

JRC TECHNICAL REPORTS

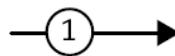
INFORM Epidemic Risk Index

*Support Collaborative
Risk Assessment for
health threats*

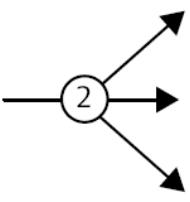
Doherty, B
Marin-Ferrer, M
Vernaccini, L

2018

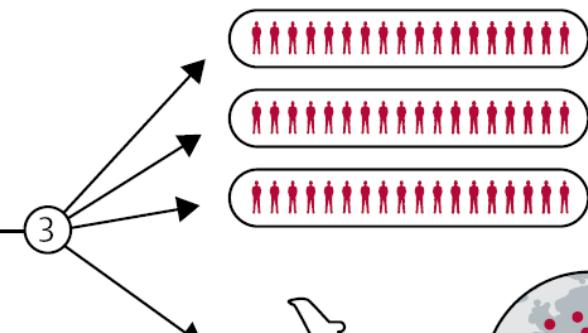
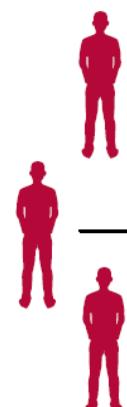
Viral transmission



Index case



Human-to-human transmission



Index-case potential

Outbreak potential

Epidemic potential

This publication is a Technical report by the Joint Research Centre (JRC), the European Commission's science and knowledge service. It aims to provide evidence-based scientific support to the European policymaking process. The scientific output expressed does not imply a policy position of the European Commission. Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use that might be made of this publication.

Contact information

Name: Brian Doherty
Address: Via Fermi, 2479 – Ispra (VA), Italy
E-mail: brian.doherty@ec.europa.eu
Tel.: +39 0332 785547

JRC Science Hub

<https://ec.europa.eu/jrc>

JRC109994

EUR 29072 EN

PDF ISBN 978-92-79-77770-7 ISSN 1831-9424 doi:10.2760/218424

Ispra: European Commission, 2018

© European Union, 2018

Reuse is authorised provided the source is acknowledged. The reuse policy of European Commission documents is regulated by Decision 2011/833/EU (OJ L 330, 14.12.2011, p. 39).

For any use or reproduction of photos or other material that is not under the EU copyright, permission must be sought directly from the copyright holders.

How to cite this report: Doherty, B., Marin-Ferrer, M., Vernaccini, L., *INFORM Epidemic Risk Index*, 29072 EN, doi:10.2760/218424

All images © European Union 2017, except: Cover image © All rights reserved by DM Pigott, A Deshpande, I Letourneau, et al. Local, national, and regional viral haemorrhagic fever pandemic potential in Africa: a multistage analysis Lancet (2017). Published online Oct 11. [http://dx.doi.org/10.1016/S0140-6736\(17\)32092-5](http://dx.doi.org/10.1016/S0140-6736(17)32092-5)

Contents

Abstract	1
1 Introduction	2
2 WHO – JRC collaboration	4
2.1 WHO Epidemic Risk Analysis meeting – Geneva, 21-22 March 2017	4
3 Epidemic Risk Index Concepts	6
3.1 Purpose	6
3.2 Objectives	6
3.3 Analytical framework.....	6
4 Inclusion of the Epidemic Risk Index in INFORM	10
5 Use of the ERI indicators for Rapid Risk Assessment	11
6 Conclusion	12

Abstract

JRC is developing a unified global system for public health threat detection and risk assessment (EIOS), and it is the technical and scientific leader of the Index for Risk Management (INFORM), a composite indicator that identifies countries at risk of humanitarian crisis and disaster that would overwhelm national response capacity. Both projects are in collaboration with the UN World Health Organisation (WHO).

WHO is working on the Epidemic Risk Index (ERI), a tool that supports strategic decision making and prioritization of capacity building activities for national epidemic prevention, preparedness, and response. The Epidemic Risk Index is calculated using the methodology of INFORM model.

Ultimately, the double objectives are to (1) the need for EIOS to include ancillary information from ERI, and (2) for INFORM to incorporate health components to improve the overall index.

This report describes the ongoing collaboration with WHO on the developing of the Epidemic Risk Index and the results achieved.

