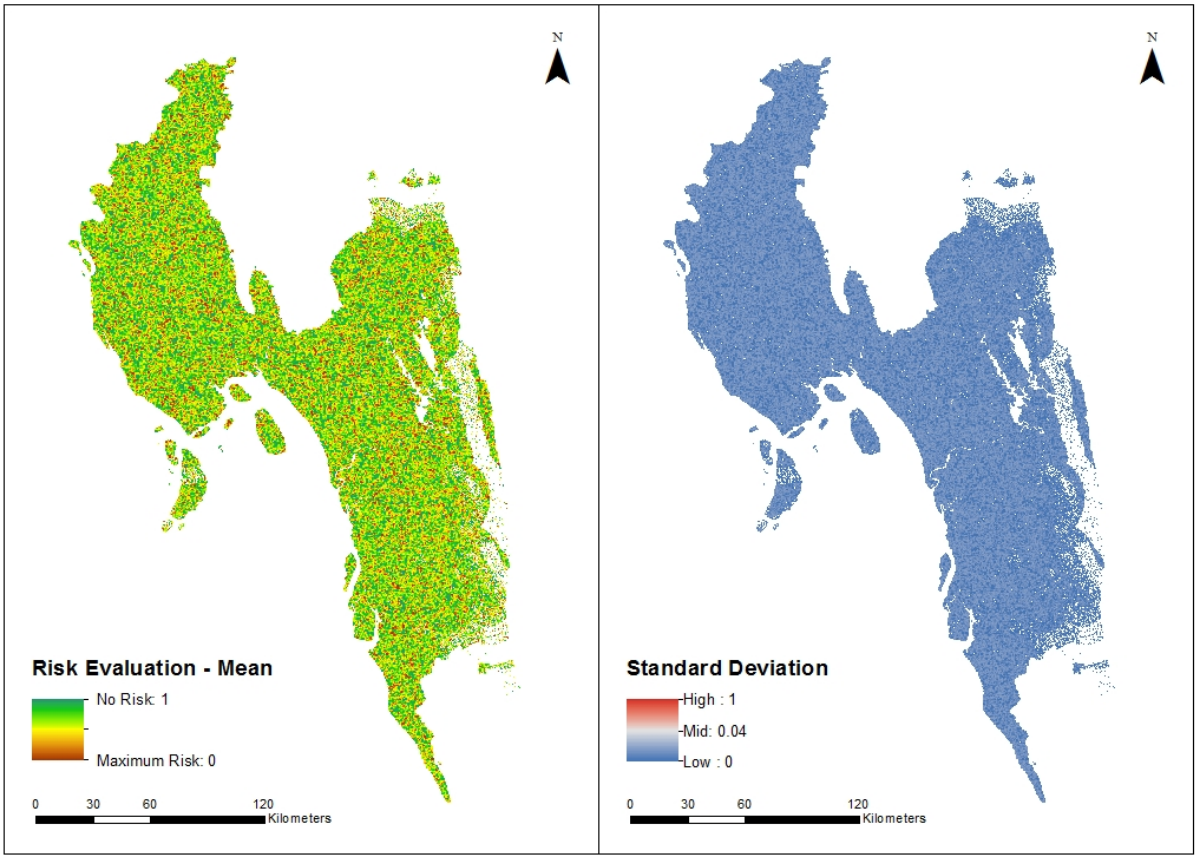
Uncertainty Values

The addition of indicators measuring past trend of civil and military response to disasters and crises could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Civil/Military Authority Failures Factor



References

United Nations High Commissioner for Refugees (UNHCR) (2001). "Coordination in Complex Emergencies." 1 Sept 2001. Accessed at http://www.unhcr.org/en-us/partners/partners/3ba88e7c6/coordination-complex-emergencies.html on 30 Jan 2017.

4.3.1 Indicator: (Lack of) Established/Delegated Authority

This indicator measures the existence of emergency-related government departments and leadership. It should be noted that while this indicator name implies that it measures the non-existence of authority structures, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Presence of Established/Delegated Authority."

PACOM specifies that metrics should include: establishment of government emergency departments; and appointment of emergency personnel department heads.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

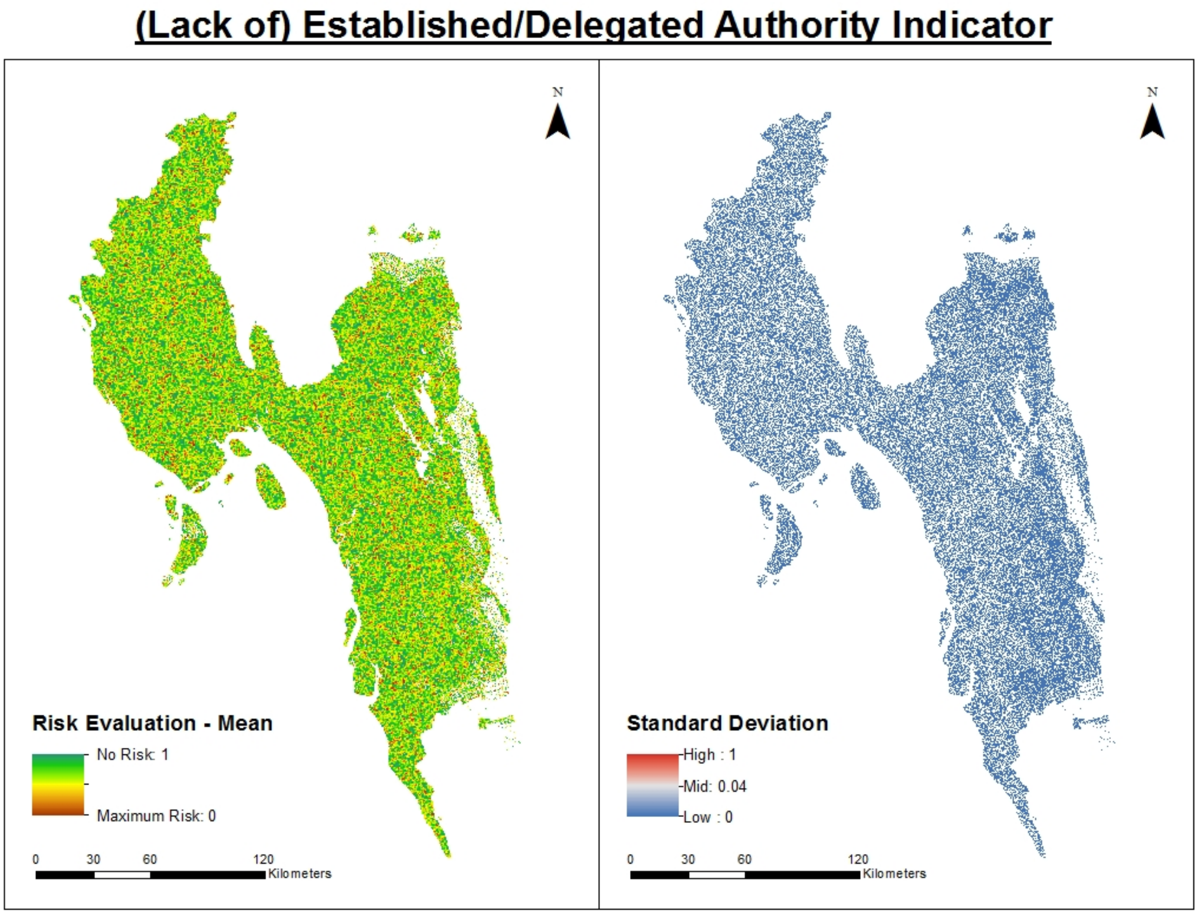
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



4.3.2 Indicator: Insufficient Interoperable Communications

Unlike previous indicators focusing on communication and information dissemination, this indicator measures the function of communications networks among civil and military agencies. It should be noted that while this indicator name implies that it measures the inadequacy of interoperable communication services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. “CIV-MIL Interoperable Communications” would be a better name for this indicator.

PACOM specifies that metrics should include: establishment of clear communication guidelines; historical use of communication between responsible departments; and frequency of communication exchange.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

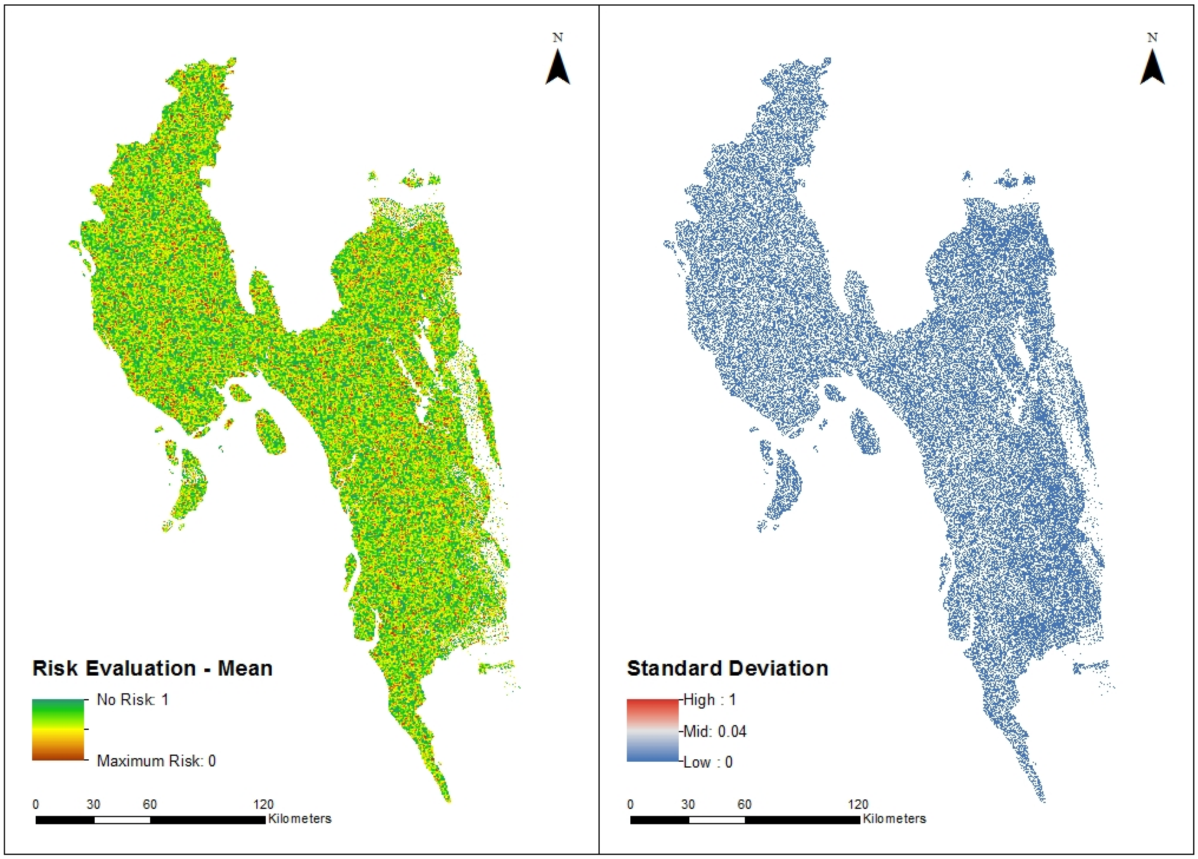
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Insufficient Interoperable Communications Indicator



4.3.3 Indicator: Lack of Technical/Functional Response Competency

This indicator takes into account the quantitative ability of a region to cope with complex emergencies. It should be noted that while this indicator name implies that it measures the inadequacy of technical response services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. Technical and Functional Response Competency would be a better indicator name.

PACOM specifies that metrics should include: number of trained personnel, and number of national emergency centers.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

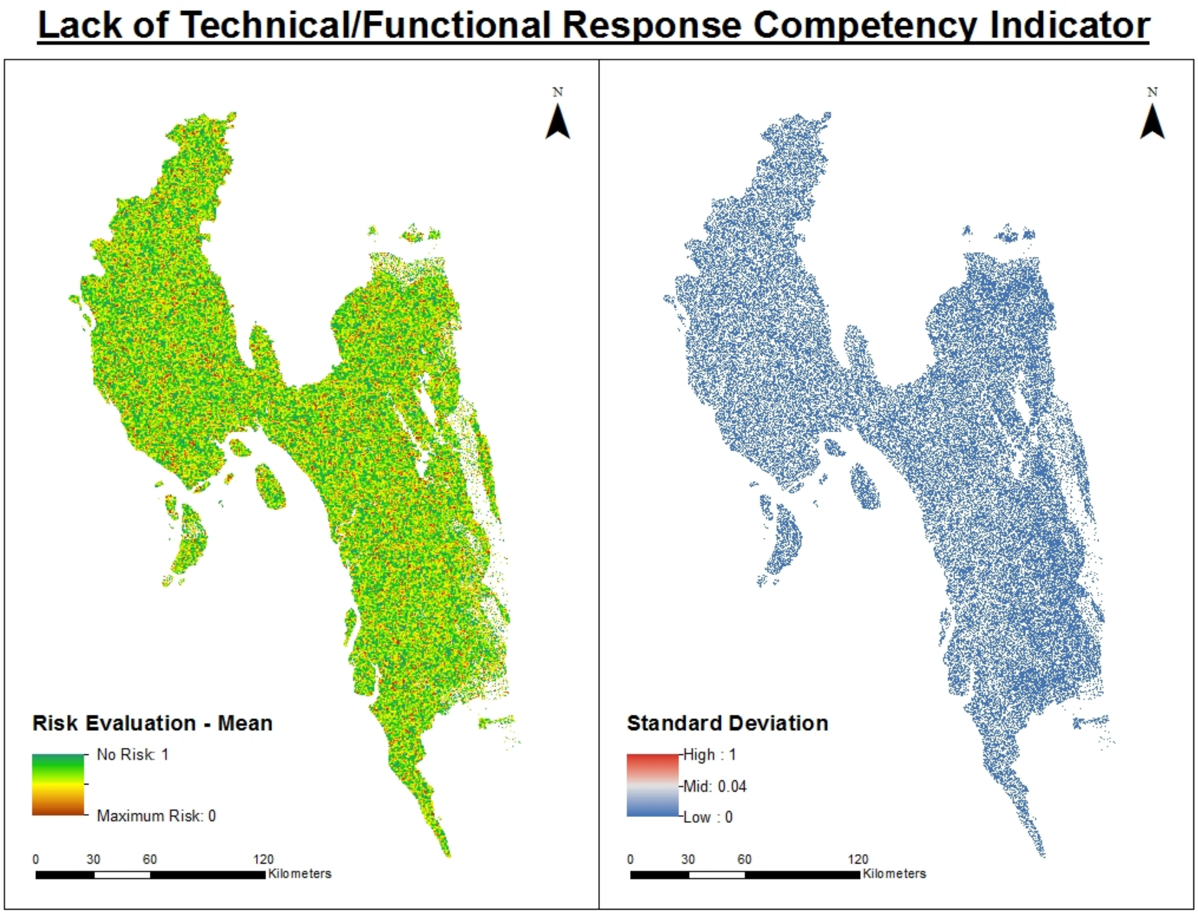
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome



4.3.4 Indicator: Breakdown of Situational Awareness

Situational awareness is seen as a state of understanding a situation as a whole; i.e., knowing what is going on around you in relation to the goals and decisions that need to be made (Endsley 2000). Achieving situational awareness relies heavily on accurate and efficient information exchange, which is what this particular indicator measures.

It should be noted that while this indicator name implies that it measures the lack of situational awareness, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Capacity for Situational Awareness."

PACOM specifies that metrics should include: frequency of information exchange; and adequacy of information exchange. Metrics should include situational awareness within the partner nation as well as international situational awareness with ASEAN and USG.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

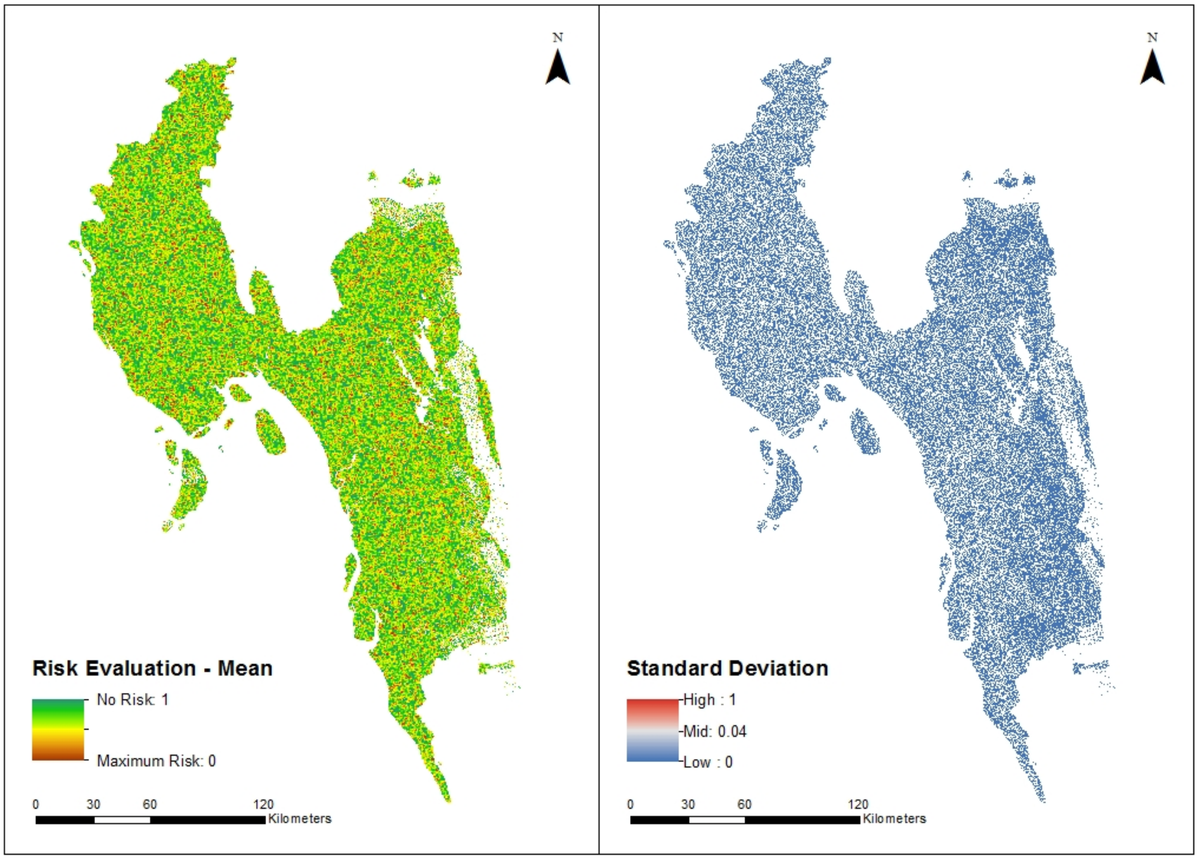
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Breakdown of Situational Awareness Indicator



References

Endsley, Mica (2000). "Theoretical underpinnings of situation awareness: A critical review". In: Situation Awareness: Analysis and Measurement. Routledge, pp. 3–32.

5 Resilience Deficiencies Condition Overview

According to the United Nations, “resilience” is defined as:

> *“The ability of a system, community or society exposed to hazards to resist, absorb, accommodate to and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions.*
>
> *Comment: Resilience means the ability to “resile from” or “spring back from” a shock. The resilience of a community in respect to potential hazard events is determined by the degree to which the community has the necessary resources and is capable of organizing itself both prior to and during times of need.”* (UNISDR 2009, pg 8)

This condition accounts for the existence or lack of those resources and capabilities at both the preventative and response stages, but emphasizes the post-disaster stage (phases 4 and 5). The factors within this condition focus on three key aspects of resilience: financial investment (Insufficient Investment/Assistance), commerce and trade (Malfunctioning Commerce/Services), and infrastructure (Inadequate Construction/Reconstruction).

It should be noted that while the name implies that it measures the lack of resilience, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Resilience Capacities.”

All of the factors currently have available metric and indicator data.

Factor Weighting Logic

All factors are given both a minimum and maximum weight of 0.333, as they are contributing equally with the condition risk potentially higher than an individual factor’s risk level.

Factor (heading number)	Weight Minimum Value	Weight Maximum Value
Insufficient Investment/Assistance (5.1)	0.333	0.333
Malfunctioning Commerce/Services (5.2)	0.333	0.333
Inadequate Construction/Reconstruction (5.3)	0.333	0.333

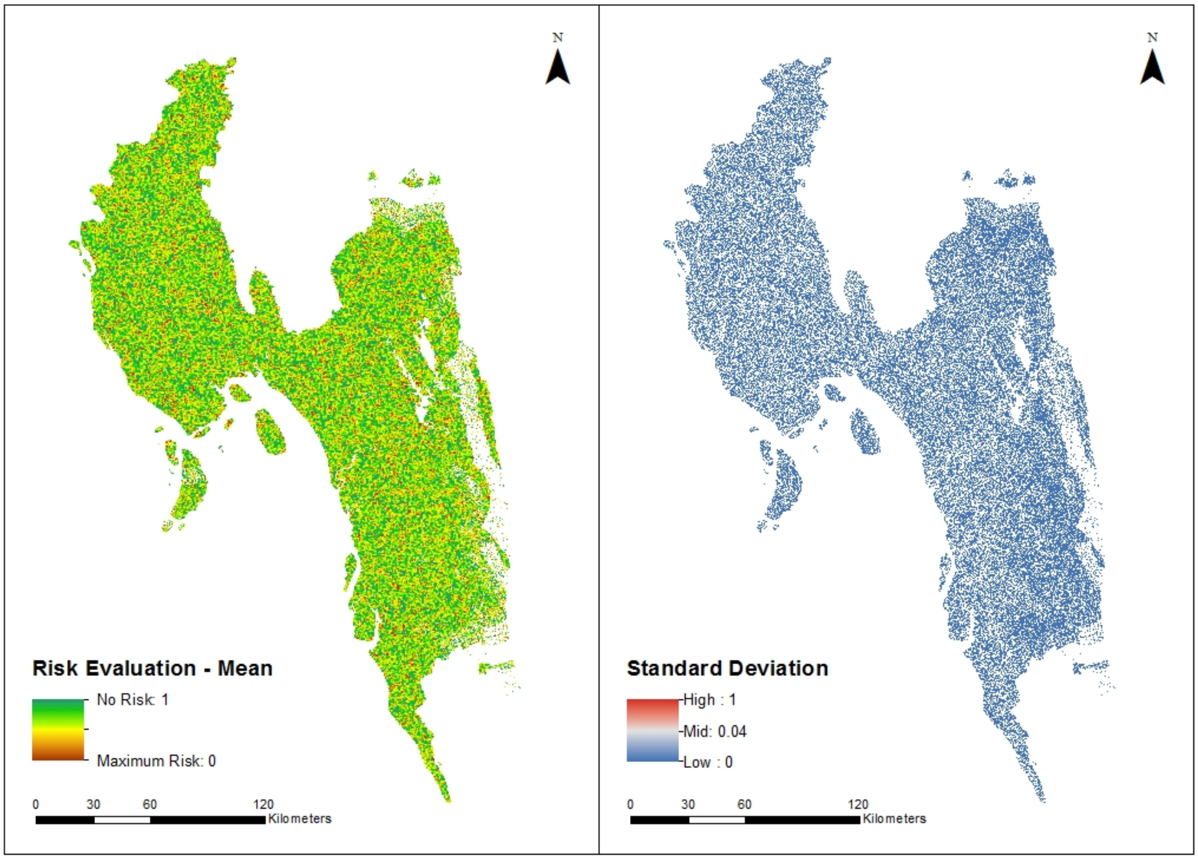
Uncertainty Values

While the factors do encompass multiple aspects of resilience failures, these low uncertainty values reflect the potential for additional factors to be added to increase accuracy.

