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Incorporating epidemics risk in the INFORM Global Risk Index

INFORM Epidemic GRI and Enhanced INFORM GRI

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Contents

Abstract

The objective of the presented study is to introduce epidemic risk in the multi-hazard risk assessment **INFORM Global Risk Index (GRI)** tool.

The INFORM GRI is a composite indicator developed by the Joint Research Centre of European Commission (JRC) that identifies countries at risk of humanitarian crisis and disaster. Although biological hazards are a significant source of risk that may result in emergency and disasters, epidemic risk was not yet included in the INFORM model.

The Sendai **Framework for Disaster Risk Reduction (SFDRR**) indicates that biological hazards such as epidemics and pandemics need to be addressed in addition to natural hazards as a key area of focus for disaster risk management. Hence, there was an increasing demand to develop a comprehensive multidimensional risk assessment tool, which is globally applicable to all types of risks, including epidemics. INFORM GRI offered the perfect ground to integrate this additional aspect and to consolidate INFORM as a reference for global multi-hazard disaster risk assessment tool.

Starting from an epidemic risk conceptual framework (**Epidemic Risk Index - ERI**) jointly developed by the World Health Organisation (WHO) and the JRC, this report describes the process and the method to convert ERI into a quantitative model. The integration of the epidemic aspect into INFORM concept has allowed JRC to develop the new version taking as well into consideration another request largely discussed with INFORM partners, namely the possibility to have a more hazard-dependent overview of the risk index. Hence, two different developments have been done:

1. developing the **INFORM Epidemic Global Risk Index (INFORM Epidemic GRI)** as an adaptation of the INFORM GRI, preserving the integrity of the original model, by adding the hazard (epidemics) dependent components derived by the ERI conceptual framework;
2. enhancing the content of the INFORM GRI 2019 (**Enhanced INFORM GRI 2019**) by adding an epidemic hazard component together to the other hazards.

For the first time, within a single framework, the INFORM Epidemic GRI allows to assess the risk for all the type of epidemics. On of the advantages of his modular approach is that it can be applied to different types of hazards, not necessarily included in the INFORM GRI, allowing comparability among different risks.

Furthermore, with the inclusion of the epidemic exposure, the Enhanced INFORM Global Risk Index is the first comprehensive multidimensional disaster risk assessment tool, which is globally applicable to all types of risks.

Role of the authors

Karmen Poljanšek, as the editor of the report, was responsible for designing the concept and leading the development of the models and the preparation of the report.

Montserrat Marin Ferrer, as the coordinator of the DRMKC projects, overviewed the whole process.

Luca Vernaccini, as the external consultant, upgraded the INFORM GRI model and implemented the INFORM hazard dependent GRI model, analysed adopted scientific and technical solution, computed and presented the results, and wrote the report.

Laura Messina, as trainee, helps to review the report.

1 Introduction

The management of risks due to biological hazards is a national and community priority[1]. The World Health Organisation (WHO) declared a total of 1307 epidemic events in 172 countries from 2011 to 2017[2].

Epidemics of infectious diseases like recent outbreaks of Ebola, Middle East Respiratory Syndrome (MERS – CoV), Zika and other emerging and re-emerging diseases have shown the capacity to disrupt many dimensions of human existence. Moreover, they can affect anywhere in the world and severely test the global community's resilience.

The Sendai Framework for Disaster Risk Reduction (SFDRR) indicates that biological hazards such as epidemics and pandemics need to be addressed in addition to natural hazards as a key area of focus for disaster risk management[3]. In support of this, in 2017 the UNISDR published a report on a hazard-specific risk assessment module to introduce the assessment of biological hazards[4]. The report outlines various approaches to assess the risk of biological hazards, which differ according to the purpose of the assessment. These include strategic risk assessment, rapid risk assessment, and post-event assessment.

Several risk assessment tools for specific epidemics and explicit countries have been established. However, in the field of epidemic risk, holistic frameworks are lacking and existing models are built for either specific pathogens or restricted to a specific geographical region [6].

Global epidemic risk models would provide an opportunity to identify high priority risk areas and prioritize resources for prevention, preparedness, capacity development and medium-long term risk monitoring and evaluation.

Furthermore, several European Commission institutions and United Nations agencies have been involved in the development of global risk assessment data framework.[5,6] However, a comprehensive multidimensional risk assessment tool globally applicable to all types of risks, including the epidemics, has not been developed yet. This report presents a step forward in this direction. Additional risks could be included in the future to reach a holistic overview of risk at global level.

In 2017, the WHO started developing a framework for an epidemic risk assessment tool (later referred as Epidemic Risk Index - ERI) [1]. The WHO decided to follow the composite indicator approach used by the INFORM Global Risk Index (INFORM GRI) methodology [2], and therefore asked the Joint Research Centre of the European Commission (JRC) to assist and contribute during the development process. The INFORM GRI is a composite indicator developed by the JRC, that identifies countries at risk of humanitarian crisis and disaster that would overwhelm national response capacity. It provides an open, transparent, flexible, consensus-based methodology for analysing crisis risk at global, regional or national level (a more detailed description is given in Section 2). Through extensive consultation within and outside the organisation, the WHO identified the underlying risk drivers of epidemic, which enabled the WHO to develop a conceptual framework for epidemic risk assessment in countries. Most of the identified risk drivers for epidemics were already considered in the INFORM GRI; the synergies between the two conceptual frameworks are therefore large.

The WHO ERI framework remained at the conceptual level and the first part of this study has consisted in transforming the concept into a real quantitative risk index including and testing the correlations and availabilities of the proposed datasets.

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1 https://www.preventionweb.net/files/52828_05biologicalhazardsriskassessment.pdf

2 WHO/IHM data as of 12 January 2018

3 https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

4 https://www.unisdr.org/we/inform/publications/57459

5 https://www.preventionweb.net/files/58255_gar19conceptnote18.05.2018final.pdf (GAR2019)

6 Cambridge Centre for Risk Studies, 2018. Outline Plan for Developing a Global Crisis Risk Assessment Method. Cambridge Centre for Risk Studies at the University of Cambridge Judge Business School. (GCRP)

At the last annual meeting[7] held in Geneva in June 2018, the INFORM partners agreed to include an infectious disease outbreaks component in the natural hazard category of the INFORM GRI.

Moreover, some of the INFORM partners considered that for disasters as epidemics the INFORM GRI had low sensibility to capture the potential evolution and hence it was not yet optimised to meet the specific needs of their organisation[8].

The JRC, as scientific and technical responsible of INFORM, took the lead in incorporating epidemic risk in the INFORM GRI.

Starting from the WHO ERI concept model, JRC decided to focus on:

- developing a hazard-dependent version of the INFORM Global Risk Index in a modular way and as a case study by introducing all the additional features from the WHO ERI concept model in order to create an epidemiological model of INFORM (**INFORM Epidemic GRI**); this was possible due to the large similarity between the type of indicators proposed in ERI and the ones used in the INFORM GRI;
- enhancing the content of the INFORM GRI (**Enhanced INFORM GRI**) by adding an epidemic hazard component together with the other hazards, having for the first time a multi-hazards risk assessment tool including epidemics.

The scope of this report is to describe the development process and the method used to add all the additional features from the WHO ERI conceptual model in order to incorporate the epidemiological risk in the INFORM GRI.

After introducing INFORM in the first chapter, we start describing the process lead to convert the WHO ERI conceptual framework into a quantitative model.

We describe the development process and the method used to integrate all the additional features taken from the ERI quantitative model lead into the INFORM GRI model with the objective to create the INFORM Epidemic Global Risk Index as an hazard-dependent version of the INFORM GRI.

The Enhanced INFORM GRI is then presented, with the inclusion of the epidemic hazard component as a new natural hazard.

Finally, we anticipate that the set of structural indicators that will be systematically collected for feeding the INFORM Epidemic GRI will be part of the contextual information that could be used by a Rapid Risk Assessment platform.

[7] INFORM Annual Partners' Meeting, 28-29 June 2018, UNDP, Geneva

[8] INFORM Annual Partners' Meeting, 22-23 June 2017, FAO, Rome

2 The Index for Risk Management - INFORM

The Index for Risk Management - INFORM - is a way to understand and measure the risk of a humanitarian crisis. The INFORM initiative started in a workshop in October 2012 organised at the JRC. Since that time, INFORM has become a multi-stakeholder forum for developing shared analyses to help manage humanitarian crises and disasters. INFORM now has partners from across the UN system, donors, civil society, academic/technical community, and the private sector.

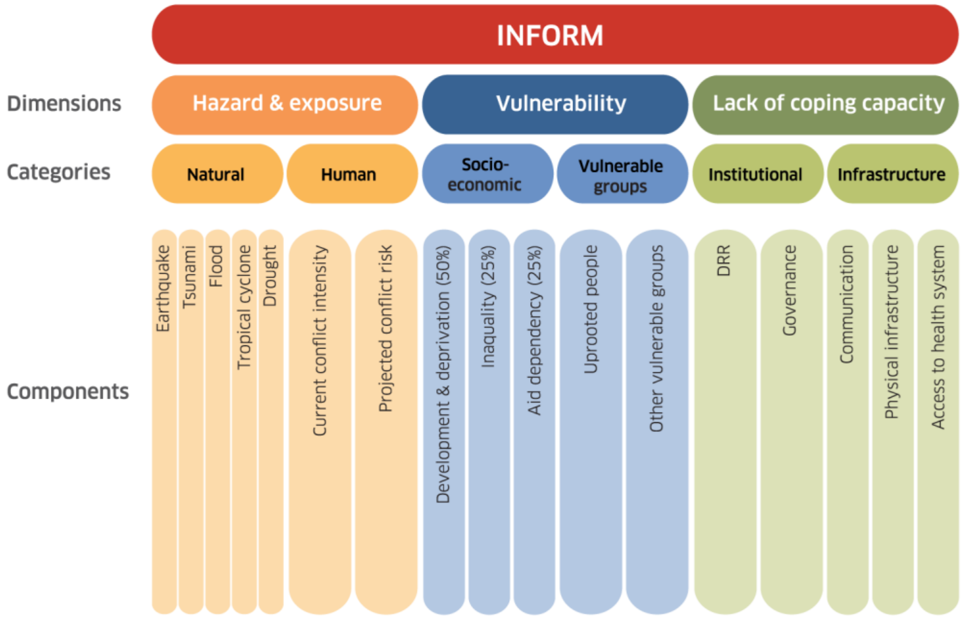
The JRC is the main scientific partner in the INFORM process, and has lead the bottom-up process of building a consensus-based new methodology, taking into account the requirements of participating institutions as well as limitations of data availability. INFORM has an annual partner conference where strategic developments are discussed, and frequent teleconferences of the core group and/or thematic groups to discuss implementation of methodological improvements and changes.

The INFORM GRI has been developed to improve the common evidence basis for risk analysis so that all governments, development agencies, disaster risk reduction actors and organisations can work together. INFORM GRI is the first global, open-source, continuously updated, transparent and reliable tool for understanding risk of humanitarian crises and disasters. It covers 191 countries. All the results and data used are freely available and the INFORM partnership includes many data source organisations. The methodology is completely transparent and based on scientific concepts and methods.

INFORM GRI is a composite indicator developed by the JRC by combining more than 50 indicators into three dimensions of risk (**Figure 1**): hazards (events that could occur) and exposure to them, vulnerability (the susceptibility of communities to those hazards) and the lack of coping capacity (lack of resources that can alleviate the impact). They give an overall risk score out of 10 for each country, and for each of the dimensions, categories, and components of risk. The purpose of INFORM is to provide an open, transparent, consensus-based methodology for analysing crisis risk at the global, regional or national level. The index results are published twice a year. This year is the fifth edition of the INFORM GRI.

INFORM GRI is a widely recognised and valuable tool that supports decision-making of INFORM partners and others. The INFORM risk analysis process and methodology has been extended to the regional and country level and adapted to many scopes and targets.

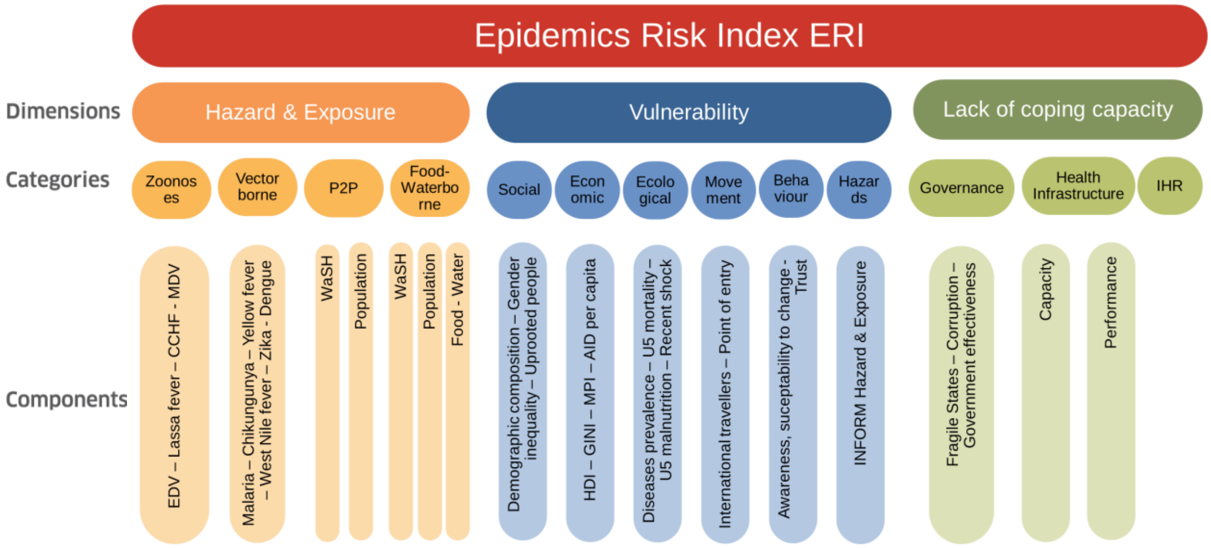
Figure 1: INFORM GRI Conceptual Framework



3 Epidemic risk index: from conceptual to data level

The Infectious Hazard (IHM) Department of the WHO Health Emergencies (WHE) Programme organised an informal consultation on 21-22 March 2017 [5] to develop a draft Conceptual Framework for an Epidemic Risk Index (**Figure 2**), following the composite index methodology, as well as the risk concept implemented in INFORM.

Figure 2: Epidemic risk index conceptual framework



Almost 50 expert participants represented diverse views and disciplines, from various agencies and institutions related to epidemics, which enabled a comprehensive review of the draft Conceptual Framework for Infectious Hazards. The emerging components of risk were thereof classified according to INFORM dimensions: Hazard & Exposure, Vulnerabilities and Lack of Coping Capacities.

However, this analysis did not provide the set of indicators beyond the concept. Therefore, ERI has never existed as an index. For the purpose of introducing epidemic risk in INFORM, it was necessary to finalise the ERI model first. This allows then to use the final risk score as benchmark for validation of the INFORM Epidemic GRI, and to introduce the epidemic component (ERI Hazard & Exposure dimension) in the INFORM GRI.

3.1 The Epidemic Risk Index conceptual framework

When a country is exposed to an infectious hazard event of a multifaceted nature, its complexity and interactions with various dimensions makes a unique optimal solution not possible.

The declared objective of the WHO Epidemic Risk Index was to present epidemic risk in quantitative terms. Due to the complexity of the problem, the evolution of the epidemics and their potential impacts, it was conceptually based on the methodology of the INFORM GRI, a well-established tool for disaster risk assessment.

The INFORM model describes three dimensions of risk: hazards & exposure, vulnerability and lack of coping capacity dimensions. Each dimension includes different categories. Each category cannot be completely captured by any individual indicator, thus each category is broken into components that capture the topic and are presented with a reliable set of indicators.

Like the INFORM GRI [2], the ERI model can be divided into different levels to provide a quick overview (**Figure 2**):

- Status level (Risk);
- Concept level – Dimensions (Hazard & Exposure, Vulnerabilities and Lack of Coping Capacities);
- Functional level – Categories (Zoonoses, Vector borne, Social, Governance, …); and
- Component level - sets of indicators that capture concept of each category.

Infectious disease susceptibility (in terms of exposure to infectious agents related to human and animal) is considered under the Hazard & Exposure dimension. Any other hazard (like natural and manmade hazards), which increases the susceptibility to infectious disease, is considered under the Vulnerability dimension. The higher the fragility of the socio-economic system combined with low level of awareness and nutritional and health status is, the higher the risk is.

Likewise, the vulnerability dimension covers the fragility of the socio-economic system, and the susceptibility due to low level of awareness, nutritional and health status. The higher the fragility of the socio-economic system, low level of awareness and nutritional and health status, the higher is the risk.

Finally, under the coping capacity, the institutional and infrastructure resources are considered by including the capacities for the implementation of the International Health Regulations (IHR)[9]. Conceptually, better epidemic management means higher coping capacity, which means lower level of risk. For the sake of more straightforward communication, higher indicator values in Epidemic risk index refer to worse conditions. Therefore a coping capacity dimension is transformed into a lack of coping capacity. Higher lack of coping capacity means higher risk.

A risk can be defined as a combination of the probability of an event (Hazard variable) and its negative consequences (vulnerability variable) on an exposed element (exposure variable). The UNISDR and most of the literature express risk by Equation 1.

$$Risk = Hazard \times Exposure \times Vulnerability \qquad \text{Equation 1}$$

The INFORM methodology, where the vulnerability variable is split among three dimensions, Equation 1 is updated into Equation 2:

$$Risk = Hazard\&Exposure \times Vulnerability \times Lack\ of\ Coping\ Capacity \qquad \text{Equation 2}$$

The epidemic risk approach conceptualizes risk as the interaction of hazards, exposure, vulnerability and coping capacity of the system. These dimensions are carefully defined as there are innumerable interactions and overlapping exists among the dimensions. This framework does not define the interactions among the dimensions; however, it allows for a simple and transparent calculation of epidemic risk using composite index methodology.

Hazard & Exposure: The Hazard & Exposure dimension represents the probability of exposure to infectious agents. There are inter linkages between hazard and exposure as there is no risk if there is no exposure, no matter how severe the hazard event is, thus it is coupled into this dimension.

Vulnerability: Vulnerability describes how simply and how severely exposed people can be affected. This dimension addresses the inherent predispositions of an exposed population to be affected or susceptible to the effects of hazards. Thus the vulnerability

[9] World Health Organization. IHR Core Capacity Monitoring Framework. 2011.

dimensions represent the health vulnerability due to the social, economic, ecological, migratory behavioural and hazards characteristics of the country.

Lack of Coping Capacity: It encompasses the physical infrastructure, health system capacity, institutional and management capacity. This is the capacity of the country to conduct activities before, during and after infectious disease hazard event(s). Conceptually, better epidemic management means higher coping capacity, therefore lower risk opportunity. As just said above, for the sake of more straightforward communication, higher indicator values in index refer to worse conditions. Therefore, a coping capacity dimension is transformed into a lack of coping capacity.

3.2 From the concept to the model of ERI

The components and sub-components of ERI have been suggested by epidemiologists during the workshop, while the underlying indicators have been identified and collected by the JRC after a large literature review, following the INFORM principles of openness, reliability and completeness [2].

3.2.1 Indicator selection and data source

The JRC did small modifications in the original ERI framework. [1] Some components and/or indicators have been removed while new ones have been added for a number of reasons.

- The main motivation for removing components was the lack of available quantitative data at global level. Examples are the data concerning "Food consumption and habits", "Householding type", "Agriculture and food production" and "Hospital beds".
- Other indicators have been dropped due to the strong correlation with other indicators in the model[10]. "Infant mortality" under the Lack of Coping Capacity dimension and the "Under 5 mortality" in the Vulnerability dimension are essentially the same indicator; therefore the first one has been removed due to redundancy of indicators within the same component.
- Finally, new indicators have been added due to their evidence in literature ("Population Under 5" as the most exposed to foodborne diseases[11]), or in order to enhance proposed components with relevant indicators ("Local movements" in addition to the "International travellers" allows to capture all the spillover routes).

The final ERI framework is presented by the single dimensions, in

Figure 3, **Figure 4**, and **Figure 5**.

[10] Strong correlation between indicators (large than 90%) should be avoided for reducing the double counting [3].

[11] Children under 5 years of age carry 40% of the foodborne disease burden, with 125 000 deaths every year (http://www.who.int/en/news-room/fact-sheets/detail/food-safety)

Figure 3: Conceptual framework – Hazard & Exposure dimension

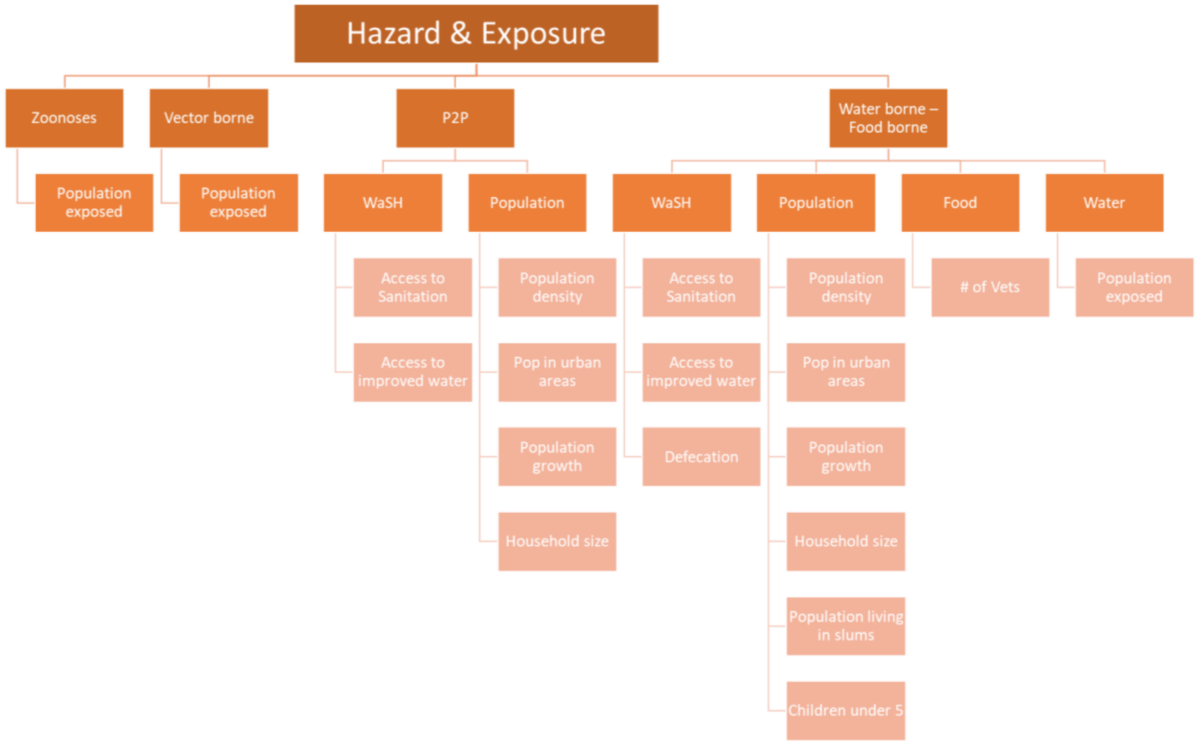


Figure 4: Conceptual framework - Vulnerability dimension

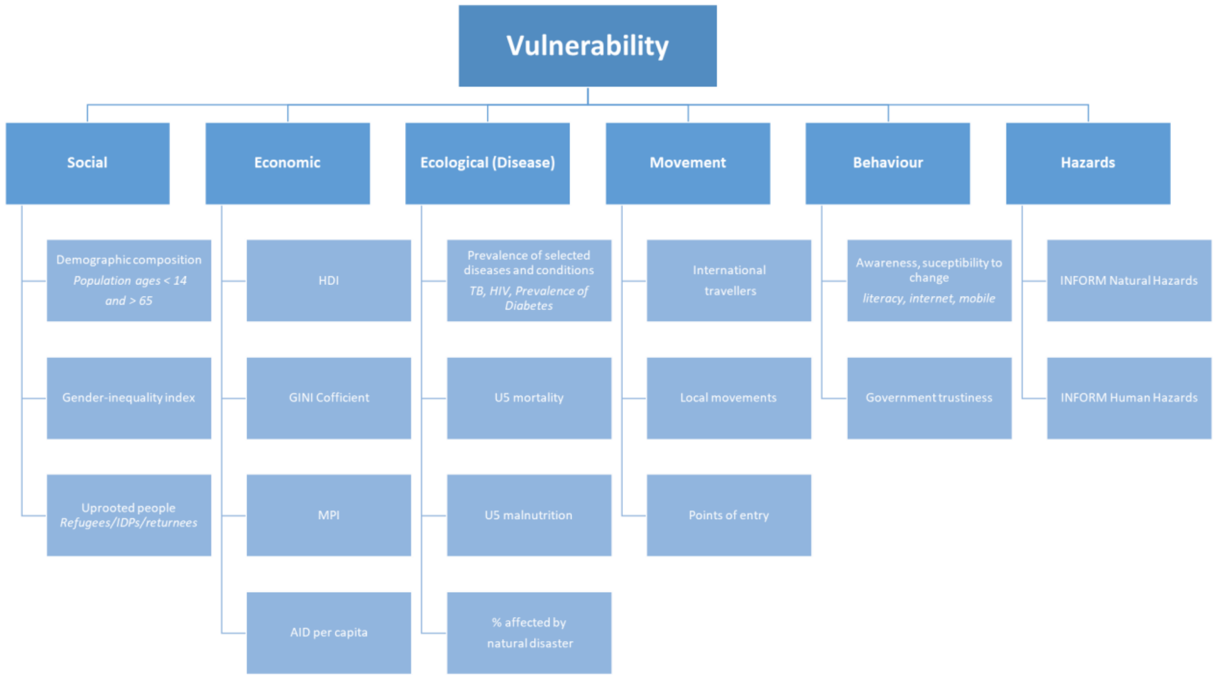
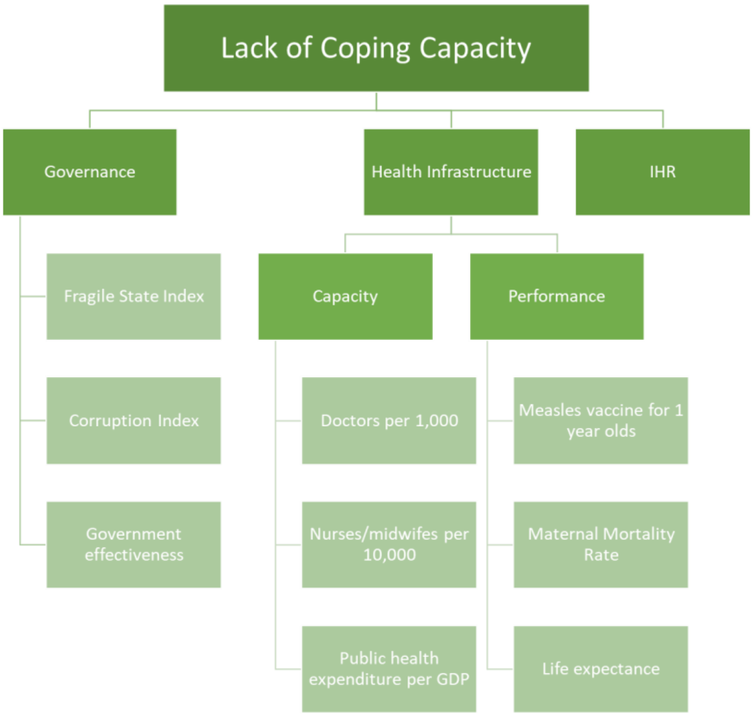


Figure 5: Conceptual framework - Lack of Coping Capacity dimension



3.2.2 Data processing

Before the construction of the composite indicator and sub-indices, all indicator values need to be pre-processed. A pre-processed indicator is referred to as an index.

