

Interactive comment on “Interdependence and dynamics of essential services in an extensive risk context: a case study in Montserrat, West Indies” by V. L. Sword-Daniels et al.

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Authors response for “Interdependence and dynamics of essential services in an extensive risk context: a case study in Montserrat, West Indies” by V. L. Sword-Daniels et al. Authors response on Nat. Hazards Earth Syst. Sci. Discuss., 3, 1025, 2015.

OVERALL RESPONSE We would like to thank the reviewers for their thoughtful and constructive comments on this paper. We have decided to make changes to the manuscript to take account of these suggestions for improvement. We have responded to each comment point-by-point below, and described our changes to the manuscript

C247

in order to address each of these. We believe that these changes have improved the manuscript.

Anonymous Referee #1 Received and published: 18 February 2015

The manuscript is of scientific significance and has likewise a sound empirical basis, a promising research approach, and some interesting new ideas. It is properly organized and well structured. But nonetheless some improvements could enhance the paper.

(1) Due to the long duration of the hazard presented, there are some specific limitations of the case study that need to be reflected upon. The volcanic activity in itself is not a totally surprising event, but rather it is a “long-duration volcanic hazard context.” The bespoken recurring heightened volcanic activity is highly probable and even anticipated in routine periods where there is an absence of volcanic activity. Therefore “hidden” volcanic relationships might be already implemented in the non-volcanic general relationships.

RESPONSE (REFEREE #1, COMMENT 1) This is a good point, which is echoed in a slightly different way by referee #2 (point 2). ‘Volcanic’ and ‘general’ relationships may not be mutually exclusive in this context, and as a result we have considered these relationships as differentiated based on whether they are ‘active’ (or visible) in the presence and absence of volcanic activity (i.e. implicitly general relationships are not considered to be relationships that are detached or wholly independent from the volcanic context). However, the distinction between the two typologies makes a useful framework for analysis of those relationships that ‘emerge’ or ‘become visible’ during heightened volcanic activity. This allows some interpretation of which relationships are more frequently used or active during times of low volcanic activity, and in times of heightened volcanic activity.

To address this point, we have clarified the text so that it is clear to the reader that non-volcanic (general) relationships may indeed have hidden volcanic relationships within this long-duration eruption context Section 5.1 (page 10, lines 11-17). Further, in Sec-

C248

tion 5.1 (page 10, lines 18-19) we have changed the sentence starting 'Volcanic refers to the relationships that exist in heightened volcanic activity...'. The word 'exist' (used twice in this sentence when describing volcanic and general relationship types) has been changed to 'become active (or visible)' in the first usage, and 'are active' in the second occurrence in this sentence, for improved clarity.

(2) The focus on relationships between sectors indiscriminate of their relevance and performance, is a weakness and ought to be considered in more detail. The relationships are not only minor interconnections, rather some of them represent "essential services" for the relevant communities. If one does not focus on differentiating the respective relevance of essential services, those being really essential at all times, such as healthcare, are treated equally as relationships which could be suspended in volcanic periods without major harm (education). Which relationships are essential and which can be suspended? Even if said relationships persist in times of volcanic activity their performance might be decreased. Hence how emerging relationships might have a considerable reduced performance and so on.

RESPONSE (REFEREE #1, COMMENT 2) We agree, this is a valid and important point. Not all relationships are equal and not differentiating relationship importance or significance across the network is an important limitation to this study. Yet to address differentials in relationship significance across the network would require a detailed analysis of context-specific data in order to provide an interpretation that has real meaning. To aid interpretation this would also require a wider study of the impacts of disruption on society, which was beyond the scope of this research (due to time and resource restrictions). As a result, within the scope of this article we have not attempted to differentiate relationship importance.

We have addressed this comment by clearly stating that considering relationship importance (or significance), including the impacts on wider society, is an important consideration, and is a limitation of this particular study in the discussion (Section 6, page 13, lines 22-23, 39-40), we have also described the detail that would be required to in-

C249

terpret relationship significance here (Section 6, page 13, lines 37-42). We have clearly stated the boundaries of this study (i.e. focus on essential services and not detailed consideration of interactions with wider society) (Section 4, page 6, lines 24-29), and re-stated this in the discussion (Section 6, page 13, lines 23-27). We have highlighted this aspect as an important avenue of further enquiry, both here in the discussion, and in the conclusions (Section 7).

To further improve the manuscript, we have added some examples to demonstrate some variations seen in relationship importance (Section 6, page 13, lines 28-37), to give a sense of where a sector has a significant impact on the function of other essential services and on wider society, and where disruption may be non-critical.

(3) Some changes in categories and terms ought to be considered so as to improve the clarity. Analysing social relationships (as defined in the manuscript: "Influence that one service may have on societal factors such as public opinion, public confidence, or cultural issues that cause an effect in another infrastructure") with a sole focus on organizations and infrastructures without taking the general public into account runs the risk of missing essential relationships.

RESPONSE (REFEREE #1, COMMENT 3) We agree, the 'societal relationship' category requires further clarification.

We have clarified the 'social relationship' category by moving reference to Pederson et al's (2006) description of their 'social' category to describe their approach alongside description of Rinaldi et al's (2001) framework for context. This is now at the end of paragraph 1, Section 5.1, page 9, lines 23-25.

We have added text to state the boundaries of this study, and that the sole focus on organisations and infrastructure systems here is a limitation (Section 5.1, page 9, line 26-28), as public opinion, public confidence and cultural issues as described by Pederson (2006) cannot be addressed within the scope of this study.