Condition Uncertainty Min: 0.1
Condition Uncertainty Max: 0.3

Example Outcome

Resilience Deficiencies Condition



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

5.1 Insufficient Investment/Assistance Factor Overview

This factor emphasizes the financial aspects of resilience, both in terms of preparation and response. The indicators encompass investment at all levels – from the personal (i.e., individual life and health insurance policies) to the international (i.e., humanitarian aid from NGOs).

A report from the New Economics Foundation (2015) identified seven key factors that influence financial system resilience:

1. **Diversity** – healthy systems have a diversity of actors who occupy a variety of different niches in the system and employ different strategies to thrive.
2. **Interconnectedness and network structure** – the way financial institutions are connected to each other affects the way a crisis spreads.
3. **Financial system size** – financial systems that are large relative to their domestic economy pose a greater threat to economic stability.
4. **Asset composition** – where banks invest matters, with some types of financial assets particularly prone to boom and bust.
5. **Liability composition** – the way banks are funded also matters: short-term borrowing from other banks are more fickle and volatile than customer deposits.
6. **Complexity and transparency** – the growing complexity associated with securitization and the 'slicing and dicing' of loans can spread risks around the financial network and make those risks harder to judge, especially during a crisis.
7. **Leverage** - the ratio between banks' assets and their capital; this has been a key focus of post-crisis financial regulation.

Except for the Decreased Foreign Investment Based on Assessed Risk indicator, all of the indicators currently have available metric data.

Indicator Weighting Logic

All four indicators within the Substandard Conditions factor are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Insurance/Reinsurance (5.1.1)	0.25	0.25
Insufficient Loans/Debt Forbearance and Cancellation (5.1.2)	0.25	0.25
Foreign/Federal Relief/Grants/Social Funds (5.1.3)	0.25	0.25
Decreased Foreign Investment Based on Assessed Risk (5.1.4)	0.25	0.25

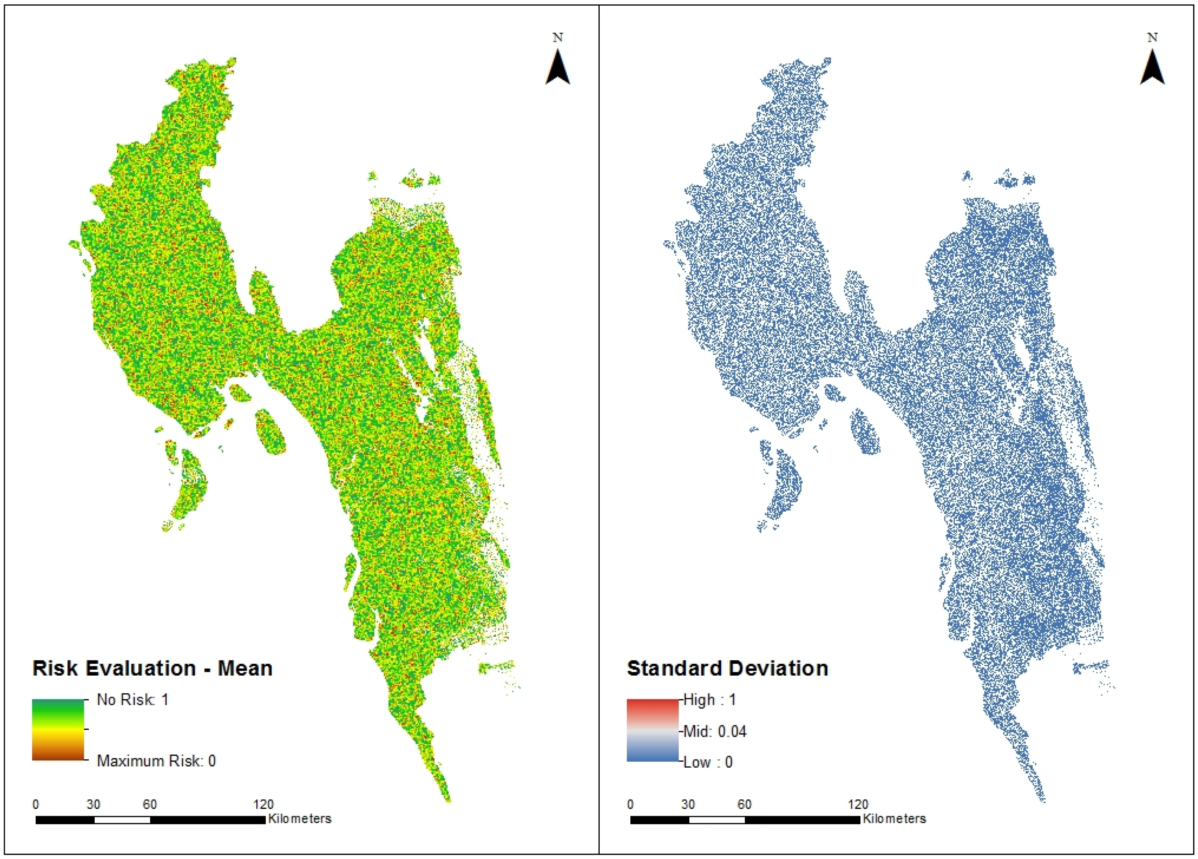
Uncertainty Values

The addition of indicators measuring more regional and national financial indicators could further decrease the uncertainty values. In a Western context, additional indicators and metrics could include state and metropolitan grants, presence of local NGO’s and non-profits, national and regional GDP’s, etc.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Insufficient Investment/Assistance Factor



References

New Economics Foundation (2015). *Financial System Resilience Index: Building a strong financial system*. Accessed at http://b.3cdn.net/nefoundation/3898c6a7f83389375a_y1m6ixqbv.pdf on 31 Jan 2017.

5.1.1 Indicator: Insurance/Reinsurance

This indicator takes into account quantitative data on individual insurance policies and practices.

PACOM specifies that metrics should include: percentage of population insured (compare with historical data); number of insurance payouts; monetary amount of insurance payments; and number of new (re)insurance plans (compare with historical data).

Metric Weighting Logic

As there is currently only one metric within this indicator, it is given both a minimum and maximum value of 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TypeHealthInsurance (5.1.1.1)	1.0	1.0

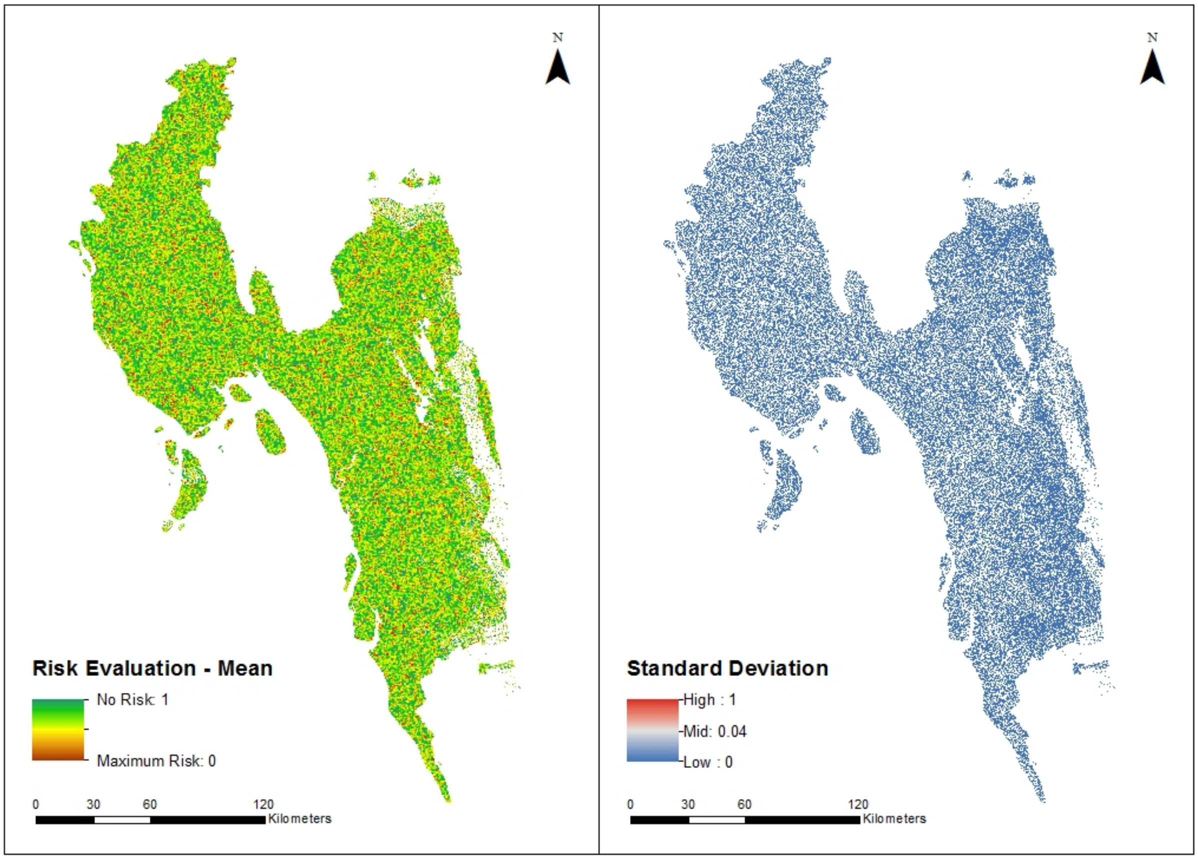
Uncertainty Values

This indicator has a minimum uncertainty value of 0.90 and a maximum uncertainty value of 0.95, due to the presence of only one metric which focuses on the type of health insurance. The addition of metrics speaking to the broader insurance market and how it has changed over time could decrease the uncertainty values.

Indicator Uncertainty Min: 0.90
Indicator Uncertainty Max: 0.95

Example Outcome

Insurance/Reinsurance Indicator



5.1.1.1 Metric: TypeHealthInsurance

Indicator:	Insurance/Reinsurance
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	None/No Health Insurance (min: 0.0625, max: 0.5) Community-Based/MutualOrg (min: 0.125, max: 1.0) Employer (min: 0.5, max: 1.0) SocialSecurity (min: 0.5, max: 1.0) Other Commercial (min: 0.5, max: 1.0) Other (write-in) (min: 0.5, max: 1.0)
Survey:	DHS
Survey Date:	2011
Other Data Sources:	Donfouet et al 2012, Adebayo et al 2015

Logic:

This metric consists of answers to two questions: “Are you covered by health insurance?” and (if respondent answers “Yes”) “What type of health insurance are you covered by?” in both the men’s and women’s portions of the DHS survey.

Answers to the first question of “No” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$).

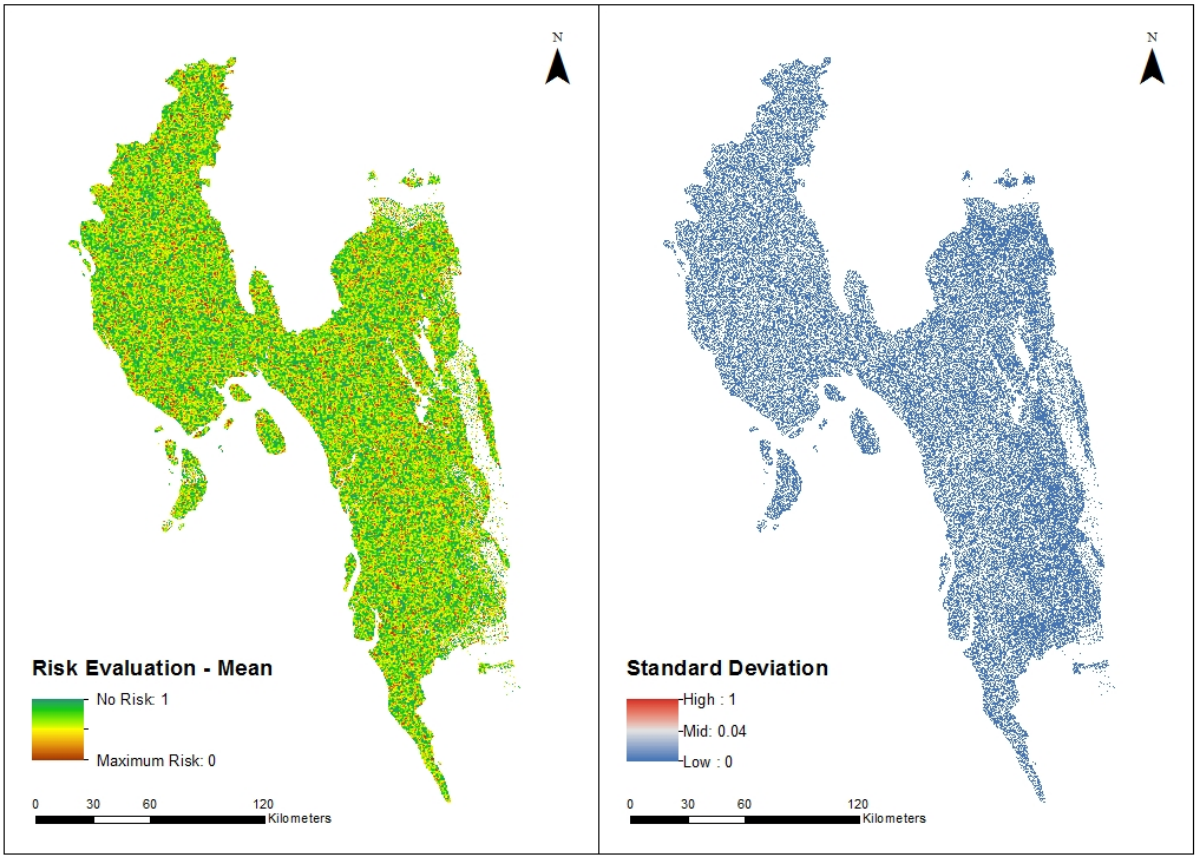
Answers to the second question of “Community-Based/Mutual Org” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Community-based or mutual health organizations are usually found in poorer, rural areas where other health insurance options are not available, hence the lower minimum value versus the other response options (Donfouet et al 2012, Adebayo et al 2015).

Answers of “Employer” (insurance from employer), “Social Security,” “Other Commercial,” and “Other” (write-in) are given a minimum value of 0.5 and a maximum value of 1.0.

Maps will range from extreme risk to no risk.

Example Realization Metric Map

Type Health Insurance Metric



5.1.2 Indicator: Insufficient Loans/Debt Forbearance and Cancellation

This indicator focuses on the resilience of the financial system in terms of credit. Access to credit is seen as a way to build resilience, while debt burden increases vulnerability and risk (Tulane University 2012). Economic vulnerability also includes levels of individual, community and national economic reserves, levels of debt and the degree of access to credit, loans and insurance (UNISDR 2004, pg 42).

It should be noted that while this indicator name implies that it measures the lack of loans/debt forbearance, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Credit Availability and Debt Forbearance."

PACOM specifies that metrics should include: long-term interest rates (compare with historical data); consumer credit availability; and loan forgiveness (national).

Metric Weighting Logic

As there is currently only one metric within this indicator, it is given both a minimum and maximum value of 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
SocioEconomicStatus (5.1.2.1)	1.0	1.0

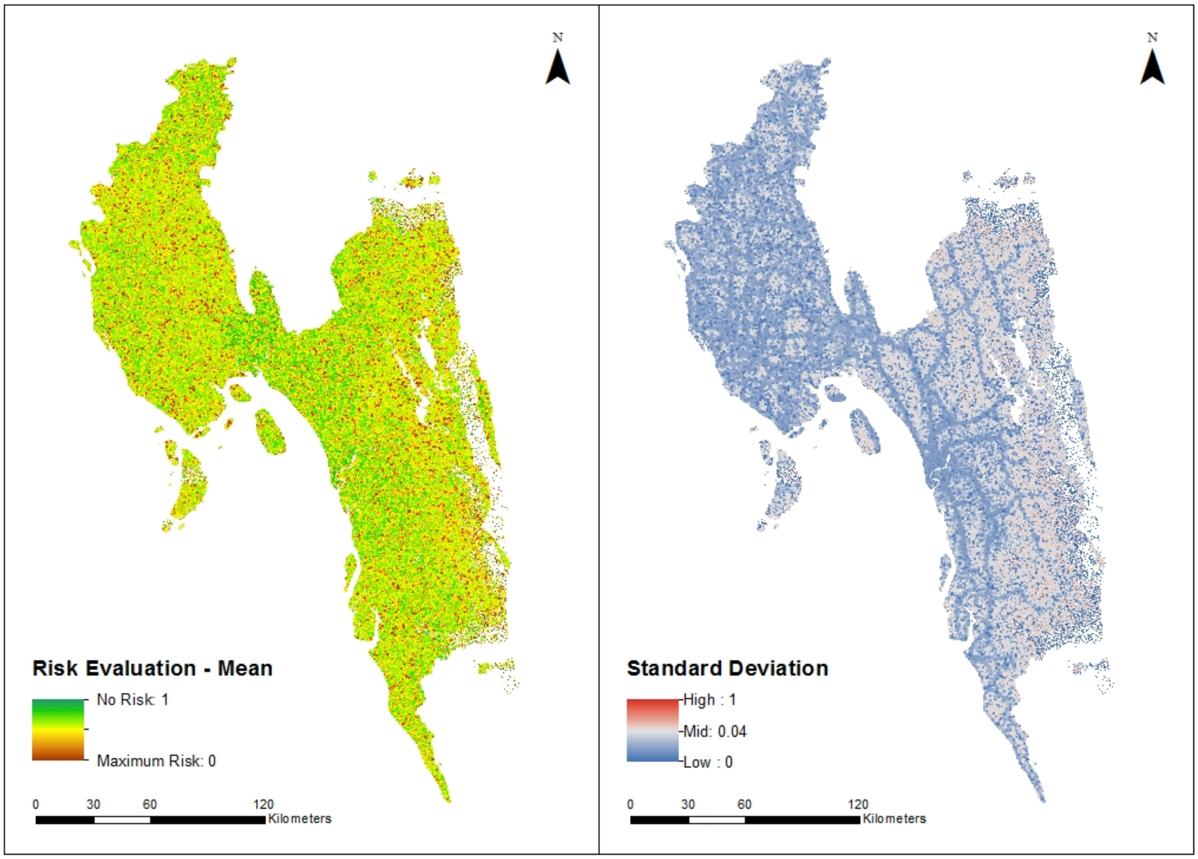
Uncertainty Values

This indicator has a minimum uncertainty value of 0.75 and a maximum uncertainty value of 0.95, due to the presence of only one metric which focuses on the socioeconomic status of the respondent. The addition of metrics actually addressing the credit market, including loans and debts, could further decrease the uncertainty values.

Indicator Uncertainty Min: 0.75
Indicator Uncertainty Max: 0.95

Example Outcome

Insufficient Loans/Debt Forbearance and Cancellation Indicator



References

Tulane University (2012). *Haiti Humanitarian Assistance Evaluation from a Resilience Perspective*. Tulane University's Disaster Resilience Leadership Academy and State University of Haiti, New Orleans.