1 Introduction

The Multi-hazard Risk Assessment for Disaster Risk Management Knowledge Centre (MHRA for DRMKC) work package aims, in collaboration with other JRC projects involved in DRM and DRR, to contribute to an improved science-policy interface through activities in the field of Multi-hazard Risk Assessment, Risk reduction, Risk Management Capabilities, and Risk for Human Losses. The global and EU legal/policy context serves as basis for better orienting the proposals provided. One of the objectives of this WPK is to establish the basis towards a common consolidated methodology and understanding of the risk, which would lead to easily comparable results, facilitating in this way the prioritization of funding programs that would revert on effective mitigation and preventive actions. Fast developing crises of social (conflict) or biological (pandemics and disease outbreaks) origin need collaborative, expert-sourced risk assessment (RA) to support informed decision-making by European institutions (SANTE, EEAS, FRONTEX, Council) and international organisations (African Union, World Health Organisation). The DRMKC supports the bringing together of media information, structural indicator data and geographic data, as well as collaborative IT technology, to provide appropriate contextual information for a truly actionable RA. The WPK focuses on the Science Policy Interface needed to convey complex information to domain analysts. The WPK will focus firstly on the development of contextual information for Public Health and CBRN response on through the partnership with the Global Health Security Initiative (GHSI). Results will be of the interest of SANTE, the World Health Organisation (WHO) and DEVCO.

One of the 2017 MHRA for DRMKC deliverable, is "support collaborative risk assessment Collaborative risk assessment CRA for health threats", through the "CRA for health threats needs ancillary information about vulnerability and coping capacity that can be derived from the Index for Risk Management (INFORM)^a. It would be necessary to enhance the health related components in INFORM for better assess the vulnerability and coping capacity of the countries to epidemics threats".

Since 2008 the JRC has been working together with the WHO and the GHSI to develop two systems for open source news monitoring and collaborative risk assessment, namely HDRAS and EAR respectively. JRC developed the first version of the Epidemic Intelligence from Open Sources (EIOS) system which builds on the architecture and functionality of the existing systems. The finished EIOS system ultimate aim is to create a unified global system for public health threat detection and risk assessment. This fits extremely well into the overall objectives of the DRMKC, and in specific with the current plan for improvement of the INFORM methodology.

In particular EIOS will support the bringing together of media information, structural indicator data and geographic data, as well as collaborative IT technology, to provide appropriate contextual information for a truly actionable Risk Assessment.

The Index for Risk Management INFORM is a composite indicator that identifies countries at risk of humanitarian crisis and disaster that would overwhelm national response capacity. The INFORM index supports a proactive crisis and disaster management framework. The INFORM initiative began in 2012 as a convergence of interests of UN agencies, donors, NGOs and research institutions to establish a common evidence base for global humanitarian risk analysis.

The INFORM model is based on risk concepts published in scientific literature and envisages three dimensions of risk: Hazards & exposure, Vulnerability, and Lack of coping capacity. The INFORM model is split into different levels to provide a quick overview of the underlying factors leading to humanitarian risk and builds up the picture of risk by more than 50 core indicators.

Biological hazards (i.e. epidemics/large-scale epidemics/pandemics) are not currently included in the INFORM framework. They can have a large impact not only on mortality and morbidity but also on travel and trade as well as socioeconomic effects. To consider

^a <http://www.inform-index.org/>

their potential threat, the data on probability of re-emerging diseases with certain level of impact are needed and are not so easily available. The World Health Organisation WHO, an INFORM partner and the most experienced and relevant organisation for epidemic matter, and the JRC as scientific and technical leader if INFORM, agreed to work together to include an infectious disease outbreaks component in the natural hazard category of INFORM^b.

WHO, represented by the Global Infectious Threats Management, Department of Infectious Hazard Management IHM, WHO Health Emergencies Programme and JRC by the Disaster Risk Management Knowledge Centre, Disaster Risk Management Unit, presented in the INFORM Annual meeting 2017 in Rome^c, the ongoing collaboration to develop the WHO Epidemic Risk Index (ERI), which is an INFORM-style model of epidemic risk. This has been based on extensive consultation within and outside WHO on epidemic risk factors and risk drivers. It is intended that the ERI will be used by WHO to generate country-level risk scores by the end of 2017. It is then intended to use elements of the ERI to incorporate epidemic risk into the INFORM Global Risk Index. The inclusion of epidemic risk into INFORM has been a long-standing aspiration and this will be the first major change to the original INFORM analytical framework.