Pre-processing may include:

- Imputation of missing values;
- Transformation into non-dimensional scales, e.g. utilising percentages, per capita or density functions;
- Log transformation;
- Re-scaling into range 0-10 in combination with min–max normalisation:
  - Outliers identification;
  - Setting min and max values;
  - Inversion of values for the clear communication of the results: the higher the worse through all the dimensions, categories and components.

For all the pre-process steps, JRC followed the same approach of the INFORM GRI [2].

3.2.3 Aggregation

The aggregation of the indicators has been performed following the INFORM model criteria [2].

The INFORM methodology adopts the arithmetic and (inverted) geometric average[12]. Aggregation rules are applied to indexes according to the general criteria to use arithmetic

[12] The geometric average is always smaller or equal than the arithmetic average. To use that characteristic of geometric average, i.e., to reward more those countries with high scores, the following procedure was applied:

1. Inversion of index following the notion higher the better.
2. Rescaling of index into the range [1,10].

average for the component and functional level (up to the category), the (inverted) geometric average to the concept level (category), while the final score is calculated with the risk equation (Equation 2).

3.2.4 Statistical validation

An important aspect to consider within composite indicators is the impact that nominal weighting schemas have on the resulting scores, with the weights often used as proxies for their relative importance.

A Pearson's correlation coefficient (always squared) between the sub-indices and one-level-up aggregated index (component/category/dimension) can measure the influence of sub-index on the aggregated index due to correlation [4]. The relative differences among those correlations explain the influence of a given sub-index for the aggregated index. In composite indicator models, the nominal weights are defined by the methodology. However, the relative influence of indices for the aggregated index depends on their distribution after normalisation as well as their correlation structure [2].

The ERI conceptual framework didn't provide any indication on nominal weights to be applied to the model. Therefore, the JRC built the model without assigning any explicit weights all along the model's hierarchy. In other words, the JRC used equal weights approach consistently for calculating the ERI results.

Within all the model dimensions and categories, there is no *a priori* evidence to suggest that any component should have more of an impact than any other (**Figure 6**).

Figure 6: ERI Correlation matrix

	Zoonoses	Vectorborne	P2P	Waterborne - Foodborne	**HAZARD & EXPOSURE**	Social	Economic	Ecological	Movement	Behaviour	Hazards	**VULNERABILITY**	Institutional	Capacity	Performance	Infrastructure	IHR	**LACK OF COPING CAPACITY**	**ERI**
Zoonoses	1.00	0.17	0.31	0.15	0.53	0.38	0.21	0.07	0.16	0.25	0.15	0.21	0.30	0.25	0.30	0.39	0.12	0.36	0.46
Vectorborne	0.17	1.00	0.30	0.15	0.71	0.27	0.31	0.20	0.07	0.26	0.25	0.36	0.39	0.53	0.39	0.48	0.09	0.41	0.61
P2P	0.31	0.30	1.00	0.53	0.69	0.29	0.51	0.32	0.28	0.37	0.08	0.31	0.38	0.46	0.38	0.57	0.26	0.53	0.64
Waterborne - Foodborne	0.15	0.15	0.53	1.00	0.48	0.14	0.29	0.28	0.13	0.27	0.04	0.20	0.16	0.23	0.16	0.31	0.05	0.22	0.36
HAZARD & EXPOSURE	0.53	0.71	0.69	0.48	1.00	0.43	0.48	0.31	0.20	0.44	0.23	0.45	0.50	0.60	0.50	0.70	0.17	0.59	0.85
Social	0.38	0.27	0.29	0.14	0.43	1.00	0.29	0.11	0.12	0.30	0.38	0.54	0.36	0.31	0.36	0.45	0.14	0.42	0.56
Economic	0.21	0.31	0.51	0.29	0.48	0.29	1.00	0.47	0.36	0.42	0.10	0.42	0.53	0.66	0.53	0.71	0.32	0.68	0.69
Ecological	0.07	0.20	0.32	0.28	0.31	0.11	0.47	1.00	0.26	0.31	0.08	0.29	0.33	0.40	0.33	0.48	0.15	0.41	0.43
Movement	0.16	0.07	0.28	0.13	0.20	0.12	0.36	0.26	1.00	0.18	0.00	0.00	0.29	0.30	0.29	0.38	0.58	0.49	0.28
Behaviour	0.25	0.26	0.37	0.27	0.44	0.30	0.42	0.31	0.18	1.00	0.12	0.50	0.24	0.41	0.24	0.50	0.15	0.38	0.51
Hazards	0.15	0.25	0.08	0.04	0.23	0.38	0.10	0.08	0.00	0.12	1.00	0.55	0.35	0.16	0.35	0.20	0.01	0.23	0.37
VULNERABILITY	0.21	0.36	0.31	0.20	0.45	0.54	0.42	0.29	0.00	0.50	0.55	1.00	0.34	0.35	0.34	0.44	0.03	0.34	0.60
Institutional	0.30	0.39	0.38	0.16	0.50	0.36	0.53	0.33	0.29	0.24	0.35	0.34	1.00	0.59	1.00	0.65	0.27	0.83	0.77
Capacity	0.25	0.53	0.46	0.23	0.60	0.31	0.66	0.40	0.30	0.41	0.16	0.35	0.59	1.00	0.59	0.89	0.30	0.77	0.78
Performance	0.30	0.39	0.38	0.16	0.50	0.36	0.53	0.33	0.29	0.24	0.35	0.34	1.00	0.59	1.00	0.65	0.27	0.83	0.77
Infrastructure	0.39	0.48	0.57	0.31	0.70	0.45	0.71	0.48	0.38	0.50	0.20	0.44	0.65	0.89	0.65	1.00	0.37	0.87	0.88
IHR	0.12	0.09	0.26	0.05	0.17	0.14	0.32	0.15	0.58	0.15	0.01	0.03	0.27	0.30	0.27	0.37	1.00	0.57	0.31
LACK OF COPING CAPACITY	0.36	0.41	0.53	0.22	0.59	0.42	0.68	0.41	0.49	0.38	0.23	0.34	0.83	0.77	0.83	0.87	0.57	1.00	0.86
ERI	0.46	0.61	0.64	0.36	**0.85**	0.56	0.69	0.43	0.28	0.51	0.37	**0.60**	0.77	0.78	0.77	0.88	0.31	**0.86**	1.00

The dimensions have similar Pearson's correlation coefficient, with small lower value for Vulnerability (0.60, vs 0.85 and 0.86 of Hazards & Exposure and Lack of Coping Capacity

3. Calculation of geometric average.
4. Rescaling the score back into the range [0,10].
5. Inversion of the score with the notion that higher is worse.

respectively), mainly due to the "Movement" category, which is uncorrelated with all the others.

Also the coefficient of the categories within the same dimension justifies the equal weighting imposed to the model.

Within the Hazard & Exposure category the subcomponents are well balanced, with equal contribution to all of them to the category's score (Zoonoses: 0.53; Vector borne: 0.71; P2P: 0.69; Waterborne and foodborne: 0.48).

The same goes for the categories under the other two dimensions, with the above mentioned "Movement" category.

4 Development of INFORM hazard-dependent GRI: test case on epidemics risk

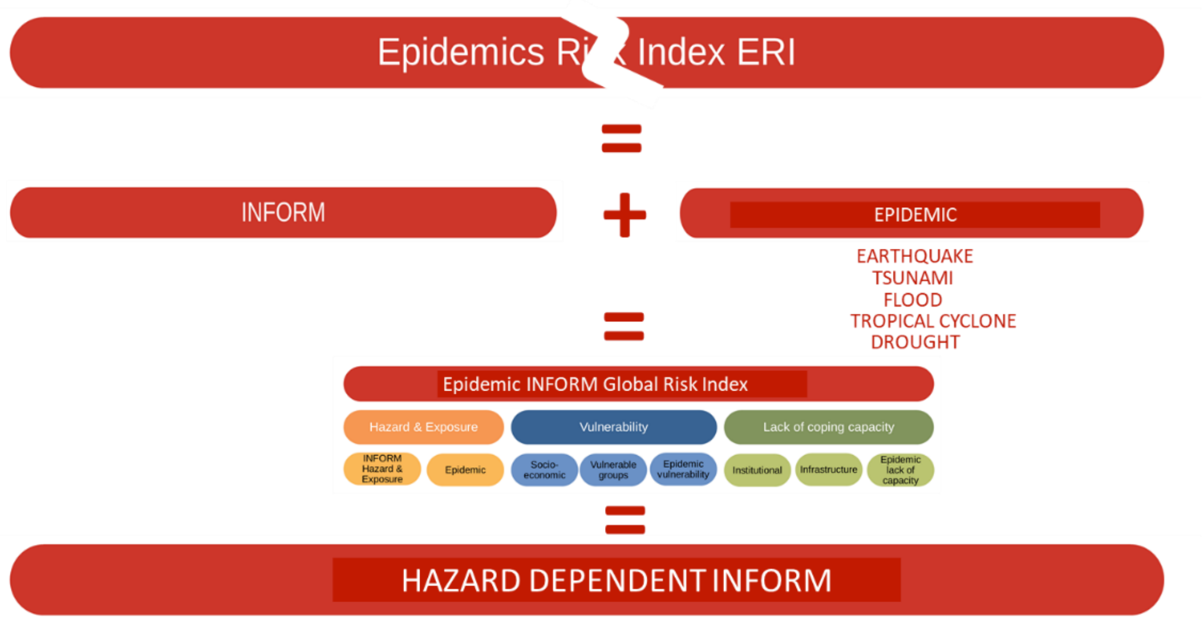
INFORM proved to be a successful tool used and adopted by several organisations. Yet, some partners consider it too generic to meet the specific needs of their organisation.

Some INFORM partners highlighted the lack of specificity of INFORM for its use only in one hazard area and the need to have more customised versions[13]. With this purpose, the WHO decided to develop the Epidemic Risk Index.

In the INFORM methodology, the Vulnerability and Lack of Coping Capacity dimensions are hazard's independent. This means that all the components and underlying indicators are significant for all the type of crisis and disasters, despite the hazard generated by them.

In order to provide a hazard-dependent version of INFORM, we need not only to weight more the specific hazard in the Hazard & Exposure dimension, but also to include hazard-dependent components in the other two dimensions of Vulnerability and Lack of Coping Capacity, in order to capture those drivers that are relevant for a disaster generated by the selected hazard (**Figure 7**).

Figure 7: Epidemics risk as proof of concept for the INFORM Hazard-dependent GRI



Whit the INFORM Hazard-dependent GRI model we include also all the advantages of the INFORM approach[14]:

- **Significant** (INFORM products are used by many key humanitarian and development organizations, and they became a reference tools for crisis risk assessment).
- **Robust** and well balanced model (the INFORM GRI is statistically sounds and based on solid scientific concepts and methods).
- In the future, also allows **comparability** among different risks (others INFORM Hazard-dependent GRI model, based on the same methodology).

Using this modular hazard-dependent approach, the INFORM Epidemic GRI is an upgrade of the INFORM GRI, preserving the integrity of the original model while adding the hazard

[13] INFORM Annual Partners' Meeting, 22-23 June 2017, FAO, Rome

[14] INFORM's approach and products are increasingly recognised to support several key components of the post-2015 humanitarian, DRR and development agenda. Shared analysis and joint humanitarian and development action are principles recognised by the World Humanitarian Summit outcomes, Sendai Framework and Sustainable Development Goals. (INFORM Report 2019, UNOCHA)

dependent components derived by the WHO Epidemic Risk Index conceptual framework (**Figure 8**).

This is possible because the Vulnerability and Lack of Coping Capacity dimensions in the ERI model are conceptually very similar to the INFORM GRI. In each of the ERI dimensions, there are indicators already present in the INFORM GRI, and some are specific for biological disasters (**Table 1**), which makes the hazard dependent model of INFORM feasible in case of epidemics and at the same time, it adopts all the features and knowledge of the ERI framework.

Figure 8: Adaptation of the ERI framework to the INFORM Epidemic GRI (in Black: ERI components not present in the INFORM GRI framework; in Green: ERI components already present in the INFORM GRI framework)

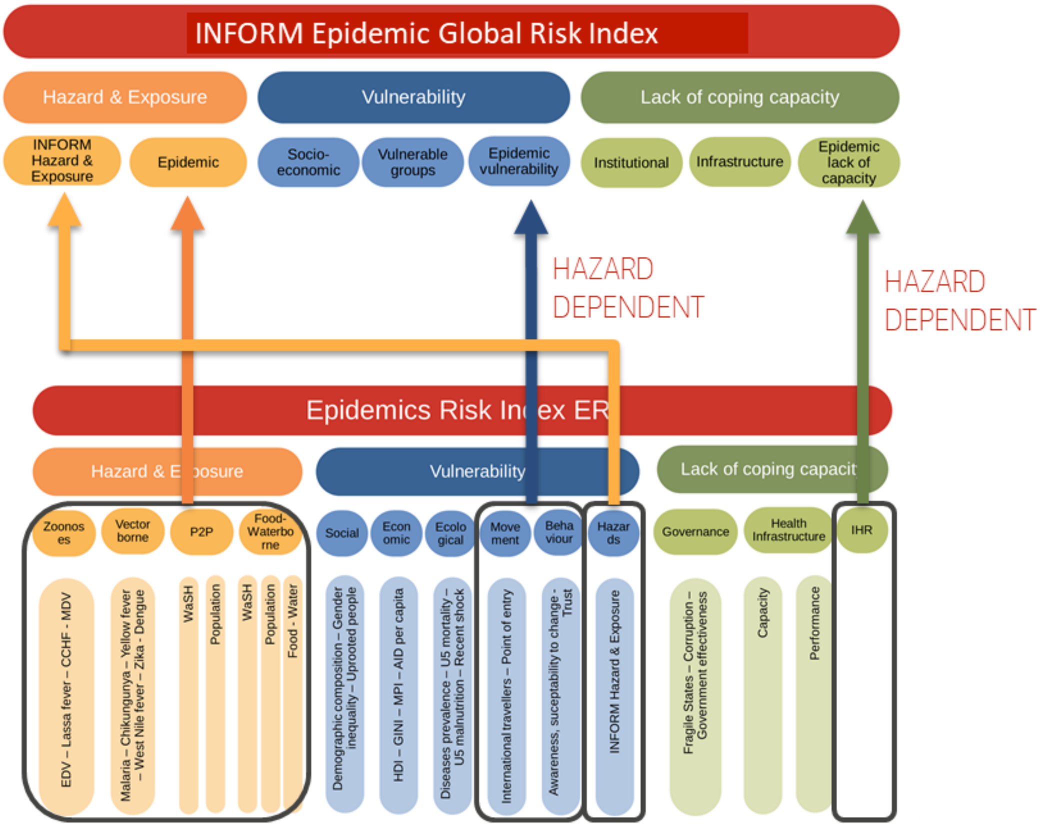


Table 1: Mapping of the ERI indicators already present in the INFORM GRI

ERI Dimension /Category	**Indicator Name**	**INFORM GRI Dimension /Category**
Vulnerability / Social	Population ages 65 and above (% of total)	-
	Population ages 0-14 (% of total)	-
	Total persons of concerns	Vulnerability / Vulnerable Groups
	Gender Inequality Index	Vulnerability / Socio-Economic Vulnerability

Vulnerability / Economic	The Multidimensional Poverty Index (MPI)	Vulnerability / Socio-Economic Vulnerability
	Human Development Index (HDI)	Vulnerability / Socio-Economic Vulnerability
	Income Gini coefficient - Inequality in income or consumption	Vulnerability / Socio-Economic Vulnerability
	Public Aid per capita (current USD)	Vulnerability / Socio-Economic Vulnerability
Vulnerability / Ecological (disease)	Percentage of population affected by natural disasters	Vulnerability / Vulnerable Groups
	HIV prevalence among adults aged 15-49 years (%)	Vulnerability / Vulnerable Groups
	Estimated incidence of tuberculosis (per 100 000 population)	Vulnerability / Vulnerable Groups
	Diabetes prevalence (% of population ages 20 to 79)	-
	Mortality rate, under-5 (per 1,000 live births)	Vulnerability / Vulnerable Groups
	Percentage of under 5 underweight	Vulnerability / Vulnerable Groups
Vulnerability / Movement	Air transport, passengers carried	-
	International tourism, number of arrivals	-
	IHR capacity score: Points of entry	-
Vulnerability / Behaviour	Adult literacy rate, population 15+ years, both sexes (%)	Lack of Coping Capacity / Infrastructure
	Mobile cellular subscriptions (per 100 people)	Lack of Coping Capacity / Infrastructure
	Individuals using the Internet (% of population)	Lack of Coping Capacity / Infrastructure
	Boys- Tobacco Prevalence %	-
	Girls-Tobacco Prevalence %	-
	Trust Index	-
Vulnerability / Hazard	INFORM Natural Hazards	Hazard & Exposure / Natural Hazard
	INFORM Human Hazards	Hazard & Exposure / Human Hazard
	Government effectiveness	Lack of Coping Capacity / Institutional

Lack of Coping Capacity / Governance	Corruption Perception Index CPI	Lack of Coping Capacity / Institutional
	Fragile States Index	-
Lack of Coping Capacity / Health Infrastructure	Nursing and midwifery personnel density (per 1000 population)	-
	Physicians density (per 1000 population)	Lack of Coping Capacity / Infrastructure
	Current health expenditure per capita, PPP (current international $)	Lack of Coping Capacity / Infrastructure
	Life expectancy at birth, total (years)	-
	Immunization, measles (% of children ages 12-23 months)	Lack of Coping Capacity / Infrastructure
	Mortality rate, infant (per 1,000 live births)	-
	Maternal Mortality Ratio per 100,000 live births	Lack of Coping Capacity / Infrastructure
IHR	International Health Regulations capacity scores	-

4.1 The INFORM Epidemic GRI model

Epidemic is defined as an unusual increase at a particular time in the number of cases of an infectious disease, which already existed in a certain region or population[15]. Infectious diseases are caused by pathogenic microorganisms, such as bacteria, viruses, parasites or fungi; the diseases can be spread, directly or indirectly, from one person to another.[16]

The first step in the risk assessment for an epidemic is to identify the areas with the possible presence of the pathogens and the population exposed to them. In other terms, we need to model the conditions where an outbreak could start.

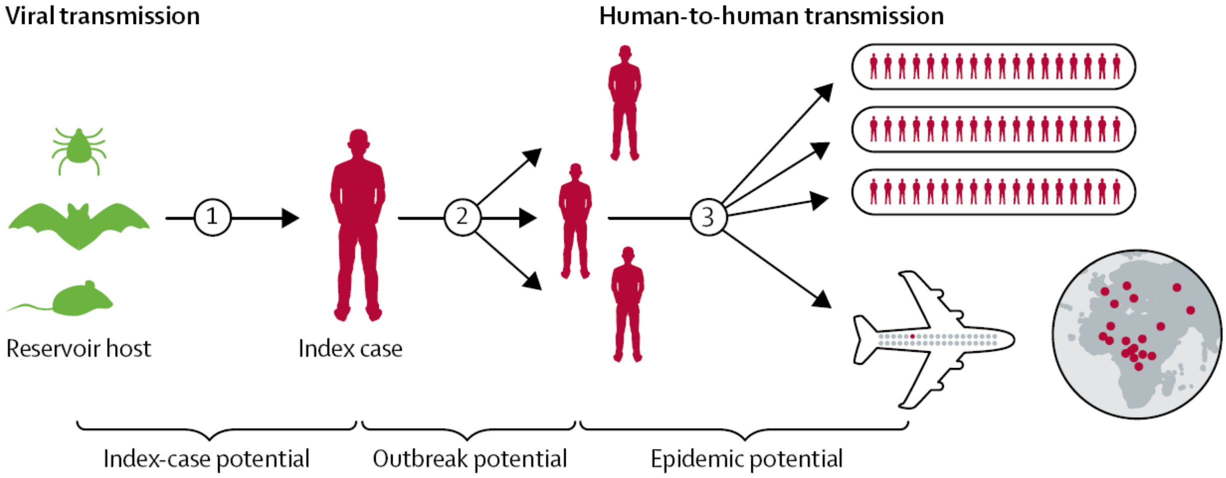
The spillover of the disease, arising to an epidemic event, depends on the context of the vulnerability and coping capacity of the community of interest. Those countries with the most vulnerable populations and the poorest infrastructural capacity to handle such cases are hypothesised to be most at risk of such outbreaks occurring [7].

This dynamic has been very well conceptualised in a recent publication [7], presenting an adaptation of the INFORM GRI for assessing the risk of viral haemorrhagic fevers VHF epidemics.

[15] https://www.ifrc.org/en/what-we-do/disaster-management/about-disasters/definition-of-hazard/biological-hazards-epidemics/

[16] https://www.who.int/topics/infectious_diseases/en/

Figure 9: Conceptual progression of a viral haemorrhagic fever from animal reservoir to global pandemic



Source: Pigott and al., 2017

Figure 9 shows the processes by which an index case can arise, then cause secondary infections in a focal location, and subsequently spread to other geographies via regional connectivity patterns, or global travel connections, referred to hereafter as Stages 1, 2, and 3 respectively.

The Stage 1 presents the hazard within the risk concept of INFORM GRI and it is used for modelling the Epidemic Hazard & Exposure dimension, while the drivers for Stage 2 and 3 are relevant for the Vulnerability and Lack of Coping Capacity dimensions.

4.1.1 The Epidemic component in the Hazards & Exposure dimension

Common drivers of four groups has been identified on the base of the mode of transmission and the epidemiological triad addressing agent, host and environment: (1) Zoonoses, (2) Vector borne, (3) Person-to-person (P2P), (4) Foodborne, and Waterborne [5].

Zoonoses are any disease or infection that are naturally transmissible from vertebrate animals to humans.[17] Examples are Ebola, Lassa Fever, Crimean-Congo haemorrhagic fever (CCHF), and Marburg virus disease.

Vector-borne diseases are human illnesses caused by parasites, viruses and bacteria that are transmitted by mosquitoes, fleas and ticks.[18] Examples of vector-borne diseases include Dengue fever, West Nile Virus, Lyme disease, and malaria.

Person-to-person are infectious diseases that are transmitted from human to human. Example are hepatitis B and C, HIV/AIDS, influenza, measles, and poliomyelitis.

Foodborne diseases encompass a wide spectrum of illnesses and are the result of ingestion of foodstuffs contaminated with microorganisms or chemicals.[19] Waterborne diseases are caused by a variety of microorganisms, biotoxins, and toxic contaminants, contained in the water.[20] Examples are cholera, diarrhoeal disease, and salmonella.

When available (Zoonoses, Vector borne and Waterborne diseases), we used environmental suitability maps to define exposed populations. We benefited from existing

17 https://www.who.int/topics/zoonoses/en/
18 https://www.who.int/en/news-room/fact-sheets/detail/vector-borne-diseases
19 https://www.who.int/topics/foodborne_diseases/en/
20 https://www.niehs.nih.gov/research/programs/geh/climatechange/health_impacts/waterborne_diseases/index.cfm

models of environmental suitability for the transmission of a virus from environmental sources into human populations to establish regions at risk of spillover infections.

Previous studies used species distribution modelling approaches, specifically boosted regression trees[2], to model the environmental suitability for the transmission of diseases from animals to human. Each map represents a probabilistic surface with values ranging from 0 (most environmentally unsuitable for transmission) to 1 (most environmentally suitable). Each map was converted into a binary at-risk/not-at-risk surface by deriving a threshold probability for each individual niche map, which captured 95% of the occurrence data included in the original model. To calculate the potential population exposed, a gridded population surface[21] was used to evaluate the numbers of individuals living within each country.

Table 2 shows all the details of the suitability maps identified in order to be used in the model.

Table 2: Suitability maps identified for being used in the Hazard & Exposure dimension of the Epidemic INFORM

Disease	**Description**	**Reference**
Zoonoses		
Crimean-Congo haemorrhagic fever CCHF	These map uses reported geographic information on index cases of outbreaks and viral detection in animals related to a number of environmental factors thought to influence the distribution of these pathogens using species distribution models in order to build an environmental profile that best characterizes possible pathogen presence.	Messina JP, Pigott DM, Golding N, et al. *The global distribution of Crimean-Congo haemorrhagic fever*. Trans R Soc Trop Med Hyg 2015; 109: 503–13.
Ebola Virus Disease EVD		Pigott DM, Millear, Anoushka I, Earl L, et al. *Updates to the zoonotic niche map of Ebola virus disease in Africa*. Elife 2016; 5: e16412. Pigott DM, Golding N, Mylne A, et al. Mapping the zoonotic niche of Ebola virus disease in Africa. Elife 2014; 3: e04395.
Lassa Fever		Mylne AQN, Pigott DM, Longbottom J, et al. *Mapping the zoonotic niche of Lassa fever in Africa*. Trans R Soc Trop Med Hyg 2015; 109: 483–92.
Marburg Virus Disease MVD		Pigott DM, Golding N, Mylne A, et al. *Mapping the zoonotic niche of Marburg virus disease in Africa*. Trans R Soc Trop Med Hyg 2015; 109: 366–78.