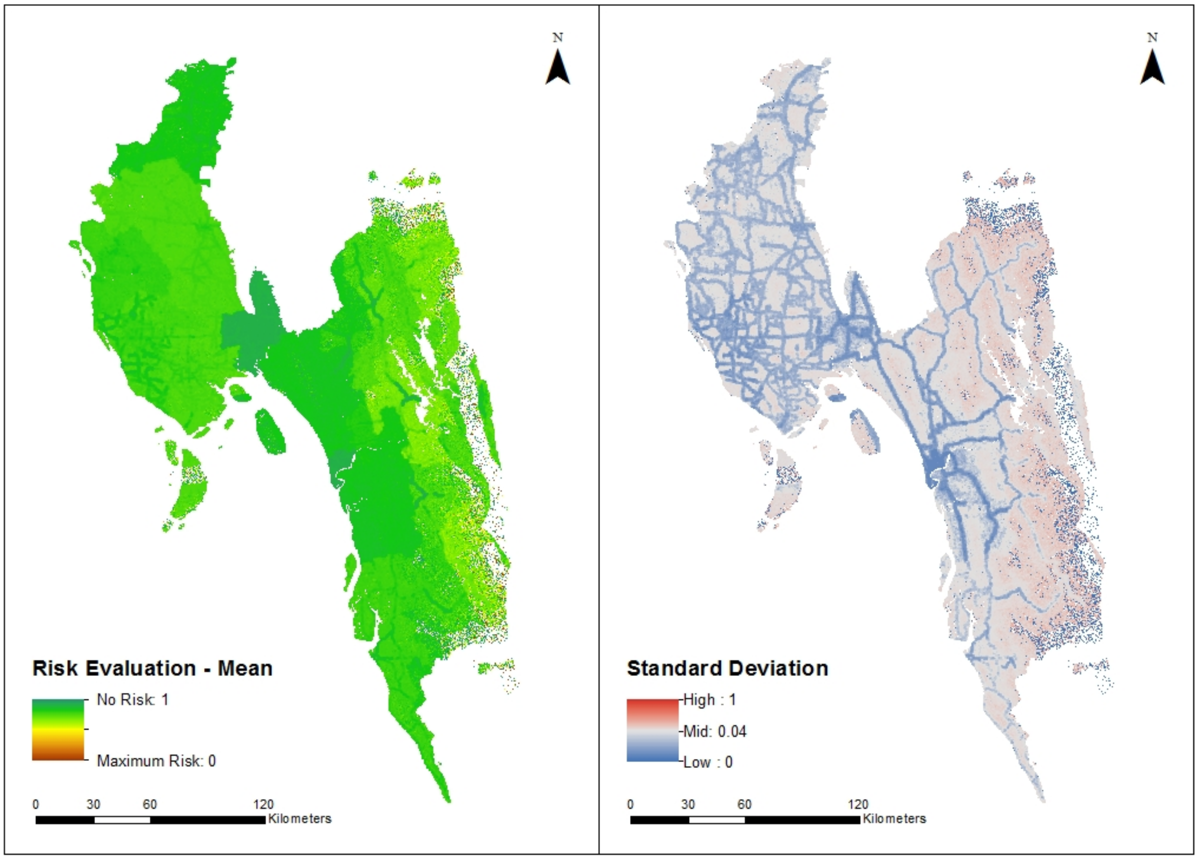
United Nations International Strategy for Disaster Reduction (UNISDR) (2004), *Living with Risk: A global review of disaster reduction initiatives*, Geneva, Switzerland, 2004.

5.1.2.1 Metric: SocioEconomicStatus

Indicator:	Insufficient Loans/Debt Forbearance and Cancellation
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	A1 (businessmen with higher educational degrees) (min: 1.0, max: 1.0) A2 (businessmen with some higher education (no degrees)) (min: 1.0, max: 1.0) B1 (businessmen with HS degree) (min: 1.0, max: 1.0) B2 (businessmen with 5-9 years of school) (min: 0.25, max: 0.75) C (skilled with HS degree) (min: 0.25, max: 0.75) D (skilled with less than 9 years of school) (min: 0.125, max: 0.5) E1 (unskilled with less than 9 years of school) (min: 0.125, max: 0.5) E2 (unskilled illiterate) (min: 0.07, max; 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question in the VPS survey that asks that surveyor to record the socioeconomic status of the respondent. Answers of A1, A2, and B1 are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of B2 and C are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.75 (minimal risk). Answers of D and E1 are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of E2 are given a minimum value of 0.07 (high risk) and a maximum value of 0.5. Maps will range from high risk to no risk.

Example Realization Metric Map

Socioeconomic Status Metric



5.1.3 Indicator: Foreign/Federal Relief/Grants/Social Funds (Aid)

This indicator focuses on non-credit related sources of finances, such as grants, donations, etc.

PACOM specifies that metrics should include: monetary amount of government foreign aid (compare with historical data); and monetary amount of NGO assistance (compare with historical data).

Metric Weighting Logic

As both "PerceivedImpactAidOrganization" (opinion on several international aid organizations and national banks) and "PerceivedIssueHADR" (whether humanitarian and disaster relief is more or less serious in respondent's community vs. Bangladesh) both speak to the effectiveness of aid organizations within the study area, they are both weighted the same. They are also weighted higher than "PerceivedEffortHADR", as they encompass a broader picture of humanitarian relief instead of a specific organization or individual working to improve access to aid.

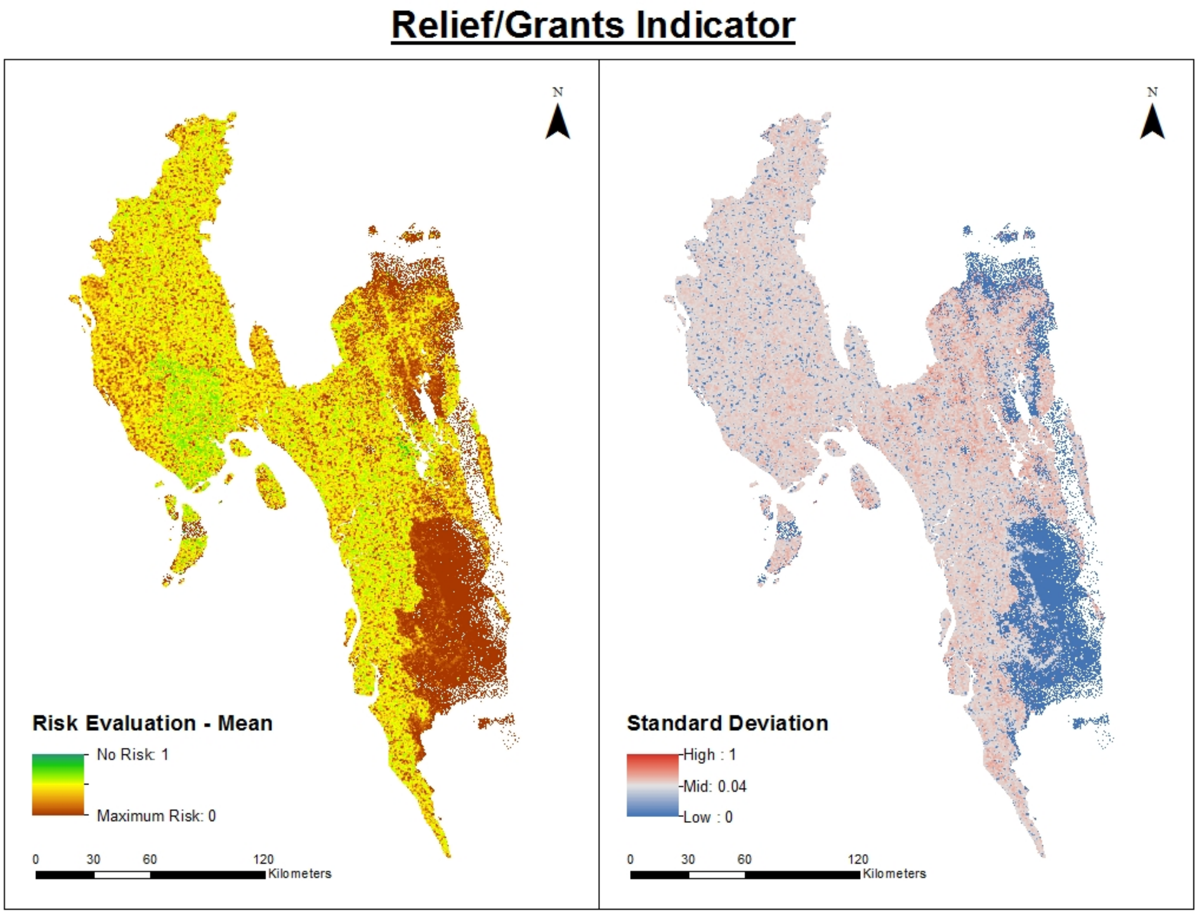
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedImpactAidOrganization (5.1.3.1)	0.5	0.75
PerceivedIssueHADR (5.1.3.2)	0.5	0.75
PerceivedEffortHADR (5.1.3.3)	0.35	0.6

Uncertainty Values

The addition of metrics with quantitative measures of aid, number of active aid organizations, and other potential metrics mentioned above, could further decrease the uncertainty values.

Indicator Uncertainty Min: 0.7
Indicator Uncertainty Max: 0.8

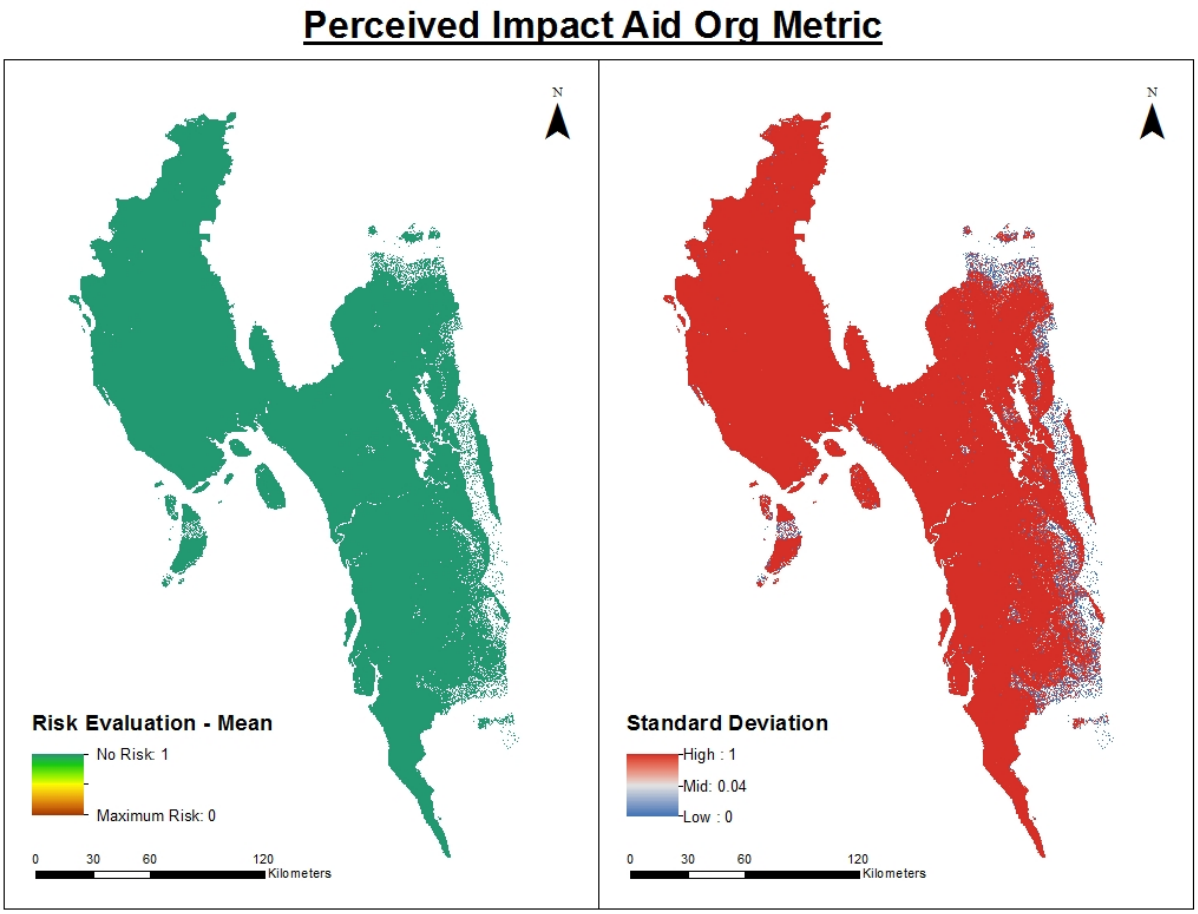
Example Outcome



5.1.3.1 Metric: PerceivedImpactAidOrganization

Indicator:	Foreign/Federal Relief/Grants/Social Funds
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami. Answers of “Mainly Positive” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Mainly Negative” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of “Not Familiar” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

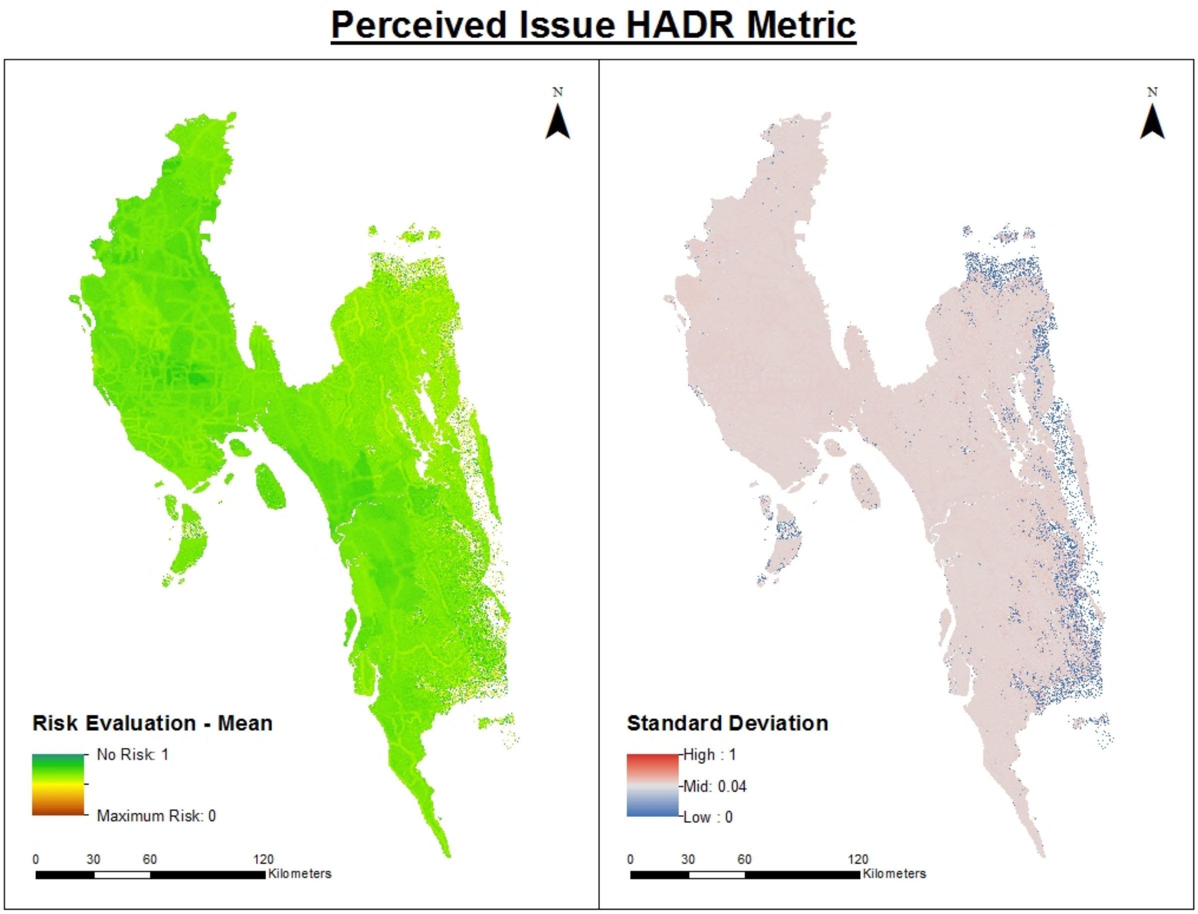
Example Realization Metric Map



5.1.3.2 Metric: PerceivedIssueHADR

Indicator:	Foreign/Federal Relief/Grants/Social Funds
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	Not an Issue (min: 1.0, max: 1.0) Not at all Serious (min: 0.8, max: 1.0) Not Very Serious (min: 0.25, max: 0.9) Very Serious (min: 0.125, max: 0.7) Extremely Serious (min: 0.07, max: 0.5)
Metric Weight Min	0.4
Metric Weight Max	0.6
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether humanitarian and disaster relief is more or less serious in your community than in the rest of Bangladesh?” from the VPS survey. Answers of “Not an Issue” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Not at all Serious” are given a minimum of 0.8 (minimal risk) and a maximum of 1.0. Answers of “Not Very Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “Very Serious” are given a minimum of 0.125 (high risk) and a maximum of 0.7 (minimal risk). Answers of “Extremely Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

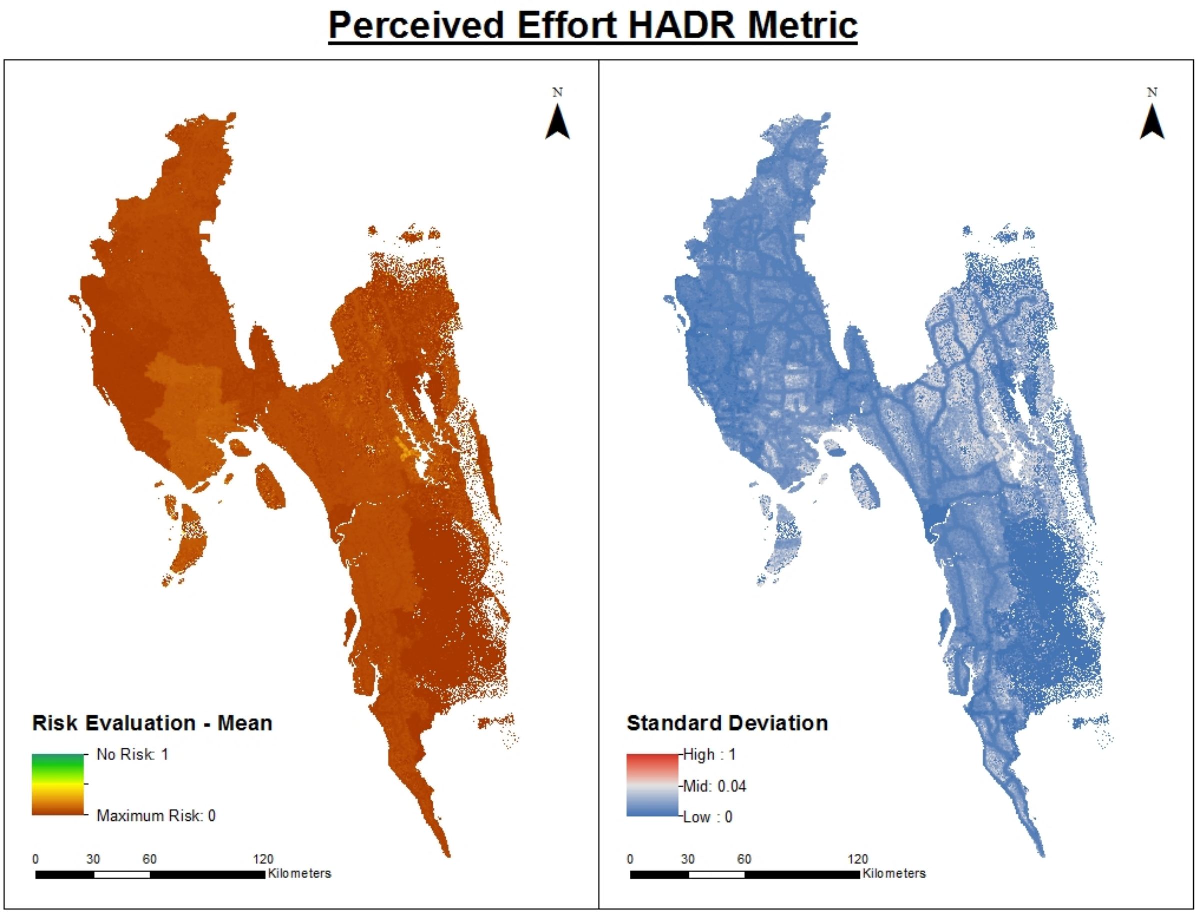
Example Realization Metric Map



5.1.3.3 Metric: PerceivedEffortHADR

Indicator:	Foreign/Federal Relief/Grants/Social Funds
Factor:	Insufficient Investment/Assistance
Condition:	Resilience Deficiencies
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Metric Weight Min	0.35
Metric Weight Max	0.7
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve humanitarian and disaster relief in Bangladesh today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map



5.1.4 Indicator: Decreased Foreign Investment Based on Assessed Risk

Unlike the previous indicator, this indicator focuses specifically on foreign investment outside of grants and humanitarian aid.

PACOM specifies that metrics should include: monetary amount of foreign investment (compare with historical data).

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

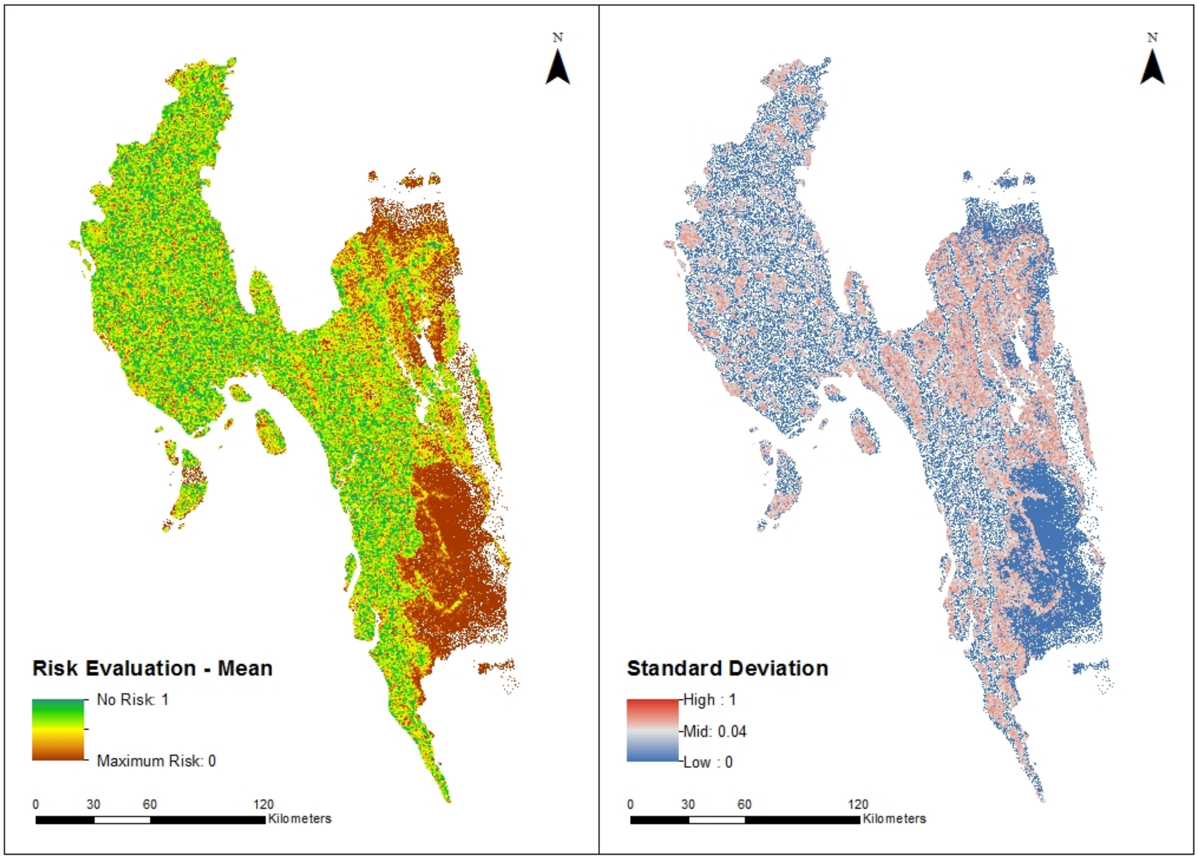
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Decreased Foreign Investment Based on Assessed Risk Indicator



5.2 Malfunctioning Commerce/Services Factor Overview

This factor emphasizes the commerce and trade aspect of resilience. According to a joint report form the World Trade Organization and the World Bank Group (2015), trade increases can contribute to sharp declines in extreme poverty:

> *Developing countries now constitute 48 percent of world trade, up from 33 percent in 2000, and the number of people living in extreme poverty has been cut in half since 1990, to just under one billion people. Trade has helped increase the number and quality of jobs in developing countries, stimulated economic growth, and driven productivity increases.*

Indicators within this factor measure employee efficiency, production, trade, and market function.