Ultimately, the double objectives are to:

1. the need for EIOS to include ancillary information from the ERI,
2. for INFORM to incorporate health components to improve the overall index.

This report describes the ongoing collaboration with WHO on the developing of the Epidemic Risk Index and the results achieved.

^b INFORM Annual Meeting 2016 Outcomes: https://docs.google.com/document/d/1_Jwjs2UH-YEfXrs6eRhufFBMPFjIcnlerLnZ3BGlqIA/edit?usp=sharing

^c INFORM Annual Meeting 2017 Outcomes:
https://docs.google.com/document/d/13B8L7_XQLWNxp_vZa8Dbow2cWLUOo2UGoSN083yKSZs/edit?usp=sharing

2 WHO – JRC collaboration

As part of the reform of the new WHO Health Emergencies Programme, IHM is leading a project on the prioritization of countries for infectious hazards risks. The first step was the development of a technically-sound, scientifically rigorous conceptual framework for drivers and risk factors of epidemics. This cross-cutting approach to understanding the major risk factors for infectious disease outbreaks at country level could then be applied to undertaking appropriate types of risk assessment (strategic, baseline, response planning, event etc) depending on the purpose at various levels.

An initial WHO internal workshop was organised on 15 September 2016 with the aim to develop a Conceptual Framework for Infectious Hazards brought together staff from various departments within WHO HQ to ensure the broadest approach to identifying risk factors. The approach aimed to understand the major risk factors for infectious disease outbreaks at country level, which can then be applied to undertaking an appropriate risk analysis. The indicators and analysis will be applied to the INFORM index which currently does not include any epidemic hazard related indicators.

In the late 2016, WHO approached then JRC. A teleconference (11/01/2017), following by a physical meeting in Ispra on 31 January 2017, were needed to agree to put the basis of the collaboration. JRC agreed to support WHO team during the process of development of INFORM index for infectious disease risk, particularly with regard to methodology and approach. JRC also collaborated to the organisation of a technical workshop (2.1), providing his expertise on the INFORM methodological approach.

2.1 WHO Epidemic Risk Analysis meeting – Geneva, 21-22 March 2017

An informal consultation was organized by the Infectious Hazard (IHM) Department of the WHO Health Emergencies (WHE) Programme on 21-22 March 2017 to review the progress to date and advise on next steps on elucidating an Epidemic Risk Index following the composite index methodology used by INFORM. The consultation involved UN partners, global experts, headquarters, regional and country office WHO staff who worked in groups to review the relevance and appropriateness of indicators that have previously been identified in the September workshop to develop a draft Conceptual Framework for Infectious Hazards. IHM also prepared and presented a preliminary model and analysis of the ERI based on existing, open-source global databases; however, this analysis did not represent a complete set of indicators.

The meeting objectives were specifically:

- To orient regional and country staff on the draft Conceptual Framework for Infectious Hazards.
- To review indicators and assumptions on hazard and exposure, vulnerability and coping capacity dimensions.
- To preview preliminary epidemic risk analyses for selected key indicators.
- To discuss and agree on application of the revised Conceptual Framework indicators using INFORM index methodology.

The 47 expert participants represented diverse views and disciplines, from various agencies and institutions, that relate to epidemics which enabled a comprehensive review of the draft Conceptual Framework for Infectious Hazards and the indicators emerging thereof classified according to INFORM dimensions of Hazard & Exposure, Vulnerabilities and Coping Capacities at country level. Each indicator was thoroughly considered in small working groups including review of the assumptions/rationale. This resulted in a process of validation by a wider, multidisciplinary audience which was designed to provide feedback on the approach and to critically evaluate the relevance and appropriateness of

the indicators identified thus far. The expected outcome was that such a process will ensure robust data and methods are employed in subsequent analyses.

Overall, the participants were supportive of the approach and methodology towards describing an Epidemic Risk Index at country level that would provide countries and partner agencies with information on addressing specific structural causes of epidemics to enhance preparedness and response measures. However, there is still some work still to be done on defining and specifying the statistical and analytic relationships of the indicators to be included in the final ERI model. Each of the working groups have presented their version of the contributing indicators which will be used for further analyses and development of the Epidemic Risk Index.

3 Epidemic Risk Index Concepts

In the 2017 summer, there has been a change of the member's team in the Global Infectious Threats Management, Department of Infectious Hazard Management, WHO Health Emergencies Programme. The continuity of the work on the Epidemics Risk Index has been ensured, and the support from the WHO management is further enhanced.