[21] European Commission, Joint Research Centre (JRC); Columbia University, Center for International Earth Science Information Network - CIESIN (2015): GHS population grid, derived from GPW4, multitemporal (1975, 1990, 2000, 2015). European Commission, Joint Research Centre (JRC) [Dataset] PID: http://data.europa.eu/89h/jrc-ghsl-ghs_pop_gpw4_globe_r2015a

Disease	Description	Citation
Vector borne		
Malaria - Plasmodium vivax	This is a very broad classification of risk including any regions where the annual case incidence is likely to exceed 1 per 10,000. Annual case incidence data over the most recent four years (where we have access to the data) and at the smallest district size available has been used.	Gething, P. W., Elyazar, I. R., Moyes, C. L., Smith, D. L., Battle, K. E., Guerra, C. A., Patil, A. P., Tatem, A. J., Howes, R. E., Myers, M. F., George, D. B., Horby, P., Wertheim, H. F., Price, R. N., Müeller, I., Baird, J. K., … Hay, S. I. (2012). *A long neglected world malaria map: Plasmodium vivax endemicity in 2010*. PLoS neglected tropical diseases, 6(9), e1814.
Malaria - Plasmodium falciparum		Gething, P. W., Patil, A. P., Smith, D. L., Guerra, C. A., Elyazar, I. R., Johnston, G. L., Tatem, A. J., … Hay, S. I. (2011). *A new world malaria map: Plasmodium falciparum endemicity in 2010*. Malaria journal, 10, 378. doi:10.1186/1475-2875-10-378
Zika (not yet included)	Species distribution modelling to map environmental suitability for Zika	J. P. Messina, M. U. Kraemer, O. J. Brady, D. M. Pigott, F. M. Shearer, D. J. Weiss, N. Golding, C. W. Ruktanonchai, P. W. Gething, E. Cohn, J. S. Brownstein, K. Khan, A. J. Tatem, T. Jaenisch, C. J. Murray, F. Marinho, T. W. Scott, S. I. Hay, *Mapping global environmental suitability for Zika virus*. eLife 5, e15272 (2016). 10.7554/eLife.15272pmid:27090089 doi:10.7554/eLife.15272
Chikungunya (not yet included)	High-resolution maps of the global distribution of chikungunya, using an established modelling framework that combines a comprehensive occurrence database with bespoke environmental correlates, including up-to-date Aedes distribution maps. This enables estimation of the current total population-at-risk of CHIKV transmission and identification of areas where the virus may spread to in the future.	Nsoesie, E. O., Kraemer, M. U., Golding, N., Pigott, D. M., Brady, O. J., Moyes, C. L., Johansson, M. A., Gething, P. W., Velayudhan, R., Khan, K., Hay, S. I., Brownstein, J. S. (2016). *Global distribution and environmental suitability for chikungunya virus, 1952 to 2015*. Euro surveillance : bulletin Europeen sur les maladies transmissibles = European communicable disease bulletin, 21(20), 10.2807/1560-7917.ES.2016.21.20.30234.
Dengue and chikungunya (not yet included)	The dengue and chikungunya viruses are transmitted among people by two species of mosquitoes called Aedes aegypti and Ae. albopictus. The global maps show the distribution of these vectors and the geographical determinants of their ranges, helping to define the spatial limits of current autochthonous transmission of dengue and chikungunya viruses.	Kraemer MU , Sinka ME , Duda KA , Mylne A , Shearer FM , Barker CM , Moore CG , Carvalho RG , Coelho GE , Van Bortel W , Hendrickx G , Schaffner F , Elyazar IR , Teng H-J , Brady OJ , Messina JP , Pigott DM , Scott TW , Smith DL , Wint GW , Golding N , Hay SI . 2015. *The global distribution of the arbovirus vectors Aedes aegypti and A. albopictus* . Elife 4:e08347. doi:10.7554/eLife.08347

Yellow Fever (not yet included)	Poisson point process boosted regression tree model that explicitly incorporated environmental and biological explanatory covariates, vaccination coverage, and spatial variability in disease reporting rates to predict the relative risk of apparent yellow fever virus infection at a 5×5 km resolution across all risk zones.	Shearer, F.; Longbottom, J.; Browne, A.; Pigott, D.M.; Brady, O.J.; Kraemer, M.U.G.; Marinho, F.; Yactayo, S.; Valdelaine, E.M.; Aglaer, A.; et al. *Existing and potential infection risk zones of yellow fever worldwide: A modelling analysis*. Lancet Glob. Health 2018
West Nile fever (not yet included)	Current potential distribution of Culex quinquefasciatus, vector of the West Nile Fever, based on present-day climatic conditions.	Samy AM, Elaagip AH, Kenawy MA, Ayres CFJ, Peterson AT, Soliman DE (2016) *Climate Change Influences on the Global Potential Distribution of the Mosquito Culex quinquefasciatus, Vector of West Nile Virus and Lymphatic Filariasis*. PLoS ONE 11(10): e0163863. doi:10.1371/journal.pone.0163863
Waterborne		
Waterborne (not yet included)		Yang K, LeJeune J, Alsdorf D, Lu B, Shum CK, et al. (2012) *Global Distribution of Outbreaks of Water-Associated Infectious Diseases*. PLoS Negl Trop Dis 6(2): e1483. doi:10.1371/journal.pntd.0001483

For the aggregation of the "zoonoses" and "vector borne" components, we used the same approach adopted in the INFORM GRI methodology for the exposed population to natural hazard [2]. We calculated two subcomponents for each indicator (population exposed to a disease), one based on the total number of people (absolute), and one on the ratio to the total population in the country (relative). The resulting subcomponents are then aggregated up using the (inverted) geometric average (**Table 3** and **Table 4**).

Table 3: Aggregation of the Zoonoses component

Component	**Zoonoses**							
Sub-component	**GEOMETRIC AVERAGE**							
	CCHF		EVD		Lassa Fever		MVD	
	GEOMETRIC AVERAGE		**GEOMETRIC AVERAGE**		**GEOMETRIC AVERAGE**		**GEOMETRIC AVERAGE**	
Core indicator	CCHF Log(absolute)	CCHF Relative	EVD Log(absolute)	EVD Relative	LF Log(absolute)	LF Relative	MVD Log(absolute)	MVD Relative

Absolute: absolute value of physical exposure
Relative: relative value of physical exposure
CCHF: Crimean-Congo haemorrhagic fever
EDV: Ebola Virus Disease
LF: Lassa Fever
MVD: Marburg Virus Disease

Table 4: Aggregation of the Vector borne component

Component	Vector borne															
	GEOMETRIC AVERAGE															
Sub-component	Malaria								*Zika*		*Dengue/ Chik*		*YF*		*WNF*	
Aggregation	GEOMETRIC AVERAGE								*GEOMETRIC AVERAGE*		*GEOMETRIC AVERAGE*		*GEOMETRIC AVERAGE*		*GEOMETRIC AVERAGE*	
	PV				PF											
	GEOMETRIC AVERAGE				GEOMETRIC AVERAGE											
	PV Abs		PV Rel		PF Abs		PF Rel									
	ARITHMETIC AVERAGE		ARITHMETIC AVERAGE		ARITHMETIC AVERAGE		ARITHMETIC AVERAGE									
Core indicator	PV – U Log(absolute)	PV – S Log(absolute)	PV – U Relative	PV – S Relative	PF – U Log(absolute)	PF – S Log(absolute)	PF – U Relative	PF – S Relative	*Zika Log(absolute)*	*Zika Relative*	*Dengue / Chik Log(absolute)*	*Dengue / Chik Relative*	*YF Log(absolute)*	*YF Relative*	*WNF Log(absolute)*	*WNF Relative*

Absolute: absolute value of physical exposure
Relative: relative value of physical exposure
PV - U: Plasmodium vivax - Unstable transmission
PV - S: Plasmodium vivax - Stable transmission
PF - U: Plasmodium falciparum - Unstable transmission
PF - S: Plasmodium falciparum - Stable transmission
Chik: Chikungunya
YF: Yellow Fever
WNF: West Nile Fever

For the P2P and Foodborne diseases, the niche maps are either not pertinent (i.e. influenza can spread anywhere), or not available. We used instead the composite indicator approach, selecting the components and the corresponding covariates more representative to assess the potential exposure (as proposed by the experts for the ERI framework) (**Table 5** and **Table 6**).

Table 5: Aggregation of the P2P component

Component	P2P					
Sub-component	ARITHMETIC AVERAGE					
	WaSH		Population			
	ARITHMETIC AVERAGE		ARITHMETIC AVERAGE			
Core indicator	Access to sanitation	Access to improved water	Population density	Population in the urban areas	Population growth	Household size

Table 6. Aggregation of the Waterborne and Foodborne component

Component	Waterborne and Foodborne													
	ARITHMETIC AVERAGE													
Sub-component	WaSH			Population						Food		Water	
	ARITHMETIC AVERAGE			ARITHMETIC AVERAGE						ARITHMETIC AVERAGE		*GEOMETRIC AVERAGE*	
Core indicator	Access to sanitation	Access to improved water	Defecation	Population density	Population in the urban areas	Population growth	Household size	Population living in slums	Children Under 5	Number of veterinarian	Food safety	*Log(absolute)*	*Relative*

Finally, the single components are aggregated to the "Epidemic Hazard" category again with the (inverted) geometric average.

4.1.2 The Epidemic component in the Vulnerability dimension

The mapping of the indicators in the ERI Vulnerability dimension that were already present in the INFORM GRI (**Table 1**), shows that only two components out of six were new and they could be interpreted as the hazard dependent drivers for epidemic vulnerability.

Table 7 and

Table 8 describe the aggregation criteria for the Movement and Behaviour components respectively.

Table 7: Aggregation of the Movement component

Component	Movement			
	ARITHMETIC AVERAGE			
Sub-component	International travelers		Local movements	Point of entry
	ARITHMETIC AVERAGE			
Core indicator	Air transport, passengers carried	International tourism, number of arrivals	Accessibility to cities	Point of entry

Table 8: Aggregation of the Behaviour component

Component	Behaviour			
Sub-component	ARITHMETIC AVERAGE			
	Awareness			Trust Index
Core indicator	ARITHMETIC AVERAGE			
	Adult literacy rate	Mobile cellular subscriptions	Internet users	Confidence in National Government (*)

(*) Indicator with restricted access to be replaced

The two components are then aggregated using the arithmetic average in order to form the Epidemic Vulnerability category.

4.1.3 The Epidemic component in the Lack of Coping Capacity dimension

The mapping of the indicators in the ERI Lack of Coping Capacity dimension that were already present in the INFORM GRI (**Table 1**), shows that only the IHR component was new and it could be interpreted as the hazard dependent driver for epidemic lack of coping capacity.

4.1.4 Final aggregation

The hazard-dependent epidemic components are finally aggregated at the category level with the original INFORM GRI dimensions (**Table 9**), using the (inverted) geometric average. We gave more weight to the Epidemic hazard component in order to capture the specificity of the model, having in mind that in the ERI framework, the Hazard & Exposure dimension of INFORM GRI were considered as one of the six categories of the Vulnerability dimension, assigning therefore a relative lower weight. Finally, a weighted geometric average was applied, by giving a weight of three to the Epidemic hazard category.

The final risk score is calculated with the risk equation (Equation 2).

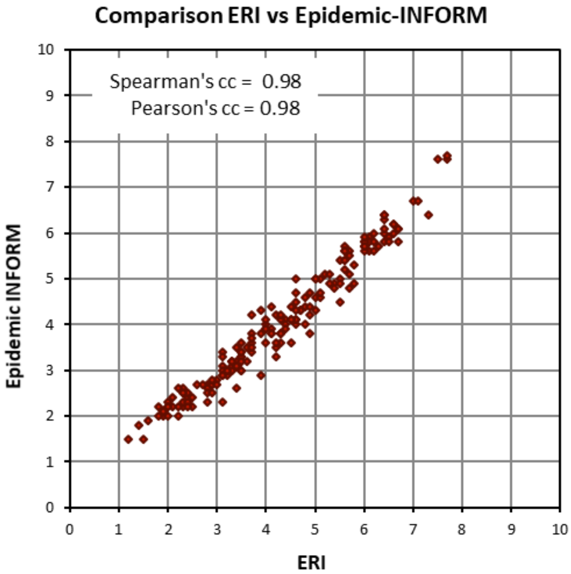
Table 9: Aggregation of the Epidemic INFORM GRI

Risk	EPIDEMIC INFORM GRI					
Dimension	RISK FORMULA					
	Hazard & Exposure		Vulnerability		Lack of Coping Capacity	
Category	GEOMETRIC AVERAGE		GEOMETRIC AVERAGE		GEOMETRIC AVERAGE	
	1 : 3					
	INFORM Hazard & Exposure	Epidemic Hazard	INFORM Vulnerability	Epidemic Vulnerability	INFORM Lack of Coping Capacity	Epidemic Lack of Coping Capacity

4.2 Preliminary validation

The evidence of the similarity between the ERI and the INFORM Epidemic models is proved by the correlation performance between the two models (**Figure 10**). Very high values of Spearman's correlation coefficient (0.98), and Pearson's cc (0.98) confirm that the two models are extremely similar and that we can be quite confident to present the INFORM Epidemic GRI as a replacement of the ERI.

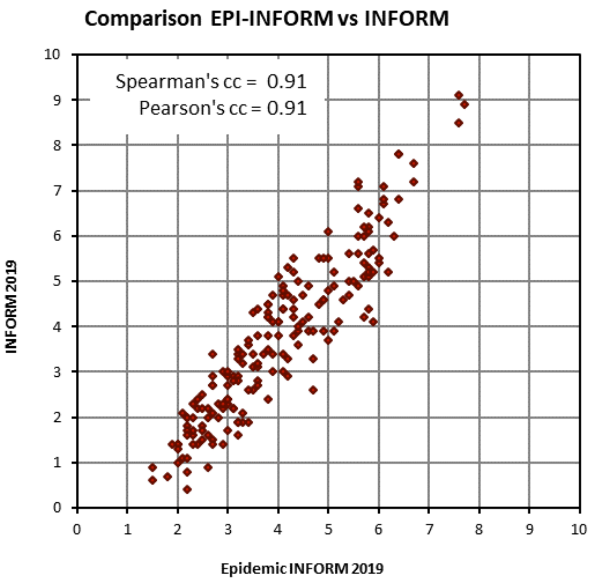
Figure 10: Comparison of WHO Epidemic Risk Index ERI with the INFORM Epidemic GRI (EPI-INFORM)



Furthermore, with hazard dependent INFORM we could address specific humanitarian risks, and introduce additional variation in the model ranking.

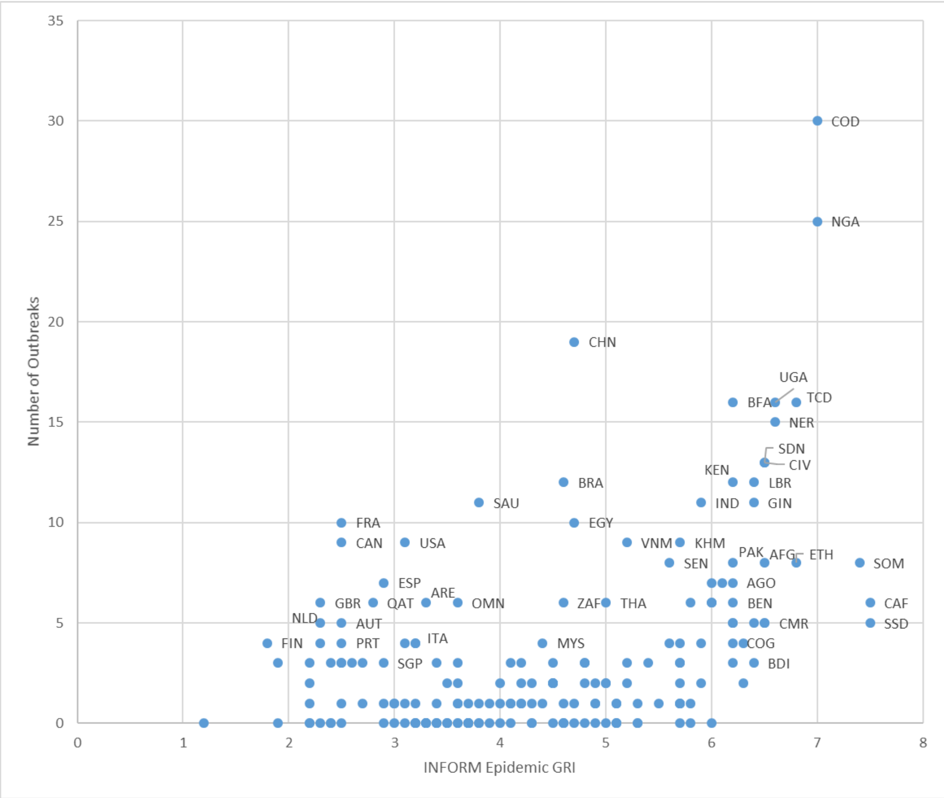
Although there is a high correlation (both Pearson's and Spearman's correlation coefficients are 0.91) between the INFORM Epidemic and the INFORM GRI, the INFORM Epidemic still shows high variances among the countries with similar INFORM Risk level (**Figure 11**).

Figure 11: Comparison of INFORM Epidemic GRI (EPI-INFORM) with the INFORM GRI (INFORM)



A preliminary validation of the INFORM Epidemic GRI results against historical epidemic events have been carried out using as benchmark the WHO Disease Outbreak News (DONs)[22] database of events between 1996 to 2018.

Figure 12: Correlation between INFORM Epidemic Risk scores and historical outbreaks events



Although the **Figure 12** shows a positive correlation between INFORM Epidemic GRI outputs and historical epidemic events, the resulting correlation coefficient is not high (R^2=0.2). This could be mainly explained by the limitation of the outbreaks data (the WHO Disease Outbreak News is a collection of disease outbreaks around the world notified to the WHO and it might contains bias if used as database of epidemic events). JRC will work with WHO in order to obtained a consistent historical epidemic events database for improving the validation.

Further possible improvements could be obtained with the calibration of the epidemic hazard components using the Global Burden of Disease[23]. This analysis could provide an indication of the human impact of the different diseases, providing an indication of their relative contribution on the overall risk.

[22] http://www.who.int/csr/don/en/
[23] https://www.who.int/healthinfo/global_burden_disease/about/en/

4.3 Results

Table 10 shows the dimensions and categories values for the first ten countries ranked by the INFORM Epidemic GRI.

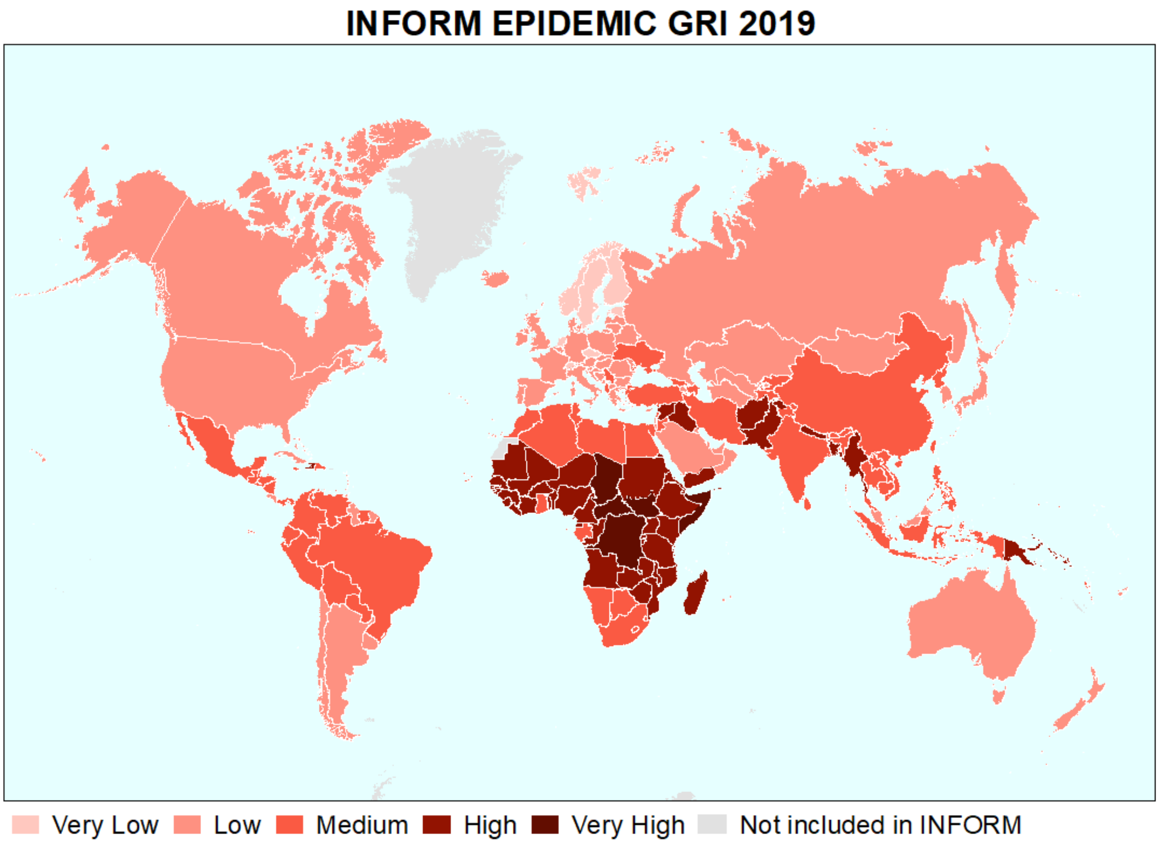
Table 10: Top then countries in the INFORM Epidemic GRI with the dimensions and categories values (Annex 3)

Ranking	COUNTRY	INFORM Hazard & Exposure	Epidemic Hazard	Epidemic INFORM Hazard & Exposure	INFORM Vulnerability	Epidemic Vulnerability	Epidemic INFORM Vulnerability	INFORM Lack of Coping Capacity	Epidemic Lack of Coping Capacity	Epidemic INFORM Lack of Coping Capacity	INFORM Epidemic Risk
1	South Sudan	8.2	6.6	7.1	9.2	4.9	7.7	9.3	6.6	8.3	**7.7**
2	Central African Republic	7.9	6.7	7.0	8.8	5.9	7.6	8.7	7.3	8.1	**7.6**
3	Somalia	9.0	5.8	6.9	9.2	5.1	7.7	9.0	7.1	8.2	**7.6**
4	Chad	5.5	6.3	6.1	7.6	5.4	6.6	8.9	5.6	7.6	**6.7**
5	Congo DR	7.1	7.8	7.6	7.6	5.0	6.5	8.0	3.5	6.2	**6.7**
6	Afghanistan	8.8	5.2	6.4	7.2	4.5	6.0	7.5	5.8	6.7	**6.4**
7	Nigeria	8.0	7.5	7.6	6.0	5.8	5.9	6.5	4.9	5.8	**6.4**
8	Yemen	8.1	5.2	6.1	7.5	4.5	6.2	7.9	5.2	6.8	**6.4**
9	Burundi	4.9	6.1	5.8	6.7	5.7	6.2	6.5	7.5	7.0	**6.3**
10	Liberia	2.8	7.2	6.4	6.4	6.8	6.6	7.7	2.4	5.7	**6.2**

The full ranking of the INFORM Epidemic GRI is available in the Annex 3 and 4.

The map below (**Figure 13**) highlight the countries with very low, low, medium, high, and very high risk for the INFORM Epidemic GRI.

Figure 13: INFORM Epidemic GRI Risk map



All the data source, together with the relevant metadata are available in the Annex 7.

4.4 Limitations and constraints

There are certain areas of the model that are not covered or covered only partially. Constraints are related to limitations in the methodology and incomplete data availability.

4.4.1 Data constraints

The **suitability maps** used to assess the population exposed to different diseases are incomplete. Some of them were indeed not available. Requests to access the data have been sent to the authors of the maps but at the time of writing this report, they are still not available.

It is dramatically complex to find quantitative global data for the **Behaviour** component in the Vulnerability dimension. Most of the relevant data found in literature are based on local surveys, and are peculiar to the specific population. Further investigation and research is needed in order to improve the data production.

For the **Trust Index** in the Behaviour component, the JRC preliminary used, only for the purpose of this exercise, data source with restricted access[24]. This is, however, going against the INFORM principle of open data and open access. JRC will investigate how to replace the indicator.

[24] Confidence in National Government, World Poll. Copyright © 2017 Gallup, Inc. All rights reserved. The information contained in this document may only be used for noncommercial personal use and is subject to Gallup's Terms of Use.

4.4.2 Methodological limitations

Under the International Health Regulation (IHR), the **IHR Monitoring Framework**[25] provides member states with a set of 28 global indicators for monitoring the development of IHR core capacities. The IHR report is a **self-assessment**, naturally politically and strategically biased. In order to reduce the arbitrariness of the IHR self-evaluation, the WHO introduced the Joint External Evaluation (JEE)[26] as an independent instrument to assess the country reporting. At the moment, the JEE is not consider in the model due to the lack of coverage and the methodology on how to combine the its results with the IHR self-evaluation ones.

Some relevant factors in epidemic risk were not included in ERI framework, and therefore not considered for the scope of this exercise.

The **immunisation status** of the exposed population is not taken into account. Vaccination can reduce the exposure to many types of diseases.

Diagnostic capacities (laboratory capacity and capability, surveillance capacity) are also not explicitly[27] included in the INFORM Epidemic GRI model. WHO stated, "disease outbreaks may be inevitable but epidemics are preventable"[28]. Early detection on a disease outbreak (unusual clusters of severe cases), allowed by laboratory diagnostics and alert surveillance units, can facilitate the prompt response and contain within the early phase of the epidemic.

