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Following evidence from production to use at the International Federation of Red Cross and Red Crescent Societies: where does it all go?

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Most humanitarian organisations claim to be evidence-based but how often has this been tested? The International Federation of Red Cross and Red Crescent Societies (IFRC) carried out a network analysis of its documentation to examine how evidence is produced, circulated and used within the IFRC. Network graphs were produced from a sample of 404 documents, depicting the structure of citations between documents. Methodologically, an actor-network perspective was employed to follow the flow of evidence and information through documents in a bid to understand the effort applied to our commitment to be evidence-based. This analysis found the uptake of evidence by other documents to be wanting. Through conventional metrics, we also found that connected documents follow a power-law distribution at multiple scales, implying the structure is scale-free, and identified the key documents shape this hierarchical structure. Unlike conventional explanations for scale-free networks, we found Least Effort provides a better explanation to how this specific arrangement arose. The limited and fragmented use of citations suggests that the principle of Least Effort is a consequence of the organisational culture in the aid sector which fails to adequately incentivise more reflexive practices in the production and use of evidence.

Keywords: International Federation of Red Cross and Red Crescent Societies; citation analysis; evidence; humanitarian crises

Introduction

Every tribe is guided by its mythologies, habits, understandings, craft skills, what is referred to as its culture (Latour and Woolgar, 1986). The humanitarian and development sector is no exception, its activities being guided by LogFrames and best practices, and its knowledge set in an ordered system. Activities and knowledge join in the understanding, or myth, that humanitarian practice is evidence-based. And with good reason, the value and necessity of producing evidence to improve the quality of humanitarian action is well-founded. Yet

challenges as to the production, circulation and use of evidence lay doubts on the systematicity of our grounding in it.

The International Federation of Red Cross and Red Crescent Societies (IFRC) also faces challenges in terms of the production, circulation and use of evidence. Evidence is generally produced ad-hoc, resulting in a cluttered evidence-base where efforts are regularly duplicated and sharing limited (Mohamed 2012). These challenges are compounded by the lack of capacities and funding for generating and using evidence, resulting in a gap between these two poles (Corboz 2015). The coordinating organisation of the IFRC, the IFRC Secretariat, and National Societies developed Reference Centres to produce evidence for, carry out capacity-building activities with, and generally support National Societies in their respective area of interest. Despite these developments, the gap between evidence production and use remains. The disconnection between complex humanitarian interventions and the framing of evidence applied to these interventions feeds this gap. Humanitarian interventions often rely on linear and rationalistic models which, while adapted to simple or complicated activities, are inadequate for complex social settings involving multiple interacting systems and nonlinear dynamics (Westhorpe 2012: 407-408).

Organisations implementing complex interventions effectively require greater reflexivity in how information is produced, interpreted and applied because the tools we currently rely on fail to capture or anticipate the emergent effects generated in such contexts, which can produce outcomes which deviate from programme objectives (Davies 2004: 103-105). We understand evidence-use in complex interventions to require theories of change, tailored to the specific contexts of programme actors, and higher-level theories to frame information across multiple levels of context (Barnes et al. 2003). Multiple iterations between empirical inquiry and theory adjustment then serve to refine midrange programme theories adapted to specific activities in unique locations (Westhorpe 2012: 411). The Active Learning Network for Accountability and Performance (ALNAP), a global network of diverse organizations and individuals dedicated to learning how to improve response to humanitarian crises, defines evidence as ‘information that relates to a specific proposition, and which can be used to support or challenge that proposition’ (Cristoplos et al. 2017: 5) and that ‘information only becomes evidence when it is related to a specific proposition’ (Clarke and Darcy 2014: 7). In each case, evidence is the combination of a theory, an explanation of why something ‘is’, and the information that supports it. In this article, we follow the ALNAP definition above and consider ‘evidence’ as information that supports a specific proposition.

Information and supporting propositions are often found in separate documents. Evaluation reports, for example, usually contain information on specific intervention outcomes which can be cited as evidence in a policy document that advances a given approach. Put simply, the evaluation report is an ‘evidence document’ and the policy is an ‘evidence-based’ document. The link between the two documents is the citation found in the policy document. An

'evidence-based document' is thus expected to cite documents that contain the evidence to support its claims. More specifically, a citation should: correctly reproduce and represent the content of a reference, make clear which statements references support, refer to the correct publication, and use a reliable source (Harzing 2002: 130-137). Referencing is as much a social process as an empirical one, one of being convinced by a statement and appropriately transposing it to the construction of another statement (Latour and Woolgar 1986: 75-76). Correct referencing is therefore essential to reflexive and transparent practices in evidence production, ensuring continuity between the quality of evidence used, of the citation and of claims made. It also supports more reflexive evidence use by facilitating the evaluation of how statements and claims were constructed.

Exploring the whole referencing process is beyond the scope of this article. As a first foray into the matter, we focus on the IFRC document-base to observe how evidence is produced and circulates in this network. To this end, we carried out a citation analysis of IFRC documentation using network analysis, framing the construction of graphs and their interpretation in terms of actor-network theory. As far as the authors as aware, this study constitutes the first citation analysis to be carried out in a humanitarian organisation and aims to provide other organisations with a simple method for carrying out similar analyses on their own body of work. In using the same method, findings can then be compared across organisations.

Theoretical framework and methodology

Network analysis

Network analysis (NA) represents phenomena as a set of vertices or nodes (*V)* and edges (*E)* in a graph (*G*) where $G=(V;E)$. The versatility of representing phenomena as series of points and lines, and the metrics used for analysing them has found great use in citation analysis. Early studies examined the structure of knowledge in scientific domains or disciplines (Small and Griffith 1974; McCain 1986), concluding that papers cluster by discipline and speciality. Price (1965) carried on this work, explaining that older and more authoritative papers get cited more. This process gives citation networks a power-law distribution, whereby most articles will rarely be cited while a few prominent pieces account for most citations in the network. Graphically, a power-law resembles a hockey stick curve flipped horizontally with a 'long-tail' to the right, as shown below in Figure 1. In citation analysis, the x-axis represents the number of citations and the y-axis the number of documents. A point along the curve therefore represents the number of documents that have a given number of references to other IFRC documents. Subsequent work in other disciplines has found a prevalence of power-law distributions, using both statistical (Brzezinski 2015) and network analysis (Kim et al. 2014).

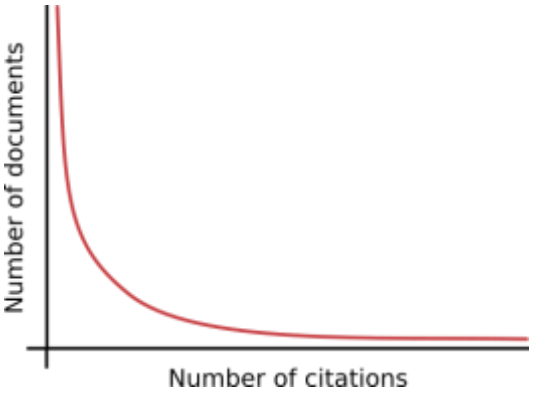

Figure 1. Example of a power-law distribution

As well as mapping the structure of different disciplines (Baggio et al. 2015; Kristensen 2012), analyses of citation networks have been used to assess the strength of evidence-bases (Du et al. 2012; Kumar et al. 2011). This includes examining citation practices (Hargens 2000), how they support the credibility of academic work (Harzing 2002), and how to improve the development and sharing of knowledge, theoretically (Zervas et al. 2014) and by improving knowledge management systems (Li et al. 2009). While not the only tool used in citation analysis, network analysis is widely used to visually represent the connections between manuscripts, where documents are depicted as a vertex and the references between them as edges. Since the references represent an interaction with a direction, an author referencing a document, edges are given a direction which is represented by an arrow. In citation analysis, edge direction typically starts from the referencing document and points to the document being referenced.