The new group developed a new Concept Note. On despite of the change of the name of the Index as Epidemic Vulnerability Assessment (EVA), the idea is to complete what has been done so far, applying the analytical framework proposed by the working group to generate a first prototype of the Index by the end of 2017. In this report, we keep the original name of the index, Epidemic Risk Index (ERI).

3.1 Purpose

The Epidemic Risk Index is a tool that supports strategic decision making and prioritization of capacity building activities for national epidemic prevention, preparedness, and response. ERI evaluates national and sub-national vulnerabilities and risks to epidemic prone diseases through a data-driven model and provides a simulation platform to test epidemic prevention and preparedness strategies.

3.2 Objectives

The Epidemic Risk Index has four main objectives:

- To identify countries and populations that are most vulnerable to an infectious disease epidemic.
- To inform and assess epidemic prevention and preparedness strategies by means of informing prioritisation of resource allocation for epidemic prevention and preparedness activities.
- To evaluate potential impacts of a likely epidemic given risks, vulnerabilities and coping capacities.
- To provide evidence based assessment of epidemic drivers.

3.3 Analytical framework

When country exposed to an infectious hazard event, it is clearly a multifaceted nature and observing its complexity of the phenomena and interactions with various dimensions, unique optimal solution is not possible. The objective of the ERI is to present epidemic risk in quantitative term.

Infectious disease susceptibility (in terms of exposure to infectious agents related to human and animal) is considered under the People at Risk 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 infectious hazard exposure the higher the risk, which is further aggravated by exposure to other hazards leading to further increase of the risk.

Likewise, the vulnerability dimension covers fragility of the socio-economic system, 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 including capacities for implementation of the International Health Regulations IHR^d. Conceptually, better epidemic management means higher coping capacity, which means low level of risk. For the sake of more straightforward communication, higher indicator values in Epidemic Risk Index refer to worse conditions.

^d World Health Organization. IHR Core Capacity Monitoring Framework. 2011.

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.

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

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

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

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 doesn't define the interactions among the dimension; however, allows for a simple and transparent calculation of epidemic risk using composite index methodology.

People at Risk: The People at Risk dimension represents the probability of exposure to infectious agents. There is 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.

There has been identified common drivers of four groups based on mode of transmission (Zoonoses, Vector borne, Person to person (P2P), Food borne, and Water borne) with the concept of epidemiological triad addressing agent, host and environment.

When available (Zoonoses and Vector borne diseases), we used environmental suitability maps to define at-risk populations. We benefit of existing models of environmental suitability^e for the transmission of a virus from environmental sources into human populations to establish regions at risk of spillover infections.

For the remaining categories (P2P, water and food borne), we used proxy indicators to estimate the exposure to the pathogens.

^e DM Pigott, A Deshpande, I Letourneau, et al. Local, national, and regional viral haemorrhagic fever pandemic potential in Africa: a multistage analysis Lancet (2017). Published online Oct 11. [http://dx.doi.org/10.1016/S0140-6736\(17\)32092-5](http://dx.doi.org/10.1016/S0140-6736(17)32092-5)