25 http://apps.who.int/iris/bitstream/handle/10665/43883/9789241580410_eng.pdf

26 "To move from exclusive self-evaluation to approaches that combine self-evaluation, peer review and voluntary external evaluations involving a combination of domestic and independent experts." In light of this, WHO, in collaboration with partners and initiatives such as the Global Health Security Agenda (GHSA), developed the Joint External Evaluation (JEE) process as part of the IHR (2005) Monitoring and Evaluation framework. (https://www.who.int/ihr/publications/WHO_HSE_GCR_2016_2/en/)

27 They are part of the IHR evaluation.

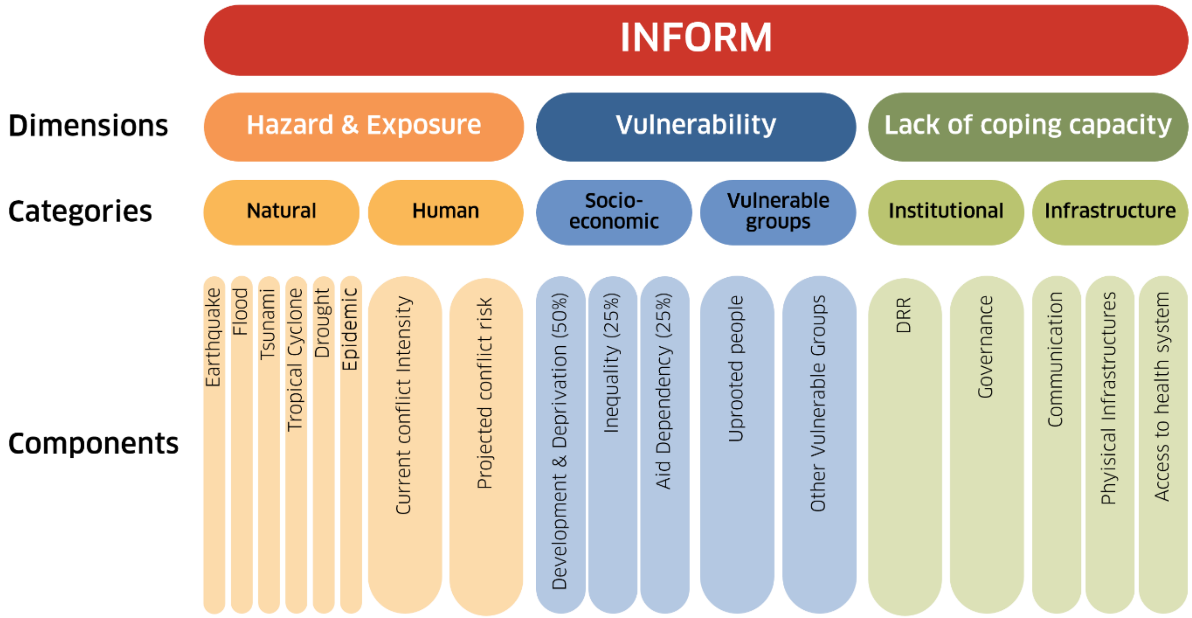
28 http://apps.who.int/iris/bitstream/handle/10665/252646/WHO-OHE-PED-2016.2-eng.pdf;jsessionid=F193823220FF7B7EC58F56047E53A0F7?sequence=1

5 Enhanced INFORM GRI: inclusion of epidemic hazard in the INFORM GRI

The INFORM GRI is a dynamic model. Every year the JRC works on improving the quality, the reliability, the completeness of the model based on the state of the art in data and modelling. Epidemics had been considered from the very beginning to be part of the INFORM GRI model, but at that time the lack of data did not allow to include the epidemic component in the model.

In particular, we focused on the human exposure to infectious disease, considering epidemic hazard as one of natural hazards like earthquake and flood. In practice, we propose to add the Epidemic hazard component from the INFORM Epidemic GRI as an additional natural hazard in the INFORM GRI (**Figure 14**).

Figure 14: Analytical Framework of the Enhanced INFORM GRI included the Epidemic component.



Box 1: New health indicators provided by post-2015 global frameworks

Post-2015 global frameworks like Sustainable Development Goals (SDG) and Sendai framework for Disaster Risk Reduction will produce large quantity of relevant indicators. In particular, there are 21 health-related SDGs targets, with 35 indicators[29].

JRC is carrying out a review of data and indicators from Sendai and SDGs frameworks with the scope to include them in the future releases of the INFORM GRI. JRC will publish a report describing the results of the analysis in the March 2019.

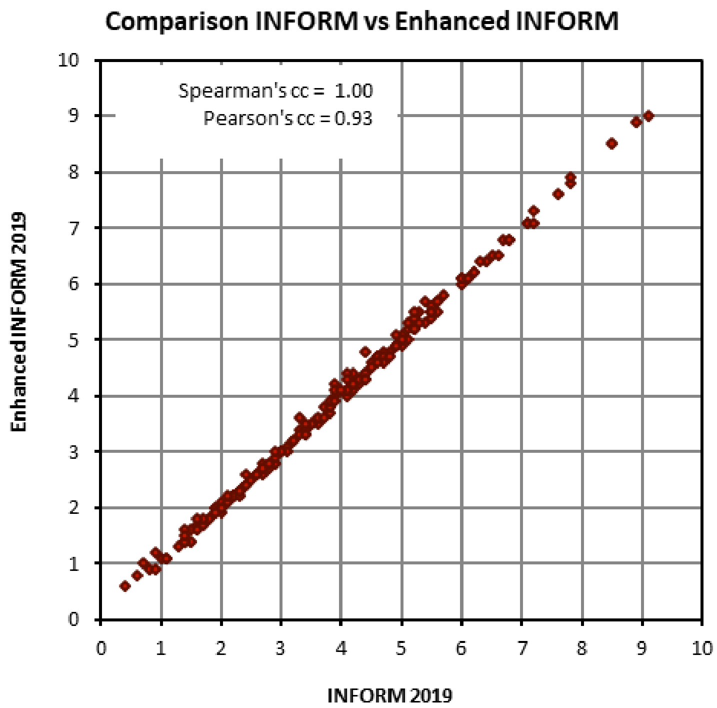
5.1 Results: influence of the epidemic component in the INFORM GRI

The inclusion of epidemics in the INFORM GRI as one of the components in the natural hazard category, has the direct effect to reduce the relative weight of the other natural hazards already present in the model (earthquake, tsunami, flood, tropical cyclone, and drought).

[29] World Health Statistics 2017, WHO

It influences the natural hazard category score, and consequently, the level-up aggregated indices (Hazard & Exposure, INFORM Risk).

Figure 15: Comparison of INFORM 2019 Risk Index with the version included epidemic (Enhanced INFORM)



The Spearman's correlation coefficient is a nonparametric measure of statistical dependence between two ranked variables while Pearson's correlation coefficient is a measure of a linear relationship between the scores of the two variables. The two versions of the INFORM GRI are identical in ranking (Spearman's cc = 1), with small differences in the scores (Pearson's cc = 0.93).

The countries most influenced by the introduction of the epidemic component are presented in the **Table 11** and **Table 12**.

Table 11: Major changes in INFORM Risk (Top 5 and Bottom 5) due to the introduction of the epidemic component

TOP 5 (increasing)		BOTTOM 5 (decreasing)	
COUNTRY	DIFFERENCE	COUNTRY	DIFFERENCE
Sao Tome and Principe	+1	Belize	-0.6
Togo	+0.4	Saudi Arabia	-0.6
Benin	+0.3	Cameroon	-0.5
Ghana	+0.3	Chad	-0.5
Nauru	+0.3	Costa Rica	-0.5

Table 12: Higher changes in INFORM Natural Hazard category (Top 5 and Bottom 5) due to the introduction of the epidemic component

TOP 5 (increasing)		BOTTOM 5 (decreasing)	
COUNTRY	DIFFERENCE	COUNTRY	DIFFERENCE
Togo	+0.7	Saudi Arabia	-3.4
Sao Tome and Principe	+0.6	Cameroon	-1.5
Benin	+0.6	Chad	-1.4
Guinea	+0.5	Turkey	-0.8
Ghana	+0.5	Niger	-0.7

More in details, **Table 13** shows the first ten ranking countries in each sub-index of the epidemic component.

Table 14 shows the values of the Epidemic component and the sub-indices for the first ten countries ranked in the epidemic component.

Table 13: Top ten countries in each of the sub-indices of the Epidemic component

Zoonoses		Vector borne (*)		P2P		Foodborne and waterborne (*)	
COUNTRY	Score	COUNTRY	Score	COUNTRY	Score	COUNTRY	Score
Guinea	8.8	Bangladesh	9.1	Eritrea	8.1	Niger	8.0
Cameroon	8.7	India	9.1	Somalia	7.4	Timor-Leste	7.6
Congo DR	8.5	Indonesia	9.1	Togo	7.1	Angola	7.5
Nigeria	8.5	Congo DR	8.9	Burkina Faso	7.0	Côte d'Ivoire	7.3
Liberia	8.2	Thailand	8.9	Niger	7.0	Togo	6.9
Uganda	8.1	Viet Nam	8.8	Ethiopia	7.0	Lesotho	6.9
Sierra Leone	7.9	Philippines	8.8	Guinea-Bissau	7.0	Cambodia	6.9
Ghana	7.7	Malaysia	8.8	Angola	7.0	Sudan	6.5
Central African Republic	7.6	Uganda	8.7	Madagascar	7.0	Saint Kitts and Nevis	6.5
Côte d'Ivoire	7.6	Nigeria	8.6	Chad	6.9	Kiribati	6.4

(*) Scores for Vector borne and waterborne component are preliminary, since some of the key data are still missing.

Table 14: Top then countries in the Epidemic component with the sub-indices values

	COUNTRY	Epidemic	Zoonoses	Vector borne (*)	P2P	Food and Waterborne (*)
1	Congo DR	**7.8**	8.5	8.9	6.7	6.3
2	Guinea	**7.5**	8.8	7.9	6.5	6.0
3	Nigeria	**7.5**	8.5	8.6	6.6	5.6
4	Côte d'Ivoire	**7.4**	7.6	8.0	6.5	7.3
5	Uganda	**7.3**	8.1	8.7	6.5	4.8
6	Liberia	**7.2**	8.2	7.2	6.7	6.3
7	Togo	**7.1**	7.4	7.1	7.1	6.9
8	Niger	**7.0**	4.2	7.9	7.0	8.0
9	Ghana	**7.0**	7.7	8.0	6.1	5.5
10	Cameroon	**7.0**	8.7	7.6	6.0	4.8

(*) Scores for Vector borne and waterborne component are preliminary, since some of the key data are still missing.

The full ranking of the Enhanced INFORM GRI is available in the Annex 5 and 6.

6 Contextual information for Rapid Risk Assessment of Global Health Threats

The JRC has a long experience in supporting health organisations on early detection and Rapid Risk Assessment (RRA) activities. Important collaborations have been built with the WHO and the Global Health Security Initiative (GHSI)[30] in recent years.

The system developed for the WHO is the Hazard Detection and Risk Assessment System (HDRAS)[31] and it is used on a daily basis to enhance the capacity of the organization in the early detection and monitoring of ongoing public health risks globally. Since this initiative, the WHO and the JRC have signed a Collaborative Research Agreement to promote further cooperation in scientific and technological research activities. The system developed for the GHSI is the Early Alerting and Reporting system (EAR)[32], a tool used on a rotating shift basis by the members of the ECDC and public health institutions of the countries involved in order to identify threats and perform basic risk assessments activities in a collaborative way.

The WHO and the GHSI expressed a strong interest in merging the systems into a single improved system, called "Epidemic Intelligence from Open Sources" (EIOS)[33] and that represents an example of how intranational collaborations can contribute to the development of a trustable professional relationship among health experts, thus promoting further initiatives among which joint RRA activities are considered as a priority.

When a significant acute public health event occurs, health organisations performing RRA activities need to be able to promptly and appropriately describe key aspects related to: *1) the possible cause and the specific health condition implicated; 2) the affected population;* 3*) the overall context of occurrence of the event.*

A Technical Report[34] has identified the contextual information necessary to support rapid risk assessment and produce a list of data products and sources which will meet the need in practice.

The set of structural indicators that will be systematically collected for feeding the INFORM Epidemic will also be part of the contextual information needed by the RRA and as such they will be available in the EIOS system.

30 http://www.ghsi.ca/
31 https://extranet.who.int/hdras/OpenIdLogin/tabid/85/Default.aspx?returnurl=%2fhdras%2fMonitoring.aspx
32 http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0057252
33 http://www.oie.int/eng/BIOTHREAT2017/Presentations/6.2_BARBOZA-presentation.pdf
34 Identification of ICN-RRA, EC JRC report - 2017

7 Conclusions

For the first time, within a single framework, JRC developed a tool assessing the risk for all the type of epidemics. The INFORM Epidemic GRI devised a framework and then combined a significant amount of data to identify countries that are relatively more or less at risk for different types of transmission.

Furthermore, with the inclusion of the epidemic exposure, the Enhanced INFORM Global Risk Index is the first comprehensive multidimensional risk assessment tool, which is globally applicable to all types of risks.

There have been identified ways for improvement, from the data (missing suitability maps, better hazard dependent indicators), to the methodology (calibration of the epidemic hazard component using Global Burden of Disease, validation against historical epidemic events).

Relevant potential beneficiary of an epidemic risk model, like the WHO and the DG-SANTE, should be engaged in order to provide suggestion for the improvement, and finally endorse the results.

The INFORM Epidemic GRI methodology and results will be freely available and they could also support global initiatives such as the Sendai framework.

The advantage of this modular approach, here presented for the epidemic risk, is that it can be applied to different types of hazards, not necessarily included in the INFORM GRI. The plan is to expand this approach, and develop other INFORM Hazard-dependent GRI models. This will be done in collaboration with relevant partners and experts, in order to acquire the knowledge needed in the specific field of application.

The Enhanced INFORM GRI will be presented at the next INFORM partners annual meeting, and then it will replace the current methodology in the next release of the Index in September 2019 (INFORM GRI 2020 version).

JRC will then work on the integration of the INFORM Epidemic GRI data and results in the EIOS system, as contextual information needed for the Rapid Risk Assessment.

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Annexes

Annex 1. INFORM Epidemic GRI correlation matrix

	INFORM Hazard & Exposure	Epidemic Hazard & Exposure	**HAZARD & EXPOSURE**	INFORM Vulnerability	Epidemic Vulnerability	**VULNERABILITY**	INFORM Lack of Coping Capacity	Epidemic Lack of Coping Capacity	**LACK OF COPING CAPACITY**	**INFORM Epidemic RISK**
INFORM Hazard & Exposure	1.00	0.48	**0.74**	0.56	0.24	0.56	0.50	0.11	0.35	0.61
Epidemic Hazard & Exposure	0.48	1.00	**0.94**	0.72	0.26	0.68	0.78	0.41	0.67	0.88
HAZARD & EXPOSURE	0.74	0.94	1.00	0.76	0.29	0.73	0.78	0.35	0.65	0.90
INFORM Vulnerability	0.56	0.72	0.76	1.00	0.19	**0.88**	0.80	0.49	0.73	0.89
Epidemic Vulnerability	0.24	0.26	0.29	0.19	1.00	**0.63**	0.03	-0.27	-0.11	0.20
VULNERABILITY	0.56	0.68	0.73	0.88	0.63	1.00	0.64	0.26	0.52	0.79
INFORM Lack of Coping Capacity	0.50	0.78	0.78	0.80	0.03	0.64	1.00	0.60	**0.90**	0.93
Epidemic Lack of Coping Capacity	0.11	0.41	0.35	0.49	-0.27	0.26	0.60	1.00	**0.88**	0.65
LACK OF COPING CAPACITY	0.35	0.67	0.65	0.73	-0.11	0.52	0.90	0.88	1.00	0.89
INFORM Epidemic RISK	0.61	0.88	**0.90**	0.89	0.20	**0.79**	0.93	0.65	**0.89**	1.00

Element i,j equals to the Pearson's correlation coefficient between the i^{th} row and the j^{th} column variable.

Annex 2. INFORM Epidemic GRI core indicators

Name of core indicator	Position in the INFORM Epidemic GRI			
Physical exposure to earthquake MMI VI (absolute)	Earthquake	**Natural**	**INFORM Hazard & Exposure**	**Hazard & Exposure**
Physical exposure to earthquake MMI VI (relative)				
Physical exposure to earthquake MMI VIII (absolute)				
Physical exposure to earthquake MMI VIII (relative)				
Physical exposure to tsunamis (absolute)	Tsunami			
Physical exposure to tsunamis (relative)				
Physical exposure to flood (absolute)	Flood			
Physical exposure to flood (relative)				
Physical exposure to surge from tropical cyclone (absolute)	Tropical Cyclone			
Physical exposure to surge from tropical cyclone (relative)				
Physical exposure to tropical cyclone of SS 1 (absolute)				
Physical exposure to tropical cyclone of SS 1 (relative)				
Physical exposure to tropical cyclone of SS 3 (absolute)				
Physical exposure to tropical cyclone of SS 3 (relative)				
People affected by droughts (absolute)	Drought			
People affected by droughts (relative)				
Frequency of Drought events				
Agriculture Drought probability				
GCRI Violent Internal Conflict probability	Projected Conflict Risk	**Human**		
GCRI High Violent Internal Conflict probability				
Current National Power Conflict Intensity	Current Conflicts Intensity			
Current Subnational Conflict Intensity				
Population exposed to CCHF (absolute)	CCHF	**Zoonoses**	**Epidemic Hazard**	
Population exposed to CCHF (relative)				
Population exposed to EVD (absolute)	Ebola			
Population exposed to EVD (relative)				
Population exposed to Lassa Fever (absolute)	Lassa Fever			
Population exposed to Lassa Fever (relative)				
Population exposed to MVD (absolute)	MVD			
Population exposed to MVD (relative)				
Population at risk of Plasmodium vivax - Unstable transmission	Malaria	**Vector-borne**		
Population at risk of Plasmodium vivax - Stable transmission				
Population at risk of Plasmodium falciparum - Unstable transmission				
Population at risk of Plasmodium falciparum - Stable transmission				
Population exposed to Zika (absolute)	*Zika*			
Population exposed to Zika (relative)				
Population exposed to Dengue/Chikungunya (absolute)	*Dengue/ Chikungunya*			
Population exposed to Dengue/Chikungunya (relative)				
Population exposed to Yellow Fever (absolute)	*Yellow Fever*			
Population exposed to Yellow Fever (relative)				
Population exposed to West Nile Fever (absolute)	*West Nile Fever*			
Population exposed to West Nile Fever (relative)				
People using at least basic sanitation services	WaSH	**P2P**		
People using at least basic drinking water services				
Population density	Population			
Urban population growth				
Population living in urban areas				
Household size				
People using at least basic sanitation services	WaSH			

People using at least basic drinking water services		**Waterborne / Foodborne**		
People practicing open defecation				
Population density	Population			
Urban population growth				
Population living in urban areas				
Household size				
Population living in slums				
Children under 5				
Number of vets	Food			
IHR capacity score: Food safety				
Population exposed to Waterborne diseases (absolute)	Water			
Population exposed to Waterborne diseases (relative)				
Human Development Index	Poverty & Development	**Socio-Economic Vulnerability**	**INFORM Vulnerability**	**Vulnerability**
Multidimensional Poverty Index				
Gender Inequality Index	Inequality			
Gini Coefficient				
Public Aid per capita	Aid Dependency			
Net ODA Received (% of GNI)				
Total Persons of Concern (absolute)	Uprooted people	**Vulnerable Groups**		
Total Persons of Concern (relative)				
Children Underweight	Other Vulnerable Groups Children under-5			
Child Mortality				
Prevalence of HIV-AIDS above 15years	Other Vulnerable Groups Health Conditions			
Tuberculosis prevalence				
Malaria mortality rate				
Relative number of affected population by natural disasters in the last three years	Other Vulnerable Groups Recent Shocks			
Prevalence of undernourishment	Other Vulnerable Groups Food Security			
Average dietary supply adequacy				
Domestic Food Price Level Index				
Domestic Food Price Volatility Index				
Air transport, passengers carried	International travellers	**Movement**	**Epidemic Vulnerability**	
International tourism, number of arrivals				
Access to cities	Local movements			
IHR: Points of Entry	Points of entry			
Adult literacy rate, population 15+ years, both sexes	Awareness	**Behaviuor**		
Mobile cellular subscriptions				
Individuals using the Internet				
Confidence in National Government	Trust			
Hyogo Framework for Action	DRR implementation	**Institutional**	**INFORM Lack of Coping Capacity**	**Lack of Coping Capacity**
Government effectiveness	Governance			
Corruption Perception Index				
Access to electricity (% of population)	Communication	**Infrastructure**		
Internet Users (per 100 people)				
Mobile cellular subscriptions (per 100 people)				
Adult literacy rate				
Road density (km of road per 100 sq. km of land area)	Physical Connectivity			
Access to Improved water source (% of pop with access)				
Access to Improved sanitation facilities (% of pop with access)				
Physicians density	Access to health system			
Health expenditure per capita				
Measles immunization coverage				
International Health Regulations capacity scores	IHR	**IHR**		

Annex 3. INFORM Epidemic GRI results – countries by alphabetic order

Based on INFORM GRI 2019.

COUNTRY	ISO3	INFORM Hazard & Exposure	Epidemic Hazard	Epidemic INFORM Hazard & Exposure	INFORM Vulnerability	Epidemic Vulnerability	Epidemic INFORM Vulnerability	INFORM Lack of Coping Capacity	Epidemic Lack of Coping Capacity	Epidemic INFORM Lack of Coping Capacity	Epidemic INFORM Risk	RANK
Afghanistan	AFG	8.8	5.2	6.4	7.2	4.5	6.0	7.5	5.8	6.7	6.4	6
Albania	ALB	3.3	3.4	3.4	1.5	3.7	2.7	4.3	5.4	4.9	3.6	106
Algeria	DZA	5.5	3.7	4.2	3.3	5.9	4.7	4.6	2.5	3.6	4.1	82
Angola	AGO	3.6	6.7	6.1	4.5	5.8	5.2	7.3	2.5	5.4	5.6	34
Antigua and Barbuda	ATG	1.6	2.9	2.6	2.1	3.5	2.8	3.5	2.9	3.2	2.9	144
Argentina	ARG	2.4	3.4	3.2	2.1	5.6	4.1	3.5	3.0	3.3	3.5	112
Armenia	ARM	3.2	3.1	3.1	2.8	4.1	3.5	4.8	0.5	2.9	3.2	124
Australia	AUS	3.4	2.6	2.8	1.8	5.8	4.1	2.1	0.0	1.1	2.3	169
Austria	AUT	1.2	2.6	2.3	2.5	4.1	3.3	1.4	3.2	2.3	2.6	157
Azerbaijan	AZE	5.2	3.6	4.0	4.3	6.2	5.3	4.5	1.6	3.2	4.1	82
Bahamas	BHS	2.0	3.8	3.4	1.7	4.7	3.3	3.1	2.2	2.7	3.1	132
Bahrain	BHR	0.2	3.8	3.0	1.3	4.4	3.0	3.0	0.7	1.9	2.6	157
Bangladesh	BGD	7.5	6.4	6.7	5.6	7.8	6.8	5.2	2.2	3.9	5.6	34
Barbados	BRB	1.4	2.8	2.5	1.5	5.7	3.9	2.5	0.8	1.7	2.5	161
Belarus	BLR	2.6	1.7	1.9	1.3	5.5	3.7	3.0	1.1	2.1	2.5	161
Belgium	BEL	3.8	2.1	2.6	1.8	5.8	4.1	1.6	1.7	1.7	2.6	157
Belize	BLZ	3.3	2.9	3.0	2.3	5.5	4.1	5.3	4.5	4.9	3.9	93
Benin	BEN	2.1	6.6	5.7	4.7	5.9	5.3	6.8	7.0	6.9	5.9	18
Bhutan	BTN	1.8	4.2	3.7	3.3	6.2	4.9	4.5	2.7	3.7	4.1	82
Bolivia	BOL	4.3	4.5	4.5	3.3	5.2	4.3	5.3	2.4	4.0	4.3	72
Bosnia and Herzegovina	BIH	3.0	2.5	2.6	3.7	2.8	3.3	4.5	4.2	4.4	3.4	116
Botswana	BWA	1.5	3.8	3.3	3.5	5.1	4.3	4.6	5.8	5.2	4.2	78
Brazil	BRA	5.6	4.9	5.1	2.4	5.0	3.8	4.2	0.4	2.5	3.6	106
Brunei Darussalam	BRN	2.3	4.4	3.9	0.7	4.2	2.6	4.3	3.3	3.8	3.4	116
Bulgaria	BGR	2.1	3.3	3.0	2.3	3.5	2.9	3.0	3.1	3.1	3.0	137
Burkina Faso	BFA	3.8	6.5	5.9	5.8	5.5	5.7	6.1	5.5	5.8	5.8	21
Burundi	BDI	4.9	6.1	5.8	6.7	5.7	6.2	6.5	7.5	7.0	6.3	9
Cabo Verde	CPV	1.0	4.3	3.6	3.3	4.8	4.1	4.0	3.5	3.8	3.8	97
Cambodia	KHM	4.5	6.3	5.9	3.8	5.1	4.5	6.6	1.9	4.7	5.0	49
Cameroon	CMR	4.9	7.0	6.6	6.3	5.6	6.0	5.9	4.3	5.2	5.9	18
Canada	CAN	3.0	2.4	2.6	2.1	6.5	4.7	2.3	0.0	1.2	2.4	166
Central African Republic	CAF	7.9	6.7	7.0	8.8	5.9	7.6	8.7	7.3	8.1	7.6	2
Chad	TCD	5.5	6.3	6.1	7.6	5.4	6.6	8.9	5.6	7.6	6.7	4
Chile	CHL	4.8	1.8	2.7	1.7	4.6	3.3	3.0	1.6	2.3	2.7	150