Power-laws are now found in a variety of empirical structures, from the topology of the internet to protein interactions. In many cases, both the overall network and their sub-networks follow a power-law distribution. Since these networks display the same distribution, and therefore properties, at multiple levels, they are called scale-free networks (Barabási 2009). Such networks are formed as new vertices join the network by attaching to already prominent nodes, what Barabási calls preferential attachment (ibid.). As the most prominent vertices gain more connections, they become hubs in the network which control key flows across levels. Because they act as hubs, they are core structural nodes which improve the efficiency of the network by centralising flows and filtering out redundant ones, thereby structuring the network in a hierarchical manner. Their structural role, however, means their loss is critical to the integrity of the network. In contrast, peripheral nodes help generate new flows and their loss is unimportant to the network. (Barabási 2013; Newman 2003: 189-190).

Other mechanisms can also explain power law distributions. We focus on the Principle of Least Effort (Zipf 1949), which was first developed to explain the frequency of word use in certain languages. This results from the common preference to use the minimum amount of

words needed for meaningful communication. More broadly, it holds that actors prefer to follow the most energy-efficient path in their activities. That actors follow energy-efficient strategies has also explained certain economic, organisational, and computational networks (Adriani and McKelvey 2009: 1058-1062).

Actor-network theory

Actor-network theory focuses on how social and technological networks co-construct each other, and how this affects knowledge construction. This has involved working beyond citation analyses to examine the strategic use of citations among scientists, highlighting their function as tools of persuasion (Latour and Woolgar 1986). To this end, it analyses humans and non-humans, called actants, together in material, social and discursive networks. Part of this involves moving from explaining causality to exploring mediation, 'the aim is […] to trace effort' (Mol 2010: 261). Forming a network effectively requires effort from the different actants involved to persuade, induce or compel other actants to form an attachment (an edge) in what Latour calls an act of translation – to be cited, a text needs to compel its reader that it is useful (Latour and Stark 1999: 24-26). The effort involved in this activity represents a cost to actants because reading the text takes time and energy while, if not compelling enough, the time reading is wasted effort. A successful translation and attachment, however, will contribute to the formation of a network (Latour and Woolgar 1986: 238-240). Actor-network theory is purposefully vague and flexible in its vocabulary to avoid the sedimentation of any prescriptive theory.

Citation analyses typically place edge direction from the referencing paper to the cited paper, from more recent to older text (Newman 2010: 68). This process examines how older materials compete in a present context to gain the authority to become citable elements (Leydesdorff 1998: 14). The concept of preferential attachment effectively captures this process; texts will favour citing authoritative pieces which are already highly cited. In using actor-network theory, we want to trace effort of evidence-use among IFRC documents by following the uptake of references by more recent documents. The emphasis is on how references are constitutive of the documents they are found in, how the knowledge and evidence of one text becomes part of the text it is being cited in: each reference is not just an FYI pointing to a source, it is first and foremost an indicator of where evidence and ideas have compelled the author and nudged the structure of the manuscript to be as it is, and not any other way (Latour and Stark 1999: 30). Conversely, the reach and influence of a cited document is extended as it gets integrated into another text and lends it its credibility. It therefore makes sense that the direction of edges is inverted, from older documents to newer ones. As this is the case, however, some metrics will have to be interpreted in a new way. The most important change in this regard will concern the change from the number of incoming edges attached to a node (in-degree) as being a measure of prestige to the number of out-going edges (out-degree), as this represents a document being cited by another. Tables 1a and 1b present the different metrics used in the analysis and how we interpreted them.

Table 1a. Vertex-specific metrics in citation networks and actor-network interpretation

NA Metric	Notation	Definition (Newman, 2010)	Application in citation networks
Degree	*k*	The degree of a vertex is the number of edges connected to it. It gives a measure of how connected a vertex is to others in the network.	It measures how much a document cites (in-degree) or the number of times it is cited (out-degree) and provides a crude measure of whether a document is well-informed or influential, respectively.
Betweenness	*b*	Betweenness measures the extent to which a vertex lies on the paths between other vertices. It is a guide to the influence vertices have over the flow of information between others.	Documents with high betweenness are important in bridging groups of documents and exchanging new information across them. Removal of these documents will disrupt the structure of the network most as they lie on the largest number of paths between groups. As betweenness rests on a vertex having an out-degree, only documents which are cited will score on this metric.
Closeness centrality	*ircc*	Closeness centrality measures the mean distance from a vertex to other vertices. High closeness centrality indicates better access to information at other vertices or more direct influence on other vertices. Since it takes into account all vertices, we will use a variant of the metric called information range closeness centrality which discards vertices with no degree.	As closeness centrality is based on in-degree, it provides a rough estimate of how much a document will draw in information, knowledge and evidence from surrounding texts.
Clustering coefficient	*C*	The clustering coefficient is the average probability that two neighbours of a vertex are themselves neighbours and measures how complete a vertex's neighbourhood is.	It measures the extent to which documents will use the same references.

Three assumptions, drawn from the literature on bibliometrics and network analysis ground this study. First, if the patterns of the network are known, it is possible to influence flows by stimulating or dampening strategically located nodes and links. Second, network metrics assume that flows will follow the shortest path between nodes. The risk here is that in many cases flows are indirect or oblique, metrics therefore measure best-case scenarios in how flows travel. Finally, the most influential documents are cited more and therefore located along key paths.

Table 1b. Graph metrics in citation networks and actor-network interpretation

NA Metric	Notation	Definition (Newman, 2010)	Application in citation networks
Average degree	d	Average degree calculates the mean degree of vertices in a network and represents the how well connected the average vertex is.	It represents the average number of times documents will cite or be cited by other documents in the network.
Average path length	l	The average path length measures the mean number of edges along the shortest paths between any two vertices in the network. It measures the efficiency of flows in a network.	It measures how far, on average, any piece of information or evidence from one document can travel to any other connected document in the network.
Density	δ	The density of a graph is the the fraction of maximum possible edges in a graph. Maximum density is 1 (all possible ties are present), the minimal density is 0.	It measures the extent to which documents are citing each other relative to the maximum number of citations possible. A maximum value of 1 would be undesirable as only relevant citations need to be made between texts.
Diameter	D	The diameter of a graph is the length of the longest calculated shortest path between any pair of vertices in the network for which a path actually exists.	It provides a rough measure on how far information or evidence can travel across the network.
Average clustering coefficient	C_{avg}	The average clustering coefficient calculates the mean clustering coefficient of all vertices in a network. It measures the extent to which vertices will form highly connected groups.	It denotes how much one can expect documents to share references across the network.
Modularity	Q	Modularity measures the tendency of vertices with similar properties to connect. It is strictly less than 1, takes positive values if there are more edges between vertices of the same type than we would expect by chance, and negative ones if there are less. In other words, it is a measure of how structured connections in the network are.	It measures the extent to which texts will cite across document types and areas of specialty. A higher value indicates more referencing occurs across categories and therefore that there is more cross-fertilisation between domains.

Methods

We developed a simple method that could be replicated by non-experts, thereby enabling similar studies to be carried out within and outside of the IFRC. Consequently, we used open-source software for the creation and analysis of the graphs, namely Gephi (Bastian et al. 2009) and SocNetV (Kalamaras 2015), and for the statistical analysis, namely R (R Core Team 2017).