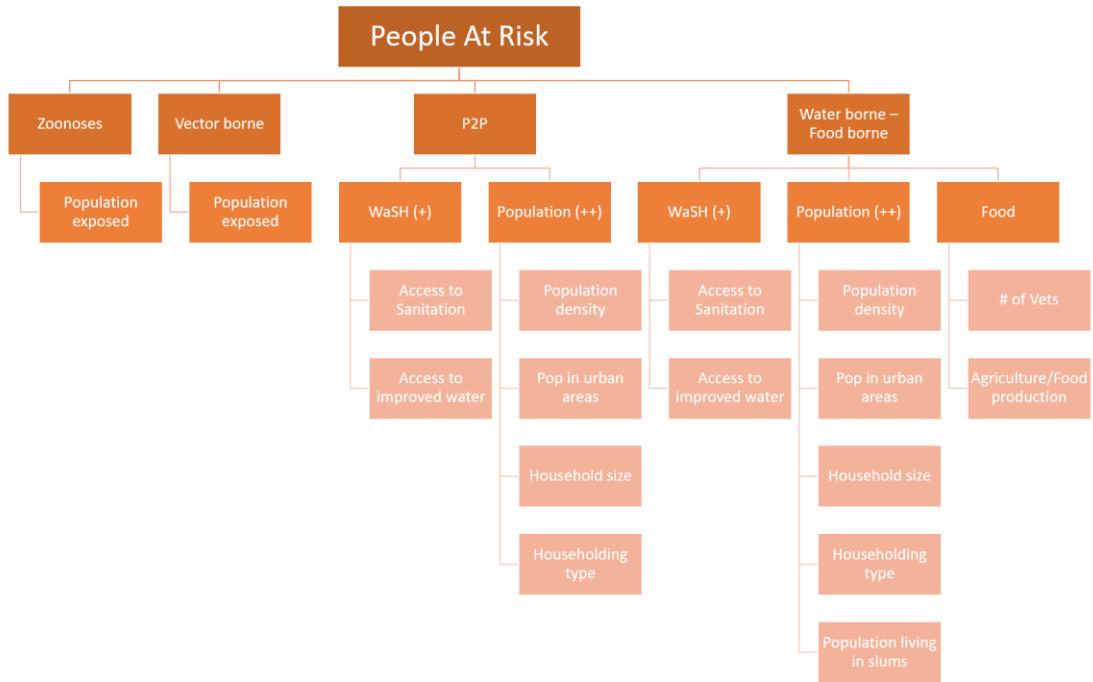


Figure 1: Analytical framework - People at Risk dimension

Vulnerability: Vulnerability describes how simply and how severely exposed people can be affected. The impact of any epidemics in terms of numbers is morbidity (number of cases) and mortality (number of deaths) and its impact on socio-economy of individuals, family and country. This dimension addresses the inherent predispositions of an exposed population to be affected or susceptible to the effects of hazards. Thus vulnerability dimensions represent health vulnerability due to social, economic, ecological, migratory and behavioural characteristics of the community.

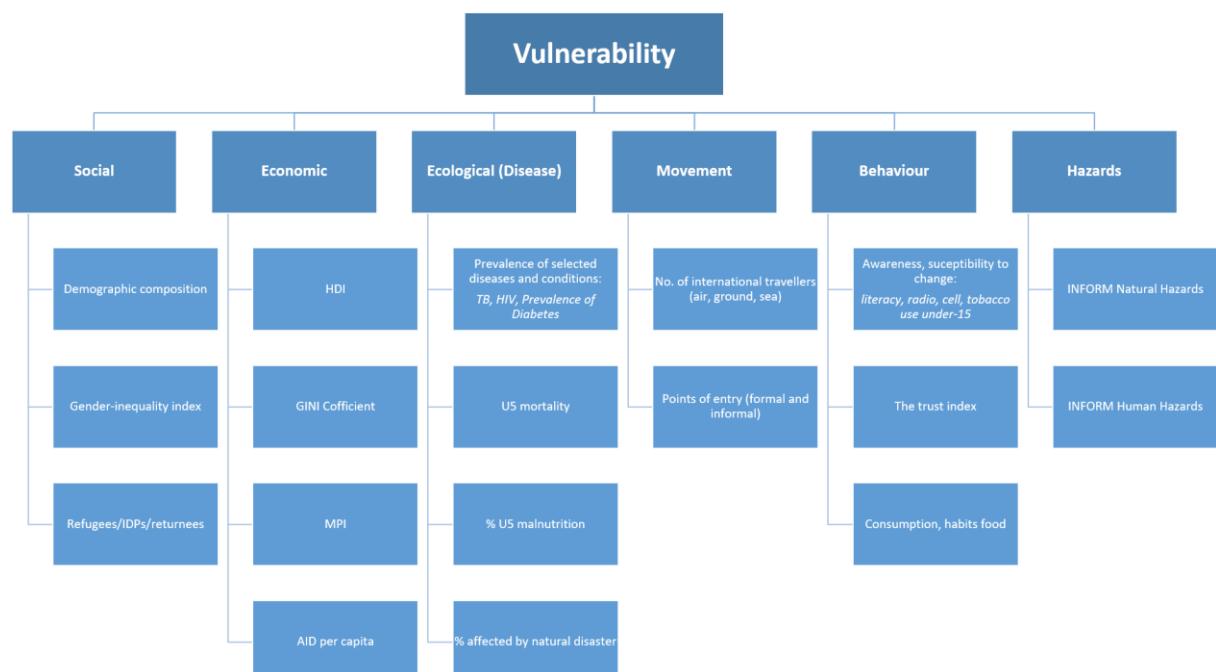


Figure 2: Analytical framework - Vulnerability dimension

Coping Capacity (Systems): It encompasses 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. 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.