China	CHN	7.0	4.5	5.2	3.3	5.6	4.6	3.6	0.0	2.0	3.6	106
Colombia	COL	6.8	4.5	5.2	6.2	4.6	5.5	4.0	1.2	2.7	4.3	72
Comoros	COM	1.5	4.6	3.9	4.9	4.6	4.8	6.7	6.3	6.5	5.0	49
Congo	COG	3.8	6.2	5.7	6.0	4.5	5.3	7.3	6.9	7.1	6.0	15
Congo DR	COD	7.1	7.8	7.6	7.6	5.0	6.5	8.0	3.5	6.2	6.7	4
Costa Rica	CRI	3.8	3.6	3.7	2.3	4.6	3.5	2.7	1.3	2.0	3.0	137
Côte d'Ivoire	CIV	4.8	7.4	6.9	5.1	6.6	5.9	7.1	1.3	4.8	5.8	21
Croatia	HRV	3.2	2.6	2.8	1.1	5.3	3.5	3.1	2.9	3.0	3.1	132
Cuba	CUB	3.7	4.3	4.2	3.2	5.9	4.7	3.0	0.1	1.7	3.2	124
Cyprus	CYP	1.8	2.9	2.6	4.3	5.0	4.7	2.6	0.4	1.6	2.7	150
Czech Republic	CZE	1.1	1.9	1.7	1.1	5.2	3.4	2.1	0.6	1.4	2.0	184
Denmark	DNK	0.5	2.2	1.8	1.8	5.7	4.0	1.4	1.0	1.2	2.1	182
Djibouti	DJI	4.5	4.9	4.8	5.4	5.9	5.7	6.4	6.7	6.6	5.7	29
Dominica	DMA	2.7	3.6	3.4	3.7	3.8	3.8	3.8	3.8	3.8	3.7	105
Dominican Republic	DOM	4.6	4.0	4.2	2.9	5.5	4.3	4.6	4.5	4.6	4.4	68
Ecuador	ECU	4.6	3.8	4.0	3.7	5.1	4.4	4.2	1.9	3.1	3.8	97
Egypt	EGY	6.3	3.5	4.3	3.8	7.3	5.8	4.5	0.4	2.7	4.1	82
El Salvador	SLV	6.6	4.6	5.2	2.2	5.6	4.1	4.7	0.7	2.9	4.0	89
Equatorial Guinea	GNQ	2.9	5.4	4.9	2.8	4.7	3.8	7.3	7.3	7.3	5.1	46
Eritrea	ERI	3.9	6.1	5.6	4.5	6.5	5.6	7.8	5.1	6.6	5.9	18
Estonia	EST	0.5	1.9	1.6	1.1	2.8	2.0	2.0	3.0	2.5	2.0	184
Ethiopia	ETH	7.2	6.8	6.9	6.6	7.5	7.1	6.6	2.1	4.7	6.1	12
Fiji	FJI	2.3	2.9	2.8	3.5	5.5	4.6	3.4	0.2	1.9	2.9	144
Finland	FIN	0.1	1.3	1.0	1.7	5.7	4.0	1.4	0.4	0.9	1.5	190
France	FRA	2.9	2.5	2.6	2.7	4.8	3.8	2.0	1.1	1.6	2.5	161
Gabon	GAB	4.1	6.3	5.8	3.6	3.4	3.5	6.2	4.8	5.5	4.8	58
Gambia	GMB	2.4	5.6	4.9	5.8	5.7	5.8	5.4	7.3	6.4	5.7	29
Georgia	GEO	3.5	3.9	3.8	4.9	4.8	4.9	3.3	2.6	3.0	3.8	97
Germany	DEU	1.8	1.9	1.9	3.3	6.8	5.3	1.5	0.3	0.9	2.1	182
Ghana	GHA	2.7	7.0	6.2	4.3	5.2	4.8	5.2	2.6	4.0	4.9	54
Greece	GRC	4.2	3.2	3.5	2.4	4.4	3.5	2.4	x	2.4	3.1	132
Grenada	GRD	0.4	2.8	2.3	1.8	4.3	3.1	3.7	3.4	3.6	2.9	144
Guatemala	GTM	5.7	4.2	4.6	5.5	5.1	5.3	5.4	4.5	5.0	5.0	49
Guinea	GIN	3.9	7.5	6.8	4.8	4.9	4.9	7.3	4.1	5.9	5.8	21
Guinea-Bissau	GNB	3.1	6.3	5.6	6.5	5.3	5.9	7.9	4.7	6.6	6.0	15
Guyana	GUY	2.1	4.3	3.8	2.7	4.1	3.4	5.2	1.1	3.4	3.5	112
Haiti	HTI	5.3	5.5	5.5	7.1	4.4	5.9	7.4	3.9	5.9	5.8	21
Honduras	HND	4.6	4.5	4.5	5.1	4.1	4.6	5.2	3.0	4.2	4.4	68
Hungary	HUN	2.0	3.2	2.9	1.7	4.0	2.9	2.2	1.8	2.0	2.6	157
Iceland	ISL	0.8	1.9	1.6	0.8	4.6	2.9	2.0	2.8	2.4	2.2	174
India	IND	7.0	6.6	6.7	5.2	7.7	6.6	4.5	0.5	2.7	4.9	54
Indonesia	IDN	7.1	5.9	6.2	3.2	7.0	5.4	4.7	0.1	2.7	4.5	66
Iran	IRN	6.3	4.2	4.8	4.2	7.1	5.8	4.5	2.4	3.5	4.6	63
Iraq	IRQ	8.6	4.5	5.9	6.1	6.2	6.2	7.0	1.1	4.7	5.6	34
Ireland	IRL	1.3	2.0	1.8	1.3	6.2	4.2	1.9	2.2	2.1	2.5	161

Israel	ISR	4.3	3.8	3.9	1.9	5.5	3.9	2.1	2.9	2.5	3.4	116
Italy	ITA	3.4	2.9	3.0	2.4	5.3	4.0	2.3	1.0	1.7	2.7	150
Jamaica	JAM	2.2	3.5	3.2	2.2	5.2	3.9	3.7	10.0	8.2	4.7	60
Japan	JPN	5.8	2.6	3.5	0.9	5.8	3.7	1.5	0.0	0.8	2.2	174
Jordan	JOR	2.6	3.3	3.1	6.3	4.5	5.5	4.2	2.8	3.5	3.9	93
Kazakhstan	KAZ	2.9	2.4	2.5	1.0	4.9	3.2	3.8	2.2	3.0	2.9	144
Kenya	KEN	5.8	6.3	6.2	6.2	5.6	5.9	6.2	4.2	5.3	5.8	21
Kiribati	KIR	2.1	4.4	3.9	4.9	5.7	5.3	5.8	4.0	5.0	4.7	60
Korea DPR	PRK	3.9	3.4	3.5	4.1	4.4	4.3	6.4	3.3	5.0	4.2	78
Korea Republic of	KOR	3.9	3.4	3.5	0.6	5.2	3.2	1.9	0.2	1.1	2.3	169
Kuwait	KWT	1.3	3.0	2.6	1.6	4.0	2.9	3.9	1.5	2.8	2.8	148
Kyrgyzstan	KGZ	5.1	3.3	3.8	2.3	4.5	3.5	4.5	5.0	4.8	4.0	89
Lao PDR	LAO	3.3	5.2	4.8	3.7	5.0	4.4	6.1	2.5	4.5	4.6	63
Latvia	LVA	1.2	2.0	1.8	1.3	4.8	3.2	2.6	1.0	1.8	2.2	174
Lebanon	LBN	5.7	3.8	4.3	6.3	4.6	5.5	4.2	2.0	3.2	4.2	78
Lesotho	LSO	2.4	4.2	3.8	6.0	5.8	5.9	6.7	3.8	5.4	4.9	54
Liberia	LBR	2.8	7.2	6.4	6.4	6.8	6.6	7.7	2.4	5.7	6.2	10
Libya	LBY	8.4	3.1	5.0	3.9	5.0	4.5	6.9	3.6	5.5	5.0	49
Liechtenstein	LIE	0.7	1.4	1.2	0.8	3.4	2.2	1.2	x	1.2	1.5	190
Lithuania	LTU	0.9	2.0	1.7	1.3	4.4	3.0	2.4	2.3	2.4	2.3	169
Luxembourg	LUX	0.3	2.8	2.2	1.2	6.2	4.1	1.2	1.2	1.2	2.2	174
Madagascar	MDG	3.9	6.3	5.8	4.5	4.9	4.7	7.6	5.7	6.8	5.7	29
Malawi	MWI	2.6	5.5	4.9	5.9	5.3	5.6	6.4	4.4	5.5	5.3	44
Malaysia	MYS	3.4	4.9	4.6	3.0	6.0	4.7	3.2	0.0	1.7	3.3	120
Maldives	MDV	1.8	3.3	2.9	1.9	2.6	2.3	4.1	3.7	3.9	3.0	137
Mali	MLI	6.1	6.5	6.4	6.1	4.4	5.3	6.9	6.0	6.5	6.0	15
Malta	MLT	1.3	4.0	3.4	2.2	6.6	4.8	2.4	2.1	2.3	3.3	120
Marshall Islands	MHL	2.9	3.4	3.3	5.4	3.5	4.5	6.3	4.3	5.4	4.3	72
Mauritania	MRT	5.3	5.3	5.3	6.4	3.8	5.2	7.0	6.8	6.9	5.8	21
Mauritius	MUS	2.1	3.8	3.4	1.6	5.2	3.6	2.8	2.9	2.9	3.3	120
Mexico	MEX	8.2	4.0	5.4	3.6	5.2	4.4	4.4	0.6	2.7	4.0	89
Micronesia	FSM	2.7	3.9	3.6	5.3	6.0	5.7	5.8	1.4	3.9	4.3	72
Moldova Republic of	MDA	2.2	3.0	2.8	2.0	3.6	2.8	4.7	1.9	3.4	3.0	137
Mongolia	MNG	2.0	2.8	2.6	3.7	4.7	4.2	5.1	1.3	3.4	3.3	120
Montenegro	MNE	2.4	2.3	2.3	1.4	3.3	2.4	3.6	4.4	4.0	2.8	148
Morocco	MAR	4.6	4.1	4.2	3.4	5.5	4.5	4.9	0.5	3.0	3.8	97
Mozambique	MOZ	5.1	6.3	6.0	6.5	5.8	6.2	6.6	3.1	5.1	5.7	29
Myanmar	MMR	8.6	5.4	6.5	5.3	4.9	5.1	6.3	3.8	5.2	5.6	34
Namibia	NAM	2.5	5.0	4.5	4.7	6.3	5.6	5.1	2.1	3.8	4.6	63
Nauru	NRU	1.4	4.5	3.8	4.7	4.4	4.6	5.7	5.8	5.8	4.7	60
Nepal	NPL	5.2	5.1	5.1	4.3	5.2	4.8	5.7	7.8	6.9	5.5	40
Netherlands	NLD	1.0	2.0	1.8	2.2	6.6	4.8	1.3	0.5	0.9	2.0	184
New Zealand	NZL	3.1	2.1	2.4	1.0	5.9	3.9	2.0	0.2	1.1	2.2	174
Nicaragua	NIC	4.9	4.4	4.5	3.4	5.7	4.7	5.2	0.9	3.3	4.1	82

Niger	NER	6.3	7.0	6.8	6.4	5.6	6.0	7.6	2.6	5.6	6.1	12
Nigeria	NGA	8.0	7.5	7.6	6.0	5.8	5.9	6.5	4.9	5.8	6.4	6
Norway	NOR	0.1	1.9	1.5	2.0	6.1	4.4	1.6	0.1	0.9	1.8	189
Oman	OMN	3.6	4.0	3.9	1.6	4.5	3.2	3.9	1.0	2.6	3.2	124
Pakistan	PAK	7.6	5.5	6.1	5.7	5.7	5.7	5.6	4.9	5.3	5.7	29
Palau	PLW	1.9	3.8	3.4	2.7	3.5	3.1	4.4	0.9	2.8	3.1	132
Palestine	PSE	2.2	3.6	3.3	6.5	5.3	5.9	4.5	x	4.5	4.4	68
Panama	PAN	3.1	4.3	4.0	2.3	4.5	3.5	4.1	2.4	3.3	3.6	106
Papua New Guinea	PNG	4.8	5.0	5.0	4.8	5.6	5.2	7.6	3.6	6.0	5.4	41
Paraguay	PRY	1.9	4.1	3.6	2.3	5.1	3.8	4.4	2.3	3.4	3.6	106
Peru	PER	4.9	3.7	4.0	3.7	3.2	3.5	4.5	3.4	4.0	3.8	97
Philippines	PHL	8.8	5.7	6.7	4.5	5.9	5.2	4.3	1.9	3.2	4.8	58
Poland	POL	1.4	1.5	1.5	1.5	5.3	3.6	2.9	2.6	2.8	2.5	161
Portugal	PRT	2.2	2.6	2.5	1.2	5.0	3.3	2.0	0.9	1.5	2.3	169
Qatar	QAT	0.7	3.2	2.6	1.6	4.0	2.9	2.5	2.4	2.5	2.7	150
Romania	ROU	4.1	3.1	3.4	1.7	4.3	3.1	3.6	2.4	3.0	3.2	124
Russian Federation	RUS	6.6	2.2	3.6	2.7	5.9	4.5	4.6	0.2	2.7	3.5	112
Rwanda	RWA	3.9	5.8	5.4	6.4	6.8	6.6	5.1	3.4	4.3	5.4	41
Saint Kitts and Nevis	KNA	1.0	4.1	3.4	1.4	3.4	2.5	3.2	4.8	4.0	3.2	124
Saint Lucia	LCA	1.0	3.0	2.5	1.7	5.9	4.1	3.9	2.3	3.1	3.2	124
Saint Vincent and the Grenadines	VCT	0.6	2.6	2.1	2.2	4.5	3.4	3.7	3.5	3.6	3.0	137
Samoa	WSM	1.6	2.0	1.9	3.3	5.3	4.4	4.2	2.5	3.4	3.1	132
Sao Tome and Principe	STP	0.2	5.3	4.3	4.5	3.8	4.2	5.1	8.4	7.1	5.0	49
Saudi Arabia	SAU	3.3	4.2	4.0	1.0	5.0	3.3	3.5	0.1	2.0	3.0	137
Senegal	SEN	3.6	5.8	5.3	5.1	5.1	5.1	5.7	5.6	5.7	5.4	41
Serbia	SRB	4.4	3.3	3.6	2.5	3.8	3.2	3.9	5.6	4.8	3.8	97
Seychelles	SYC	1.6	4.0	3.5	1.7	2.7	2.2	3.5	1.3	2.5	2.7	150
Sierra Leone	SLE	3.7	6.8	6.2	5.8	6.0	5.9	7.0	3.0	5.3	5.8	21
Singapore	SGP	0.1	4.4	3.5	0.4	7.7	5.1	1.1	0.1	0.6	2.2	174
Slovakia	SVK	1.8	2.1	2.0	1.1	4.9	3.2	2.6	0.5	1.6	2.2	174
Slovenia	SVN	2.2	2.4	2.4	0.8	4.5	2.9	1.7	2.3	2.0	2.4	166
Solomon Islands	SLB	3.7	4.7	4.5	4.9	5.6	5.3	6.5	4.3	5.5	5.1	46
Somalia	SOM	9.0	5.8	6.9	9.2	5.1	7.7	9.0	7.1	8.2	7.6	2
South Africa	ZAF	5.0	4.6	4.7	4.6	4.6	4.6	4.4	0.9	2.8	3.9	93
South Sudan	SSD	8.2	6.6	7.1	9.2	4.9	7.7	9.3	6.6	8.3	7.7	1
Spain	ESP	3.4	3.1	3.2	1.6	5.2	3.6	1.9	0.5	1.2	2.4	166
Sri Lanka	LKA	3.3	5.0	4.6	3.4	7.0	5.5	4.1	2.4	3.3	4.4	68
Sudan	SDN	7.3	6.5	6.7	6.9	5.3	6.2	7.0	3.3	5.4	6.1	12
Suriname	SUR	2.0	3.9	3.5	2.7	5.8	4.4	4.8	2.8	3.9	3.9	93
Swaziland	SWZ	1.3	4.1	3.5	5.2	5.2	5.2	5.3	2.5	4.0	4.2	78
Sweden	SWE	0.6	1.6	1.4	3.0	5.4	4.3	1.5	0.7	1.1	1.9	188
Switzerland	CHE	1.0	2.1	1.8	2.3	6.8	4.9	0.9	0.9	0.9	2.0	184
Syria	SYR	8.6	3.9	5.6	7.4	6.2	6.8	5.7	3.6	4.7	5.6	34
Tajikistan	TJK	5.5	4.0	4.4	3.3	4.6	4.0	5.1	0.6	3.2	3.8	97

Tanzania	TZA	4.7	6.4	6.0	5.9	6.1	6.0	6.4	3.1	5.0	5.6	34
Thailand	THA	5.4	5.1	5.2	3.3	6.8	5.3	4.0	0.3	2.3	4.0	89
The former Yugoslav Republic of Macedonia	MKD	3.6	2.9	3.1	2.0	4.9	3.6	3.8	1.0	2.5	3.0	137
Timor-Leste	TLS	3.2	5.8	5.2	4.6	4.3	4.5	6.5	2.8	4.9	4.9	54
Togo	TGO	2.2	7.1	6.2	4.9	5.6	5.3	7.7	3.6	6.0	5.8	21
Tonga	TON	2.2	2.6	2.5	4.7	3.8	4.3	4.5	2.6	3.6	3.4	116
Trinidad and Tobago	TTO	1.1	3.3	2.8	1.8	5.0	3.6	3.5	2.8	3.2	3.2	124
Tunisia	TUN	3.9	2.7	3.0	1.8	4.7	3.4	4.8	4.3	4.6	3.6	106
Turkey	TUR	7.1	4.2	5.1	5.1	6.8	6.0	3.2	1.2	2.3	4.1	82
Turkmenistan	TKM	3.4	2.6	2.8	1.9	5.0	3.6	6.3	1.6	4.3	3.5	112
Tuvalu	TUV	1.5	3.3	2.9	5.0	4.1	4.6	5.4	4.6	5.0	4.1	82
Uganda	UGA	5.2	7.3	6.9	6.9	5.3	6.2	6.9	4.2	5.7	6.2	10
Ukraine	UKR	7.0	2.7	4.1	4.0	3.8	3.9	5.0	5.1	5.1	4.3	72
United Arab Emirates	ARE	3.5	3.9	3.8	1.2	4.6	3.1	1.9	0.3	1.1	2.3	169
United Kingdom	GBR	2.7	2.0	2.2	2.1	5.2	3.8	1.5	1.1	1.3	2.2	174
United States of America	USA	6.8	2.7	4.0	2.8	5.7	4.4	2.1	0.0	1.1	2.7	150
Uruguay	URY	0.7	3.3	2.7	1.6	5.1	3.5	2.9	1.3	2.1	2.7	150
Uzbekistan	UZB	4.9	3.0	3.5	1.9	4.2	3.1	4.1	1.7	3.0	3.2	124
Vanuatu	VUT	2.6	3.6	3.4	4.4	3.9	4.2	6.0	6.5	6.3	4.5	66
Venezuela	VEN	5.9	4.7	5.0	3.5	4.9	4.2	4.4	0.6	2.7	3.8	97
Viet Nam	VNM	5.6	5.6	5.6	2.4	7.5	5.5	4.2	0.5	2.5	4.3	72
Yemen	YEM	8.1	5.2	6.1	7.5	4.5	6.2	7.9	5.2	6.8	6.4	6
Zambia	ZMB	2.0	5.6	4.9	5.9	6.2	6.1	5.8	3.6	4.8	5.2	45
Zimbabwe	ZWE	4.7	4.9	4.9	5.2	6.8	6.1	5.7	2.8	4.4	5.1	46

Annex 4. INFORM Epidemic GRI results – countries by ranking order

Based on INFORM GRI 2019.

COUNTRY	ISO3	INFORM Hazard & Exposure	Epidemic Hazard	Epidemic INFORM Hazard & Exposure	INFORM Vulnerability	Epidemic Vulnerability	Epidemic INFORM Vulnerability	INFORM Lack of Coping Capacity	Epidemic Lack of Coping Capacity	Epidemic INFORM Lack of Coping Capacity	Epidemic INFORM Risk	RANK
South Sudan	SSD	8.2	6.6	7.1	9.2	4.9	7.7	9.3	6.6	8.3	7.7	1
Central African Republic	CAF	7.9	6.7	7.0	8.8	5.9	7.6	8.7	7.3	8.1	7.6	2
Somalia	SOM	9.0	5.8	6.9	9.2	5.1	7.7	9.0	7.1	8.2	7.6	2
Chad	TCD	5.5	6.3	6.1	7.6	5.4	6.6	8.9	5.6	7.6	6.7	4
Congo DR	COD	7.1	7.8	7.6	7.6	5.0	6.5	8.0	3.5	6.2	6.7	4
Afghanistan	AFG	8.8	5.2	6.4	7.2	4.5	6.0	7.5	5.8	6.7	6.4	6
Nigeria	NGA	8.0	7.5	7.6	6.0	5.8	5.9	6.5	4.9	5.8	6.4	6
Yemen	YEM	8.1	5.2	6.1	7.5	4.5	6.2	7.9	5.2	6.8	6.4	6
Burundi	BDI	4.9	6.1	5.8	6.7	5.7	6.2	6.5	7.5	7.0	6.3	9
Liberia	LBR	2.8	7.2	6.4	6.4	6.8	6.6	7.7	2.4	5.7	6.2	10
Uganda	UGA	5.2	7.3	6.9	6.9	5.3	6.2	6.9	4.2	5.7	6.2	10
Ethiopia	ETH	7.2	6.8	6.9	6.6	7.5	7.1	6.6	2.1	4.7	6.1	12
Niger	NER	6.3	7.0	6.8	6.4	5.6	6.0	7.6	2.6	5.6	6.1	12
Sudan	SDN	7.3	6.5	6.7	6.9	5.3	6.2	7.0	3.3	5.4	6.1	12
Congo	COG	3.8	6.2	5.7	6.0	4.5	5.3	7.3	6.9	7.1	6.0	15
Guinea-Bissau	GNB	3.1	6.3	5.6	6.5	5.3	5.9	7.9	4.7	6.6	6.0	15
Mali	MLI	6.1	6.5	6.4	6.1	4.4	5.3	6.9	6.0	6.5	6.0	15
Benin	BEN	2.1	6.6	5.7	4.7	5.9	5.3	6.8	7.0	6.9	5.9	18
Cameroon	CMR	4.9	7.0	6.6	6.3	5.6	6.0	5.9	4.3	5.2	5.9	18
Eritrea	ERI	3.9	6.1	5.6	4.5	6.5	5.6	7.8	5.1	6.6	5.9	18
Burkina Faso	BFA	3.8	6.5	5.9	5.8	5.5	5.7	6.1	5.5	5.8	5.8	21
Côte d'Ivoire	CIV	4.8	7.4	6.9	5.1	6.6	5.9	7.1	1.3	4.8	5.8	21
Guinea	GIN	3.9	7.5	6.8	4.8	4.9	4.9	7.3	4.1	5.9	5.8	21
Haiti	HTI	5.3	5.5	5.5	7.1	4.4	5.9	7.4	3.9	5.9	5.8	21
Kenya	KEN	5.8	6.3	6.2	6.2	5.6	5.9	6.2	4.2	5.3	5.8	21
Mauritania	MRT	5.3	5.3	5.3	6.4	3.8	5.2	7.0	6.8	6.9	5.8	21
Sierra Leone	SLE	3.7	6.8	6.2	5.8	6.0	5.9	7.0	3.0	5.3	5.8	21
Togo	TGO	2.2	7.1	6.2	4.9	5.6	5.3	7.7	3.6	6.0	5.8	21
Djibouti	DJI	4.5	4.9	4.8	5.4	5.9	5.7	6.4	6.7	6.6	5.7	29
Gambia	GMB	2.4	5.6	4.9	5.8	5.7	5.8	5.4	7.3	6.4	5.7	29
Madagascar	MDG	3.9	6.3	5.8	4.5	4.9	4.7	7.6	5.7	6.8	5.7	29
Mozambique	MOZ	5.1	6.3	6.0	6.5	5.8	6.2	6.6	3.1	5.1	5.7	29
Pakistan	PAK	7.6	5.5	6.1	5.7	5.7	5.7	5.6	4.9	5.3	5.7	29
Angola	AGO	3.6	6.7	6.1	4.5	5.8	5.2	7.3	2.5	5.4	5.6	34

Bangladesh	BGD	7.5	6.4	6.7	5.6	7.8	6.8	5.2	2.2	3.9	5.6	34
Iraq	IRQ	8.6	4.5	5.9	6.1	6.2	6.2	7.0	1.1	4.7	5.6	34
Myanmar	MMR	8.6	5.4	6.5	5.3	4.9	5.1	6.3	3.8	5.2	5.6	34
Syria	SYR	8.6	3.9	5.6	7.4	6.2	6.8	5.7	3.6	4.7	5.6	34
Tanzania	TZA	4.7	6.4	6.0	5.9	6.1	6.0	6.4	3.1	5.0	5.6	34
Nepal	NPL	5.2	5.1	5.1	4.3	5.2	4.8	5.7	7.8	6.9	5.5	40
Papua New Guinea	PNG	4.8	5.0	5.0	4.8	5.6	5.2	7.6	3.6	6.0	5.4	41
Rwanda	RWA	3.9	5.8	5.4	6.4	6.8	6.6	5.1	3.4	4.3	5.4	41
Senegal	SEN	3.6	5.8	5.3	5.1	5.1	5.1	5.7	5.6	5.7	5.4	41
Malawi	MWI	2.6	5.5	4.9	5.9	5.3	5.6	6.4	4.4	5.5	5.3	44
Zambia	ZMB	2.0	5.6	4.9	5.9	6.2	6.1	5.8	3.6	4.8	5.2	45
Equatorial Guinea	GNQ	2.9	5.4	4.9	2.8	4.7	3.8	7.3	7.3	7.3	5.1	46
Solomon Islands	SLB	3.7	4.7	4.5	4.9	5.6	5.3	6.5	4.3	5.5	5.1	46
Zimbabwe	ZWE	4.7	4.9	4.9	5.2	6.8	6.1	5.7	2.8	4.4	5.1	46
Cambodia	KHM	4.5	6.3	5.9	3.8	5.1	4.5	6.6	1.9	4.7	5.0	49
Comoros	COM	1.5	4.6	3.9	4.9	4.6	4.8	6.7	6.3	6.5	5.0	49
Guatemala	GTM	5.7	4.2	4.6	5.5	5.1	5.3	5.4	4.5	5.0	5.0	49
Libya	LBY	8.4	3.1	5.0	3.9	5.0	4.5	6.9	3.6	5.5	5.0	49
Sao Tome and Principe	STP	0.2	5.3	4.3	4.5	3.8	4.2	5.1	8.4	7.1	5.0	49
Ghana	GHA	2.7	7.0	6.2	4.3	5.2	4.8	5.2	2.6	4.0	4.9	54
India	IND	7.0	6.6	6.7	5.2	7.7	6.6	4.5	0.5	2.7	4.9	54
Lesotho	LSO	2.4	4.2	3.8	6.0	5.8	5.9	6.7	3.8	5.4	4.9	54
Timor-Leste	TLS	3.2	5.8	5.2	4.6	4.3	4.5	6.5	2.8	4.9	4.9	54
Gabon	GAB	4.1	6.3	5.8	3.6	3.4	3.5	6.2	4.8	5.5	4.8	58
Philippines	PHL	8.8	5.7	6.7	4.5	5.9	5.2	4.3	1.9	3.2	4.8	58
Jamaica	JAM	2.2	3.5	3.2	2.2	5.2	3.9	3.7	10.0	8.2	4.7	60
Kiribati	KIR	2.1	4.4	3.9	4.9	5.7	5.3	5.8	4.0	5.0	4.7	60
Nauru	NRU	1.4	4.5	3.8	4.7	4.4	4.6	5.7	5.8	5.8	4.7	60
Iran	IRN	6.3	4.2	4.8	4.2	7.1	5.8	4.5	2.4	3.5	4.6	63
Lao PDR	LAO	3.3	5.2	4.8	3.7	5.0	4.4	6.1	2.5	4.5	4.6	63
Namibia	NAM	2.5	5.0	4.5	4.7	6.3	5.6	5.1	2.1	3.8	4.6	63
Indonesia	IDN	7.1	5.9	6.2	3.2	7.0	5.4	4.7	0.1	2.7	4.5	66
Vanuatu	VUT	2.6	3.6	3.4	4.4	3.9	4.2	6.0	6.5	6.3	4.5	66
Dominican Republic	DOM	4.6	4.0	4.2	2.9	5.5	4.3	4.6	4.5	4.6	4.4	68
Honduras	HND	4.6	4.5	4.5	5.1	4.1	4.6	5.2	3.0	4.2	4.4	68
Palestine	PSE	2.2	3.6	3.3	6.5	5.3	5.9	4.5	x	4.5	4.4	68
Sri Lanka	LKA	3.3	5.0	4.6	3.4	7.0	5.5	4.1	2.4	3.3	4.4	68
Bolivia	BOL	4.3	4.5	4.5	3.3	5.2	4.3	5.3	2.4	4.0	4.3	72
Colombia	COL	6.8	4.5	5.2	6.2	4.6	5.5	4.0	1.2	2.7	4.3	72
Marshall Islands	MHL	2.9	3.4	3.3	5.4	3.5	4.5	6.3	4.3	5.4	4.3	72
Micronesia	FSM	2.7	3.9	3.6	5.3	6.0	5.7	5.8	1.4	3.9	4.3	72
Ukraine	UKR	7.0	2.7	4.1	4.0	3.8	3.9	5.0	5.1	5.1	4.3	72
Viet Nam	VNM	5.6	5.6	5.6	2.4	7.5	5.5	4.2	0.5	2.5	4.3	72
Botswana	BWA	1.5	3.8	3.3	3.5	5.1	4.3	4.6	5.8	5.2	4.2	78