We met 22 National Societies during a workshop held in December 2016 at the IFRC Secretariat in Geneva and then contacted National Societies referred by workshop participants. Among the 37 National Societies we contacted, nine agreed to participate in the study. Our contacts provided documents in electronic format and we acquired additional documents from each participant's website. At the same time, we gathered documents from Secretariat colleagues and the IFRC's online database. As documents were analysed, references were checked to find additional IFRC and National Society pieces. In short, materials were acquired through snowballing. Table 2 presents the inclusion and exclusion criteria for the study.

Table 2. Document inclusion and exclusion criteria.

Inclusion criteria	Exclusion criteria
Published 2012 or later	Draft document
Published or commissioned by the IFRC Secretariat, National Society or Reference Centre	Annual report
(Co)-authored by the IFRC Secretariat, National Society or Reference Centre	Financial report/audit/budget
Falls under a core IFRC activity or thematic sector	Presentation

Data was extracted from documents and recorded in Excel (see Table 3 below). Document meta-data was recorded alongside referencing data. For evidence documents, we also recorded data on evidence production, such as use of theory and methods used. Table 3 also provides the codes used to present the key analytical categories and abbreviations used throughout the study. The datasets were then disaggregated by organisation to produce graphs for each one, resulting in 11 separate analyses. We emphasise that the graphs only depict citations between IFRC documents, references to external documents are not represented. This reflects the choice to exclusively analyse the IFRC document-base and how it builds on itself. All participating organisations were provided with the opportunity to review the findings before they were finalised and disseminated. Of these, only two National Societies and two Reference Centres responded, choosing to discuss by email. The two Reference Centres continued this exchange by videocall.

Findings

We now present our findings for the IFRC and the Secretariat. For both scales of analysis, we first provide an overview of the network and of document production before defining the topology in more detail. We then examine how evidence circulates between documents. Finally, we consider findings from other organisations to examine how subsystems which display local variability populate the network.

Table 3. Database structure and analytical categories

Data type	Data description	Code
Meta-data	Title	--
	Publication year	--
	Lead author	--
	Lead author affiliation	--
	Publisher	--
	Document class	Evidence
		Evidence-based
	Document type	Research
		Evaluation
		Framework
		Advocacy
		Policy
		Programme design
	Thematic sector	Disaster Risk Reduction (DRR)
		Health
		Social Inclusion
		Livelihoods
		Culture of Non-Violence and Peace
		Shelter
		Water, Sanitation and Health (WASH)
		Migration
		All
		Other
	Core IFRC activity	National Society Development and Volunteering
		Policy and Advocacy
		Resilience
		Other
	Length in pages	--
Evidence production	Theory used	--
	Methods section	--
	Methods used	Quantitative
		Qualitative
		Mixed methods
	Participatory data collection	--
Referencing	Number of references	--
	Number of IFRC references	--
	Number of citations	--
	Number of IFRC citations	--

IFRC citation network topology

The graph for the IFRC document-base is depicted in Figure 2, where G=(404;242). The metrics for this graph are much lower than those found for citation networks in the literature (Table 4; Kristensen 2012; Baggio 2005), principally due to the low edge (references) to vertex (document) ratio, representing the low number of citations between IFRC documents. Half the vertices in the graph are effectively disconnected, naturally leading to a lower average degree, path length, and clustering coefficient. We also examined the metrics for the largest component (sub-group of connected vertices) which, while higher than for the whole graph, also lag behind other citation networks. While we anticipated lower values compared to the literature, these results are below our expectations and highlight the limited referencing between IFRC materials. The sample is evenly split between document classes, with 47% of materials being evidence documents. Considering document type shows a dominance of research and frameworks, while document thematic sector is highly skewed towards disaster risk reduction (DRR) and health (Tables 5a and 5b). This trend is unsurprising given the focus of Red Cross activities.

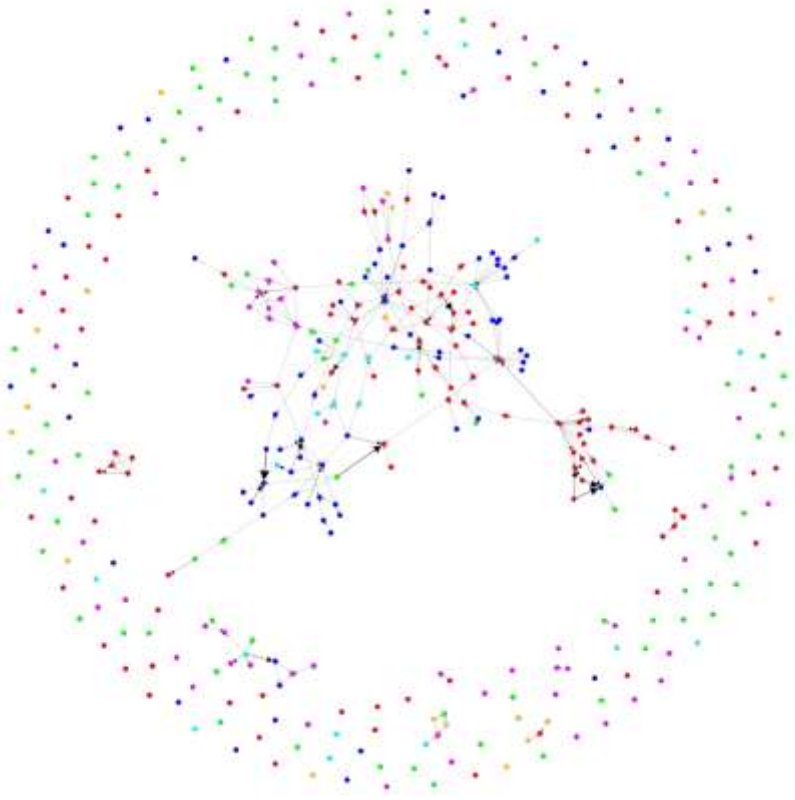

Figure 2. The IFRC citation network, with vertices coloured by type – research (red), evaluations (pink), frameworks (dark blue), advocacy (green), policies (light blue) and programme designs (yellow).

Surprise comes from the 204 disconnected nodes, which represent documents which do not cite or are not cited by other IFRC references. We can suppose different results would have been found had we included the 5,572 citations to non-IFRC references in the analysis. Yet 154 documents without citations would remain, representing 38% of the sample. The limited transparency in evidence production is visible because theory and methods sections are only present in around 60% of all evidence documents (Table 6). We also examined the content of each document and discerned the methods used in 84% of cases (eg. quantitative, qualitative or mixed). The remaining pieces lacked clear indications on the approach used, meaning assignment to any category was not possible. Limited clarity in evidence documents about theories and methods used suggests there is room for improvement in building a more robust 'evidence-base' for the IFRC.

Table 4. Basic network statistics. The properties measured are: number of vertices *V* and edges *E*; proportion of disconnected nodes *o*; average degree *d*; average path length *l*; network density δ; average clustering coefficient C_{avg}; graph diameter *D*; network modularity *Q*; scaling parameter of the power-law function α; lower limit for the function x_{min}; and proportion of power-law nodes in the largest component V_{PL}.