The indicators Absenteeism and Work Stoppages and Failure to Re-Establish Markets currently have available metric data. Other indicators may be supported by other data streams in the USG.

Indicator Weighting Logic

All four indicators are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator's risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Absenteeism and Work Stoppages (5.2.1)	0.25	0.25
Production Decreases (5.2.2)	0.25	0.25
Failure of Normal Trade to Return (5.2.3)	0.25	0.25
Failure to Re-Establish Markets (5.2.4)	0.25	0.25

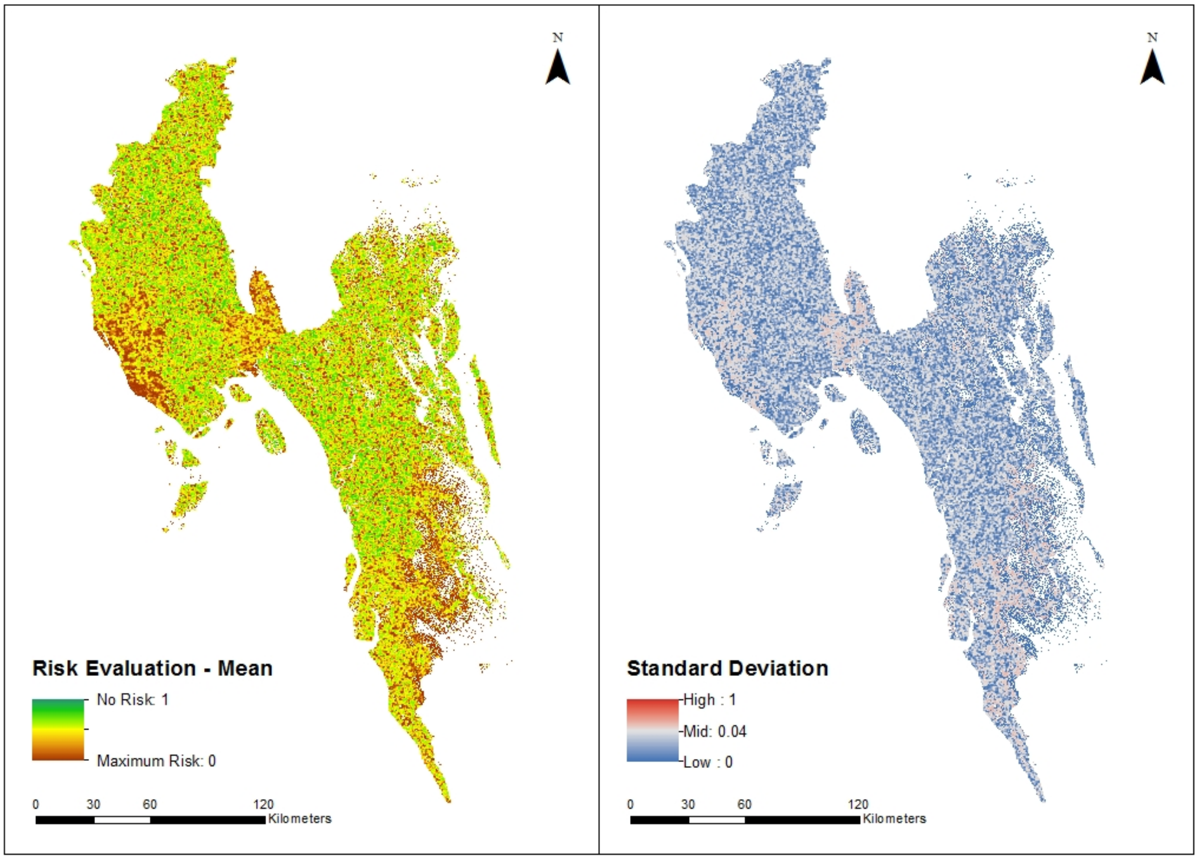
Uncertainty Values

The addition of indicators measuring other aspects of commerce and trade, such as homeownership vs. rentals, international trade partnerships, etc., could further decrease the uncertainty values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Malfunctioning Commerce Factor



References

World Trade Organization and the World Bank Group (2015). *The Role of Trade in Ending Poverty*. Accessed at http://documents.worldbank.org/curated/en/726971467989468997/pdf/97607-REPLACEMENT-The-Role-of-Trade-in-Ending-Poverty.pdf on 31 Jan 2017.

5.2.1 Indicator: Absenteeism and Work Stoppages

This indicator focuses on the capabilities of large groups of employees who are unable to work for extended periods of time.

PACOM specifies that metrics should include: percentage of employees unable to work due to illness or injury (compare with historical data); and percentage of employees unable to work due to work stoppages.

Metric Weighting Logic

Both of these metrics are given a minimum weight of 0.2 and a maximum weight of 0.5, as they are equally effective on the indicator as a whole, and the maximum weights sum to 1.0.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
Employment Status (5.2.1.1)	0.5	0.5
TypeDisability (5.2.1.2)	0.5	0.5

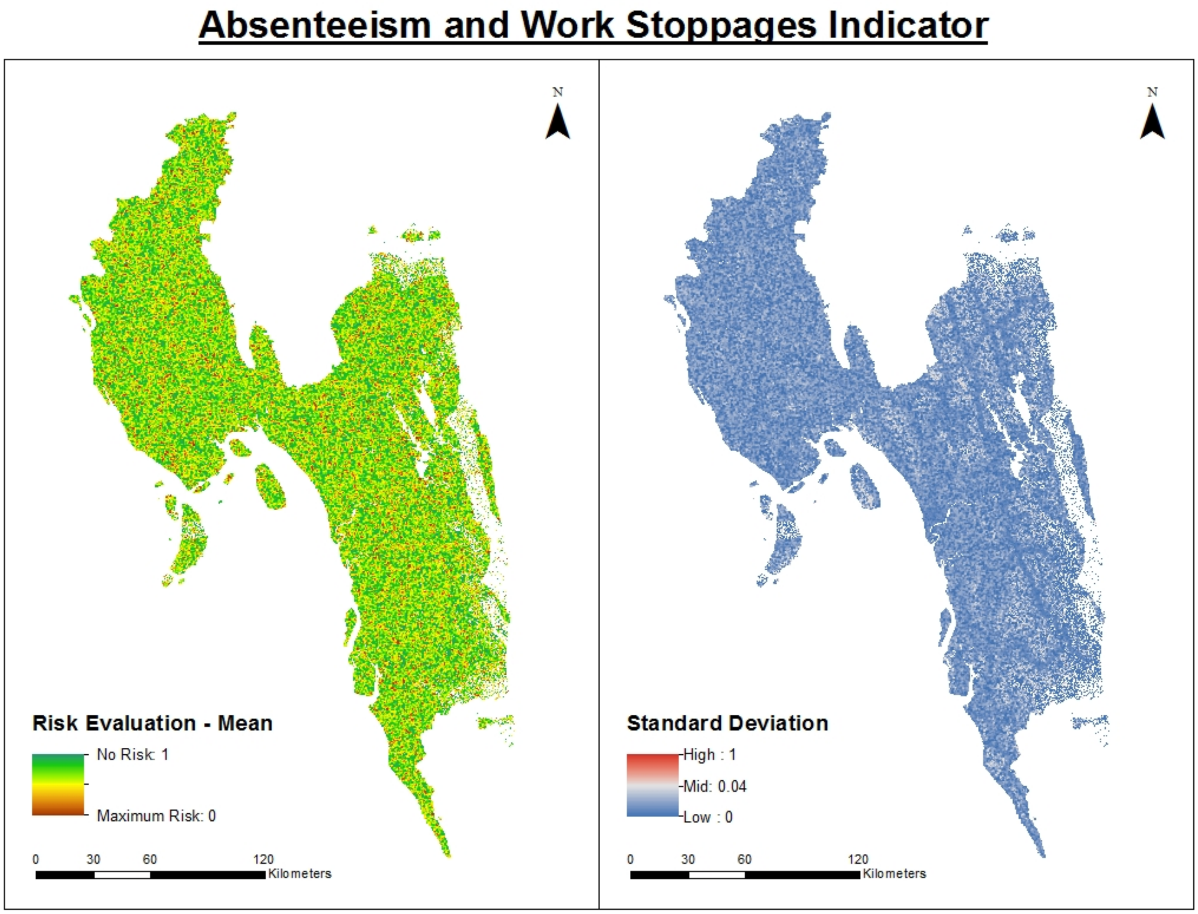
Uncertainty Values

The addition of metrics accounting for workplace injuries, long-term job risk (i.e., lung cancer in coal miners), workplace accidents, and other metrics similar to those listed above could further decrease the uncertainty values.

Alternatively, if the indicator was renamed to something like “Employment Issues”, the metrics would more adequately reflect what the indicator would address. This could decrease the uncertainty values from 0.1 to 0.3.

Indicator Uncertainty Min: 0.90
Indicator Uncertainty Max: 0.95

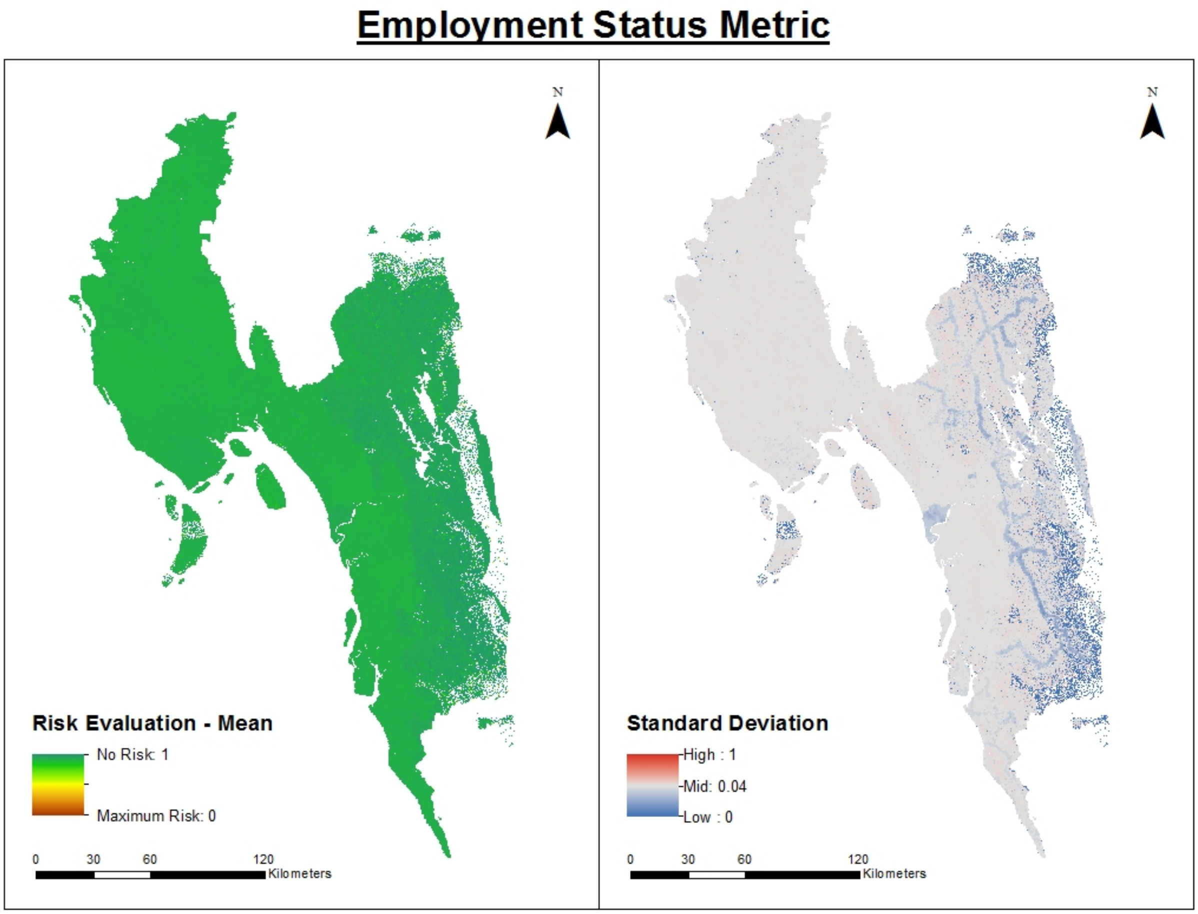
Example Outcome



5.2.1.1 Metric: EmploymentStatus

Indicator:	Absenteeism and Work Stoppages
Factor:	Malfunctioning Commerce
Condition:	Resilience Deficiencies
Metric Assigned Values:	Employed (min: 1.0, max: 1.0) Looking for job (min: 0.125, max: 0.9) Household work (min: 0.125, max: 0.9) Do not work/no work (min: 0.125, max: 0.9)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question of employment status of the respondent. Answers of “Employed” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Looking for job,” “Household work,” and “No work” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.9 (minimal risk). Maps will range from high risk to no risk.

Example Realization Metric Map



5.2.1.2 Metric: TypeDisability

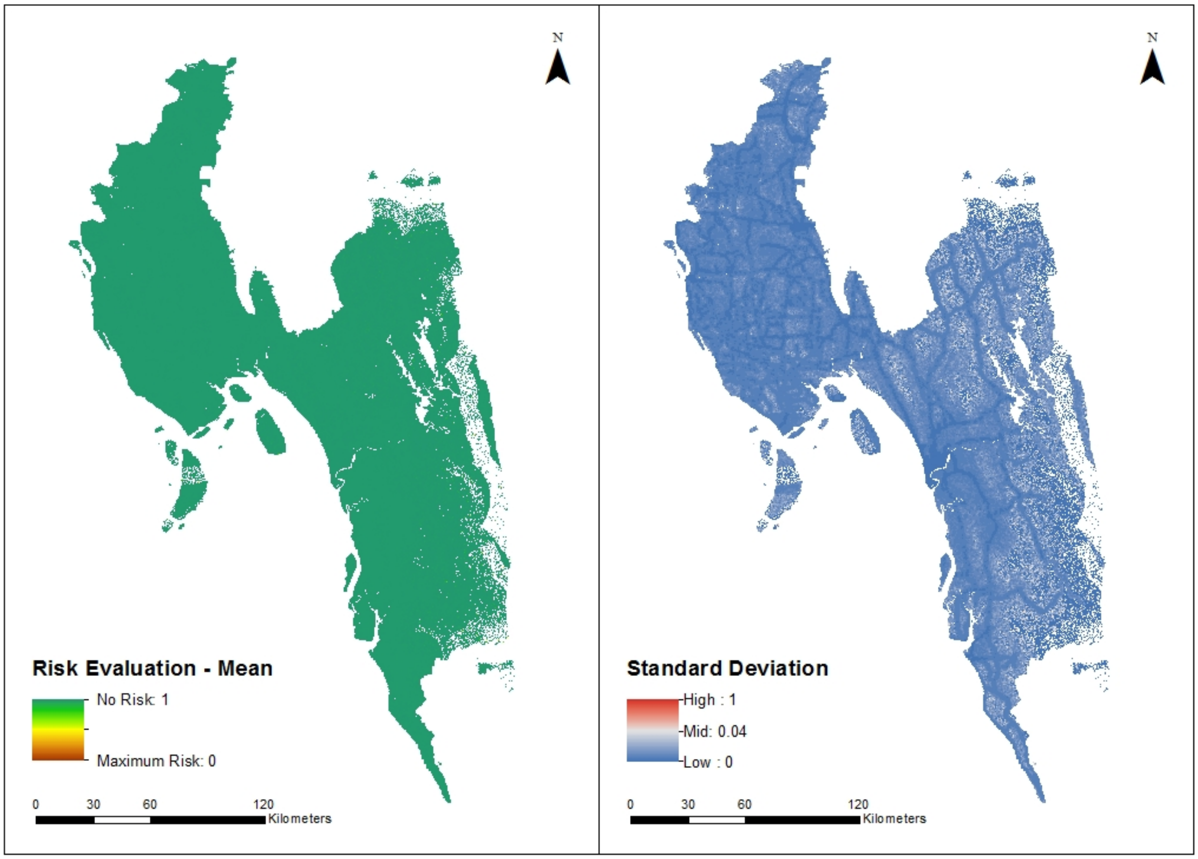
Indicator:	Absenteeism and Work Stoppages
Factor:	Malfunctioning Commerce
Condition:	Resilience Deficiencies
Metric Assigned Values:	None (min: 1.0, max: 1.0) Speech (min: 0.125, max: 0.9) Vision (min: 0.125, max: 0.9) Hearing (min: 0.125, max: 0.9) Physical (min: 0.125, max: 0.9) Mental (min: 0.125, max: 0.9) Autistic (min: 0.125, max: 0.9)
Survey:	IPUMS
Survey Date:	2011
Other Data Sources:	

Logic: This metric consists of the surveyor asking the respondent is there anybody in this household who is having trouble in speaking, seeing, listening, physical or mental. According to Disabled Welfare Act 2010 person who is by born or cause of others physically unable or completely/partly handicapped or mentally retarded is considered as Disabled. In the IPUMS census, as per recommendation of the Washington Group, disabled has been categorized into six categories.

Answers of “None” (no disability) are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Speech,” “Vision,” “Hearing,” “Physical,” “Mental,” and “Autistic” are given a minimum value of 0.125 (high risk, $½^3$) and a maximum value of 0.9 (minimal risk). Maps will range from high risk to no risk.

Example Realization Metric Map

Type Disability Metric



5.2.2 Indicator: Production Decreases

This indicator takes into account negative changes in production, both agricultural and industrial in nature, particularly following a crisis.

PACOM specifies that metrics should include: percentage of agricultural land affected by crisis; and percentage of factories shut down (compare with historical data).

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

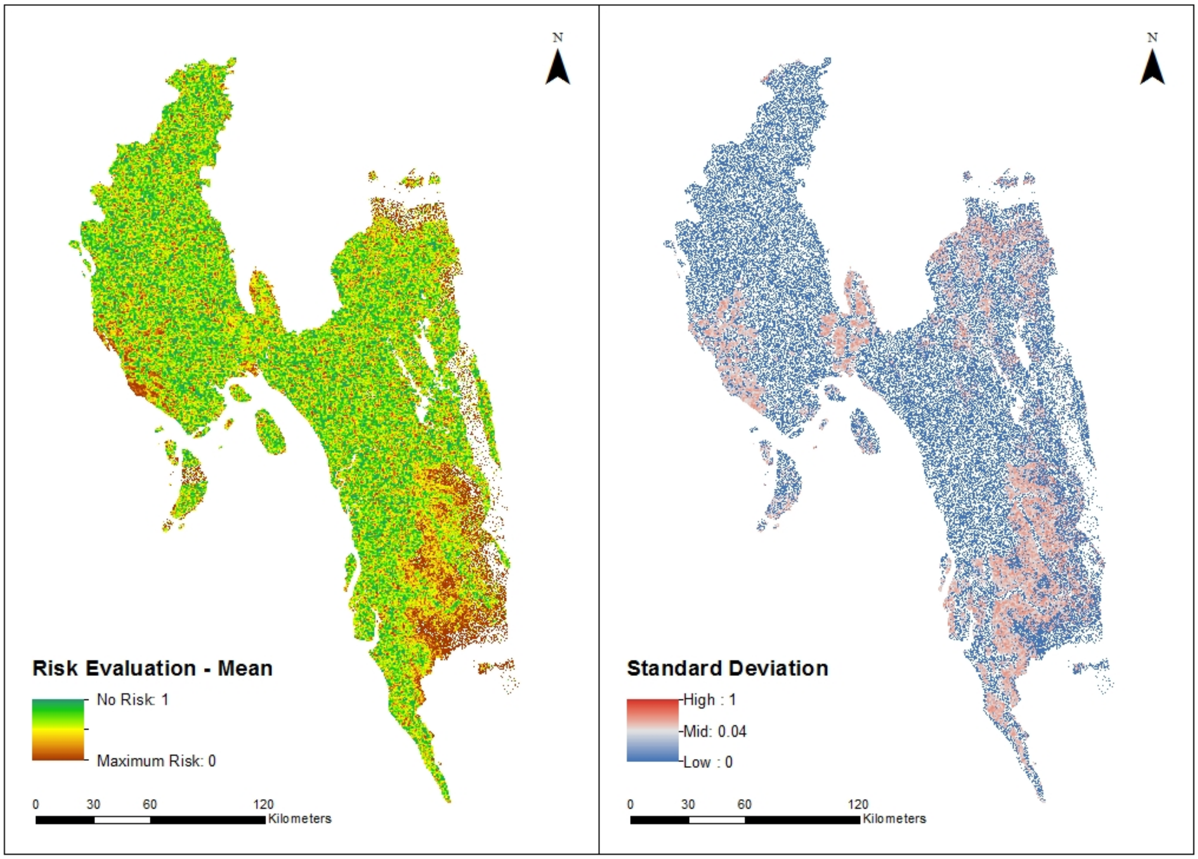
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Production Decreases Indicator



5.2.3 Indicator: Failure of Normal Trade to Return

This indicator examines the failure of normal (pre-crisis) trade to return following a crisis. It should be noted that while this indicator name implies that it measures the failure of normal trade to return, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be "Ability of Normal Trade to Return."