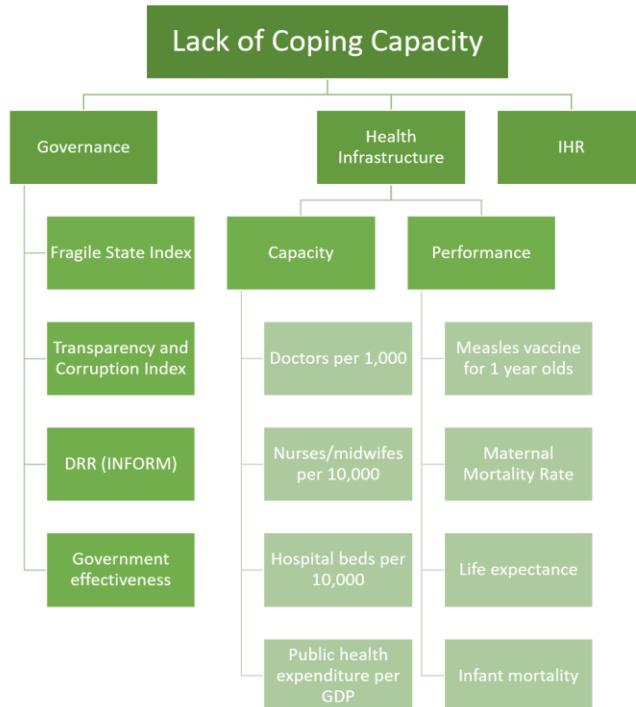


Figure 3: Analytical framework - Lack of Coping Capacity dimension

The Epidemic Risk Index is calculated using the methodology of Index for Risk Management (INFORM) model. The INFORM model describe 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.

The ERI model can be divided into different levels to provide a quick overview:

- Status level;
- Concept level – Dimensions;
- Functional level – Categories; and
- Component level - sets of indicators that capture concept of each category.

4 Inclusion of the Epidemic Risk Index in INFORM

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

In the INFORM annual meeting 2017, JRC and WHO proposed the method to add epidemic as an additional natural hazard (Figure 4).

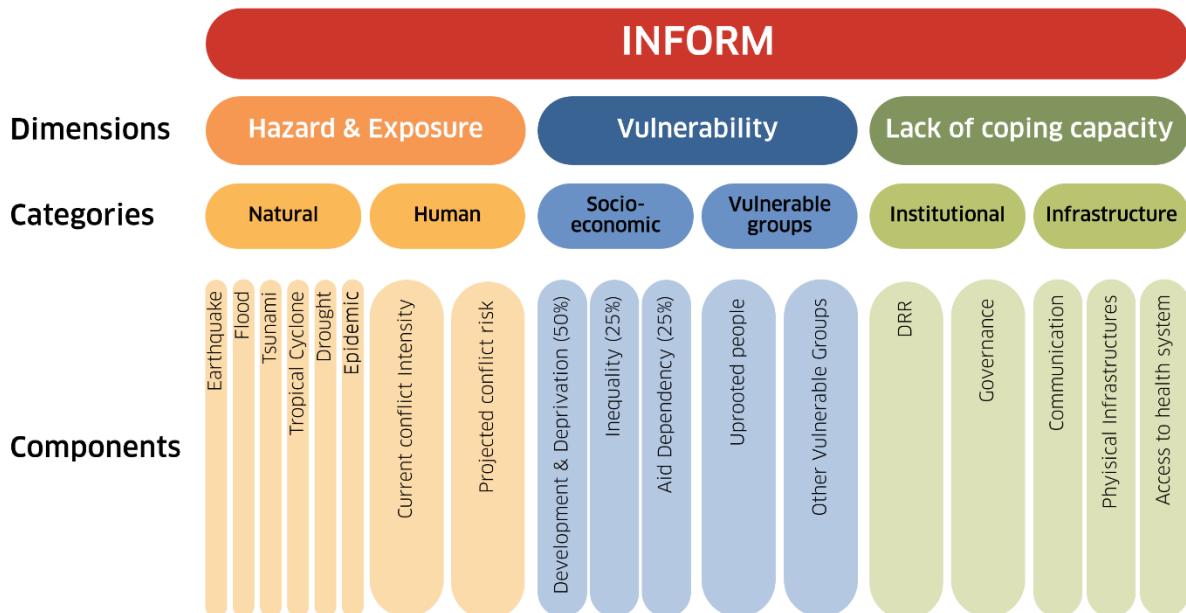


Figure 4: INFORM Analytical Framework included the Epidemic component.