Network	IFRC		Secretariat		Burundi RC	Climate Centre	Japanese RC
	Full network	Largest component	Full network	Largest component			
V	404	157	171	94	31	31	50
E	242	203	143	114	13	15	26
o	0.5	–	0.25	–	0.52	0.45	0.62
d	1.198	2.599	1.673	2.426	0.839	0.968	1.04
l	1.633	1.687	1.569	1.632	1.133	1.435	1.278
δ	0.001	0.008	0.005	0.013	0.014	0.016	0.011
C_{avg}	0.023	0.032	0.022	0.006	0.027	0.038	0.014
D	4	4	4	4	2	3	2
Q	0.815	0.771	0.778	0.699	0.463	0.634	0.321
α	–	2.87	–	3.18	–	–	–
x_{min}	–	3	–	4	–	–	–
V_{PL}	–	0.36	–	0.2	–	–	–

Table 5a. Distribution of documents by type

Network	Research	Evaluation	Framework	Advocacy	Policy	Programme design
IFRC	0.31	0.16	0.21	0.21	0.06	0.05
Secretariat	0.35	0.06	0.27	0.15	0.06	0.11
Burundi Red Cross	0.03	0.74	0.1	0.03	0.1	0
Climate Centre	0.48	0	0.23	0.29	0	0
Japanese Red Cross	0.26	0.34	0.08	0.28	0.04	0

Table 5b. Distribution of documents by thematic sector

Network	IFRC	Secretariat	Burundi RC	Climate Ctr.	Japanese RC
DRR	0.42	0.42	0.19	0.94	0.74
Health	0.35	0.28	0.45	0	0.2
Social Inclusion	0.05	0.06	0.03	0.03	0
Livelihoods	0.05	0.06	0.06	0	0
Culture of Non-Violence	0.02	0.03	0.13	0	0
Shelter	0.02	0.04	0	0.03	0
WASH	0.01	0.02	0.06	0	0
Migration	0.01	0.01	0	0	0
All	0.06	0.08	0.06	0	0.06
Other	0.01	0.02	0	0	0

Table 6. Evidence production statistics by organisation.

Network	Describe theory	Describe methods	Quantitative methods	Qualitative methods	Mixed methods	Participatory data collection
IFRC	0.61	0.6	0.32	0.29	0.22	0.1
Secretariat	0.3	0.4	0.14	0.29	0.14	0.06
Burundi RC	0.5	0.5	0	0.27	0.73	0.45
Climate Centre	0.93	0.78	0.07	0.71	0.21	0
Japanese RC	0.78	0.32	0.46	0.28	0.21	0

We examined the degree distribution to test a fit with a model, first removing isolated nodes to focus on connected components, and found a skewed distribution. Following Newman (2010), we linearised the data on doubly logarithmic axes which suggested the network follows power-law ($\alpha = 2.87$, $x_{min} = 3$; Figure 2). We then carried out a regression analysis for both logarithmic ($r^2 = 0.885$, $p < 0.0001$) and exponential models ($r^2 = 0.832$, $p < 0.0001$), finding a stronger fit with the former. In addition, we carried out a Kolmogorov–Smirnov test on the cumulative distribution function (KS.p = 0.936) which confirmed the fit with a power-law (Csardi and Nepusz 2006). As demonstrated above, the network follows a power-law for all vertices of degree 3 or higher, representing 36% of vertices in the large component. This indicates the latter is hierarchically structured around key documents with other materials attaching to these hubs. In other words, new information can spread efficiently throughout connected documents but depends on few key pieces.

Circulation of evidence

To find if the focus on specific document types and thematic sectors contributes to this phenomenon, we examined the references between documents. The high modularity of the network indicates that referencing follows a structured pattern (Table 4). We therefore counted edges between document categories and calculated the probability that two documents of a given type or sector chosen at random interact. We found that referencing focuses within DRR and health documents, with referencing between them forming the next largest category (Table 7a). Referencing among and between other sectors is limited, instead tending to concentrate around DRR and health. A similar pattern emerges when considering document type, with edges focusing around research and frameworks (Table 7b). The focus around DRR and health is unsurprising given they are important activities in the IFRC, as is the focus around frameworks given the IFRC's practical orientation. The focus around research is less trivial and may indicate strong uptake of evidence among referencing documents.

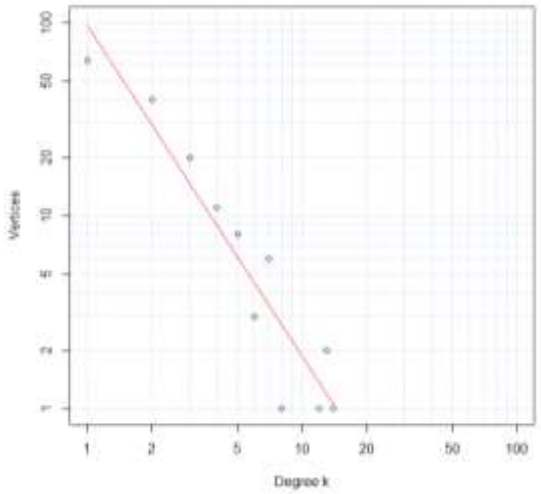

Figure 3. Log-log plot of the IFRC citation network degree distribution.

Table 7a. Number of references between document types.

Doc. Type	Research	Evaluation	Framework	Advocacy	Policy	Programme Design
Research	66	–	–	–	–	–
Evaluation	13	14	–	–	–	–
Framework	33	4	37	–	–	–
Advocacy	8	6	10	2	–	–
Policy	9	5	18	2	4	–
Prog. Design	4	4	1	2	0	0
Total	133	46	103	30	38	11

Table 7b. Number of references between document sectors

Sector	DRR	Health	Social inclusion	Livelihoods	Culture of non-violence	Shelter	WASH	Migration	All	Other
DRR	78	–	–	–	–	–	–	–	–	–
Health	27	72	–	–	–	–	–	–	–	–
Social inclusion	7	5	2	–	–	–	–	–	–	–
Livelihoods	7	3	2	2	–	–	–	–	–	–
Culture of non-violence	0	3	1	0	0	–	–	–	–	–
Shelter	9	2	0	0	0	0	–	–	–	–
WASH	1	0	0	0	0	0	0	–	–	–
Migration	0	1	0	0	0	0	0	0	–	–
All	9	2	2	1	0	1	0	0	1	–
Other	0	4	0	0	0	0	0	0	0	0
Total	138	119	19	15	4	11	1	1	7	4

To refine the analysis, we examined the distribution of edges according edge direction (Figure 3). The results are instructive: evidence documents are nearly 40% more likely to reference IFRC materials than evidence-based texts are, and three times as likely to cite evidence-based materials than the inverse. That evidence documents cite evidence-based documents is important for informing research agendas and ensuring they remain relevant to practice. Yet the ratio of referencing between documents classes is too uneven, suggesting practitioners are

not referencing the evidence materials they consult - or not even using them. In effect, only 24% of documents in the sample make use of IFRC references, the majority evidence documents (see Figure 8). Although referencing of non-IFRC materials does double this proportion, it still represents a limited commitment to transparent writing practices across document classes.

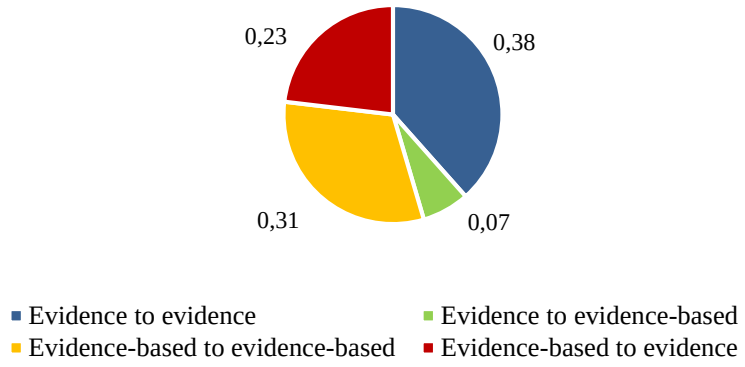

Figure 4. Proportion of references between IFRC document classes

We ranked the ten highest-scoring documents according to out-degree, closeness centrality and betweenness (Table 8). Evidence documents, all research, form 70% of pieces in the rankings and tend to have a broad scope of applicability. The Secretariat's *World Disasters Report* (2013; 2014; 2015) series is exemplar here, providing general overviews of topics with broad statistics. Other Secretariat research, *The Road to Resilience* (2012), *Learning from the City* (2012), and *Programmatic Directions* (2012), are also illustrative cases, covering the interdisciplinary topic of resilience, and are mostly cited by materials covering other broad IFRC topics, such as psychosocial support, DRR, and volunteering. In other words, documents which have little contextual barriers to their use are the most influential pieces of evidence.