C250

With the description of 'societal' types of relationship by Pederson (2006) removed from our description of the 'social' category used in this context (Section 5.1, page 10, lines 3-7), this is now a clear reflection of the ways in which our data has been analysed, using the data that we have available from our bounded organisations and infrastructure system study (i.e. not including the general public).

Anonymous Referee #2 Received and published: 4 March 2015 The article is extremely well structured. Methodology and case study context are thoroughly described, therefore the research aim and results are comprehensible. Thank you for that. With respect to the results and discussions I have a few comments that you might want to take into account:

1. The types of interdependencies that you introduce are of a qualitative nature, for example in your description of the typology you argue in a qualitative way why you chose those five. Your results however are mainly derived from quantitative analysis of occurrences. This implies that all relationships are of the same importance or relevance which is highly unlikely.

RESPONSE (REFEREE #2, COMMENT 1) To analyse the data we felt it important to try to draw out some mechanisms for comparison across the network. The data is qualitative, yet the number of connections and complexity of relationships means that simplification through classification and numerical analysis of relationships by type, lends explanatory power to this complex network. Our approach to this is to both qualitatively describe and provide a classification system for analysis of relationships types, as well as to quantitatively 'count' the relationships within each category to draw out important inferences from this data. However, this analysis is limited in not differentiating the importance or significance of relationships. We agree that not all relationships are equally important to the function of the network as a whole, or indeed to society. This is an important limitation to this study.

As with point (2) made by referee #1, we have addressed this comment by clearly stat-

C251

ing that not considering differentials in relationship importance/strength/significance is a limitation of this particular study (Section 6, page 13, lines 37-40). We have also added that the boundaries of this study do not include wider society (Section 4, page 6, lines 27-29) and (Section 6, page 13, lines 23-24), and that the inclusion of the impacts of relationship disruption on the general public is needed to help to qualify and differentiate relationship importance, in order to provide interpretation that has real meaning (Section 6, page 13, lines 37-42). We have highlighted in the discussion (Section 6, page 13, lines 39-40), and in the conclusions (Section 7, page 15, lines 29-34), that analysis of relationship significance is an important avenue of further enquiry for future studies (and one that requires in-depth and context-specific analysis).

2. You might give more thought to the connection between general and volcanic relationships. The concept of sleeping links is mentioned in the article but there is no discussion on how that refers to the method of mapping that you apply yourself. Furthermore, especially with informational relations these usually rely on a communicative routines. Whether any relationship can be treated as a link existing only during volcanic activity needs to be explained.

RESPONSE (REFEREE #2, COMMENT 2) In a similar way to point (1) made by referee #1, we have addressed this comment by more clearly wording the text to clarify that 'volcanic' relationships may in fact be dormant, or in some way implicit within 'general' relationships (i.e. do not solely exist during volcanic activity), and that these two typologies may not be wholly independent in this hazard context Section 5.1 (page 10, lines 11-13). We have included in the manuscript clearer wording to highlight that even with our in-depth qualitative approach to data gathering, implicit links may remain unidentified and therefore not fully represented in the data (Section 4.1, page 7, lines 22-27). We have also highlighted this limitation referring specifically to our methodological approach and the data-capture for 'sleeping links' (Section 6, page 13, lines 14-21), as although we believe that data capture is much improved by adopting such an in-depth approach, some sleeping links may indeed remain 'invisible' in data collection

C252

until they are enacted.

3. If I understand you correctly, you argue that the need for coordination increases in crises (which is a common observation) and therefore the corresponding linkages are needed. But the dominance of informational and organisational linkages in a stressed state could easily be explained as an artefact of the data collection as during the interviews general communicative processes are not mentioned because they are a matter of course and therefore implicit. Maybe you could counter this expectable objection somehow.

RESPONSE (REFEREE #2, COMMENT 3) Thank you for this comment. We acknowledge that conversation tends to focus on 'obvious' rather than 'implicit' relationships. We took measures to reduce this inherent bias where possible, by directly seeking details of relationships in existence during 'normal' (low volcanic activity) times, as well as seeking functional descriptions of these relationships (for further validation, and to draw out more of these 'everyday' connections). Additional relationships are identified from secondary documents also (termed 'implicit relationships'), as described in the text (Section 4.1, page 8, lines 1-8), which provides further triangulation. However, we acknowledge that despite efforts made in this regard, participants may still neglect to mention some implicit/matter-of-course relationships, as you rightly point out. To address this comment, we have now stated explicitly that we sought relationship data in times of low-volcanic activity as well as in heightened volcanic activity (Section 4.1, page 7, lines 22-23). We have discussed this approach as a mechanism employed to minimise the potential bias in participants' reporting of relationships that are more 'obvious' during data collection, yet we add an acknowledgement in the text that some implicit relationships may not be fully represented as a result of this bias (Section 4.1, page 7, lines 23-27). We have added a sentence following the description of secondary data sources to highlight that this secondary data augments the qualitative data from interviews and focus groups (Section 4.1, page 8, lines 8-9). This text is added in order to draw attention to the design of data collection, using secondary data

C253

in order to supplement the dataset to supplement and minimise any effect of 'reporting bias'.

Please also note the supplement to this comment:

<http://www.nat-hazards-earth-syst-sci-discuss.net/3/C247/2015/nhessd-3-C247-2015-supplement.pdf>

Interactive comment on Nat. Hazards Earth Syst. Sci. Discuss., 3, 1025, 2015.

C254