PACOM specifies that metrics should include: gross imports and exports; industrial production operation; and consumer price index.

Metric Weighting Logic

As there are currently no metrics, this indicator produces a random map.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
TBD	x	x
TBD	x	x

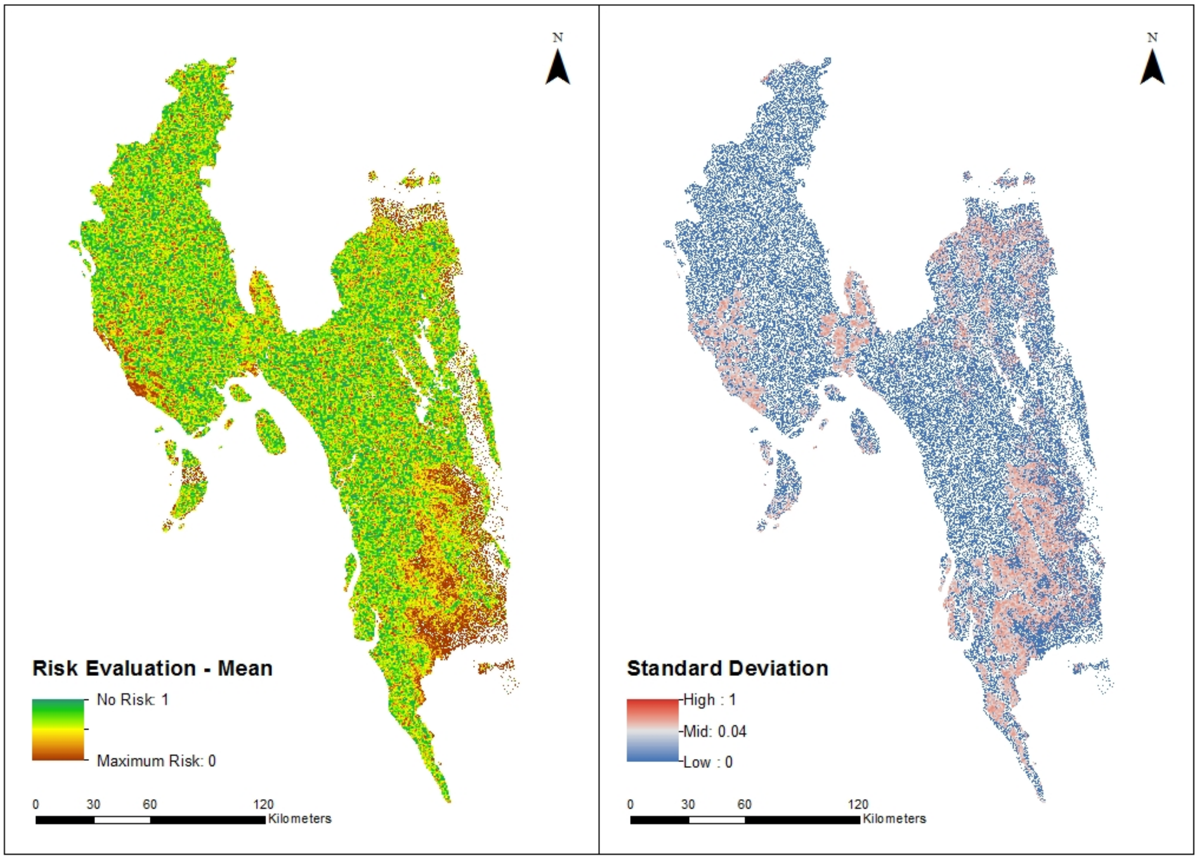
Uncertainty Values

As the Urban Security data has no metrics for this indicator, the uncertainty minimum and maximum values are left at 1.0. Uncertainty values will decrease once metrics are added and risk maps are created.

Indicator Uncertainty Min: 1.0
Indicator Uncertainty Max: 1.0

Example Outcome

Failure of Normal Trade to Return Indicator



5.2.4 Indicator: Failure to Re-Establish Markets

This indicator focuses on the recovery capabilities of local and regional markets (retail, grocery, bank, etc.). Metrics should account for negative differences between historical, pre-crisis trends and post-crisis realities. It should be noted that while this indicator name implies that it measures the failure for markets to re-establish following a crisis, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Ability to Re-establish Markets.”

PACOM specifies that metrics should include: percentage of retail stores open (compare with historical data); percentage of grocery stores open; percentage of banks open; percentage of companies unable to operate; total retail sales of consumer goods; and perception of availability of commerce/services.

Metric Weighting Logic

As “PerceivedEffortEmployment” (Can you name an organization or public figure that you believe is working hard to improve access to employment opportunities in Bangladesh today) is a broader, qualitative question, it is given both a slightly lower minimum weight and the highest maximum weight.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueEmployment (5.2.4.1)	0.6	0.6
PerceivedEffortEmployment (5.2.4.2)	0.45	0.7

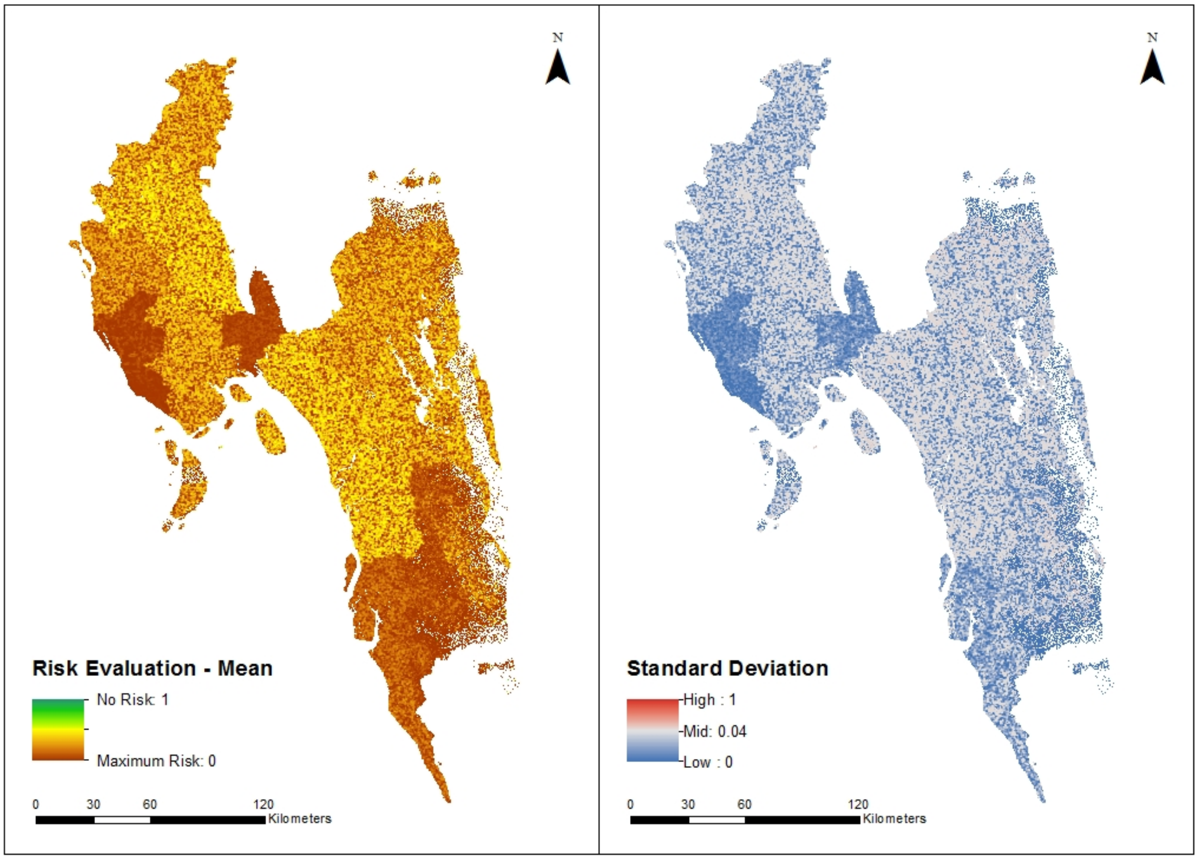
Uncertainty Values

The addition of metrics like those mentioned above, especially more quantitative metrics, could decrease these uncertainty values.

Indicator Uncertainty Min: 0.90
Indicator Uncertainty Max: 0.95

Example Outcome

Failure to Re-Establish Markets Indicator

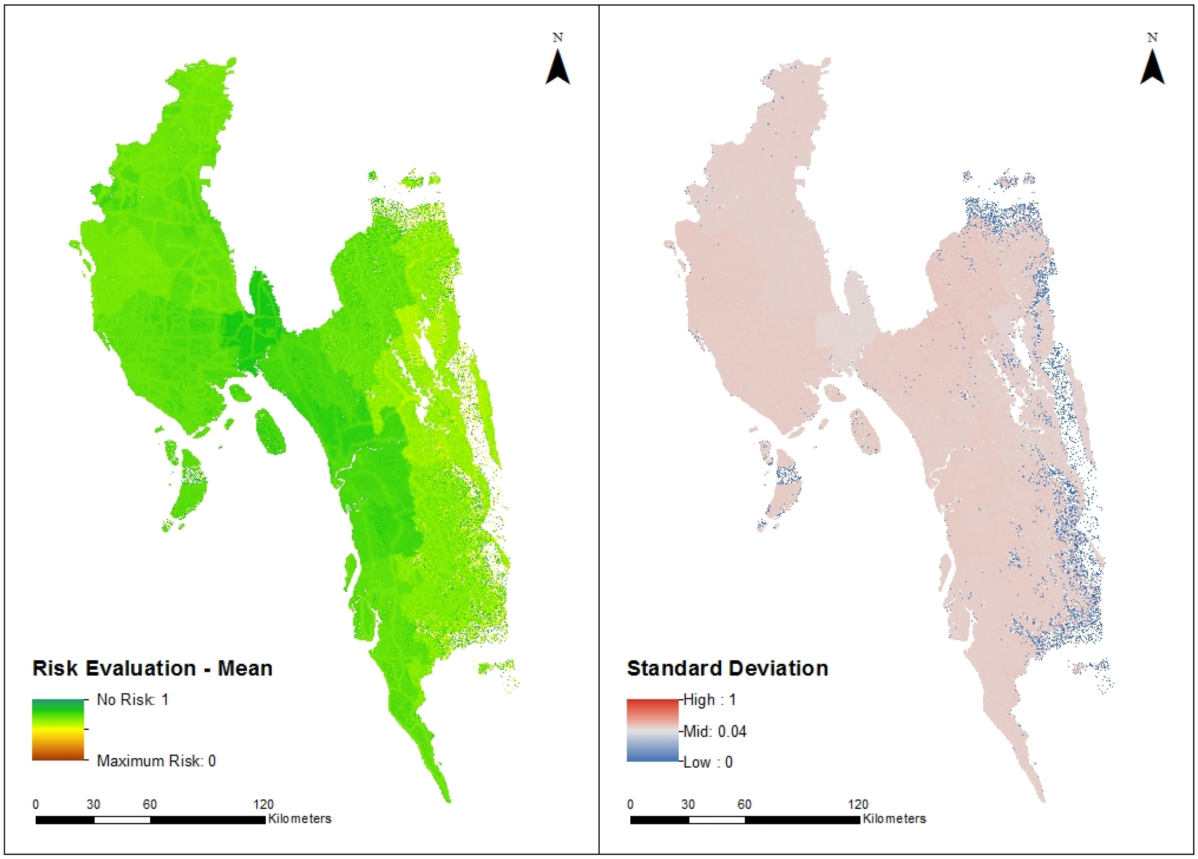


5.2.4.1 Metric: PerceivedIssueEmployment

Indicator:	Failure to Re-Establish Markets
Factor:	Malfunctioning Commerce
Condition:	Resilience Deficiencies
Metric Assigned Values:	Not Issue (min: 1.0, max: 1.0) Less Serious (min: 0.25, max: 0.9) More Serious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether access to employment opportunities is more or less serious in your community than in the rest of Bangladesh?” from the VPS survey. Answers of “Not Issue” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

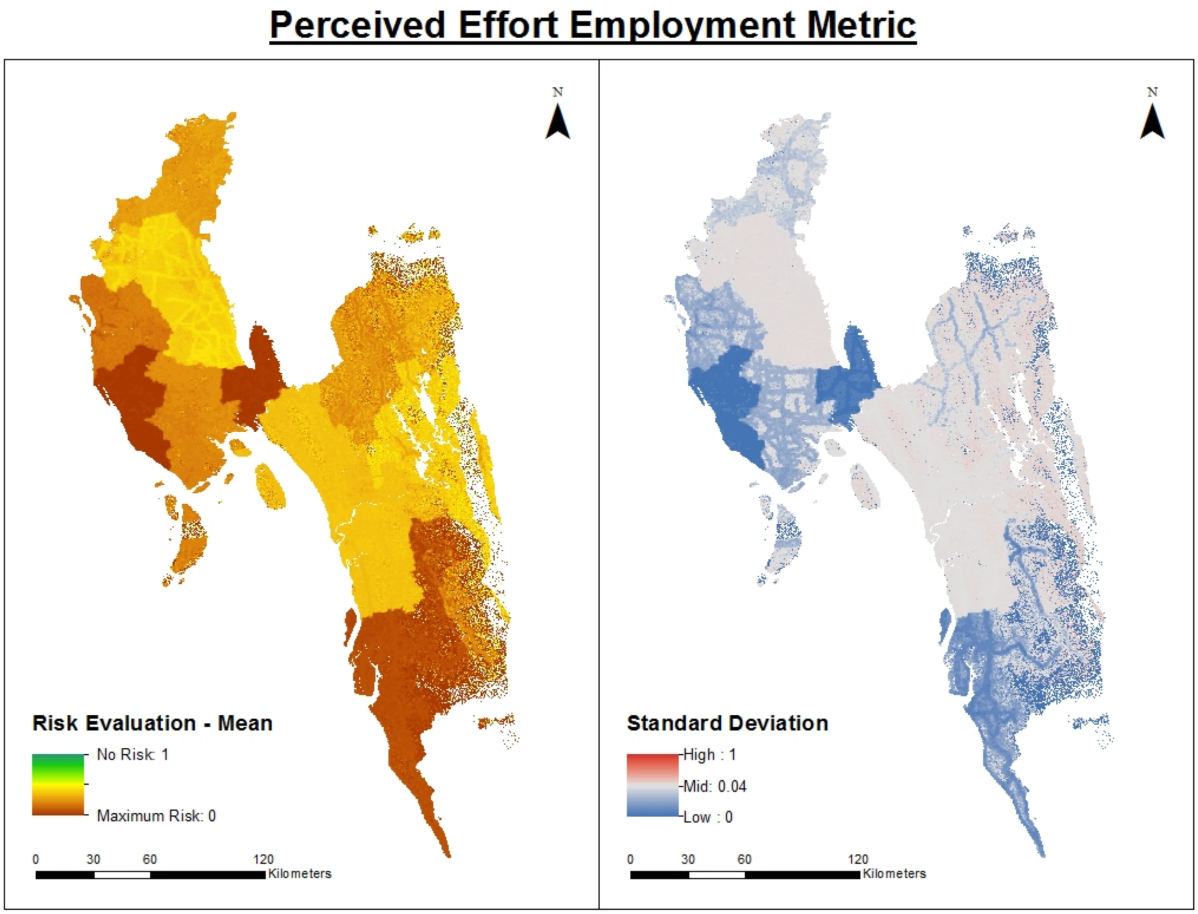
Perceived Issue Employment Metric



5.2.4.2 Metric: PerceivedEffortEmployment

Indicator:	Failure to Re-Establish Markets
Factor:	Malfunctioning Commerce
Condition:	Resilience Deficiencies
Metric Assigned	Yes (min: 1.0, max: 1.0)
Values:	No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve access to employment opportunities in Bangladesh today?” from the VPS survey. Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map



5.3 Inadequate Construction/Reconstruction Factor Overview

This factor addresses the infrastructure aspect of resilience. “Poor design and construction of buildings” and “inadequate protection of assets” are identified as key contributors to vulnerability (UNISDR 2009).

It should be noted that while the name implies that it measures the inadequacy of construction services, it actually does the opposite; and still is evaluated on the 0-1 risk scale with 0 being total risk and 1 being no risk. A better name would be “Construction/Reconstruction Response Capacity.”

Indicators within this factor cover the topic of infrastructure in terms of buildings, utilities, transportation, and agriculture. And, unlike other indicators within this condition, each indicator and metric within the Inadequate Construction/Reconstruction factor utilize post-disaster or post-crisis data – even if the disaster/crisis happens at a smaller geospatial and/or a longer temporal scale.

All indicators currently have available metric data.

Indicator Weighting Logic

All four indicators within this factor are given both a minimum and a maximum value of 0.25. As such, they are contributing equally with the factor risk potentially higher than an individual indicator’s risk level.

Indicator (heading number)	Weight Minimum Value	Weight Maximum Value
Insufficient Rebuilding of Shelter/Housing (5.3.1)	0.25	0.25
Sustained Lack of Operational Utilities (5.3.2)	0.25	0.25
Delays to Re-establishment of Transportation Systems (5.3.3)	0.25	0.25
Diminished Agricultural Production (5.3.4)	0.25	0.25

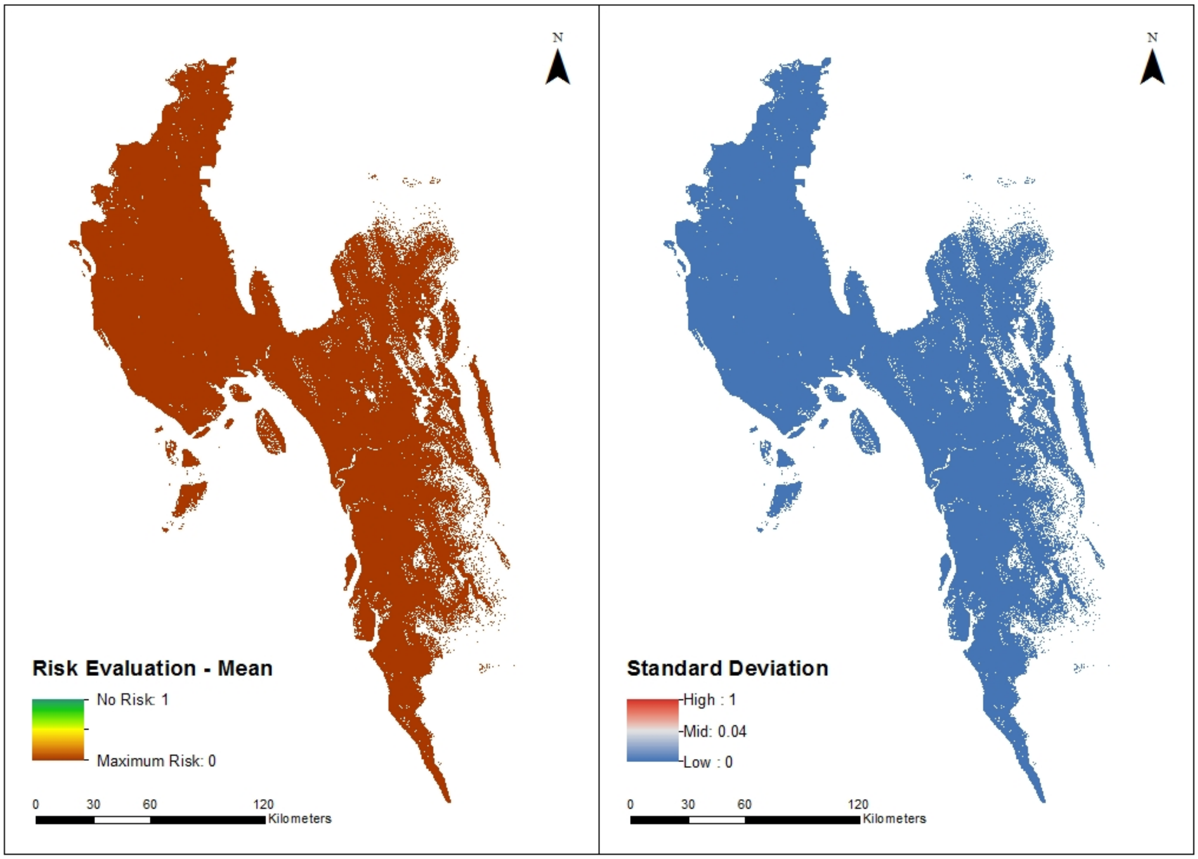
Uncertainty Values

The addition of indicators measuring other aspects of infrastructure recovery, such as potential damage to water and sewage systems, could further decrease these values.

Factor Uncertainty Min: 0.1
Factor Uncertainty Max: 0.3

Example Outcome

Inadequate Construction/Reconstruction Factor



References

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

5.3.1 Indicator: Insufficient Rebuilding of Shelter/Housing

This indicator focuses on the reconstruction of buildings and shelter following a disaster or crisis, particularly residential buildings.

Land-use planning can help to mitigate disasters and reduce risks by discouraging settlements and construction of key installations in hazard-prone areas, including consideration of service routes for transport, power, water, sewage and other critical facilities (UNISDR 2009, pg 9). “When the social consequences of settling in hazardous zones are so adverse, the correct response is for governments to make targeted interventions” (The World Bank 2010, pg 6).

PACOM specifies that metrics should include: percentage of damaged housing rebuilt following disaster; and perception of shelter/housing rebuilding process.