What little research in the rankings does have specific foci represents the specialisation of Reference Centres and therefore score highly, particularly in closeness centrality, due to more intense referencing within these organisations. Documents which rank highly in betweenness are then pieces which provide links between these organisations and the rest of the network. Prominent evidence-based documents, mostly Secretariat pieces, also represent broad interdisciplinary topics, namely gender and resilience, or fall into the 'All' category. Unlike evidence materials, however, their practical focus means they tend to be referenced by documents covering the same topic and are thus important in informing specific areas of practice. Nonetheless, the limited number of evidence-based documents in the rankings indicates their limited interaction with the network.

Table 8. Ten highest scoring IFRC documents according to out-degree centrality, betweenness centrality and information range closeness centrality.

Out-degree centrality ranking			
Rank	Document	Class	Out-DC
1	De Buck E., *Use of Evidence-Based Practice in an Aid Organisation*, (2014)	E	10
2	IFRC, *Strategic Framework on Gender and Diversity Issues (2013-2020)*, (2013)	E-b	7
3	Talbot J., *Preparing for and Responding to Large Scale Disasters in High Income Countries*, (2013)	E	6
4	Singh G., *Predictable, Preventable*, (2012)	E-b	5
5	Kyass A., *Learning from the City*, (2012)	E	4
6	IFRC, *Framework for Community Resilience*, (2015)	E-b	4
7	Vinck P., *World Disasters Report 2013*, (2013)	E	4
8	Cannon T., *World Disasters Report 2014*, (2014)	E	4
9	Bendimerad F., *Programmatic Directions for the Red Cross Red Crescent in Building Urban Community Resilience in the Asia Pacific Region*, (2012)	E	4
10	IFRC, *The Road to Resilience*, (2013)	E	4
Betweenness centrality ranking			
Rank	Document	Class	BC
1	IFRC, *Principles and Rules for Red Cross and Red Crescent Humanitarian Assistance*, (2013)	E-b	40
2	De Buck, E., *Use of Evidence-Based Practice in an Aid Organisation*, (2014)	E	34.5
3	Kyazz A., *Learning from the City*, (2012)	E	31
4	IFRC, *Integrating Climate Change and Urban Risks into the VCA*, (2014)	E-b	23
5	Hamza M., *World Disasters Report 2015*, (2015)	E	17
6	PS Centre, *Life Skills. Skills for Life. A Handbook*, (2013)	E-b	16
7	Taylor N., *Urban Volunteering in South East Asia*, (2014)	E	15
8	IFRC, *9th APC: Community Resilience*, (2014)	E	13
9	Babé M., *Evaluation of the JRCS and IFRC Recovery and Rehabilitation Interventions after the GEJE and Tsunami of 11 March 2011*, (2013)	E	11
10	IFRC, *The Road to Resilience*, (2012)	E	10
Information range closeness centrality ranking			
Rank	Document	Class	IRCC

1	De Buck, E., *Use of Evidence-Based Practice in an Aid Organisation*, (2014)	E	0.025
2	De Buck, E., *Is Blood of Uncomplicated Hemochromatosis Patients Safe and Effective for Blood Transfusion?*, (2012)	E	0.019
3	Dieltjens T., *Evidence-Based Recommendations on Automated External Defibrillator Training for Children and Young People in Flanders-Belgium*, (2013)	E	0.018
4	IFRC, *Strategic Framework on Gender and Diversity Issues (2013-2020)*, (2013)	E-b	0.018
5	Talbot J., *Preparing for and Responding to Large Scale Disasters in High Income Countries*, (2013)	E	0.016
6	Cusack L., *Blood Type Diets Lack Supporting Evidence: A Systematic Review*, (2013)	E	0.016
7	Bendimerad F., *Programmatic Directions for the Red Cross Red Crescent in Building Urban Community Resilience in the Asia Pacific Region*, (2012)	E	0.015
8	Kyazz A., *Learning from the City*, (2012)	E	0.015
9	IFRC, *The Road to Resilience*, (2012)	E	0.015
10	Singh G., *Predictable, Preventable*, (2012)	E-b	0.013

IFRC Secretariat citation network topology

In this section we focus on the Secretariat subnetwork, where G=(171:143) (Figure 4). Of these documents, 139 are Secretariat documents, making just over a third of materials in the sample. The metrics for this graph and its largest component are very similar to those observed for the IFRC network, again due to the low edge to vertex ratio (Table 4). The proportions for document types and thematic sectors are also similar, with only evaluations dropping 0.1 points (Tables 5a and 5b). As such, the Secretariat subnetwork approximates the structure and composition of the overall sample.

Analysis of evidence production methods for the 139 Secretariat documents shows more limited transparency and rigour (Table 6). We were unable to identify how evidence was produced for nearly half of all documents, both by searching for formal indicators (eg. theory and methods sections) and examining the findings. These results are surprising considering the Secretariat should be setting the standards for evidence production in the IFRC.

We examined the degree distribution, again focusing on the largest component, and found a long-tail. The log-log plot suggested a fit with a power-law model (α = 3.18, x_{min} = 4; Figure 5) which was confirmed by the regression analyses, against both logarithmic (r^2 = 0.973, p < 0.0001) and exponential (r^2 = 0.719, p < 0.0001) models, and the Kolmogorov–Smirnov test (KS.p = 0.99). The power-law fit is stronger here than for the global analysis for vertices of degree 4 and higher, representing 20% of vertices in the component. This again indicates that

documents are hierarchically structured around key texts which inform the network, with peripheral pieces then linking to these core texts. Having found power-law behaviour at two different scales in the sample, we confirm the network is scale-free for vertices of degree 3 or higher. While this hierarchical structure is efficient in gathering and redistributing information and evidence, how effectively it is used remains questionable, as the following section will show.