This can be taken directly from the ERI, namely the People at Risk dimension. This is possible since conceptually the Vulnerability and LCC dimensions are very similar to the INFORM, as well as most of the indicators proposed. This means that the People at Risk dimension extracted from ERI can be plugged in INFORM preserving the original meaning. The two models are also fully compatible, since they are based on the same methodological method.

In addition, selected indicators from the ERI vulnerability and coping capacity dimensions will be considered for use in the INFORM Global Risk Index, in order to improve the overall coverage of health.

The INFORM partners agreed on:

- Include epidemic risk in the INFORM Global Risk Index through the addition of a natural hazard component, based on the forthcoming WHO Epidemic Risk Index (ERI).
- Make adjustments to indicators in the vulnerability and lack of coping capacity dimensions to improve the overall coverage of health by the INFORM Global Risk Index, based on the forthcoming WHO Epidemic Risk Index (ERI).

As action, WHO and JRC will finalise the WHO Epidemic Risk Index and make a proposal for incorporating an epidemic risk component and improved health indicators in the 2019 release of the INFORM Global Risk Index. To be presented at the INFORM annual meeting 2018.

5 Use of the ERI indicators for Rapid Risk Assessment

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

The system developed for WHO is the Hazard Detection and Risk Assessment System (HDRAS)^g and is used on a daily basis to enhance the capacity of the organization in early detection and monitoring of ongoing public health risks globally. Since this initiative, WHO and 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)^h, a tool used on a rotating shift basis by members of ECDC and public health institutions of countries involved to identify threats and perform basic risk assessments activities in a collaborative way.

WHO and GHSI expressed strong interest for merging the systems into a single improved system, called Epidemic Intelligence from Open Sources" (EIOS)ⁱ and represents an example of how intranational collaborations contribute in building trustable professional relationship among health experts, promoting further initiatives among which joint RRA activities are considered 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^j 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 Epidemic Risk Index, they will be part of the contextual information needed by the RRA and be available in the EIOS system.

^f <http://www.ghsi.ca/>

^g <https://extranet.who.int/hdras/OpenIdLogin/tabid/85/Default.aspx?returnurl=%2fhdras%2fMonitoring.aspx>

^h <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0057252>

ⁱ http://www.oie.int/eng/BIOTHREAT2017/Presentations/6.2_BARBOZA-presentation.pdf

^j Identification of ICN-RRA, EC JRC report - 2017

6 Conclusion

In the 2018, JRC will continue to support WHO in the development of the Epidemic Risk Index, with the goal to integrate the first results in the INFORM 2019 release and in the EIOS system.

***Europe Direct is a service to help you find answers
to your questions about the European Union.***

Freephone number (*):

00 800 6 7 8 9 10 11

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

More information on the European Union is available on the internet (<http://europa.eu>).

HOW TO OBTAIN EU PUBLICATIONS

Free publications:

- one copy:
via EU Bookshop (<http://bookshop.europa.eu>);
- more than one copy or posters/maps:
from the European Union's representations (http://ec.europa.eu/represent_en.htm);
from the delegations in non-EU countries (http://eeas.europa.eu/delegations/index_en.htm);
by contacting the Europe Direct service (http://europa.eu/europedirect/index_en.htm) or calling 00 800 6 7 8 9 10 11 (freephone number from anywhere in the EU) (*).

(*) The information given is free, as are most calls (though some operators, phone boxes or hotels may charge you).

Priced publications:

- via EU Bookshop (<http://bookshop.europa.eu>).

JRC Mission

As the science and knowledge service of the European Commission, the Joint Research Centre's mission is to support EU policies with independent evidence throughout the whole policy cycle.



EU Science Hub
ec.europa.eu/jrc

@EU_ScienceHub

EU Science Hub - Joint Research Centre

Joint Research Centre

EU Science Hub



Publications Office

doi:10.2760/218424

ISBN 978-92-79-77770-7