Metric Weighting Logic

As USAID most directly addresses housing and shelter issues, both in an emergency response capacity and beyond, “PerceivedImpactUSAID” (opinion on USAID) is weighted the highest. All but one metric are weighted slightly higher than “PerceivedEffortHADR” (in terms of the minimum weight value), as they encompass a broader picture of humanitarian relief instead of a specific organization or individual working to improve access to aid.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueHADR (5.3.1.1)	0.4	0.7
PerceivedEffortHADR (5.3.1.2)	0.35	0.7
PerceivedImpactUSAID (5.3.1.3)	0.5	0.9
PerceivedImpactMuslimAid (5.3.1.4)	0.4	0.7
PerceivedImpactIIRO (5.3.1.5)	0.4	0.7
PerceivedImpactUNICEF (5.3.1.6)	0.4	0.7
PerceivedImpactCAREIntl (5.3.1.7)	0.4	0.7

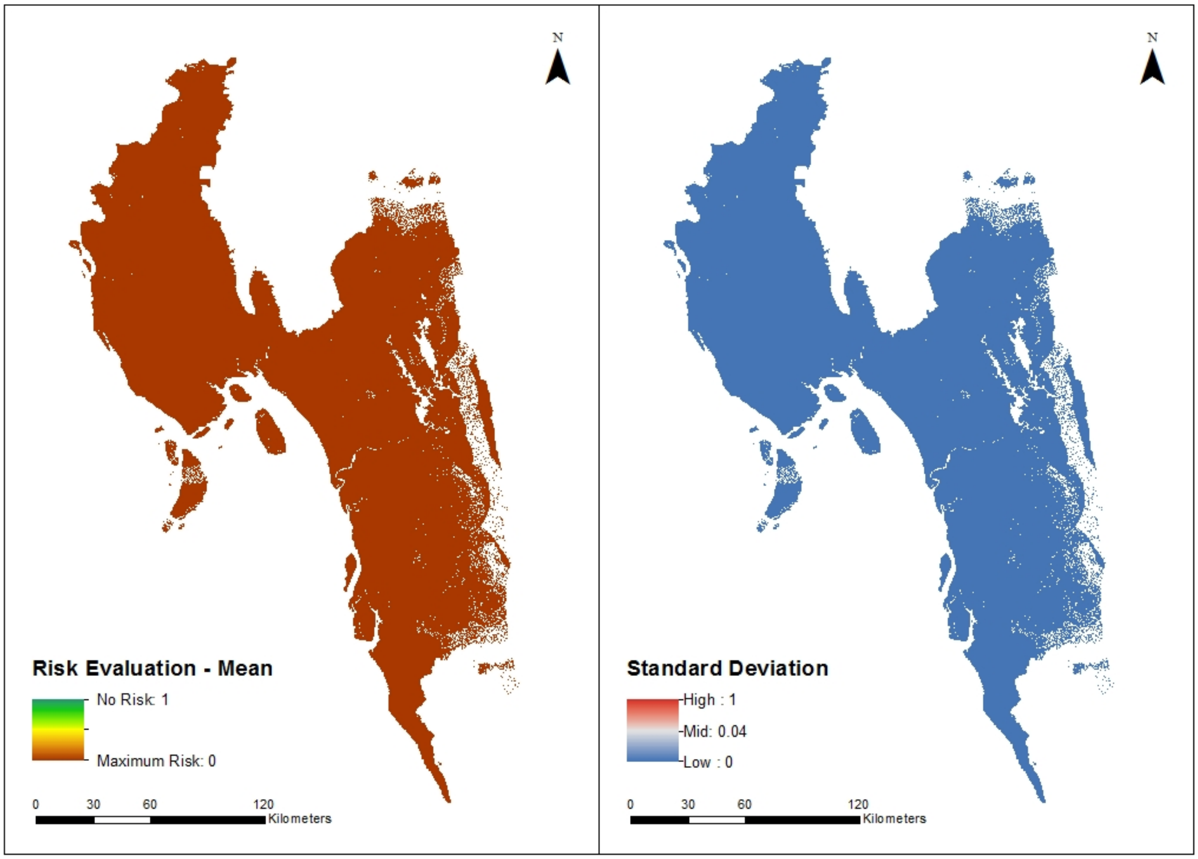
Uncertainty Values

The addition of metrics measuring the residential reconstruction process (i.e., percent of people homeless post-disaster, percent damaged housing, number of aid organizations focusing specifically on housing reconstruction) could decrease these high uncertainty values.

Indicator Uncertainty Min: 0.75
Indicator Uncertainty Max: 0.90

Example Outcome

Rebuild Shelter Indicator



References

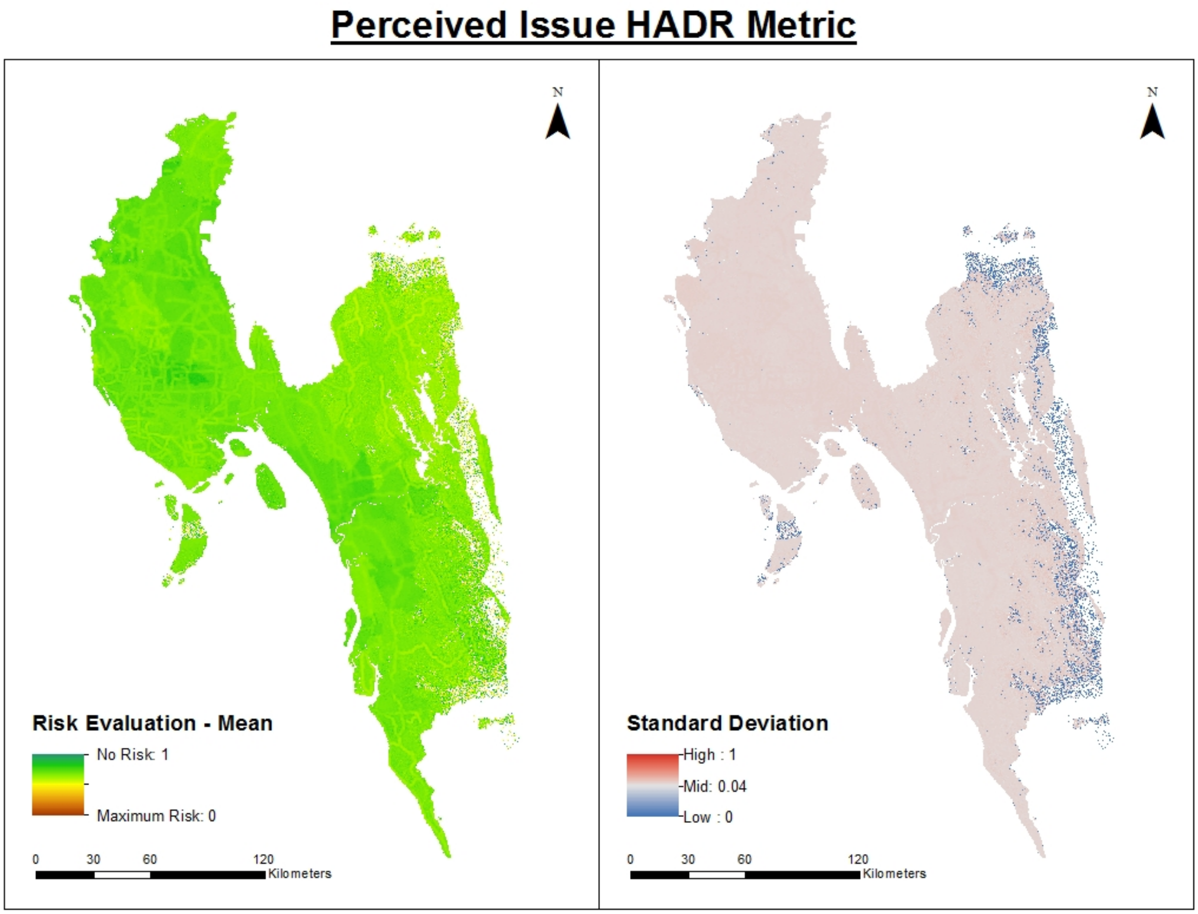
The World Bank (2010). *Natural Hazards, UnNatural Disasters: The Economics of Effective Prevention (Overview).* The International Bank for Reconstruction and Development / The World Bank, Washington, D.C., 2010.

United Nations International Strategy for Disaster Reduction (UNISDR) (2009). *2009 UNISDR Terminology on Disaster Risk Reduction*. Geneva, Switzerland. May 2009.

5.3.1.1 Metric: PerceivedIssueHADR

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Not Issue (min: 1.0, max: 1.0) Less Serious (min: 0.25, max: 0.9) More Serious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether humanitarian and disaster relief is more or less serious in your community than in the rest of Bangladesh?” from the VPS survey. Answers of “Not Issue” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

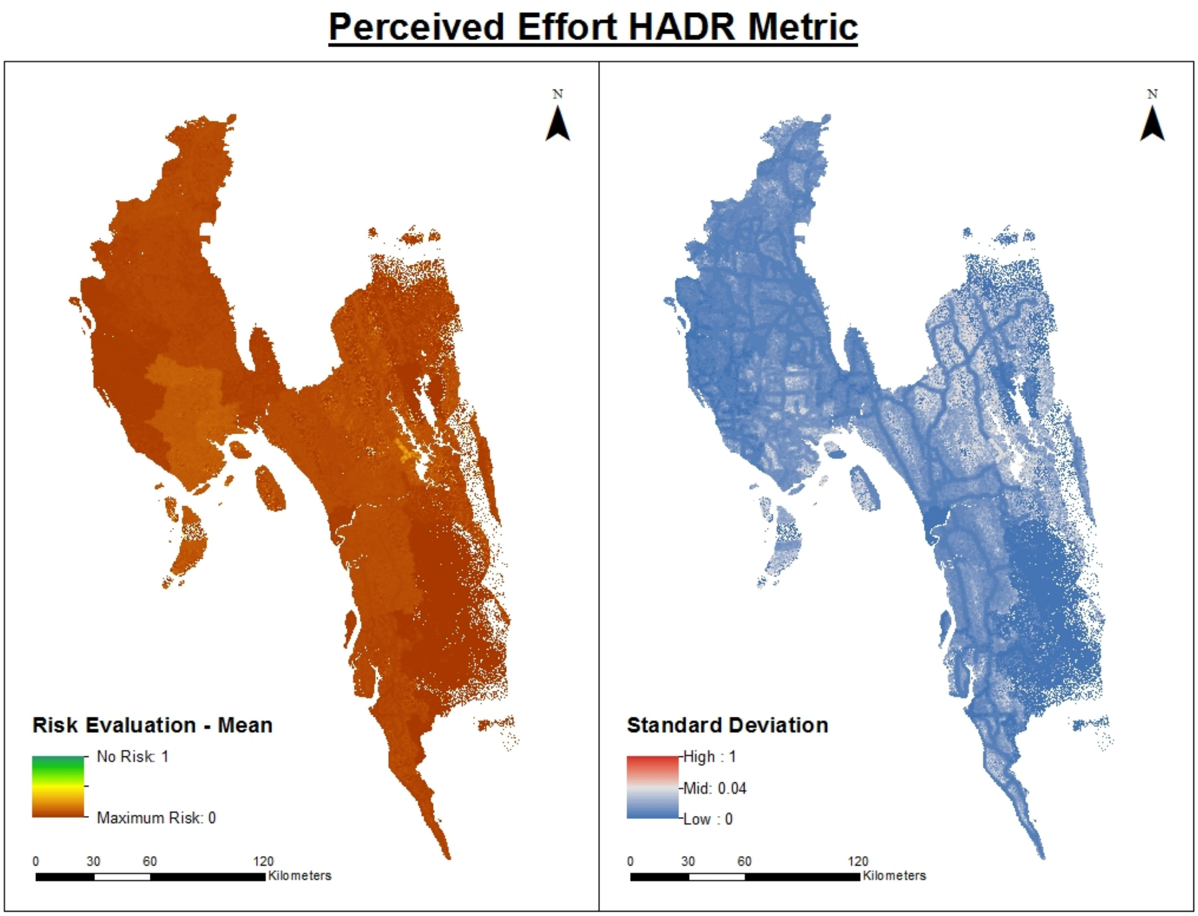
Example Realization Metric Map



5.3.1.2 Metric: PerceivedEffortHADR

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve humanitarian and disaster relief in Bangladesh today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map



5.3.1.3 Metric: PerceivedImpactUSAID

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	https://www.usaid.gov/what-we-do/working-crises-and-conflict/responding-times-crisis/how-we-do-it/humanitarian-sectors/shelter-and-settlements

Logic:

This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami.

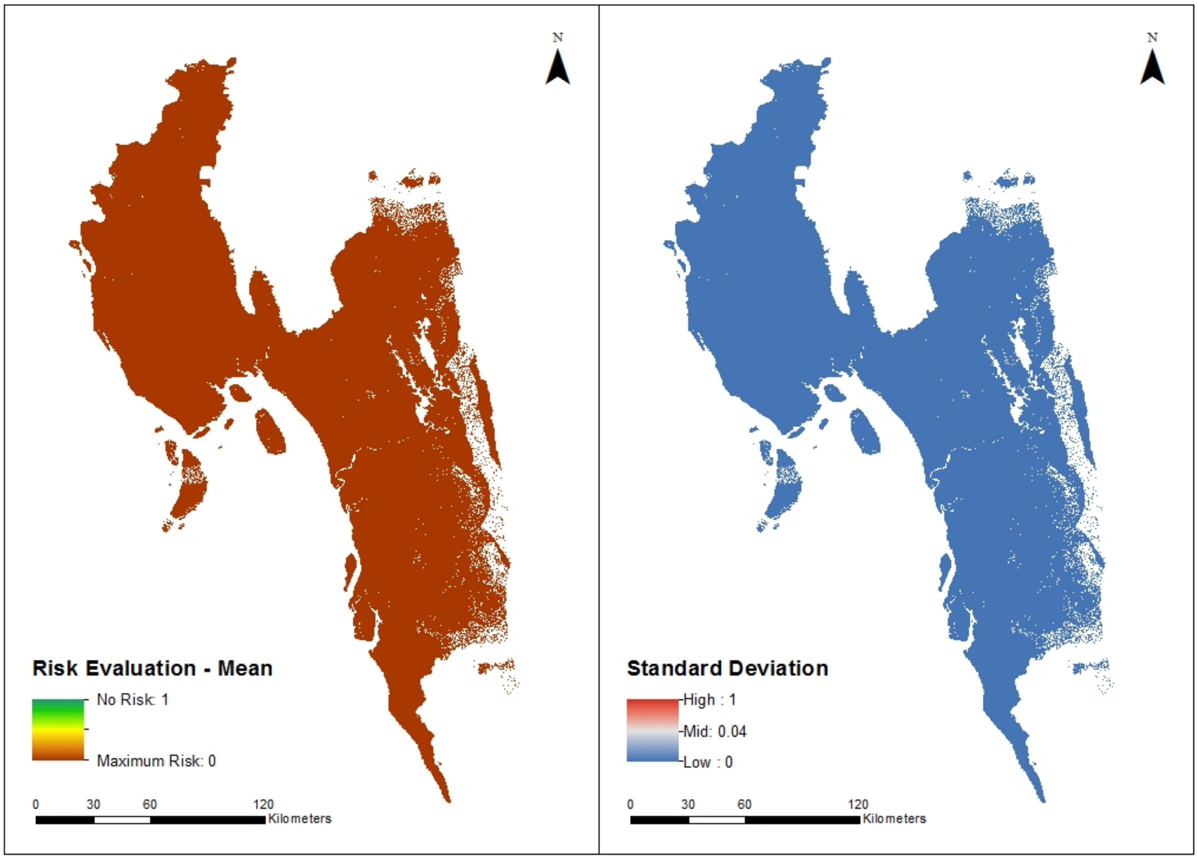
For this metric, only responses concerning the US Agency for International Development (USAID) are highlighted. From the USAID website (link above):

> *USAID's Office of U.S. Foreign Disaster Assistance (USAID/OFDA) remains at the forefront of the humanitarian community's shelter and settlements (S&S) activities, which focus on a common goal: the expeditious and appropriate provision of covered living space to adequately shelter displaced populations, while also promoting safer, healthier settlements that link emergency S&S assistance to longer-term recovery efforts.*

Answers of "Mainly Positive" are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Mainly Negative" are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of "Not Familiar" are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

Example Realization Metric Map

Perceived Impact USAID Metric



5.3.1.4 Metric: PerceivedImpactMuslimAid

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	https://www.muslimaid.org/what-we-do/shelter-and-construction/

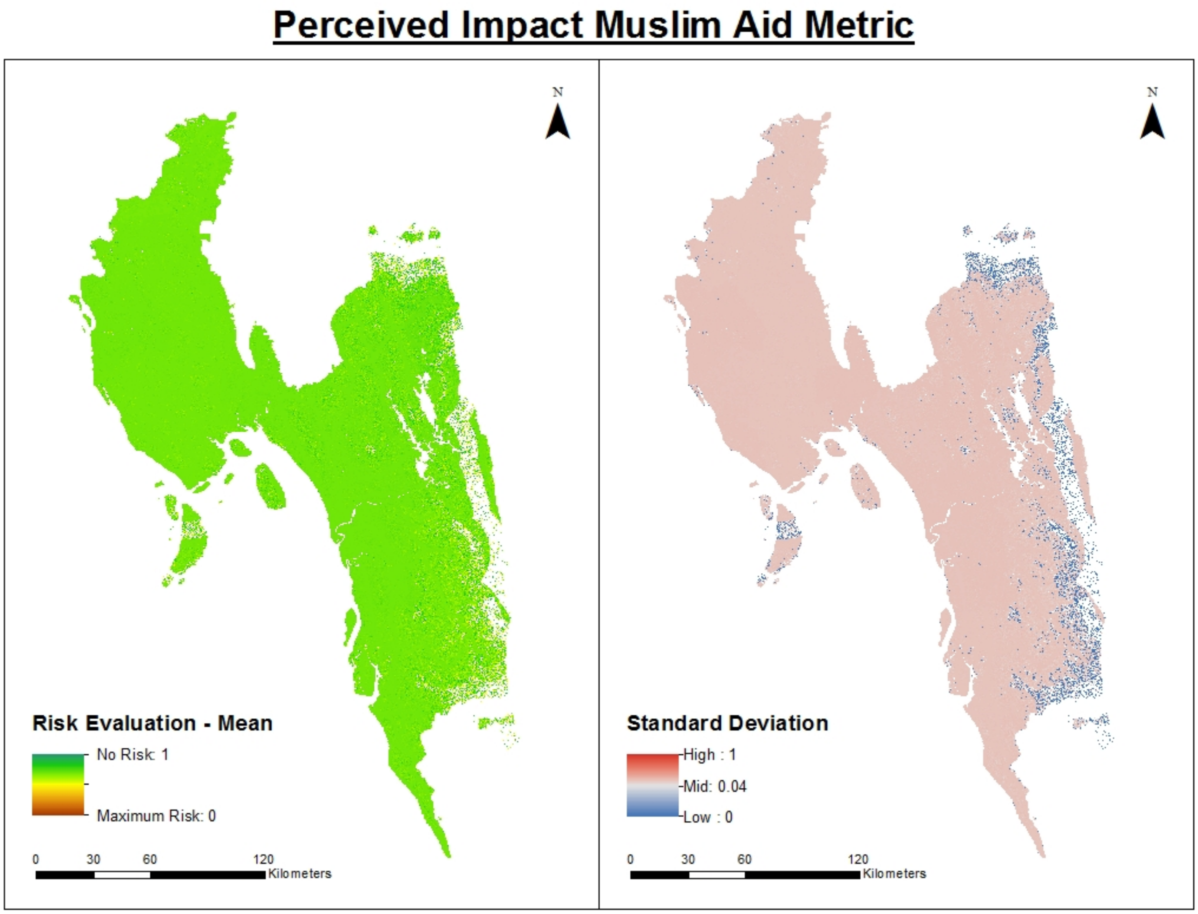
Logic:

This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami.

For this metric, only responses concerning Muslim Aid are highlighted. The Muslim Aid Housing Programme is intended to provide housing for widows and orphans who can't otherwise sustain housing on their own.