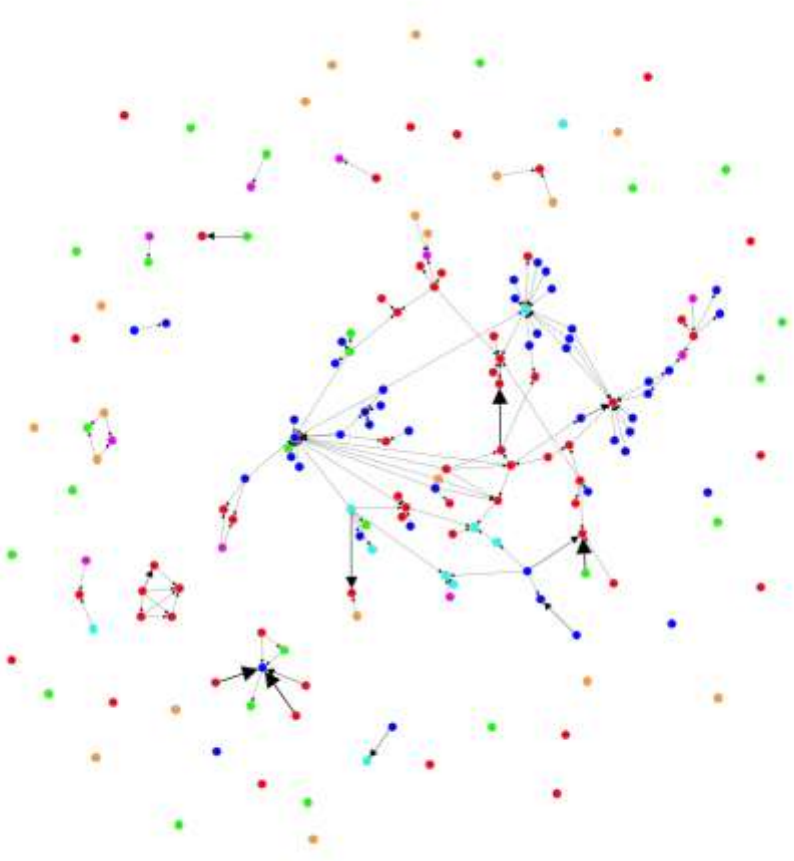

Figure 5. The Secretariat citation subnetwork, with vertices coloured by type – research (red), evaluations (pink), frameworks (dark blue), advocacy (green), policies (light blue) and programme designs (yellow).

Circulation of evidence

Analysing edge occurrence returned a similar pattern to the full sample, showing a focus around DRR and health documents, and research and frameworks. Given the resemblance between the structure of the IFRC and Secretariat document-base and elements that compose them, it is unsurprising that citation patterns would also be similar. Following the edges between document types again revealed that the distribution of edges between evidence and evidence-based documents is highly unbalanced (Figure 6). Referencing among categories represents roughly the same proportion of edges, but evidence is more than five times as likely as to cite evidence-based materials than the inverse.

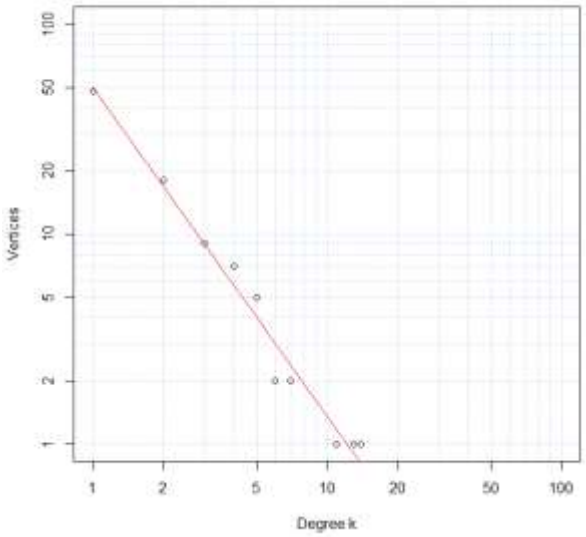

Figure 6. Log-log plot of the Secretariat subnetwork degree distribution

The proportion of Secretariat evidence documents which use references is 0.1 points lower than the whole sample but similar when only IFRC references are considered (Figure 8). Proportions for evidence-based documents are again lower for all referencing but comparable when considering only IFRC references. As such, Secretariat documents follow the referencing trend towards IFRC documentation seen in the global network but reference external sources less.

We again ranked the top ten documents using the same metrics (Table 10). With few exceptions, the same documents appear in these rankings, meaning evidence documents again dominate the rankings. Yet new entries cover the topic of resilience and DRR, repeating the tendency to cover interdisciplinary themes identified in the previous part. Interestingly, the highest ranking out-degree and closeness centrality documents are evidence-based pieces covering the topic of gender, while the highest ranking betweenness document is an overarching policy which covers all sectors. If we consider the number of references exchanged between the Secretariat and National Societies, we find an explanation for why the rankings are so similar across levels. The Secretariat provides nearly three times as many references to other organisations than it uses while National Societies reference Secretariat pieces disproportionality more than they cite one another (Figure 7). This naturally leads to the high ranking of Secretariat documents across levels as they constitute hubs for information exchange between documents in the sample.

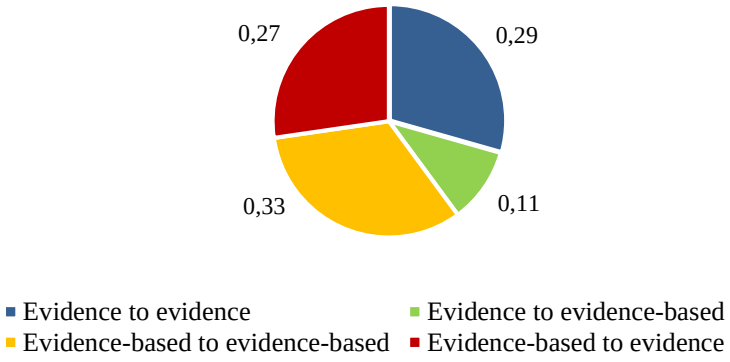

Figure 7. Proportion of references between Secretariat document classes.

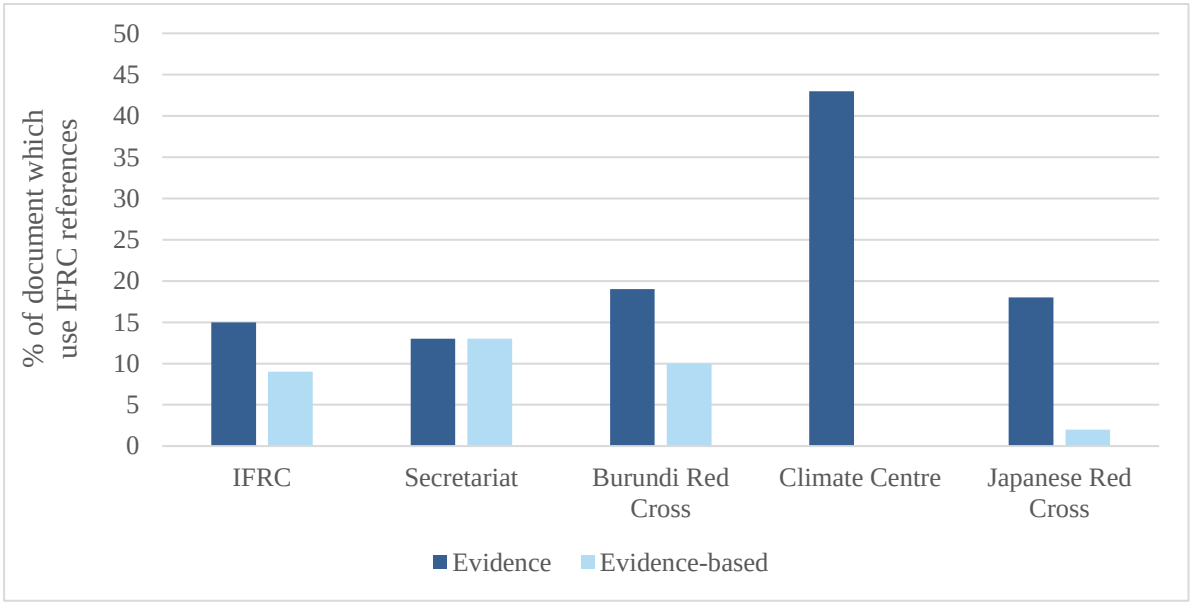

Figure 8. Percentage of documents in the sample which reference other IFRC documents.