Korea DPR	PRK	3.9	3.4	3.5	4.1	4.4	4.3	6.4	3.3	5.0	4.2	78
Lebanon	LBN	5.7	3.8	4.3	6.3	4.6	5.5	4.2	2.0	3.2	4.2	78
Swaziland	SWZ	1.3	4.1	3.5	5.2	5.2	5.2	5.3	2.5	4.0	4.2	78
Algeria	DZA	5.5	3.7	4.2	3.3	5.9	4.7	4.6	2.5	3.6	4.1	82
Azerbaijan	AZE	5.2	3.6	4.0	4.3	6.2	5.3	4.5	1.6	3.2	4.1	82
Bhutan	BTN	1.8	4.2	3.7	3.3	6.2	4.9	4.5	2.7	3.7	4.1	82
Egypt	EGY	6.3	3.5	4.3	3.8	7.3	5.8	4.5	0.4	2.7	4.1	82
Nicaragua	NIC	4.9	4.4	4.5	3.4	5.7	4.7	5.2	0.9	3.3	4.1	82
Turkey	TUR	7.1	4.2	5.1	5.1	6.8	6.0	3.2	1.2	2.3	4.1	82
Tuvalu	TUV	1.5	3.3	2.9	5.0	4.1	4.6	5.4	4.6	5.0	4.1	82
El Salvador	SLV	6.6	4.6	5.2	2.2	5.6	4.1	4.7	0.7	2.9	4.0	89
Kyrgyzstan	KGZ	5.1	3.3	3.8	2.3	4.5	3.5	4.5	5.0	4.8	4.0	89
Mexico	MEX	8.2	4.0	5.4	3.6	5.2	4.4	4.4	0.6	2.7	4.0	89
Thailand	THA	5.4	5.1	5.2	3.3	6.8	5.3	4.0	0.3	2.3	4.0	89
Belize	BLZ	3.3	2.9	3.0	2.3	5.5	4.1	5.3	4.5	4.9	3.9	93
Jordan	JOR	2.6	3.3	3.1	6.3	4.5	5.5	4.2	2.8	3.5	3.9	93
South Africa	ZAF	5.0	4.6	4.7	4.6	4.6	4.6	4.4	0.9	2.8	3.9	93
Suriname	SUR	2.0	3.9	3.5	2.7	5.8	4.4	4.8	2.8	3.9	3.9	93
Cabo Verde	CPV	1.0	4.3	3.6	3.3	4.8	4.1	4.0	3.5	3.8	3.8	97
Ecuador	ECU	4.6	3.8	4.0	3.7	5.1	4.4	4.2	1.9	3.1	3.8	97
Georgia	GEO	3.5	3.9	3.8	4.9	4.8	4.9	3.3	2.6	3.0	3.8	97
Morocco	MAR	4.6	4.1	4.2	3.4	5.5	4.5	4.9	0.5	3.0	3.8	97
Peru	PER	4.9	3.7	4.0	3.7	3.2	3.5	4.5	3.4	4.0	3.8	97
Serbia	SRB	4.4	3.3	3.6	2.5	3.8	3.2	3.9	5.6	4.8	3.8	97
Tajikistan	TJK	5.5	4.0	4.4	3.3	4.6	4.0	5.1	0.6	3.2	3.8	97
Venezuela	VEN	5.9	4.7	5.0	3.5	4.9	4.2	4.4	0.6	2.7	3.8	97
Dominica	DMA	2.7	3.6	3.4	3.7	3.8	3.8	3.8	3.8	3.8	3.7	105
Albania	ALB	3.3	3.4	3.4	1.5	3.7	2.7	4.3	5.4	4.9	3.6	106
Brazil	BRA	5.6	4.9	5.1	2.4	5.0	3.8	4.2	0.4	2.5	3.6	106
China	CHN	7.0	4.5	5.2	3.3	5.6	4.6	3.6	0.0	2.0	3.6	106
Panama	PAN	3.1	4.3	4.0	2.3	4.5	3.5	4.1	2.4	3.3	3.6	106
Paraguay	PRY	1.9	4.1	3.6	2.3	5.1	3.8	4.4	2.3	3.4	3.6	106
Tunisia	TUN	3.9	2.7	3.0	1.8	4.7	3.4	4.8	4.3	4.6	3.6	106
Argentina	ARG	2.4	3.4	3.2	2.1	5.6	4.1	3.5	3.0	3.3	3.5	112
Guyana	GUY	2.1	4.3	3.8	2.7	4.1	3.4	5.2	1.1	3.4	3.5	112
Russian Federation	RUS	6.6	2.2	3.6	2.7	5.9	4.5	4.6	0.2	2.7	3.5	112
Turkmenistan	TKM	3.4	2.6	2.8	1.9	5.0	3.6	6.3	1.6	4.3	3.5	112
Bosnia and Herzegovina	BIH	3.0	2.5	2.6	3.7	2.8	3.3	4.5	4.2	4.4	3.4	116
Brunei Darussalam	BRN	2.3	4.4	3.9	0.7	4.2	2.6	4.3	3.3	3.8	3.4	116
Israel	ISR	4.3	3.8	3.9	1.9	5.5	3.9	2.1	2.9	2.5	3.4	116
Tonga	TON	2.2	2.6	2.5	4.7	3.8	4.3	4.5	2.6	3.6	3.4	116
Malaysia	MYS	3.4	4.9	4.6	3.0	6.0	4.7	3.2	0.0	1.7	3.3	120
Malta	MLT	1.3	4.0	3.4	2.2	6.6	4.8	2.4	2.1	2.3	3.3	120
Mauritius	MUS	2.1	3.8	3.4	1.6	5.2	3.6	2.8	2.9	2.9	3.3	120
Mongolia	MNG	2.0	2.8	2.6	3.7	4.7	4.2	5.1	1.3	3.4	3.3	120

Armenia	ARM	3.2	3.1	3.1	2.8	4.1	3.5	4.8	0.5	2.9	3.2	124
Cuba	CUB	3.7	4.3	4.2	3.2	5.9	4.7	3.0	0.1	1.7	3.2	124
Oman	OMN	3.6	4.0	3.9	1.6	4.5	3.2	3.9	1.0	2.6	3.2	124
Romania	ROU	4.1	3.1	3.4	1.7	4.3	3.1	3.6	2.4	3.0	3.2	124
Saint Kitts and Nevis	KNA	1.0	4.1	3.4	1.4	3.4	2.5	3.2	4.8	4.0	3.2	124
Saint Lucia	LCA	1.0	3.0	2.5	1.7	5.9	4.1	3.9	2.3	3.1	3.2	124
Trinidad and Tobago	TTO	1.1	3.3	2.8	1.8	5.0	3.6	3.5	2.8	3.2	3.2	124
Uzbekistan	UZB	4.9	3.0	3.5	1.9	4.2	3.1	4.1	1.7	3.0	3.2	124
Bahamas	BHS	2.0	3.8	3.4	1.7	4.7	3.3	3.1	2.2	2.7	3.1	132
Croatia	HRV	3.2	2.6	2.8	1.1	5.3	3.5	3.1	2.9	3.0	3.1	132
Greece	GRC	4.2	3.2	3.5	2.4	4.4	3.5	2.4	x	2.4	3.1	132
Palau	PLW	1.9	3.8	3.4	2.7	3.5	3.1	4.4	0.9	2.8	3.1	132
Samoa	WSM	1.6	2.0	1.9	3.3	5.3	4.4	4.2	2.5	3.4	3.1	132
Bulgaria	BGR	2.1	3.3	3.0	2.3	3.5	2.9	3.0	3.1	3.1	3.0	137
Costa Rica	CRI	3.8	3.6	3.7	2.3	4.6	3.5	2.7	1.3	2.0	3.0	137
Maldives	MDV	1.8	3.3	2.9	1.9	2.6	2.3	4.1	3.7	3.9	3.0	137
Moldova Republic of	MDA	2.2	3.0	2.8	2.0	3.6	2.8	4.7	1.9	3.4	3.0	137
Saint Vincent and the Grenadines	VCT	0.6	2.6	2.1	2.2	4.5	3.4	3.7	3.5	3.6	3.0	137
Saudi Arabia	SAU	3.3	4.2	4.0	1.0	5.0	3.3	3.5	0.1	2.0	3.0	137
The former Yugoslav Republic of Macedonia	MKD	3.6	2.9	3.1	2.0	4.9	3.6	3.8	1.0	2.5	3.0	137
Antigua and Barbuda	ATG	1.6	2.9	2.6	2.1	3.5	2.8	3.5	2.9	3.2	2.9	144
Fiji	FJI	2.3	2.9	2.8	3.5	5.5	4.6	3.4	0.2	1.9	2.9	144
Grenada	GRD	0.4	2.8	2.3	1.8	4.3	3.1	3.7	3.4	3.6	2.9	144
Kazakhstan	KAZ	2.9	2.4	2.5	1.0	4.9	3.2	3.8	2.2	3.0	2.9	144
Kuwait	KWT	1.3	3.0	2.6	1.6	4.0	2.9	3.9	1.5	2.8	2.8	148
Montenegro	MNE	2.4	2.3	2.3	1.4	3.3	2.4	3.6	4.4	4.0	2.8	148
Chile	CHL	4.8	1.8	2.7	1.7	4.6	3.3	3.0	1.6	2.3	2.7	150
Cyprus	CYP	1.8	2.9	2.6	4.3	5.0	4.7	2.6	0.4	1.6	2.7	150
Italy	ITA	3.4	2.9	3.0	2.4	5.3	4.0	2.3	1.0	1.7	2.7	150
Qatar	QAT	0.7	3.2	2.6	1.6	4.0	2.9	2.5	2.4	2.5	2.7	150
Seychelles	SYC	1.6	4.0	3.5	1.7	2.7	2.2	3.5	1.3	2.5	2.7	150
United States of America	USA	6.8	2.7	4.0	2.8	5.7	4.4	2.1	0.0	1.1	2.7	150
Uruguay	URY	0.7	3.3	2.7	1.6	5.1	3.5	2.9	1.3	2.1	2.7	150
Austria	AUT	1.2	2.6	2.3	2.5	4.1	3.3	1.4	3.2	2.3	2.6	157
Bahrain	BHR	0.2	3.8	3.0	1.3	4.4	3.0	3.0	0.7	1.9	2.6	157
Belgium	BEL	3.8	2.1	2.6	1.8	5.8	4.1	1.6	1.7	1.7	2.6	157
Hungary	HUN	2.0	3.2	2.9	1.7	4.0	2.9	2.2	1.8	2.0	2.6	157
Barbados	BRB	1.4	2.8	2.5	1.5	5.7	3.9	2.5	0.8	1.7	2.5	161
Belarus	BLR	2.6	1.7	1.9	1.3	5.5	3.7	3.0	1.1	2.1	2.5	161
France	FRA	2.9	2.5	2.6	2.7	4.8	3.8	2.0	1.1	1.6	2.5	161
Ireland	IRL	1.3	2.0	1.8	1.3	6.2	4.2	1.9	2.2	2.1	2.5	161
Poland	POL	1.4	1.5	1.5	1.5	5.3	3.6	2.9	2.6	2.8	2.5	161
Canada	CAN	3.0	2.4	2.6	2.1	6.5	4.7	2.3	0.0	1.2	2.4	166
Slovenia	SVN	2.2	2.4	2.4	0.8	4.5	2.9	1.7	2.3	2.0	2.4	166

Spain	ESP	3.4	3.1	3.2	1.6	5.2	3.6	1.9	0.5	1.2	2.4	166
Australia	AUS	3.4	2.6	2.8	1.8	5.8	4.1	2.1	0.0	1.1	2.3	169
Korea Republic of	KOR	3.9	3.4	3.5	0.6	5.2	3.2	1.9	0.2	1.1	2.3	169
Lithuania	LTU	0.9	2.0	1.7	1.3	4.4	3.0	2.4	2.3	2.4	2.3	169
Portugal	PRT	2.2	2.6	2.5	1.2	5.0	3.3	2.0	0.9	1.5	2.3	169
United Arab Emirates	ARE	3.5	3.9	3.8	1.2	4.6	3.1	1.9	0.3	1.1	2.3	169
Iceland	ISL	0.8	1.9	1.6	0.8	4.6	2.9	2.0	2.8	2.4	2.2	174
Japan	JPN	5.8	2.6	3.5	0.9	5.8	3.7	1.5	0.0	0.8	2.2	174
Latvia	LVA	1.2	2.0	1.8	1.3	4.8	3.2	2.6	1.0	1.8	2.2	174
Luxembourg	LUX	0.3	2.8	2.2	1.2	6.2	4.1	1.2	1.2	1.2	2.2	174
New Zealand	NZL	3.1	2.1	2.4	1.0	5.9	3.9	2.0	0.2	1.1	2.2	174
Singapore	SGP	0.1	4.4	3.5	0.4	7.7	5.1	1.1	0.1	0.6	2.2	174
Slovakia	SVK	1.8	2.1	2.0	1.1	4.9	3.2	2.6	0.5	1.6	2.2	174
United Kingdom	GBR	2.7	2.0	2.2	2.1	5.2	3.8	1.5	1.1	1.3	2.2	174
Denmark	DNK	0.5	2.2	1.8	1.8	5.7	4.0	1.4	1.0	1.2	2.1	182
Germany	DEU	1.8	1.9	1.9	3.3	6.8	5.3	1.5	0.3	0.9	2.1	182
Czech Republic	CZE	1.1	1.9	1.7	1.1	5.2	3.4	2.1	0.6	1.4	2.0	184
Estonia	EST	0.5	1.9	1.6	1.1	2.8	2.0	2.0	3.0	2.5	2.0	184
Netherlands	NLD	1.0	2.0	1.8	2.2	6.6	4.8	1.3	0.5	0.9	2.0	184
Switzerland	CHE	1.0	2.1	1.8	2.3	6.8	4.9	0.9	0.9	0.9	2.0	184
Sweden	SWE	0.6	1.6	1.4	3.0	5.4	4.3	1.5	0.7	1.1	1.9	188
Norway	NOR	0.1	1.9	1.5	2.0	6.1	4.4	1.6	0.1	0.9	1.8	189
Finland	FIN	0.1	1.3	1.0	1.7	5.7	4.0	1.4	0.4	0.9	1.5	190
Liechtenstein	LIE	0.7	1.4	1.2	0.8	3.4	2.2	1.2	x	1.2	1.5	190

Annex 5. Enhanced INFORM GRI results – countries by ranking order

Based on INFORM GRI 2019.

COUNTRY	ISO3	Natural	Human	Hazard & Exposure	Social-Economics Vulnerability	Vulnerable Groups	Vulnerability	Institutional	Infrastructure	Lack of Coping Capacity	Enhanced INFORM 2019	RANK
Afghanistan	AFG	5.9	10.0	8.7	7.2	7.2	7.2	7.2	7.8	7.5	7.8	5
Albania	ALB	5.3	0.1	3.1	2.3	0.6	1.5	5.6	2.6	4.3	2.7	127
Algeria	DZA	4.0	6.7	5.5	3.1	3.4	3.3	5.0	4.2	4.6	4.4	68
Angola	AGO	3.1	4.9	4.1	4.4	4.6	4.5	6.5	8.0	7.3	5.1	45
Antigua and Barbuda	ATG	2.9	0.1	1.6	3.0	1.0	2.1	5.0	1.7	3.5	2.3	141
Argentina	ARG	3.4	1.2	2.4	2.8	1.3	2.1	4.6	2.2	3.5	2.6	131
Armenia	ARM	4.0	2.0	3.1	2.3	3.2	2.8	6.7	2.1	4.8	3.5	99
Australia	AUS	5.3	0.1	3.1	0.6	2.8	1.8	2.3	1.9	2.1	2.3	141
Austria	AUT	2.4	0.0	1.3	0.8	4.0	2.5	2.2	0.5	1.4	1.7	167
Azerbaijan	AZE	4.3	5.8	5.1	2.5	5.8	4.3	6.1	2.5	4.5	4.6	62
Bahamas	BHS	3.5	0.3	2.0	2.4	1.0	1.7	3.6	2.5	3.1	2.2	144
Bahrain	BHR	0.8	0.2	0.5	1.7	0.9	1.3	4.6	1.0	3.0	1.2	183
Bangladesh	BGD	8.0	6.6	7.4	4.9	6.2	5.6	4.9	5.4	5.2	6.0	24
Barbados	BRB	2.6	0.0	1.4	2.4	0.5	1.5	2.9	2.0	2.5	1.7	167
Belarus	BLR	2.2	2.9	2.6	1.1	1.4	1.3	4.3	1.4	3.0	2.2	144
Belgium	BEL	1.7	5.5	3.8	0.6	2.9	1.8	2.4	0.7	1.6	2.2	144
Belize	BLZ	5.1	0.2	3.0	3.6	0.8	2.3	6.4	3.9	5.3	3.3	107
Benin	BEN	2.6	2.7	2.7	6.4	2.5	4.7	5.8	7.6	6.8	4.4	68
Bhutan	BTN	3.4	0.1	1.9	5.0	1.2	3.3	4.1	4.9	4.5	3.0	114
Bolivia	BOL	3.8	4.8	4.3	4.6	1.8	3.3	6.0	4.6	5.3	4.2	76
Bosnia and Herzegovina	BIH	4.1	1.3	2.8	2.6	4.7	3.7	6.1	2.5	4.5	3.6	96
Botswana	BWA	3.0	0.1	1.7	4.0	2.9	3.5	4.8	4.4	4.6	3.0	114
Brazil	BRA	4.0	7.0	5.7	3.3	1.3	2.4	5.1	3.1	4.2	3.9	89
Brunei Darussalam	BRN	2.6	2.4	2.5	0.9	0.5	0.7	4.7	3.9	4.3	2.0	155
Bulgaria	BGR	3.3	0.7	2.1	1.9	2.7	2.3	4.2	1.7	3.0	2.4	138
Burkina Faso	BFA	3.4	4.8	4.1	6.9	4.4	5.8	4.6	7.3	6.1	5.3	38
Burundi	BDI	3.5	6.4	5.1	7.1	6.2	6.7	6.2	6.7	6.5	6.1	20
Cabo Verde	CPV	2.3	0.1	1.3	5.1	1.0	3.3	4.1	3.8	4.0	2.6	131
Cambodia	KHM	5.8	3.0	4.5	5.1	2.2	3.8	7.0	6.1	6.6	4.8	53
Cameroon	CMR	3.4	6.8	5.3	6.0	6.5	6.3	4.8	6.8	5.9	5.8	25
Canada	CAN	4.6	0.4	2.8	0.7	3.3	2.1	2.2	2.4	2.3	2.4	138
Central African Republic	CAF	2.8	10.0	8.1	8.7	8.9	8.8	8.1	9.1	8.7	8.5	3
Chad	TCD	3.9	7.0	5.7	7.2	7.9	7.6	8.0	9.6	8.9	7.3	7

Chile	CHL	6.1	2.0	4.4	2.2	1.1	1.7	3.2	2.7	3.0	2.8	121
China	CHN	7.5	5.7	6.7	2.9	3.6	3.3	3.8	3.4	3.6	4.3	72
Colombia	COL	6.2	7.0	6.6	3.9	7.7	6.2	4.4	3.6	4.0	5.5	30
Comoros	COM	2.6	0.8	1.7	6.7	2.3	4.9	7.8	5.2	6.7	3.8	92
Congo	COG	3.8	4.3	4.1	5.6	6.4	6.0	7.6	6.9	7.3	5.6	29
Congo DR	COD	4.4	9.0	7.3	6.8	8.3	7.6	7.8	8.1	8.0	7.6	6
Costa Rica	CRI	5.9	0.1	3.5	2.7	1.9	2.3	2.9	2.5	2.7	2.8	121
Côte d'Ivoire	CIV	3.7	6.4	5.2	6.1	3.9	5.1	7.1	7.1	7.1	5.7	26
Croatia	HRV	4.9	0.6	3.0	1.4	0.8	1.1	4.5	1.5	3.1	2.2	144
Cuba	CUB	5.5	1.0	3.6	3.5	2.9	3.2	3.9	1.9	3.0	3.3	107
Cyprus	CYP	3.3	0.1	1.8	1.2	6.4	4.3	3.7	1.3	2.6	2.7	127
Czech Republic	CZE	2.0	0.1	1.1	0.8	1.4	1.1	3.1	1.0	2.1	1.4	176
Denmark	DNK	1.2	0.0	0.6	0.4	3.1	1.8	2.0	0.7	1.4	1.1	184
Djibouti	DJI	5.8	2.5	4.3	6.1	4.7	5.4	6.2	6.6	6.4	5.3	38
Dominica	DMA	4.5	0.1	2.6	4.1	3.3	3.7	4.6	2.9	3.8	3.3	107
Dominican Republic	DOM	5.6	3.0	4.4	3.8	1.9	2.9	5.5	3.5	4.6	3.9	89
Ecuador	ECU	6.5	1.0	4.3	3.3	4.0	3.7	4.7	3.7	4.2	4.1	81
Egypt	EGY	5.2	7.0	6.2	3.3	4.2	3.8	5.4	3.5	4.5	4.7	56
El Salvador	SLV	5.9	7.0	6.5	3.4	0.8	2.2	5.7	3.5	4.7	4.1	81
Equatorial Guinea	GNQ	2.6	3.9	3.3	3.7	1.9	2.8	8.1	6.4	7.3	4.1	81
Eritrea	ERI	4.1	4.0	4.1	5.5	3.3	4.5	8.2	7.4	7.8	5.2	41
Estonia	EST	1.0	0.1	0.6	1.1	1.1	1.1	2.9	1.0	2.0	1.1	184
Ethiopia	ETH	4.4	9.0	7.3	6.3	6.8	6.6	4.7	8.0	6.6	6.8	11
Fiji	FJI	3.9	0.1	2.2	3.6	3.3	3.5	2.8	3.9	3.4	3.0	114
Finland	FIN	0.3	0.0	0.2	0.6	2.6	1.7	1.8	1.0	1.4	0.8	190
France	FRA	3.6	2.0	2.8	0.8	4.2	2.7	2.8	1.1	2.0	2.5	137
Gabon	GAB	2.8	5.8	4.5	4.4	2.6	3.6	6.7	5.7	6.2	4.6	62
Gambia	GMB	2.9	2.5	2.7	7.3	3.6	5.8	5.0	5.8	5.4	4.4	68
Georgia	GEO	4.3	2.5	3.5	3.1	6.3	4.9	4.5	1.9	3.3	3.8	92
Germany	DEU	2.2	1.3	1.8	0.5	5.3	3.3	2.2	0.7	1.5	2.1	152
Ghana	GHA	3.6	2.7	3.2	5.4	3.1	4.3	4.6	5.8	5.2	4.2	76
Greece	GRC	4.6	3.4	4.0	1.7	3.0	2.4	3.6	1.0	2.4	2.8	121
Grenada	GRD	1.0	0.1	0.6	2.5	1.0	1.8	4.9	2.2	3.7	1.6	171
Guatemala	GTM	6.4	4.3	5.4	4.1	6.6	5.5	6.1	4.6	5.4	5.4	36
Guinea	GIN	3.7	5.0	4.4	5.8	3.5	4.8	6.1	8.2	7.3	5.4	36
Guinea-Bissau	GNB	2.5	4.5	3.6	7.7	4.9	6.5	8.1	7.6	7.9	5.7	26
Guyana	GUY	3.8	0.2	2.2	4.1	1.0	2.7	5.9	4.5	5.2	3.1	113
Haiti	HTI	5.6	4.9	5.3	7.6	6.5	7.1	7.6	7.2	7.4	6.5	14
Honduras	HND	5.4	3.5	4.5	5.0	5.1	5.1	6.0	4.3	5.2	4.9	49
Hungary	HUN	3.5	0.1	2.0	1.5	1.8	1.7	3.1	1.1	2.2	2.0	155
Iceland	ISL	1.7	0.0	0.9	0.4	1.1	0.8	2.3	1.6	2.0	1.1	184
India	IND	7.5	6.4	7.0	5.0	5.3	5.2	3.6	5.3	4.5	5.5	30
Indonesia	IDN	7.5	6.2	6.9	3.4	3.0	3.2	4.5	4.9	4.7	4.7	56
Iran	IRN	6.6	5.5	6.1	2.6	5.5	4.2	5.3	3.5	4.5	4.9	49
Iraq	IRQ	5.2	10.0	8.5	4.4	7.3	6.1	8.2	5.2	7.0	7.1	8