Answers of "Mainly Positive" are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Mainly Negative" are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of "Not Familiar" are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

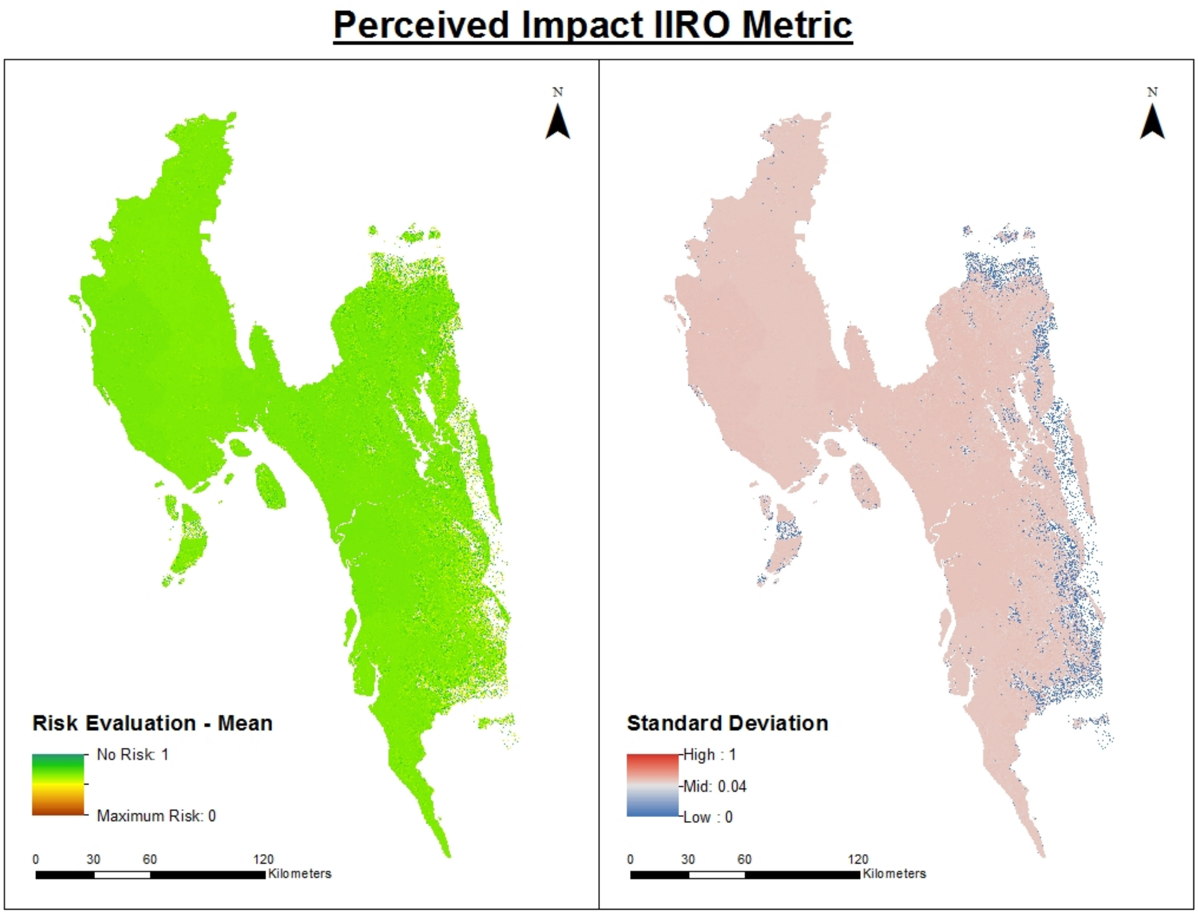
Example Realization Metric Map



5.3.1.5 Metric: PerceivedImpactIIRO

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	http://www.egatha.org/eportal/index.php?option=com_content&view=article&id=7&Itemid=3
Logic:	This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami. For this metric, only responses concerning the International Islamic Relief Organization are highlighted. Housing and shelter issues are addressed within their “Engineering” and Emergency Relief” project initiatives. Answers of “Mainly Positive” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Mainly Negative” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of “Not Familiar” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

Example Realization Metric Map



5.3.1.6 Metric: PerceivedImpactUNICEF

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	https://www.unicef.org/supply/index_cpe_shelter.html

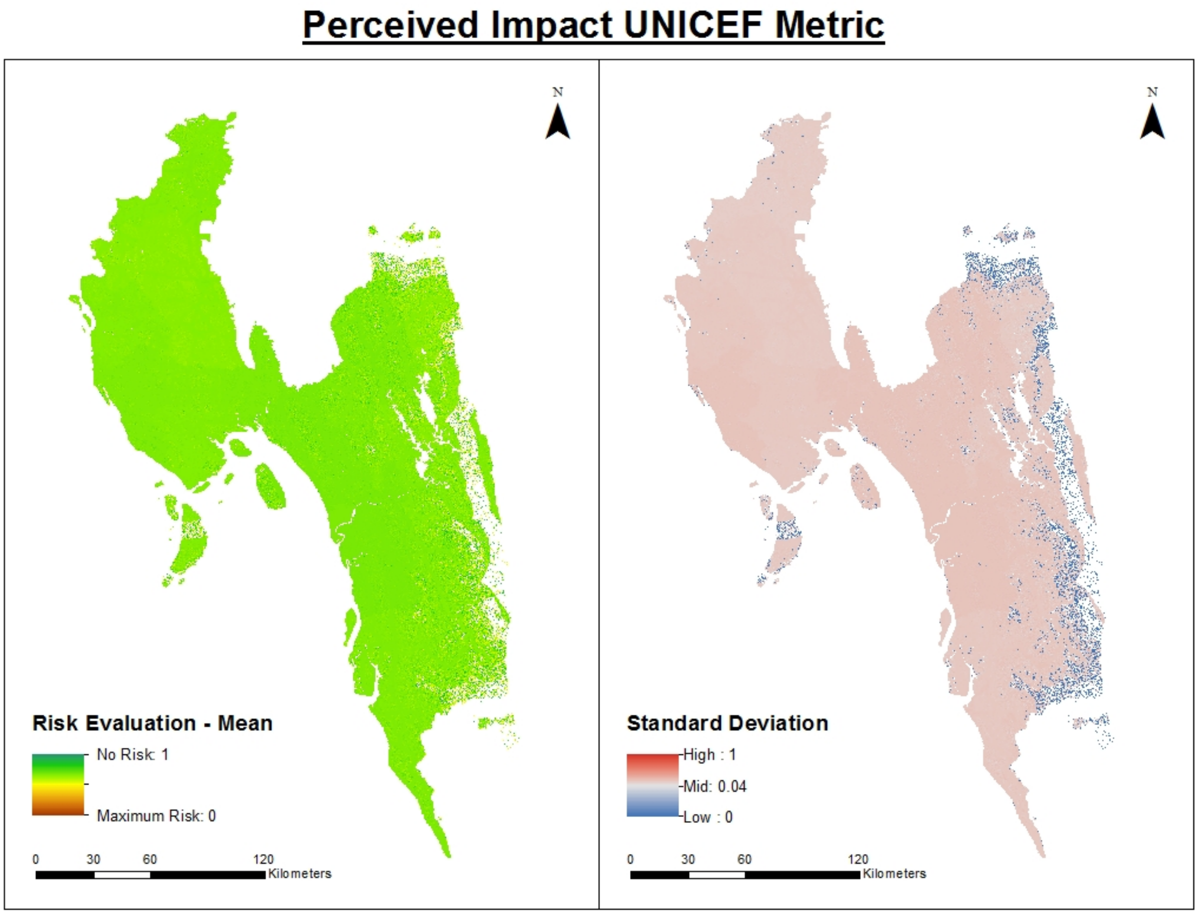
Logic:

This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami.

For this metric, only responses concerning the United Nations International Children's Emergency Fund (UNICEF) are highlighted. UNICEF often provides necessary shelter materials following a disaster, including tarps, blankets, cooking sets, and tents.

Answers of "Mainly Positive" are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "Mainly Negative" are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of "Not Familiar" are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

Example Realization Metric Map

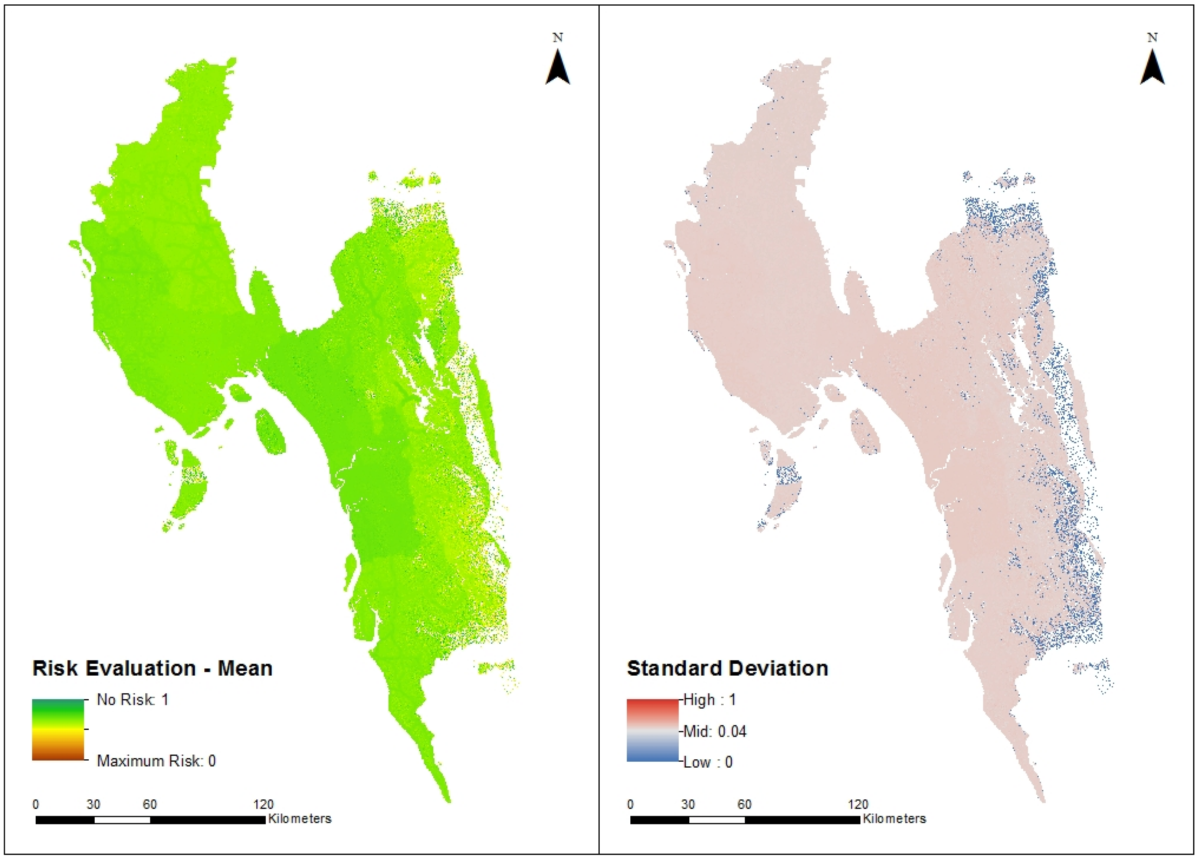


5.3.1.7 Metric: PerceivedImpactCAREIntl

Indicator:	Insufficient Rebuilding of Shelter/Housing
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Mainly Positive (min: 1.0, max: 1.0) Mainly Negative (min: 0.0625, max: 0.5) Not Familiar (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	http://www.careinternational.org.uk/fighting-poverty/building-back-safer/shelter
Logic:	This metric consists of question 8 of the VPS survey, which asks respondents about 10 international aid organizations and 4 Bangladeshi national banks, and whether their opinion is mainly positive, mainly negative, or if they are not familiar with the organization. Organizations included USAID, UNESCO, FIF, WAMY, Muslim Aid, International Islamic Relief Org, UNICEF, WHO, CARE International, Asia Foundation, Grameen Bank, Brac, Rapantar, and Rabitaal Alamal Islami. For this metric, only responses concerning CARE International are highlighted. Housing and shelter-related projects are wide-ranging, from providing temporary shelter post-disaster to improved construction and security of land rights, and from infrastructure repair to supporting home-based businesses. Answers of “Mainly Positive” are given both a minimum and maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Mainly Negative” are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 0.5 (slight risk, $½^1$). Answers of “Not Familiar” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from extreme risk to no risk.

Example Realization Metric Map

Perceived Impact CARE International Metric



5.3.2 Indicator: Sustained Lack of Operational Utilities

This indicator emphasizes potential wide-ranging electrical issues following a disaster or crisis.

PACOM specifies that metrics should include: number of days the electrical grid is offline, and the percentage of electrical grid online.

Metric Weighting Logic

As the “PerceivedEffortElectrical” metric (whether an individual or organization is working to improve access to electricity from the VPS survey) speaks to broader issues of improvement to the existing utilities, not access, it is given both a slightly lower minimum weight and a higher maximum weight.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueElectricity (5.3.2.1)	0.6	0.6
PerceivedEffortElectricity (5.3.2.2)	0.45	0.7

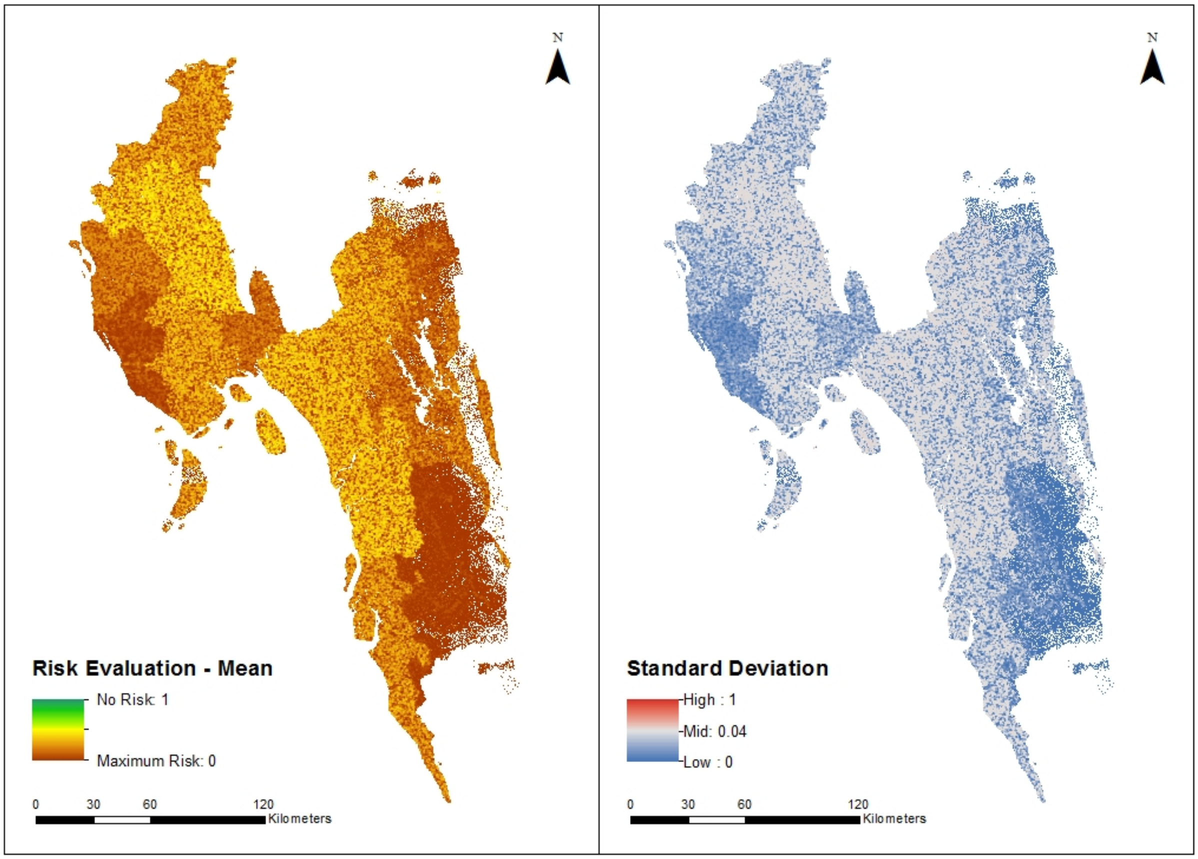
Uncertainty Values

Current metrics point to the general condition of access to electricity, rather than electrical issues following a disaster. The addition of metrics accounting for power outages (size, length, etc.), other electrical issues, and other operational utilities could further decrease the uncertainty values from 0.1 to 0.3.

Indicator Uncertainty Min: 0.65
Indicator Uncertainty Max: 0.75

Example Outcome

Sustained Lack of Operational Utilities Indicator

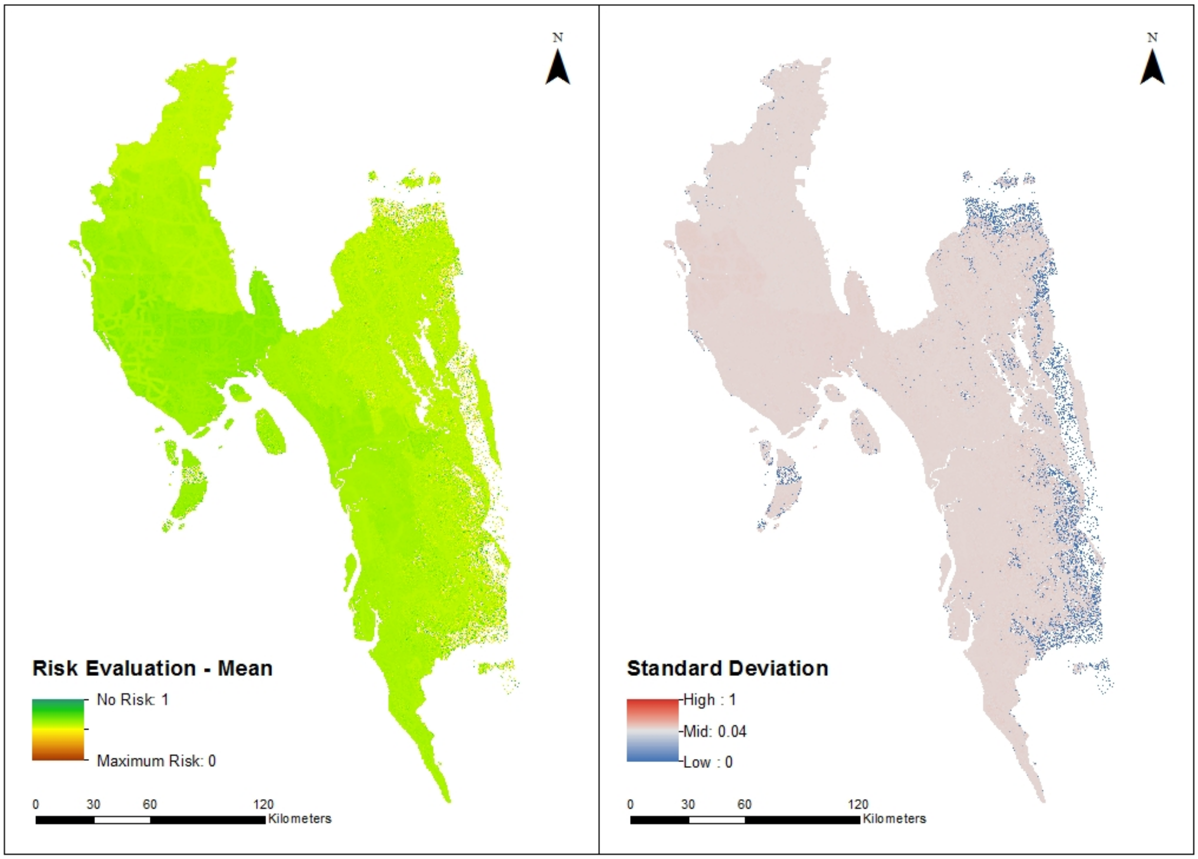


5.3.2.1 Metric: PerceivedIssueElectricity

Indicator:	Sustained Lack of Operational Utilities
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether access to electricity is more or less serious in your community than the rest of Bangladesh?” Answers of “Not Issue” and given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

Perceived Issue Electrical Metric

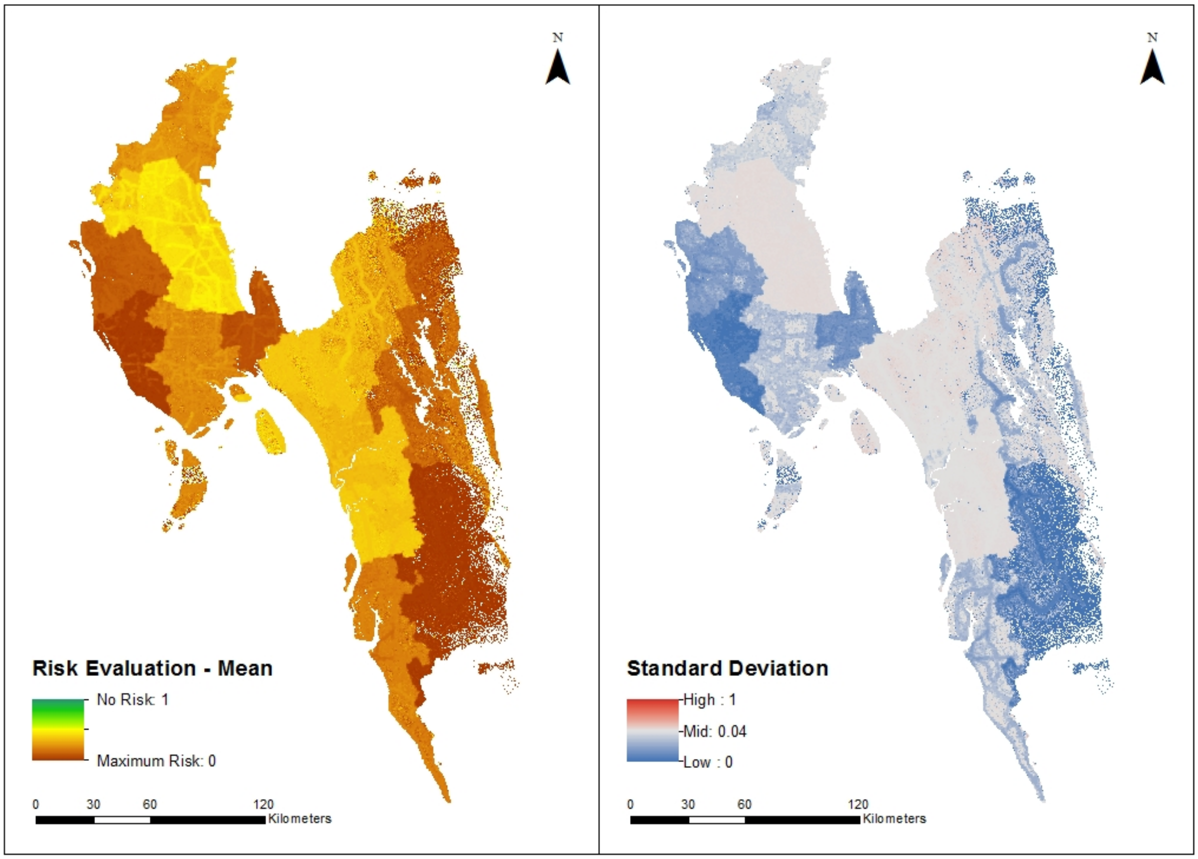


5.3.2.2 Metric: PerceivedEffortElectricity

Indicator:	Sustained Lack of Operational Utilities
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve Bangladeshis' access to electricity today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map

Perceived Effort Electricity Metric



5.3.3 Indicator: Delays to Re-establishment of Transportation Systems

This indicator encompasses all aspects of the transportation system and its relevant infrastructure: roads, railways, trains, airports, airplanes, subway stations and lines, etc. A post-Hurricane Katrina report defines transportation resiliency as a system's ability to function before, during and after major disruptions through reliance upon multiple mobility options (Amdal and Swigart 2010). Hence, the amount of transportation modes affected and the speed of their recovery should be taken into account.

PACOM specifies that metrics should include (all compared with historical data): percentage of roads unusable; percentage of railways unusable; percentage of trains not running; percentage of airports unusable; percentage of flights not operating; percentage of subway stations unusable; and percentage of subway lines not operating.

Metric Weighting Logic

As the "PerceivedEffortTransportation" metric (whether an individual or organization is working to improve access to transportation from the VPS survey) speaks to broader issues of improvement to the existing transportation, not access, it is given both a slightly lower minimum weight and a higher maximum weight.