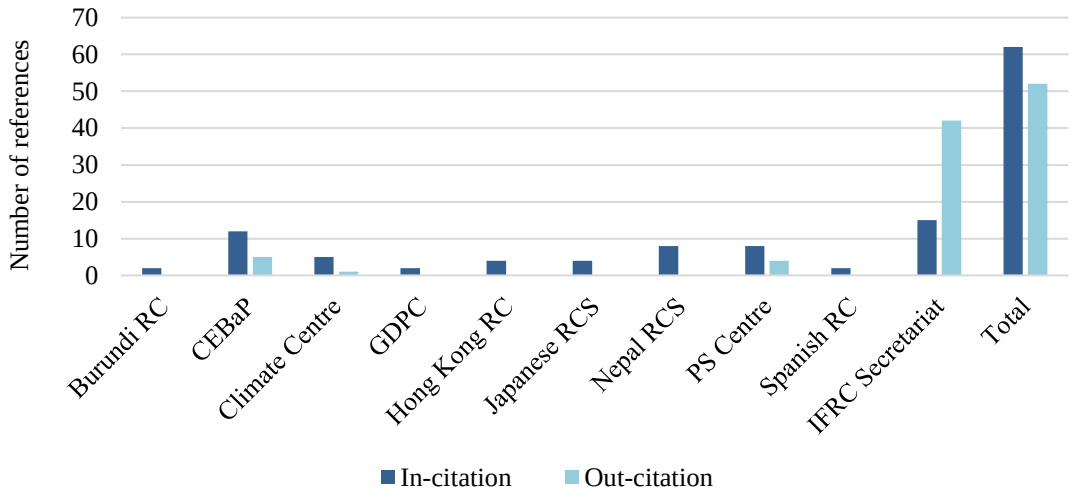

Figure 9. Inter-organisation referencing.

Table 10. Ten highest scoring Secretariat documents according to out-degree centrality, betweenness centrality and information range closeness centrality.

Out-degree centrality			
Rank	Document	Class	Out-DC
1	IFRC, *Strategic Framework on Gender and Diversity Issues (2013-2020)*, (2013)	E-b	7
2	Singh G., *Predictable, Preventable*, (2012)	E-b	5
3	Kyazz A., *Learning from the City*, (2012)	E	4
4	IFRC, *Framework for Community Resilience*, (2015)	E-b	4
5	IFRC, *The Road to Resilience*, (2012)	E	4
6	Bendimerad F., *Programmatic Directions for the Red Cross Red Crescent in Building Urban Community Resilience in the Asia Pacific Region*, (2012)	E	4
7	Vinck P., *World Disasters Report 2013*, (2013)	E	4
8	Cannon T., *World Disasters Report 2014*, (2014)	E	4
9	IFRC, *Principles and Rules for Red Cross and Red Crescent Humanitarian Assistance*, (2013)	E-b	3
10	IFRC, *Community Early Warning Systems*, (2012)	E-b	3
Betweenness centrality			
Rank	Document	Class	BC
1	IFRC, *Principles and Rules for Red Cross and Red Crescent Humanitarian Assistance*, (2013)	E-b	40
2	IFRC, *Integrating Climate Change and Urban Risks into the VCA*, (2014)	E-b	21

3	Hamza M., *World Disasters Report 2015*, (2015)	E	17
4	IFRC, *9th APC: Community Resilience*, (2014)	E	13
5	Kyazz A., *Learning from the City*, (2012)	E	11
6	Taylor N., *Urban Volunteering in South East Asia*, (2014)	E	9
7	Vinck P., *World Disasters Report 2013*, (2013)	E	6
8	Markenson D., *International First Aid and Resuscitation Guidelines 2016*, (2016)	E-b	5
9	Cannon T., *World Disasters Report 2014*, (2014)	E	5
10	IFRC, *9th APC: Climate Change and Urbanization*, (2014)	E	5
Information range closeness centrality			
Rank	Document	Class	IRCC
1	IFRC, *Strategic Framework on Gender and Diversity Issues (2013-2020)*, (2013)	E-b	0.042
2	Bendimerad F., *Programmatic Directions for the Red Cross Red Crescent in Building Urban Community Resilience in the Asia Pacific Region*, (2012)	E	0.036
3	Kyazz A., *Learning from the City*, (2012)	E	0.035
4	Zetter R., *World Disasters Report 2012*, (2012)	E	0.03
5	IFRC, *Predictable, Preventable*, (2012)	E-b	0.029
6	IFRC, *Community Early Warning Systems*, (2012)	E-b	0.028
7	Vinck P., *World Disasters Report 2013*, (2013)	E	0.026
8	IFRC, *Framework for Community Resilience*, (2015)	E-b	0.025
9	Cannon T., *World Disasters Report 2014*, (2014)	E	0.025
10	IFRC, *The Road to Resilience*, (2012)	E	0.024

Exploring other subsystems

While the findings for the global and Secretariat analysis mirror each other, we do find local variations in other subnetworks in the graph. We focus on three cases, the Burundi Red Cross, the Japanese Red Cross and the Climate Centre. The limited number of documents in each case means we cannot draw any direct comparison with citation networks in the literature but nonetheless note the high fraction of disconnected vertices and low metrics for each organisation (Table 4).

Burundi Red Cross

Document production in the Burundi Red Cross focuses on evaluations, indicating a strong practical orientation in the organisation. It is the only National Society in the sample to produce across most sectors, though focus on DRR and health is maintained (Tables 5a and 5b). Nonetheless, it produces 40% of culture of non-violence and peace documents in the

sample, an unsurprising value given the country's recent history. The Burundi Red Cross is also notable for the high proportion of volunteers involved in evidence production, which contrasts with the third of authors who are consultants (Table 11). Discussion with Secretariat staff highlighted that National Societies with limited means regularly receive donor funds to hire consultants for the evaluations of specific projects. This is a way for them to economise precious staff time and resources while quickly satisfying donor requirements. What is regrettable is the lost opportunity to builds skills and knowledge within the organisation. This logic of economy also explains the use of volunteers in data collection (Table 6).

Japanese Red Cross

The Red Cross in Japan is structured around several organisations, with the specific mandate of each creating a division of labour among them. The organisation's Nuclear Disaster Resource Centre produces frameworks and research on nuclear disaster preparedness, Red Cross Colleges of Nursing carry out medical research and contribute to health activities, and its Institute for Humanitarian Studies produces research published in its own peer-reviewed journal. Finally, the Japan Red Cross itself carries out operational activities and produces evaluations and advocacy. The documents in this network mostly cover the area of DRR, more specifically, the triple-disaster which hit Japan in 2011, while remaining pieces, mostly health documents, are framed by this cataclysm (Table 5b). Although the costs of establishing and maintaining such a diverse network are high, the division of labour among its different components results in a highly knowledgeable and skilled subnetwork.

Climate Centre

As Reference Centre, the Climate Centre has the mandate of studying and supporting National Society activities around a specific topic. Accordingly, 94% of Climate Centre documents cover the sector of DRR and are either frameworks or research (Tables 5a and 5b). The research it produces is rigorous, with a third of it being published in open-access peer-reviewed journals and another two pieces produced with academics (Table 11). This enables it to produce high quality evidence which it then disseminates throughout the IFRC in more accessible formats. Despite this strategy, none of them are cited by National Societies in the sample and only one reference is made by the Secretariat. Discussion with Climate Centre staff revealed that the organisation interacts extensively with National Societies through face-to-face capacity-building activities, many of which are recorded in the documents analysed. These National Societies were not, however, included in the study. One can expect that, had they been included, references to these materials would be found. But to what degree remains an open question, one which reflects more on the culture of evidence use in the IFRC than on the quality of Climate Centre materials.

The organisations examined above have highly focused research interests and activities but show significant variability in document production strategies. These result from the

contextual factors which nudge and incite organisations to prioritise specific issues, and adopt precise strategies and responses, which will be discussed in more detail in the following part.