Ireland	IRL	2.3	0.0	1.2	0.7	1.8	1.3	2.5	1.3	1.9	1.4	176
Israel	ISR	4.4	4.1	4.3	1.1	2.7	1.9	3.1	0.9	2.1	2.6	131
Italy	ITA	4.5	1.7	3.2	1.0	3.6	2.4	3.5	0.9	2.3	2.6	131
Jamaica	JAM	3.7	0.3	2.2	3.3	1.0	2.2	4.1	3.3	3.7	2.6	131
Japan	JPN	7.8	0.6	5.2	0.8	0.9	0.9	2.0	0.9	1.5	1.9	160
Jordan	JOR	3.7	1.3	2.6	4.3	7.7	6.3	5.6	2.4	4.2	4.1	81
Kazakhstan	KAZ	4.1	1.1	2.7	1.5	0.4	1.0	4.9	2.4	3.8	2.2	144
Kenya	KEN	5.2	6.5	5.9	5.8	6.6	6.2	5.2	7.0	6.2	6.1	20
Kiribati	KIR	3.8	0.1	2.1	6.1	3.3	4.9	5.9	5.6	5.8	3.9	89
Korea DPR	PRK	4.7	2.7	3.8	5.0	3.1	4.1	8.3	3.3	6.4	4.6	62
Korea Republic of	KOR	5.0	2.2	3.7	0.6	0.6	0.6	2.7	1.0	1.9	1.6	171
Kuwait	KWT	2.4	0.2	1.4	2.3	0.8	1.6	5.8	1.4	3.9	2.1	152
Kyrgyzstan	KGZ	5.4	4.3	4.9	3.5	1.0	2.3	5.4	3.4	4.5	3.7	95
Lao PDR	LAO	4.8	1.5	3.3	5.2	1.9	3.7	6.3	5.9	6.1	4.2	76
Latvia	LVA	2.2	0.1	1.2	1.6	1.0	1.3	3.6	1.4	2.6	1.6	171
Lebanon	LBN	4.1	7.0	5.7	4.2	7.7	6.3	5.7	2.2	4.2	5.3	38
Lesotho	LSO	2.4	2.7	2.6	6.4	5.6	6.0	7.3	6.1	6.7	4.7	56
Liberia	LBR	3.9	2.6	3.3	7.8	4.5	6.4	7.3	8.0	7.7	5.5	30
Libya	LBY	4.3	10.0	8.4	2.5	5.1	3.9	8.6	4.0	6.9	6.1	20
Liechtenstein	LIE	1.3	0.1	0.7	0.4	1.2	0.8	1.6	0.8	1.2	0.9	188
Lithuania	LTU	1.8	0.0	0.9	1.3	1.2	1.3	3.5	1.1	2.4	1.4	176
Luxembourg	LUX	0.9	0.0	0.5	0.8	1.6	1.2	1.7	0.6	1.2	0.9	188
Madagascar	MDG	6.1	0.9	4.0	5.9	2.7	4.5	6.1	8.7	7.6	5.2	41
Malawi	MWI	4.0	1.5	2.8	7.3	4.0	5.9	5.4	7.2	6.4	4.7	56
Malaysia	MYS	5.0	1.1	3.3	2.4	3.6	3.0	3.5	2.8	3.2	3.2	111
Maldives	MDV	3.2	0.1	1.8	2.9	0.8	1.9	6.0	1.5	4.1	2.4	138
Mali	MLI	3.8	8.0	6.3	6.9	5.2	6.1	6.0	7.6	6.9	6.4	16
Malta	MLT	2.7	0.0	1.4	1.4	2.9	2.2	3.8	0.8	2.4	1.9	160
Marshall Islands	MHL	3.5	2.1	2.8	6.1	4.6	5.4	7.7	4.4	6.3	4.6	62
Mauritania	MRT	5.6	5.0	5.3	6.1	6.6	6.4	5.9	7.9	7.0	6.2	18
Mauritius	MUS	3.8	0.1	2.1	2.4	0.7	1.6	3.7	1.9	2.8	2.1	152
Mexico	MEX	6.6	9.0	8.0	3.2	4.0	3.6	5.5	3.2	4.4	5.0	47
Micronesia	FSM	4.5	0.2	2.6	6.3	4.0	5.3	5.9	5.6	5.8	4.3	72
Moldova Republic of	MDA	3.6	0.3	2.1	2.6	1.3	2.0	6.4	2.5	4.7	2.7	127
Mongolia	MNG	3.1	0.8	2.0	3.8	3.6	3.7	5.5	4.6	5.1	3.4	103
Montenegro	MNE	3.9	0.1	2.2	1.6	1.2	1.4	4.6	2.5	3.6	2.2	144
Morocco	MAR	4.7	4.4	4.6	4.6	2.0	3.4	5.6	4.1	4.9	4.2	76
Mozambique	MOZ	5.9	4.4	5.2	7.5	5.1	6.5	4.6	8.0	6.6	6.1	20
Myanmar	MMR	7.7	9.0	8.4	4.6	5.9	5.3	7.1	5.4	6.3	6.5	14
Namibia	NAM	4.4	0.3	2.6	5.9	3.2	4.7	4.6	5.6	5.1	4.0	87
Nauru	NRU	3.0	0.1	1.7	5.7	3.6	4.7	7.3	3.3	5.7	3.6	96
Nepal	NPL	5.5	4.8	5.2	5.1	3.5	4.3	6.1	5.3	5.7	5.0	47
Netherlands	NLD	2.0	0.0	1.0	0.4	3.7	2.2	1.7	0.9	1.3	1.4	176
New Zealand	NZL	4.9	0.1	2.8	0.8	1.1	1.0	1.9	2.0	2.0	1.8	163
Nicaragua	NIC	6.3	2.5	4.7	5.0	1.3	3.4	5.8	4.6	5.2	4.4	68

Niger	NER	4.4	8.0	6.5	6.6	6.2	6.4	5.9	8.8	7.6	6.8	11
Nigeria	NGA	3.7	10.0	8.2	5.3	6.6	6.0	5.1	7.6	6.5	6.8	11
Norway	NOR	0.5	0.0	0.3	0.1	3.6	2.0	1.9	1.2	1.6	1.0	187
Oman	OMN	5.7	0.1	3.4	2.2	0.9	1.6	5.1	2.5	3.9	2.8	121
Pakistan	PAK	7.0	8.0	7.5	5.1	6.2	5.7	5.3	5.9	5.6	6.2	18
Palau	PLW	3.4	0.1	1.9	4.0	1.2	2.7	5.9	2.4	4.4	2.8	121
Palestine	PSE	3.0	1.5	2.3	4.8	7.8	6.5	6.0	2.6	4.5	4.1	81
Panama	PAN	5.1	0.1	3.0	2.8	1.7	2.3	4.9	3.2	4.1	3.0	114
Papua New Guinea	PNG	5.6	3.5	4.6	5.4	4.2	4.8	6.8	8.3	7.6	5.5	30
Paraguay	PRY	2.4	1.8	2.1	3.6	0.8	2.3	5.3	3.4	4.4	2.8	121
Peru	PER	6.6	1.7	4.6	3.7	3.6	3.7	4.7	4.2	4.5	4.2	76
Philippines	PHL	8.2	9.0	8.6	3.8	5.1	4.5	4.7	3.8	4.3	5.5	30
Poland	POL	2.2	0.3	1.3	1.2	1.8	1.5	4.1	1.4	2.9	1.8	163
Portugal	PRT	3.7	0.0	2.0	1.3	1.0	1.2	2.9	0.9	2.0	1.7	167
Qatar	QAT	1.6	0.1	0.9	2.5	0.7	1.6	4.2	0.4	2.5	1.5	175
Romania	ROU	4.3	3.7	4.0	1.8	1.5	1.7	4.6	2.4	3.6	2.9	120
Russian Federation	RUS	5.8	6.9	6.4	2.1	3.3	2.7	6.3	2.3	4.6	4.3	72
Rwanda	RWA	3.5	4.7	4.1	7.0	5.8	6.4	3.9	6.1	5.1	5.1	45
Saint Kitts and Nevis	KNA	2.4	0.0	1.3	2.3	0.5	1.4	4.4	1.8	3.2	1.8	163
Saint Lucia	LCA	2.1	0.0	1.1	2.6	0.8	1.7	5.0	2.6	3.9	1.9	160
Saint Vincent and the Grenadines	VCT	1.4	0.0	0.7	3.0	1.4	2.2	4.4	2.9	3.7	1.8	163
Samoa	WSM	2.8	0.0	1.5	5.4	0.3	3.3	4.3	4.0	4.2	2.7	127
Sao Tome and Principe	STP	1.2	0.3	0.8	6.5	1.6	4.5	5.9	4.2	5.1	2.6	131
Saudi Arabia	SAU	2.6	4.1	3.4	1.7	0.3	1.0	4.8	2.0	3.5	2.3	141
Senegal	SEN	4.7	2.7	3.8	6.1	3.8	5.1	5.2	6.2	5.7	4.8	53
Serbia	SRB	4.6	3.9	4.3	1.7	3.2	2.5	5.2	2.3	3.9	3.5	99
Seychelles	SYC	3.1	0.0	1.7	2.5	0.8	1.7	4.3	2.6	3.5	2.2	144
Sierra Leone	SLE	3.6	4.6	4.1	7.5	3.4	5.8	5.4	8.2	7.0	5.5	30
Singapore	SGP	0.9	0.1	0.5	0.4	0.3	0.4	1.2	0.9	1.1	0.6	191
Slovakia	SVK	3.1	0.1	1.7	1.2	1.0	1.1	3.8	1.1	2.6	1.7	167
Slovenia	SVN	3.7	0.0	2.0	0.6	0.9	0.8	2.2	1.2	1.7	1.4	176
Solomon Islands	SLB	5.6	0.8	3.6	7.2	1.1	4.9	6.6	6.4	6.5	4.9	49
Somalia	SOM	6.8	10.0	8.9	9.5	8.8	9.2	9.3	8.6	9.0	9.0	1
South Africa	ZAF	4.7	5.3	5.0	4.7	4.4	4.6	4.5	4.2	4.4	4.7	56
South Sudan	SSD	4.0	10.0	8.3	9.5	8.9	9.2	9.2	9.3	9.3	8.9	2
Spain	ESP	4.4	2.0	3.3	1.0	2.1	1.6	2.9	0.7	1.9	2.2	144
Sri Lanka	LKA	5.0	1.0	3.3	2.6	4.1	3.4	4.7	3.4	4.1	3.6	96
Sudan	SDN	4.5	9.0	7.4	5.7	7.9	6.9	6.5	7.4	7.0	7.1	8
Suriname	SUR	3.7	0.1	2.1	3.9	1.3	2.7	5.8	3.7	4.8	3.0	114
Swaziland	SWZ	2.6	0.1	1.4	5.9	4.3	5.2	5.3	5.2	5.3	3.4	103
Sweden	SWE	1.1	0.1	0.6	0.5	4.9	3.0	2.0	0.9	1.5	1.4	176
Switzerland	CHE	1.9	0.1	1.0	0.4	3.9	2.3	1.1	0.6	0.9	1.3	182
Syria	SYR	5.1	10.0	8.5	6.7	8.0	7.4	6.6	4.6	5.7	7.1	8
Tajikistan	TJK	5.7	5.0	5.4	3.8	2.8	3.3	6.1	4.0	5.1	4.5	66

Tanzania	TZA	5.0	4.7	4.9	6.0	5.8	5.9	4.9	7.5	6.4	5.7	26
Thailand	THA	6.2	4.1	5.2	2.5	4.1	3.3	5.0	2.9	4.0	4.1	81
The former Yugoslav Republic of Macedonia	MKD	3.2	3.9	3.6	2.8	1.2	2.0	4.8	2.6	3.8	3.0	114
Timor-Leste	TLS	4.3	2.4	3.4	5.7	3.3	4.6	6.5	6.4	6.5	4.7	56
Togo	TGO	2.9	2.8	2.9	6.1	3.5	4.9	8.1	7.3	7.7	4.8	53
Tonga	TON	3.7	0.1	2.1	5.8	3.4	4.7	5.7	3.1	4.5	3.5	99
Trinidad and Tobago	TTO	2.2	0.2	1.3	2.4	1.2	1.8	4.9	1.8	3.5	2.0	155
Tunisia	TUN	4.3	3.2	3.8	2.7	0.8	1.8	6.0	3.3	4.8	3.2	111
Turkey	TUR	5.7	8.0	7.0	2.6	6.9	5.1	3.8	2.6	3.2	4.9	49
Turkmenistan	TKM	4.5	1.6	3.2	2.7	1.0	1.9	7.7	4.2	6.3	3.4	103
Tuvalu	TUV	2.9	0.1	1.6	7.3	1.3	5.0	6.9	3.4	5.4	3.5	99
Uganda	UGA	4.2	6.6	5.5	6.5	7.3	6.9	6.8	7.0	6.9	6.4	16
Ukraine	UKR	3.1	9.0	7.0	1.7	5.7	4.0	6.6	2.8	5.0	5.2	41
United Arab Emirates	ARE	5.5	0.1	3.3	1.6	0.8	1.2	2.4	1.3	1.9	2.0	155
United Kingdom	GBR	2.3	2.9	2.6	0.8	3.3	2.1	2.0	0.9	1.5	2.0	155
United States of America	USA	6.5	6.6	6.6	1.1	4.2	2.8	2.7	1.5	2.1	3.4	103
Uruguay	URY	1.7	0.0	0.9	2.2	1.0	1.6	3.8	1.8	2.9	1.6	171
Uzbekistan	UZB	5.7	3.5	4.7	3.0	0.6	1.9	4.8	3.3	4.1	3.3	107
Vanuatu	VUT	4.4	0.1	2.5	6.7	0.9	4.4	5.9	6.0	6.0	4.0	87
Venezuela	VEN	5.8	5.7	5.8	2.9	4.0	3.5	5.2	3.5	4.4	4.5	66
Viet Nam	VNM	7.1	3.2	5.5	3.3	1.3	2.4	5.0	3.4	4.2	3.8	92
Yemen	YEM	3.4	10.0	8.2	6.9	8.0	7.5	8.5	7.1	7.9	7.9	4
Zambia	ZMB	3.0	1.7	2.4	6.3	5.5	5.9	4.9	6.5	5.8	4.3	72
Zimbabwe	ZWE	4.6	4.8	4.7	6.0	4.3	5.2	5.1	6.3	5.7	5.2	41

Annex 6. Enhanced INFORM GRI results – countries by ranking order

Based on INFORM GRI 2019.

COUNTRY	ISO3	Natural	Human	Hazard & Exposure	Social-Economics Vulnerability	Vulnerable Groups	Vulnerability	Institutional	Infrastructure	Lack of Coping Capacity	Enhanced INFORM 2019	RANK
Somalia	SOM	6.8	10.0	8.9	9.5	8.8	9.2	9.3	8.6	9.0	9.0	1
South Sudan	SSD	4.0	10.0	8.3	9.5	8.9	9.2	9.2	9.3	9.3	8.9	2
Central African Republic	CAF	2.8	10.0	8.1	8.7	8.9	8.8	8.1	9.1	8.7	8.5	3
Yemen	YEM	3.4	10.0	8.2	6.9	8.0	7.5	8.5	7.1	7.9	7.9	4
Afghanistan	AFG	5.9	10.0	8.7	7.2	7.2	7.2	7.2	7.8	7.5	7.8	5
Congo DR	COD	4.4	9.0	7.3	6.8	8.3	7.6	7.8	8.1	8.0	7.6	6
Chad	TCD	3.9	7.0	5.7	7.2	7.9	7.6	8.0	9.6	8.9	7.3	7
Iraq	IRQ	5.2	10.0	8.5	4.4	7.3	6.1	8.2	5.2	7.0	7.1	8
Sudan	SDN	4.5	9.0	7.4	5.7	7.9	6.9	6.5	7.4	7.0	7.1	8
Syria	SYR	5.1	10.0	8.5	6.7	8.0	7.4	6.6	4.6	5.7	7.1	8
Ethiopia	ETH	4.4	9.0	7.3	6.3	6.8	6.6	4.7	8.0	6.6	6.8	11
Niger	NER	4.4	8.0	6.5	6.6	6.2	6.4	5.9	8.8	7.6	6.8	11
Nigeria	NGA	3.7	10.0	8.2	5.3	6.6	6.0	5.1	7.6	6.5	6.8	11
Haiti	HTI	5.6	4.9	5.3	7.6	6.5	7.1	7.6	7.2	7.4	6.5	14
Myanmar	MMR	7.7	9.0	8.4	4.6	5.9	5.3	7.1	5.4	6.3	6.5	14
Mali	MLI	3.8	8.0	6.3	6.9	5.2	6.1	6.0	7.6	6.9	6.4	16
Uganda	UGA	4.2	6.6	5.5	6.5	7.3	6.9	6.8	7.0	6.9	6.4	16
Mauritania	MRT	5.6	5.0	5.3	6.1	6.6	6.4	5.9	7.9	7.0	6.2	18
Pakistan	PAK	7.0	8.0	7.5	5.1	6.2	5.7	5.3	5.9	5.6	6.2	18
Burundi	BDI	3.5	6.4	5.1	7.1	6.2	6.7	6.2	6.7	6.5	6.1	20
Kenya	KEN	5.2	6.5	5.9	5.8	6.6	6.2	5.2	7.0	6.2	6.1	20
Libya	LBY	4.3	10.0	8.4	2.5	5.1	3.9	8.6	4.0	6.9	6.1	20
Mozambique	MOZ	5.9	4.4	5.2	7.5	5.1	6.5	4.6	8.0	6.6	6.1	20
Bangladesh	BGD	8.0	6.6	7.4	4.9	6.2	5.6	4.9	5.4	5.2	6.0	24
Cameroon	CMR	3.4	6.8	5.3	6.0	6.5	6.3	4.8	6.8	5.9	5.8	25
Côte d'Ivoire	CIV	3.7	6.4	5.2	6.1	3.9	5.1	7.1	7.1	7.1	5.7	26
Guinea-Bissau	GNB	2.5	4.5	3.6	7.7	4.9	6.5	8.1	7.6	7.9	5.7	26
Tanzania	TZA	5.0	4.7	4.9	6.0	5.8	5.9	4.9	7.5	6.4	5.7	26
Congo	COG	3.8	4.3	4.1	5.6	6.4	6.0	7.6	6.9	7.3	5.6	29
Colombia	COL	6.2	7.0	6.6	3.9	7.7	6.2	4.4	3.6	4.0	5.5	30
India	IND	7.5	6.4	7.0	5.0	5.3	5.2	3.6	5.3	4.5	5.5	30
Liberia	LBR	3.9	2.6	3.3	7.8	4.5	6.4	7.3	8.0	7.7	5.5	30
Papua New Guinea	PNG	5.6	3.5	4.6	5.4	4.2	4.8	6.8	8.3	7.6	5.5	30

Philippines	PHL	8.2	9.0	8.6	3.8	5.1	4.5	4.7	3.8	4.3	5.5	30
Sierra Leone	SLE	3.6	4.6	4.1	7.5	3.4	5.8	5.4	8.2	7.0	5.5	30
Guatemala	GTM	6.4	4.3	5.4	4.1	6.6	5.5	6.1	4.6	5.4	5.4	36
Guinea	GIN	3.7	5.0	4.4	5.8	3.5	4.8	6.1	8.2	7.3	5.4	36
Burkina Faso	BFA	3.4	4.8	4.1	6.9	4.4	5.8	4.6	7.3	6.1	5.3	38
Djibouti	DJI	5.8	2.5	4.3	6.1	4.7	5.4	6.2	6.6	6.4	5.3	38
Lebanon	LBN	4.1	7.0	5.7	4.2	7.7	6.3	5.7	2.2	4.2	5.3	38
Eritrea	ERI	4.1	4.0	4.1	5.5	3.3	4.5	8.2	7.4	7.8	5.2	41
Madagascar	MDG	6.1	0.9	4.0	5.9	2.7	4.5	6.1	8.7	7.6	5.2	41
Ukraine	UKR	3.1	9.0	7.0	1.7	5.7	4.0	6.6	2.8	5.0	5.2	41
Zimbabwe	ZWE	4.6	4.8	4.7	6.0	4.3	5.2	5.1	6.3	5.7	5.2	41
Angola	AGO	3.1	4.9	4.1	4.4	4.6	4.5	6.5	8.0	7.3	5.1	45
Rwanda	RWA	3.5	4.7	4.1	7.0	5.8	6.4	3.9	6.1	5.1	5.1	45
Mexico	MEX	6.6	9.0	8.0	3.2	4.0	3.6	5.5	3.2	4.4	5.0	47
Nepal	NPL	5.5	4.8	5.2	5.1	3.5	4.3	6.1	5.3	5.7	5.0	47
Honduras	HND	5.4	3.5	4.5	5.0	5.1	5.1	6.0	4.3	5.2	4.9	49
Iran	IRN	6.6	5.5	6.1	2.6	5.5	4.2	5.3	3.5	4.5	4.9	49
Solomon Islands	SLB	5.6	0.8	3.6	7.2	1.1	4.9	6.6	6.4	6.5	4.9	49
Turkey	TUR	5.7	8.0	7.0	2.6	6.9	5.1	3.8	2.6	3.2	4.9	49
Cambodia	KHM	5.8	3.0	4.5	5.1	2.2	3.8	7.0	6.1	6.6	4.8	53
Senegal	SEN	4.7	2.7	3.8	6.1	3.8	5.1	5.2	6.2	5.7	4.8	53
Togo	TGO	2.9	2.8	2.9	6.1	3.5	4.9	8.1	7.3	7.7	4.8	53
Egypt	EGY	5.2	7.0	6.2	3.3	4.2	3.8	5.4	3.5	4.5	4.7	56
Indonesia	IDN	7.5	6.2	6.9	3.4	3.0	3.2	4.5	4.9	4.7	4.7	56
Lesotho	LSO	2.4	2.7	2.6	6.4	5.6	6.0	7.3	6.1	6.7	4.7	56
Malawi	MWI	4.0	1.5	2.8	7.3	4.0	5.9	5.4	7.2	6.4	4.7	56
South Africa	ZAF	4.7	5.3	5.0	4.7	4.4	4.6	4.5	4.2	4.4	4.7	56
Timor-Leste	TLS	4.3	2.4	3.4	5.7	3.3	4.6	6.5	6.4	6.5	4.7	56
Azerbaijan	AZE	4.3	5.8	5.1	2.5	5.8	4.3	6.1	2.5	4.5	4.6	62
Gabon	GAB	2.8	5.8	4.5	4.4	2.6	3.6	6.7	5.7	6.2	4.6	62
Korea DPR	PRK	4.7	2.7	3.8	5.0	3.1	4.1	8.3	3.3	6.4	4.6	62
Marshall Islands	MHL	3.5	2.1	2.8	6.1	4.6	5.4	7.7	4.4	6.3	4.6	62
Tajikistan	TJK	5.7	5.0	5.4	3.8	2.8	3.3	6.1	4.0	5.1	4.5	66
Venezuela	VEN	5.8	5.7	5.8	2.9	4.0	3.5	5.2	3.5	4.4	4.5	66
Algeria	DZA	4.0	6.7	5.5	3.1	3.4	3.3	5.0	4.2	4.6	4.4	68
Benin	BEN	2.6	2.7	2.7	6.4	2.5	4.7	5.8	7.6	6.8	4.4	68
Gambia	GMB	2.9	2.5	2.7	7.3	3.6	5.8	5.0	5.8	5.4	4.4	68
Nicaragua	NIC	6.3	2.5	4.7	5.0	1.3	3.4	5.8	4.6	5.2	4.4	68
China	CHN	7.5	5.7	6.7	2.9	3.6	3.3	3.8	3.4	3.6	4.3	72
Micronesia	FSM	4.5	0.2	2.6	6.3	4.0	5.3	5.9	5.6	5.8	4.3	72
Russian Federation	RUS	5.8	6.9	6.4	2.1	3.3	2.7	6.3	2.3	4.6	4.3	72
Zambia	ZMB	3.0	1.7	2.4	6.3	5.5	5.9	4.9	6.5	5.8	4.3	72
Bolivia	BOL	3.8	4.8	4.3	4.6	1.8	3.3	6.0	4.6	5.3	4.2	76
Ghana	GHA	3.6	2.7	3.2	5.4	3.1	4.3	4.6	5.8	5.2	4.2	76
Lao PDR	LAO	4.8	1.5	3.3	5.2	1.9	3.7	6.3	5.9	6.1	4.2	76