Metric (heading number)	Weight Minimum Value	Weight Maximum Value
PerceivedIssueTransportation (5.3.3.1)	0.6	0.6
PerceivedEffortTransportation (5.3.3.2)	0.45	0.7

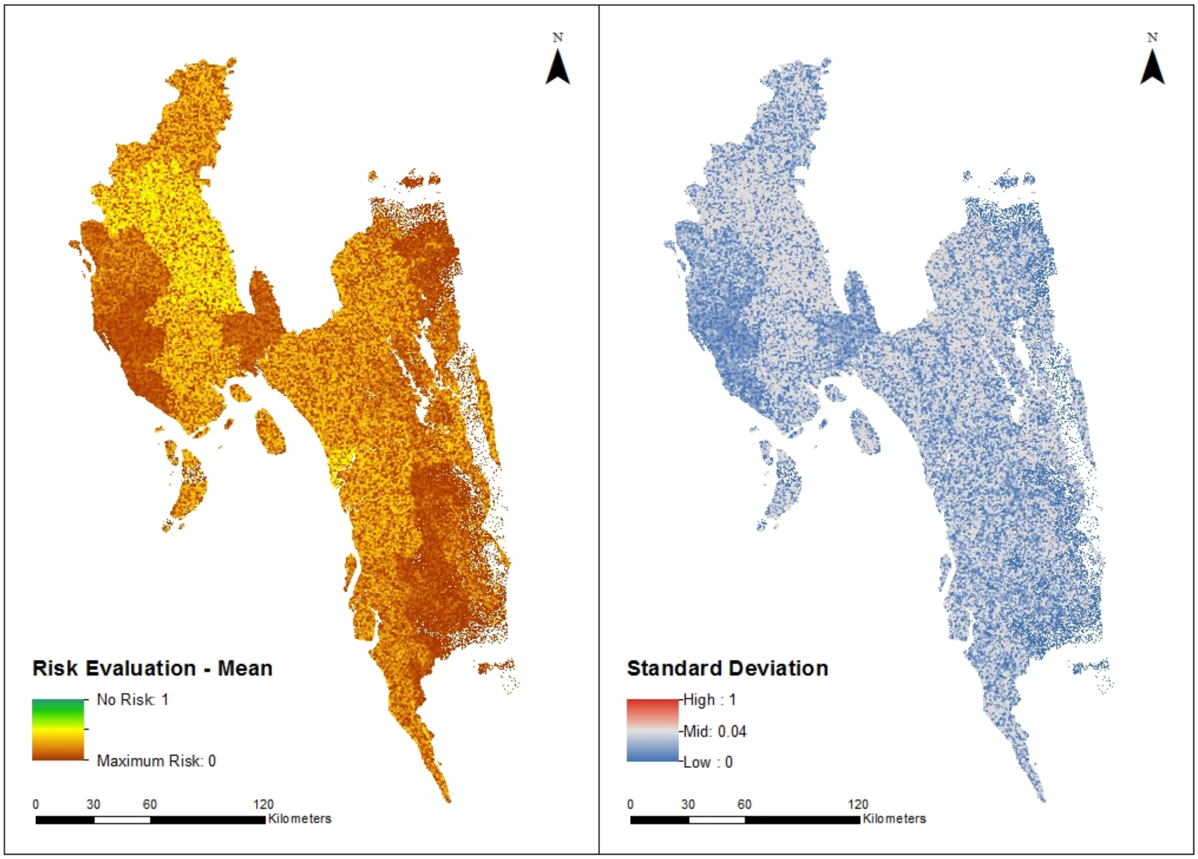
Uncertainty Values

This indicator has current metrics that speak to access to transportation in average circumstances, not specifically after a disaster. The addition of metrics called for by PACOM could decrease the uncertainty values from 0.1 to 0.3. Also, explicit computational modeling of transportation resilience assuming various road or bridge blockages would reduce uncertainty.

Indicator Uncertainty Min: 0.8
Indicator Uncertainty Max: 0.9

Example Outcome

Delays to Re-establishment of Transportation Systems Indicator



References

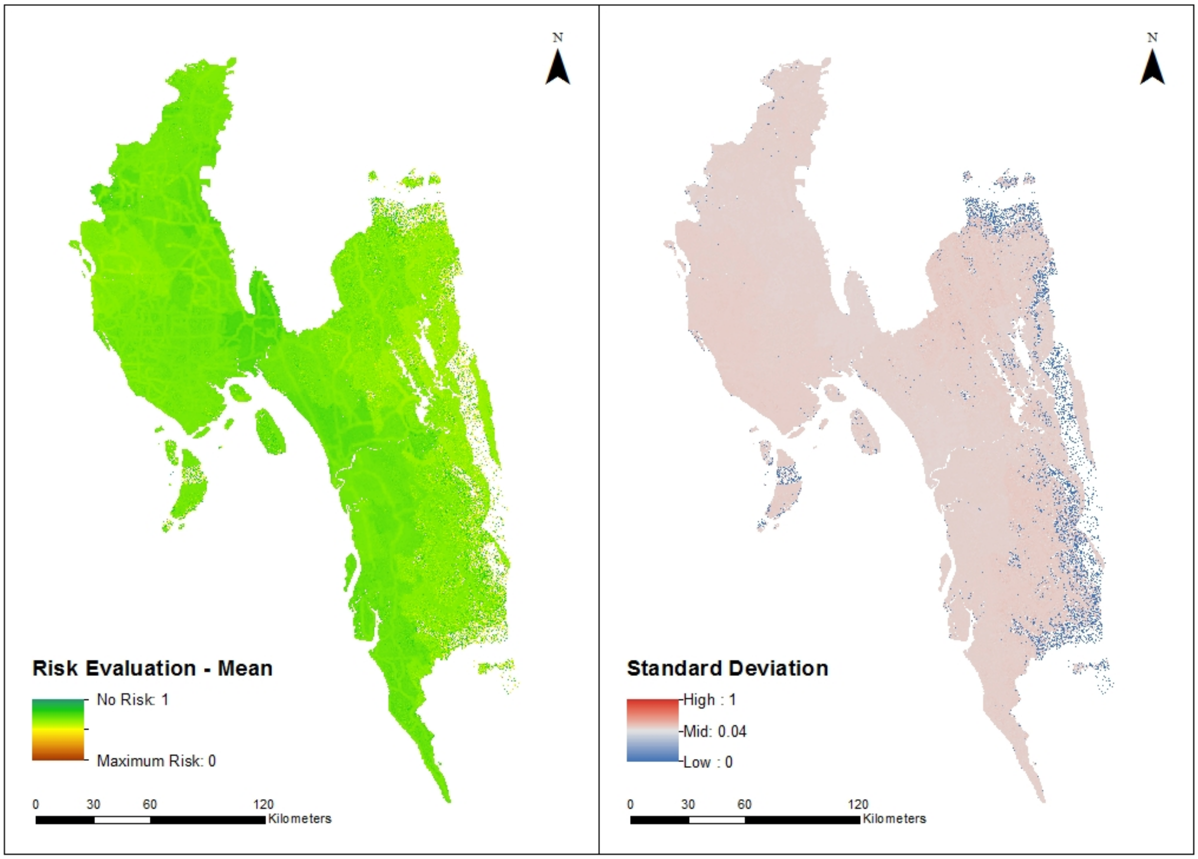
Amdal, James R. and Stan L. Swigart (2010). Resilient Transportation Systems in a Post-Disaster Environment: A Case Study of Opportunities Realized and Missed in the Greater New Orleans Region. Gulf Coast Research Center for Evacuation and Transportation Resiliency. Oct 2010. Accessed at https://ntl.bts.gov/lib/43000/43700/43782/10-01.pdf on 1 Feb 2017.

5.3.3.1 Metric: PerceivedIssueTransportation

Indicator:	Delay to Re-establishment of Transportation Systems
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	NotIssue (min: 1.0, max: 1.0) LessSerious (min: 0.25, max: 0.9) MoreSerious (min: 0.07, max: 0.5)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you tell me whether access to transportation and good roads is more or less serious in your community than in the rest of Bangladesh?” Answers of “Not Issue” and given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “Less Serious” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.9 (minimal risk). Answers of “More Serious” are given a minimum value of 0.07 (high risk) and a maximum value of 0.5 (slight risk, $½^1$). Maps will range from high risk to no risk.

Example Realization Metric Map

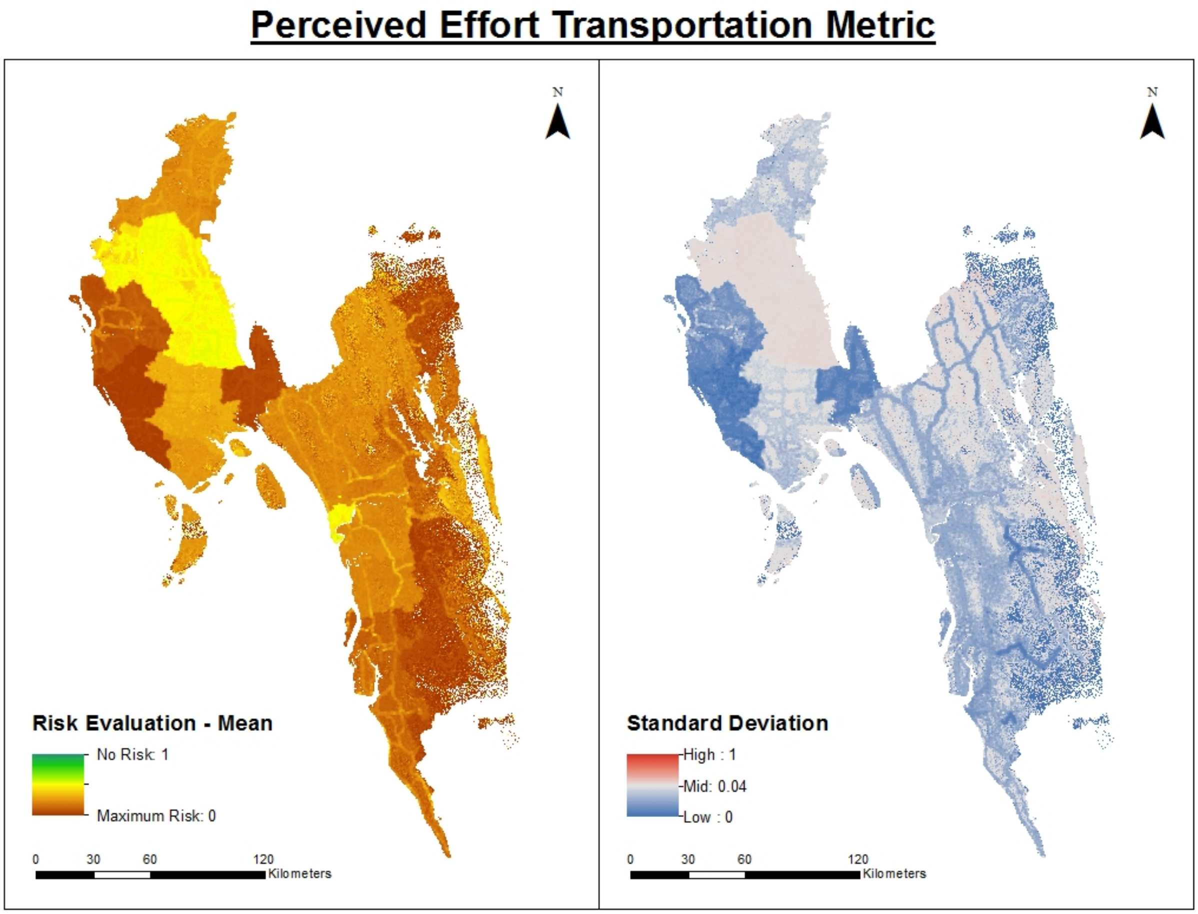
Perceived Issue Transportation Metric



5.3.3.2 Metric: PerceivedEffortTransportation

Indicator:	Delay to Re-establishment of Transportation Systems
Factor:	Inadequate Construction/Reconstruction
Condition:	Resilience Deficiencies
Metric Assigned Values:	Yes (min: 1.0, max: 1.0) No (min: 0.25, max: 0.98)
Survey:	VPS
Survey Date:	2011
Other Data Sources:	
Logic:	This metric consists of answers to the question “Can you name an organization or public figure that you believe is working hard to improve access to transportation and good roads in Bangladesh today?” Answers of “Yes” are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of “No” are given a minimum value of 0.25 (medium risk, $½^2$) and a maximum value of 0.98 (minimal risk). Maps will range from medium risk to no risk.

Example Realization Metric Map



5.3.4 Indicator: Diminished Agricultural Production

This indicator focuses on reduced agricultural production following a disaster or crisis. This takes into account more permanent metrics than the "Production Decreases" indicator in terms of effected agricultural land.

PACOM specifies that metrics should include: percentage of agricultural land permanently unusable, and percentage of agricultural land temporarily unusable (both compared with historical data).

Metric Weighting Logic

As there is currently only one metric within this indicator, it is weighted both a minimum and maximum of 1.0.

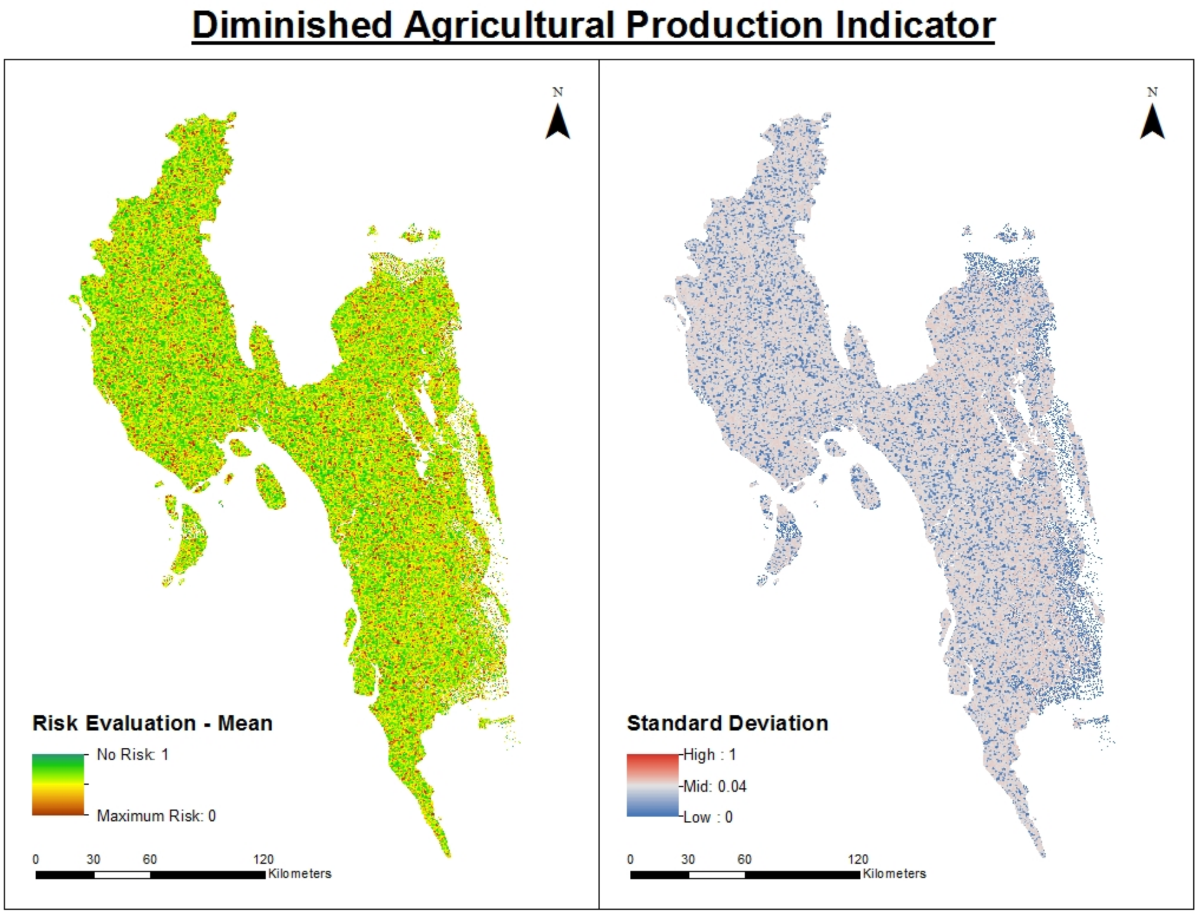
Metric (heading number)	Weight Minimum Value	Weight Maximum Value
HHOwnAgLand (5.3.4.1)	1.0	1.0

Uncertainty Values

This indicator has current metrics that only speak to agricultural land ownership. The addition of metrics recommended by PACOM could decrease the uncertainty values from 0.1 to 0.3.

Indicator Uncertainty Min: 0.95
Indicator Uncertainty Max: 0.99

Example Outcome

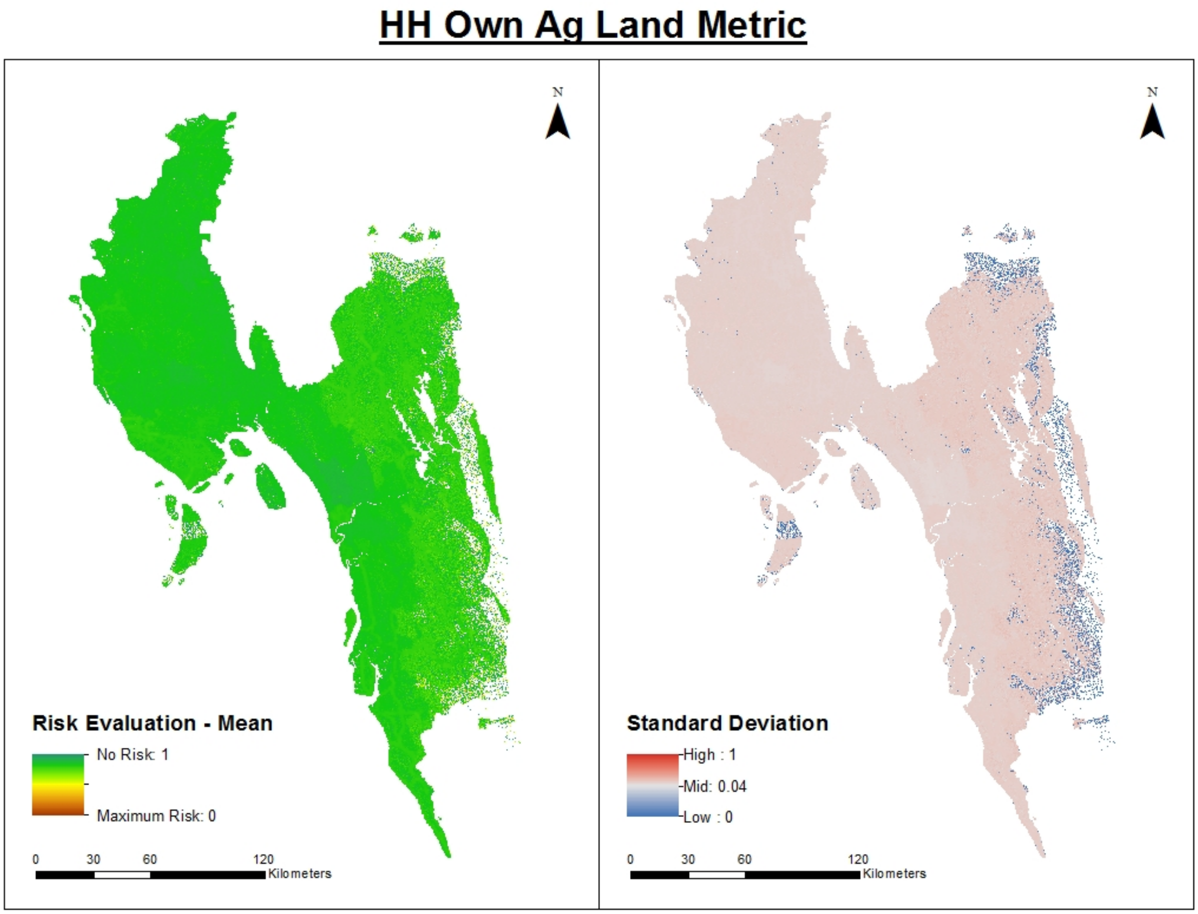


5.3.4.1 Metric: HHOwnAgLand

Indicator: Diminished Agricultural Production
Factor: Inadequate Construction/Reconstruction
Condition: Resilience Deficiencies
Metric Assigned Values: Yes (min: 1.0, max: 1.0)
No (min: 0.0625, max: 1.0)
Survey: DHS
Survey Date: 2011
Other Data Sources:

Logic: This metric consists of answers to the question "Does any member of this household own any agricultural land?" from the household portion of the DHS survey. Answers of "Yes" are given both a minimum and a maximum value of 1.0 (minimal risk with no impact on risk, $½^0$). Answers of "No" are given a minimum value of 0.0625 (extreme risk, $½^4$) and a maximum value of 1.0. The reason for the wide range of values for "No" answers is the lack of clear relevance between the question (which asks about land ownership) and the indicator (which points to land production). Maps will range from extreme risk to no risk.

Example Realization Metric Map



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14. ABSTRACT

This report describes a demonstration of the Framework for Integrating the Complexity of Urban Systems (FICUS) as applied to a theoretical humanitarian crisis (HC) analytical framework for Bangladesh provided by the U.S. Navy Joint Intelligence Center Pacific (JICPAC). This type of framework is used to monitor the risk of abuse or attack involving systems within the U.S. Navy Pacific Command area of responsibility. Output from the FICUS data-conflation model was used to populate this representative HC framework with socioeconomic survey-response data usable at fine scales of resolution. A key feature of the FICUS methodology is that it accounts for both known and unknown uncertainties in the data using statistically transparent techniques. The report discusses both the successes and limitations demonstrated by the case study. An inherent and expected limitation of this technology is that because it was developed for population-survey data conflation, it could not greatly facilitate insight into aspects of an HC framework addressing indicators such as macroeconomic investment, commerce, or construction policy.

15. SUBJECT TERMS

Military planning; Humanitarian assistance–Analysis; Economics–Social aspects; Metropolitan areas; Megacities; United States–Armed Forces–Stability operations; Bangladesh

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