Table 11. Distribution of authors by organisation.

Network	IFRC authors	Academics	Consultants	Partners
IFRC	0.55	0.15	0.25	0.05
Secretariat	0.54	0.15	0.31	0
Burundi RC	0.67	0	0.33	0
Climate Centre	0.7	0.3	0	0
Japanese RC	0.75	0	0.08	0.17

Discussion

The findings demonstrated that the structure of referencing among IFRC documents fits a scale-free pattern. Despite the effectiveness of scale-free structures in concentrating and redistributing knowledge and evidence, a finer analysis showed this redistribution lacks direction. On the one hand, citations appear to follow Least Effort more than authority or preferential attachment. Academic papers produced by Reference Centres, for instance, are not cited by National Societies, unlike the more readable, and more widely promoted and applicable *World Disasters Report*. Frameworks get cited because they provide practical information which can be directly used by National Societies with little interpretation and discussion. The higher rate of referencing within organisations also follows Least Effort; it is easier to access one's own materials, which will respond to the problems at hand, than to use texts produced in a foreign language for a global audience.

The relation to a power-law is that Principle of Least Effort will lead to the prominence of few documents which are regularly cited because of their accessibility – in terms of retrieval, readability and practical use – and applicability to diverse operational contexts or, for National Society materials, their contextual relevance (Ferguson 2005: 48-49). National Societies seek maximum payoff and avoid the costs and risks of translation. Organisations thus cite their own materials most with few Secretariat documents providing inter-organisation links, leading to the fractal nature of the network. On the other hand, referencing between National Societies and the Secretariat occurs far more than referencing across National Societies. A preferential attachment to Secretariat documents is clearly operating. We can consider Secretariat documents get cited as they structure National Society activities and would therefore hold authority because they originate from the IFRC's coordinating organism. Secretariat research exemplifies this since it is expected to be more reliable as well as being generalisable. Its frameworks and policies, furthermore, set standards and promote processes in the IFRC. Preferential attachment emerges not as a sign of quality but of origin. While National Societies have their own strategic priorities, the Secretariat provides

overarching principles which guide their work. Inter-organisation links then form mostly between the Secretariat and peripheries, with little communication among the latter, again structuring the network in a fractal manner.

While the rich get richer in both cases, the underlying mechanisms are quite different (Adriani and McKelvey 2009: 1058). Yet there is no reason one mechanism need exclude the other, particularly since authority here seems to be based more on institutional origin than quality. The two principles meet in that referencing Secretariat materials, as a source of authority, is a facility for National Societies in justifying their choices and promoting their activities to the wider network and donors. The coexistence of these two mutually reinforcing mechanisms suggests that the transparent and reflexive use of evidence is a relatively weak motivator in referencing evidence documents. We therefore recommend incentivising more rigorous evidence use in the humanitarian sector to compensate Least Effort and authority.

We did not question citation practices in this article. How many references are empty? How many references are copied without consulting original texts? How idiosyncratic or over-generalised are the references made? Conversely, how often are sources not cited? As seen above, the variance in reference use is extremely high, with just over half the documents in the sample lacking any citations. Suffice to say, lack of transparency and rigour weakens any evidence-base.

Just as ‘knowledge management is first and foremost a people issue’ (Lammers 2009: 128), we see how evidence production and use is also, first and foremost, a people issue. In this regard, several problems have already been identified within the IFRC, where evidence production is regularly outsourced to external consultants and academics, sometimes poorly practiced and seldom seen as a productive investment (Corboz 2015: 12). Limited reference to research is a logical consequence of this sceptical approach to evidence. The segregated nature of evidence and document production reflects organisational silos; communication between research interests is limited (Mohamed 2012: 13-14), leading to the clustering of materials by thematic sector and type. This is compacted by the ad-hoc nature of evidence production which impedes the capitalisation of cross-cutting interests and thematic sectors (Corboz 2015: 12). This partly contributes to the high number of disconnected documents in the sample which fail to use and contribute to existing research, and further distances the IFRC document-base from developments in the sector.

In an ideal evidence-based network, we would expect evidence-based documents to cite evidence documents more than they cite each other. An evidence-based approach effectively requires working with both practical knowledge, and the framing and evidence which supports it. We would expect similar referencing proportions among evidence documents; evidence must build on itself more than on evidence-based materials. The latter, however, is important in guiding research strategies so must not be omitted. In terms of graph metrics, we

would expect a much higher average degree, the mean number of references between documents, and clustering coefficient, a measure of the extent of co-referencing between documents. These properties would be reflected in higher graph density and average path length. Finally, a much lower, possibly null, number of disconnected documents would be found. The IFRC now has a baseline to evaluate, indeed measure, the effects of its efforts in knowledge management.

The sub-systems examined here illustrate how different approaches are taken to address challenges in compiling evidence. The Climate Centre, for instance, produces a high degree of academic work to ensure quality findings are distributed to National Societies. The Japanese Red Cross achieves a high degree of in-house expertise by dividing document production between specialised organisms. Finally, focus on programming leads evidence production in the Burundi Red Cross to concentrate on evaluations. The Principle of Least Effort has been offered as key mechanism to explain how, despite adopting context-based strategies, uptake by National Societies of their own evidence remains low, as does its use by the Secretariat. This included highlighting how the cultural disincentive against producing and using evidence within the IFRC limits greater uptake of evidence. This, however, is only part of the picture; we expect these problems to be shared by other humanitarian organisations.

At this broader scale, issues around organisational culture largely concern financial obstacles and limited time available to staff. In effect, 'many organisations find themselves pressed by the urgency of day-today operations, maintaining a focus on the here and now' (Ferguson 2005: 47). Reflection on the quality of evidence and its use become background issues most practitioners don't feel they have the liberty to consider. The challenges of working across territories and cultures is another issue. We find here language barriers and educational differences, both of which affect the quality of evidence produced and its uptake by practitioners (ibid: 48). The effort in interpreting and adapting research from different contexts thus becomes another obstacle in the uptake of research findings.

We thus return to Least Effort; the obstacles and pragmatic considerations both practitioners and researchers face oblige them to adopt time- and energy-saving strategies. Hierarchical solutions are ill-adapted to complex problems such as this. Rather, it is preferable to target the smallest scale possible to minimise effort and enable results produced to become self-generative (Barnes et al. 2003: 277-278). This requires a variety of strategies to nudge and incentivise better evidence production and use at source. It is not only aid organisations who need to operate this shift but also their partners, donors, governments – in short, all major actors in the humanitarian evidence supply-chain.

Conclusions

We have demonstrated that the structure of referencing in the IFRC document-base is hierarchically structured in a manner which is effective at concentrating and redistributing knowledge and evidence. Analysis of the content and direction of references showed a limited uptake of research evidence by evidence-based pieces, namely policy documents. We also found that the transparency and rigour of evidence produced could be greatly improved, further undermining the strength of the IFRC evidence-base, an issue it is now addressing. We therefore hope to carry out more extensive analyses to get a more accurate understanding of the network and how to influence it.

Citation practices in aid organisations have yet to be studied. We hope this article is a first step. First, we have provided a method and metrics for other organisations to analyse their own document-base. In this manner, the metrics can be used to set baselines, define targets and track progress. Second, we hope this will lead to new case studies which can then be compared to draw valid conclusions for the whole sector. Major questions nonetheless remain. What structure of citations are desirable – and feasible? What approaches and incentives can lead us there? How to track changes in a document-base as they happen? Regardless of the solutions chosen, developing more adapted approaches to evidence will require willingness to step out of comfort zones, take risks and focus on long-term outcomes.

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