Morocco	MAR	4.7	4.4	4.6	4.6	2.0	3.4	5.6	4.1	4.9	4.2	76
Peru	PER	6.6	1.7	4.6	3.7	3.6	3.7	4.7	4.2	4.5	4.2	76
Ecuador	ECU	6.5	1.0	4.3	3.3	4.0	3.7	4.7	3.7	4.2	4.1	81
El Salvador	SLV	5.9	7.0	6.5	3.4	0.8	2.2	5.7	3.5	4.7	4.1	81
Equatorial Guinea	GNQ	2.6	3.9	3.3	3.7	1.9	2.8	8.1	6.4	7.3	4.1	81
Jordan	JOR	3.7	1.3	2.6	4.3	7.7	6.3	5.6	2.4	4.2	4.1	81
Palestine	PSE	3.0	1.5	2.3	4.8	7.8	6.5	6.0	2.6	4.5	4.1	81
Thailand	THA	6.2	4.1	5.2	2.5	4.1	3.3	5.0	2.9	4.0	4.1	81
Namibia	NAM	4.4	0.3	2.6	5.9	3.2	4.7	4.6	5.6	5.1	4.0	87
Vanuatu	VUT	4.4	0.1	2.5	6.7	0.9	4.4	5.9	6.0	6.0	4.0	87
Brazil	BRA	4.0	7.0	5.7	3.3	1.3	2.4	5.1	3.1	4.2	3.9	89
Dominican Republic	DOM	5.6	3.0	4.4	3.8	1.9	2.9	5.5	3.5	4.6	3.9	89
Kiribati	KIR	3.8	0.1	2.1	6.1	3.3	4.9	5.9	5.6	5.8	3.9	89
Comoros	COM	2.6	0.8	1.7	6.7	2.3	4.9	7.8	5.2	6.7	3.8	92
Georgia	GEO	4.3	2.5	3.5	3.1	6.3	4.9	4.5	1.9	3.3	3.8	92
Viet Nam	VNM	7.1	3.2	5.5	3.3	1.3	2.4	5.0	3.4	4.2	3.8	92
Kyrgyzstan	KGZ	5.4	4.3	4.9	3.5	1.0	2.3	5.4	3.4	4.5	3.7	95
Bosnia and Herzegovina	BIH	4.1	1.3	2.8	2.6	4.7	3.7	6.1	2.5	4.5	3.6	96
Nauru	NRU	3.0	0.1	1.7	5.7	3.6	4.7	7.3	3.3	5.7	3.6	96
Sri Lanka	LKA	5.0	1.0	3.3	2.6	4.1	3.4	4.7	3.4	4.1	3.6	96
Armenia	ARM	4.0	2.0	3.1	2.3	3.2	2.8	6.7	2.1	4.8	3.5	99
Serbia	SRB	4.6	3.9	4.3	1.7	3.2	2.5	5.2	2.3	3.9	3.5	99
Tonga	TON	3.7	0.1	2.1	5.8	3.4	4.7	5.7	3.1	4.5	3.5	99
Tuvalu	TUV	2.9	0.1	1.6	7.3	1.3	5.0	6.9	3.4	5.4	3.5	99
Mongolia	MNG	3.1	0.8	2.0	3.8	3.6	3.7	5.5	4.6	5.1	3.4	103
Swaziland	SWZ	2.6	0.1	1.4	5.9	4.3	5.2	5.3	5.2	5.3	3.4	103
Turkmenistan	TKM	4.5	1.6	3.2	2.7	1.0	1.9	7.7	4.2	6.3	3.4	103
United States of America	USA	6.5	6.6	6.6	1.1	4.2	2.8	2.7	1.5	2.1	3.4	103
Belize	BLZ	5.1	0.2	3.0	3.6	0.8	2.3	6.4	3.9	5.3	3.3	107
Cuba	CUB	5.5	1.0	3.6	3.5	2.9	3.2	3.9	1.9	3.0	3.3	107
Dominica	DMA	4.5	0.1	2.6	4.1	3.3	3.7	4.6	2.9	3.8	3.3	107
Uzbekistan	UZB	5.7	3.5	4.7	3.0	0.6	1.9	4.8	3.3	4.1	3.3	107
Malaysia	MYS	5.0	1.1	3.3	2.4	3.6	3.0	3.5	2.8	3.2	3.2	111
Tunisia	TUN	4.3	3.2	3.8	2.7	0.8	1.8	6.0	3.3	4.8	3.2	111
Guyana	GUY	3.8	0.2	2.2	4.1	1.0	2.7	5.9	4.5	5.2	3.1	113
Bhutan	BTN	3.4	0.1	1.9	5.0	1.2	3.3	4.1	4.9	4.5	3.0	114
Botswana	BWA	3.0	0.1	1.7	4.0	2.9	3.5	4.8	4.4	4.6	3.0	114
Fiji	FJI	3.9	0.1	2.2	3.6	3.3	3.5	2.8	3.9	3.4	3.0	114
Panama	PAN	5.1	0.1	3.0	2.8	1.7	2.3	4.9	3.2	4.1	3.0	114
Suriname	SUR	3.7	0.1	2.1	3.9	1.3	2.7	5.8	3.7	4.8	3.0	114
The former Yugoslav Republic of Macedonia	MKD	3.2	3.9	3.6	2.8	1.2	2.0	4.8	2.6	3.8	3.0	114
Romania	ROU	4.3	3.7	4.0	1.8	1.5	1.7	4.6	2.4	3.6	2.9	120
Chile	CHL	6.1	2.0	4.4	2.2	1.1	1.7	3.2	2.7	3.0	2.8	121

Costa Rica	CRI	5.9	0.1	3.5	2.7	1.9	2.3	2.9	2.5	2.7	2.8	121
Greece	GRC	4.6	3.4	4.0	1.7	3.0	2.4	3.6	1.0	2.4	2.8	121
Oman	OMN	5.7	0.1	3.4	2.2	0.9	1.6	5.1	2.5	3.9	2.8	121
Palau	PLW	3.4	0.1	1.9	4.0	1.2	2.7	5.9	2.4	4.4	2.8	121
Paraguay	PRY	2.4	1.8	2.1	3.6	0.8	2.3	5.3	3.4	4.4	2.8	121
Albania	ALB	5.3	0.1	3.1	2.3	0.6	1.5	5.6	2.6	4.3	2.7	127
Cyprus	CYP	3.3	0.1	1.8	1.2	6.4	4.3	3.7	1.3	2.6	2.7	127
Moldova Republic of	MDA	3.6	0.3	2.1	2.6	1.3	2.0	6.4	2.5	4.7	2.7	127
Samoa	WSM	2.8	0.0	1.5	5.4	0.3	3.3	4.3	4.0	4.2	2.7	127
Argentina	ARG	3.4	1.2	2.4	2.8	1.3	2.1	4.6	2.2	3.5	2.6	131
Cabo Verde	CPV	2.3	0.1	1.3	5.1	1.0	3.3	4.1	3.8	4.0	2.6	131
Israel	ISR	4.4	4.1	4.3	1.1	2.7	1.9	3.1	0.9	2.1	2.6	131
Italy	ITA	4.5	1.7	3.2	1.0	3.6	2.4	3.5	0.9	2.3	2.6	131
Jamaica	JAM	3.7	0.3	2.2	3.3	1.0	2.2	4.1	3.3	3.7	2.6	131
Sao Tome and Principe	STP	1.2	0.3	0.8	6.5	1.6	4.5	5.9	4.2	5.1	2.6	131
France	FRA	3.6	2.0	2.8	0.8	4.2	2.7	2.8	1.1	2.0	2.5	137
Bulgaria	BGR	3.3	0.7	2.1	1.9	2.7	2.3	4.2	1.7	3.0	2.4	138
Canada	CAN	4.6	0.4	2.8	0.7	3.3	2.1	2.2	2.4	2.3	2.4	138
Maldives	MDV	3.2	0.1	1.8	2.9	0.8	1.9	6.0	1.5	4.1	2.4	138
Antigua and Barbuda	ATG	2.9	0.1	1.6	3.0	1.0	2.1	5.0	1.7	3.5	2.3	141
Australia	AUS	5.3	0.1	3.1	0.6	2.8	1.8	2.3	1.9	2.1	2.3	141
Saudi Arabia	SAU	2.6	4.1	3.4	1.7	0.3	1.0	4.8	2.0	3.5	2.3	141
Bahamas	BHS	3.5	0.3	2.0	2.4	1.0	1.7	3.6	2.5	3.1	2.2	144
Belarus	BLR	2.2	2.9	2.6	1.1	1.4	1.3	4.3	1.4	3.0	2.2	144
Belgium	BEL	1.7	5.5	3.8	0.6	2.9	1.8	2.4	0.7	1.6	2.2	144
Croatia	HRV	4.9	0.6	3.0	1.4	0.8	1.1	4.5	1.5	3.1	2.2	144
Kazakhstan	KAZ	4.1	1.1	2.7	1.5	0.4	1.0	4.9	2.4	3.8	2.2	144
Montenegro	MNE	3.9	0.1	2.2	1.6	1.2	1.4	4.6	2.5	3.6	2.2	144
Seychelles	SYC	3.1	0.0	1.7	2.5	0.8	1.7	4.3	2.6	3.5	2.2	144
Spain	ESP	4.4	2.0	3.3	1.0	2.1	1.6	2.9	0.7	1.9	2.2	144
Germany	DEU	2.2	1.3	1.8	0.5	5.3	3.3	2.2	0.7	1.5	2.1	152
Kuwait	KWT	2.4	0.2	1.4	2.3	0.8	1.6	5.8	1.4	3.9	2.1	152
Mauritius	MUS	3.8	0.1	2.1	2.4	0.7	1.6	3.7	1.9	2.8	2.1	152
Brunei Darussalam	BRN	2.6	2.4	2.5	0.9	0.5	0.7	4.7	3.9	4.3	2.0	155
Hungary	HUN	3.5	0.1	2.0	1.5	1.8	1.7	3.1	1.1	2.2	2.0	155
Trinidad and Tobago	TTO	2.2	0.2	1.3	2.4	1.2	1.8	4.9	1.8	3.5	2.0	155
United Arab Emirates	ARE	5.5	0.1	3.3	1.6	0.8	1.2	2.4	1.3	1.9	2.0	155
United Kingdom	GBR	2.3	2.9	2.6	0.8	3.3	2.1	2.0	0.9	1.5	2.0	155
Japan	JPN	7.8	0.6	5.2	0.8	0.9	0.9	2.0	0.9	1.5	1.9	160
Malta	MLT	2.7	0.0	1.4	1.4	2.9	2.2	3.8	0.8	2.4	1.9	160
Saint Lucia	LCA	2.1	0.0	1.1	2.6	0.8	1.7	5.0	2.6	3.9	1.9	160
New Zealand	NZL	4.9	0.1	2.8	0.8	1.1	1.0	1.9	2.0	2.0	1.8	163
Poland	POL	2.2	0.3	1.3	1.2	1.8	1.5	4.1	1.4	2.9	1.8	163
Saint Kitts and Nevis	KNA	2.4	0.0	1.3	2.3	0.5	1.4	4.4	1.8	3.2	1.8	163

Saint Vincent and the Grenadines	VCT	1.4	0.0	0.7	3.0	1.4	2.2	4.4	2.9	3.7	1.8	163
Austria	AUT	2.4	0.0	1.3	0.8	4.0	2.5	2.2	0.5	1.4	1.7	167
Barbados	BRB	2.6	0.0	1.4	2.4	0.5	1.5	2.9	2.0	2.5	1.7	167
Portugal	PRT	3.7	0.0	2.0	1.3	1.0	1.2	2.9	0.9	2.0	1.7	167
Slovakia	SVK	3.1	0.1	1.7	1.2	1.0	1.1	3.8	1.1	2.6	1.7	167
Grenada	GRD	1.0	0.1	0.6	2.5	1.0	1.8	4.9	2.2	3.7	1.6	171
Korea Republic of	KOR	5.0	2.2	3.7	0.6	0.6	0.6	2.7	1.0	1.9	1.6	171
Latvia	LVA	2.2	0.1	1.2	1.6	1.0	1.3	3.6	1.4	2.6	1.6	171
Uruguay	URY	1.7	0.0	0.9	2.2	1.0	1.6	3.8	1.8	2.9	1.6	171
Qatar	QAT	1.6	0.1	0.9	2.5	0.7	1.6	4.2	0.4	2.5	1.5	175
Czech Republic	CZE	2.0	0.1	1.1	0.8	1.4	1.1	3.1	1.0	2.1	1.4	176
Ireland	IRL	2.3	0.0	1.2	0.7	1.8	1.3	2.5	1.3	1.9	1.4	176
Lithuania	LTU	1.8	0.0	0.9	1.3	1.2	1.3	3.5	1.1	2.4	1.4	176
Netherlands	NLD	2.0	0.0	1.0	0.4	3.7	2.2	1.7	0.9	1.3	1.4	176
Slovenia	SVN	3.7	0.0	2.0	0.6	0.9	0.8	2.2	1.2	1.7	1.4	176
Sweden	SWE	1.1	0.1	0.6	0.5	4.9	3.0	2.0	0.9	1.5	1.4	176
Switzerland	CHE	1.9	0.1	1.0	0.4	3.9	2.3	1.1	0.6	0.9	1.3	182
Bahrain	BHR	0.8	0.2	0.5	1.7	0.9	1.3	4.6	1.0	3.0	1.2	183
Denmark	DNK	1.2	0.0	0.6	0.4	3.1	1.8	2.0	0.7	1.4	1.1	184
Estonia	EST	1.0	0.1	0.6	1.1	1.1	1.1	2.9	1.0	2.0	1.1	184
Iceland	ISL	1.7	0.0	0.9	0.4	1.1	0.8	2.3	1.6	2.0	1.1	184
Norway	NOR	0.5	0.0	0.3	0.1	3.6	2.0	1.9	1.2	1.6	1.0	187
Liechtenstein	LIE	1.3	0.1	0.7	0.4	1.2	0.8	1.6	0.8	1.2	0.9	188
Luxembourg	LUX	0.9	0.0	0.5	0.8	1.6	1.2	1.7	0.6	1.2	0.9	188
Finland	FIN	0.3	0.0	0.2	0.6	2.6	1.7	1.8	1.0	1.4	0.8	190
Singapore	SGP	0.9	0.1	0.5	0.4	0.3	0.4	1.2	0.9	1.1	0.6	191

Annex 7. INFORM Epidemic GRI data sources and metadata

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL / citation	Data Provider
Epidemic Hazards & Exposure - Zoonoses						
CCHF	Population exposed to CCHF	These maps use reported geographic information on index cases of outbreaks and viral detection in animals related to a number of environmental factors thought to influence the distribution of these pathogens using species distribution models in order to build an environmental profile that best characterizes possible pathogen presence.	Given their high case-fatality rates, direct transmissibility between humans at local and global scales, as well as their comparative rarity, four African viral haemorrhagic fevers are selected, CCHF, EVD, MVD and Lassa	2015	Messina JP, Pigott DM, Golding N, et al. The global distribution of Crimean-Congo haemorrhagic fever. Trans R Soc Trop Med Hyg 2015; 109: 503–13.	
EDV	Population exposed to EDV	These maps use reported geographic information on index cases of outbreaks and viral detection in animals related to a number of environmental factors thought to influence the distribution of these pathogens using species distribution models in order to build an environmental profile that best characterizes possible pathogen presence.	Given their high case-fatality rates, direct transmissibility between humans at local and global scales, as well as their comparative rarity, four African viral haemorrhagic fevers are selected, CCHF, EVD, MVD and Lassa	2016	Pigott DM, Millear, Anoushka I, Earl L, et al. Updates to the zoonotic niche map of Ebola virus disease in Africa. Elife 2016; 5: e16412. Pigott DM, Golding N, Mylne A, et al. Mapping the zoonotic niche of Ebola virus disease in Africa. Elife 2014; 3: e04395.	

Lassa Fever	Population exposed to Lassa Fever	These maps use reported geographic information on index cases of outbreaks and viral detection in animals related to a number of environmental factors thought to influence the distribution of these pathogens using species distribution models in order to build an environmental profile that best characterizes possible pathogen presence.	Given their high case-fatality rates, direct transmissibility between humans at local and global scales, as well as their comparative rarity, four African viral haemorrhagic fevers are selected, CCHF, EVD, MVD and Lassa	2015	Mylne AQN, Pigott DM, Longbottom J, et al. Mapping the zoonotic niche of Lassa fever in Africa. Trans R Soc Trop Med Hyg 2015; 109: 483–92.	
MDV	Population exposed to MVD	These maps use reported geographic information on index cases of outbreaks and viral detection in animals related to a number of environmental factors thought to influence the distribution of these pathogens using species distribution models in order to build an environmental profile that best characterizes possible pathogen presence.	Given their high case-fatality rates, direct transmissibility between humans at local and global scales, as well as their comparative rarity, four African viral haemorrhagic fevers are selected, CCHF, EVD, MVD and Lassa	2015	Pigott DM, Golding N, Mylne A, et al. Mapping the zoonotic niche of Marburg virus disease in Africa. Trans R Soc Trop Med Hyg 2015; 109: 366–78.	

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
Epidemic Hazards & Exposure - Vector borne						
Malaria	Populations at risk of Plasmodium vivax malaria in 2010 - Unstable transmission	These areas are those where local transmission cannot be ruled out, but levels are extremely low, with annual case incidence reported at less than 1 per 10,000. Annual case incidence data over the most recent four years (where we have access to the data) and at the smallest district size available has been used.	Like most vector-borne diseases, malaria endemicity is partly determined by the local environment that houses its human and anopheline hosts and mediates the interactions between them. This environmental dependency leads to complex patterns of geographical variation in malaria transmission at almost every scale	2010	https://map.ox.ac.uk/explorer/#/	Malaria Data Project
Malaria	Populations at risk of Plasmodium vivax malaria in 2010 - Stable transmission	This is a very broad classification of risk including any regions where the annual case incidence is likely to exceed 1 per 10,000. Annual case incidence data over the most recent four years (where we have access to the data) and at the smallest district size available has been used.	Like most vector-borne diseases, malaria endemicity is partly determined by the local environment that houses its human and anopheline hosts and mediates the interactions between them. This environmental dependency leads to complex patterns of geographical variation in malaria transmission at almost every scale	2010	https://map.ox.ac.uk/explorer/#/	Malaria Data Project

Malaria	Populations at risk of Plasmodium falciparum malaria in 2010 - Unstable transmission	These areas are those where local transmission cannot be ruled out, but levels are extremely low, with annual case incidence reported at less than 1 per 10,000. Annual case incidence data over the most recent four years (where we have access to the data) and at the smallest district size available has been used.	Like most vector-borne diseases, malaria endemicity is partly determined by the local environment that houses its human and anopheline hosts and mediates the interactions between them. This environmental dependency leads to complex patterns of geographical variation in malaria transmission at almost every scale	2010	https://map.ox.ac.uk/explorer/#/	Malaria Data Project
Malaria	Populations at risk of Plasmodium falciparum malaria in 2010 - Stable transmission	This is a very broad classification of risk including any regions where the annual case incidence is likely to exceed 1 per 10,000. Annual case incidence data over the most recent four years (where we have access to the data) and at the smallest district size available has been used.	Like most vector-borne diseases, malaria endemicity is partly determined by the local environment that houses its human and anopheline hosts and mediates the interactions between them. This environmental dependency leads to complex patterns of geographical variation in malaria transmission at almost every scale	2010	https://map.ox.ac.uk/explorer/#/	Malaria Data Project

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
Epidemic Hazards & Exposure - P2P / Water and Food borne						
Population	Population density (people per sq. km of land area)	Population density is midyear population divided by land area in square kilometers.	For communities, inadequate shelter and overcrowding are major factors in the transmission of diseases with epidemic potential such as acute respiratory infections, meningitis, typhus, cholera, scabies, etc. Outbreaks of disease are more frequent and more severe when the population density is high. Other public structures such as health facilities not only represent a concentrated area of patients but also a concentrated area of germs. In an emergency, the number of hospital-associated infections will typically rise. Decreasing overcrowding by providing extra facilities and a proper organization of the sites or services in health-care facilities is a priority.	2016	http://data.worldbank.org/indicator/EN.POP.DNST	World Bank
Population	Urban population growth (annual %)	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.		2016	http://data.worldbank.org/indicator/ SP.URB.GROW	World Bank

Population	Population living in urban areas (%)	The percentage of de facto population living in areas classified as urban according to the criteria used by each area or country as of 1 July of the year indicated.	Health challenges particularly evident in cities relate to water, environment, violence and injury, noncommunicable diseases, unhealthy diets and physical inactivity, harmful use of alcohol as well as the risks associated with disease outbreaks. City living and its increased pressures of mass marketing, availability of unhealthy food choices and accessibility to automation and transport all have an effect on lifestyle that directly affect health. Different risk factors in the urban environment can, for example, be poor housing, which can lead to proliferation of insect and rodent vector diseases and helminthiases. This is connected to inadequate water supplies as well as sanitation and waste management. All contribute to a favourable setting for both different rodents and insects which carry pathogens and soil-transmitted helminth infections. If buildings lack effective fuel and ventilation systems, respiratory tract infections can also be acquired. Contaminated water can spread disease, as can poor food storage and preparation, due to microbial toxins and zoonoses. The density of inhabitants and the close contact between people in urban areas are potential hot spots for rapid spread of merging infectious diseases such as severe acute respiratory syndrome (SARS) and the avian flu. Criteria for a worldwide pandemic could be met in urban centres, which could develop into a worldwide health crisis.	2016	http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS	World Bank
Population	Household size			2016	https://globaldatalab.org/areadata/hhsize/	OECD, GDL

WaSH	People using at least basic sanitation services (% of population)	The percentage of people using at least basic sanitation services, that is, improved sanitation facilities that are not shared with other households. This indicator encompasses both people using basic sanitation services as well as those using safely managed sanitation services. Improved sanitation facilities include flush/pour flush to piped sewer systems, septic tanks or pit latrines; ventilated improved pit latrines, compositing toilets or pit latrines with slabs.	Access to drinking water and basic sanitation is a fundamental need and a human right vital for the dignity and health of all people. The health and economic benefits of improved sanitation facilities to households and individuals are well documented. Use of an improved sanitation facility is a proxy for the use of basic sanitation.	2015	http://data.worldbank.org/indicator/SH.STA.BASS.ZS	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (http://www.wssinfo.org/).
WaSH	People using at least basic drinking water services (% of population)	The percentage of people using at least basic water services. This indicator encompasses both people using basic water services as well as those using safely managed water services. Basic drinking water services is defined as drinking water from an improved source, provided collection time is not more than 30 minutes for a round trip. Improved water sources include piped water, boreholes or tubewells, protected dug wells, protected springs, and packaged or delivered water.		2015	http://data.worldbank.org/indicator/SH.H2O.BASW.ZS	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (http://www.wssinfo.org/).
WaSH	People practicing open defecation (% of population)	People practicing open defecation refers to the percentage of the population defecating in the open, such as in fields, forest, bushes, open bodies of water, on beaches, in other open spaces or disposed of with solid waste.		2015	http://data.worldbank.org/indicator/SH.STA.ODFC.ZS	WHO/UNICEF Joint Monitoring Programme (JMP) for Water Supply and Sanitation (http://www.wssinfo.org/).

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
Epidemic Hazards & Exposure - Water and Food borne						
Food	Number of vets	Number of Veterinarians and veterinary para-professionals	About 75% of the new diseases that have affected humans over the past 10 years have been caused by pathogens originating from an animal or from products of animal origin. Veterinary medicine played a major role in the preventing of and interventions against animal diseases.	2016	http://www.oie.int/wahis_2/public/wahid.php/Countryinformation/Veterinarians	World Animal Health Information Database (WAHIS Interface), World Organisation for Animal Health (OIE)
Food	IHR capacity score: Food safety	The proportion/percentage of attribute (a set of specific elements or functions which reflect the level of performance or achievement of IHR Potential hazards 2: Food safety) that have been attained.	Mechanisms are established and functioning for detecting and responding to foodborne disease and food contamination.	2015	http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=4417	WHO
Population	Population living in slums (% of urban population)	Population living in slums is the proportion of the urban population living in slum households. A slum household is defined as a group of individuals living under the same roof lacking one or more of the following conditions: access to improved water, access to improved sanitation, sufficient living area, and durability of housing.	Cholera transmission is closely linked to inadequate access to clean water and sanitation facilities. Typical at-risk areas include peri-urban slums, where basic infrastructure is not available, as well as camps for internally displaced persons or refugees, where minimum requirements of clean water and sanitation have not been met.	2015	http://data.worldbank.org/indicator/EN.POP.SLUM.UR.ZS	UN HABITAT

Population	Children under 5		Although children <5 years of age represent only 9% of the global population, 43% of the disease burden from contaminated food occurred in this group.		https://population.un.org/wpp/	United Nations, Department of Economic and Social Affairs, Population Division (2017). World Population Prospects: The 2017 Revision

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
			Epidemic Vulnerability - Movement			
International travellers	Air transport, passengers carried	Air passengers carried include both domestic and international aircraft passengers of air carriers registered in the country.	High mobility increases the risk of disease spread (examples Pandemic H1N1, MERS – CoV, SARS etc). Highly interconnected world may actually promote the rapid expansion of infectious disease epidemics.	2017	http://data.worldbank.org/indicator/IS.AIR.PSGR	World Bank
International travellers	International tourism, number of arrivals	International inbound tourists (overnight visitors) are the number of tourists who travel to a country other than that in which they have their usual residence, but outside their usual environment, for a period not exceeding 12 months and whose main purpose in visiting is other than an activity remunerated from within the country visited.	High mobility increases the risk of disease spread (examples Pandemic H1N1, MERS – CoV, SARS etc). Highly interconnected world may actually promote the rapid expansion of infectious disease epidemics.	2017	http://data.worldbank.org/indicator/ST.INT.ARVL	World Bank
Internal movement	Access to cities	Predicted travel time (minutes) to nearest city. This is a predictive map showing the estimated time to travel from every point on earth to the nearest (in time) city.		2015	https://map.ox.ac.uk/explorer/#/ D.J. Weiss, A. Nelson, H.S. Gibson, W. Temperley, S. Peedell, A. Lieber, M. Hancher, E. Poyart, S. Belchior, N. Fullman, B. Mappin, U. Dalrymple, J. Rozier, T.C.D. Lucas, R.E. Howes, L.S. Tusting, S.Y. Kang, E. Cameron, D. Bisanzio, K.E. Battle, S. Bhatt, and P.W. Gething. *A global map of travel time to cities to assess inequalities in accessibility in 2015*.	

Entry points	IHR capacity score: Points of entry	The proportion/percentage of attribute (a set of specific elements or functions which reflect the level of performance or achievement of Points of Entry) that have been attained.	While international travel and trade bring many health benefits linked to economic development, they may also cause public health risks that can spread internationally at airports, ports and ground crossings through persons, baggage, cargo, containers, conveyances, goods and postal parcels. The IHR (2005) provide a public health response in the form of obligations and standing or temporary non-binding recommendations in ways that avoid unnecessary interference with international travel and trade. States Parties to the IHR (2005) must strengthen public health capacities at designated airports, ports and ground crossings in both routine circumstances and when responding to events that may constitute a public health emergency of international concern.	2016	http://apps.who.int/gho//data/view.main.IHRCTRY09v?lang=en	WHO

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
Epidemic Vulnerability - Behaviour						
Awareness / susceptible to change	Adult literacy rate, population 15+ years, both sexes (%)	Percentage of persons aged 15 and over who can read and write.	Low rates of literacy in a population are likely to increase its vulnerability as health promotion messages and disease etiology etc. may be less likely to be understood and the uptake low.	2016	http://data.worldbank.org/indicator/SE.ADT.LITR.ZS	World Bank
	Mobile cellular subscriptions (per 100 people)	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services.	Access to information and health messages. Increases likelyhood to change in behavious. Potentially also access to false information…	2016	http://data.worldbank.org/indicator/IT.CEL.SETS.P2	International Telecommunication Union, World Telecommunication /ICT Development Report and database.
	Individuals using the Internet (% of population)	Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV etc.		2017	https://data.worldbank.org/indicator/IT.NET.USER.ZS	International Telecommunication Union, World Telecommunication /ICT Development Report and database.

Trust	Confidence in National Government	In this country, do you have confidence in each of the following, or not? How about national government?		2017		

Subcomponent	Indicator Name	Definition	Assumption Rationale	Year of Data	Available Data sources URL	Data Provider
Epidemic Lack of Coping Capacity- IHR						
	International Health Regulations capacity scores	Average of 13 International Health Regulations core capacity scores	IHR (2005) is an obligation to member states for detecting, verifying, assessing, informing and responding to any events or threats related to infectious hazards including zoonosis, food safety, chemical events and radiation emergencies.	2016	http://apps.who.int/gho/indicatorregistry/App_Main/view_indicator.aspx?iid=4672	WHO

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