SUPPLEMENTARY MATERIAL: Business experience of floods and drought-related water and electricity supply disruption in three cities in sub-Saharan Africa during the 2015/2016 El Niño

Kate Elizabeth Gannon[1]*, Declan Conway[1], Joanna Pardoe[1], Mukelabai Ndiyoi[2], Nnyaladzi Batisani[3], Eric Odada[4], Daniel Olago[4], Alfred Opere[4], Sinah Kgosietsile[3], Mubita Nyambe[2], Jessica Omukuti[4], Christian Siderius[1,5]

[1] Grantham Research Institute on Climate Change and the Environment, London School of Economics, Houghton Street, WC2A 2AE, UK k.e.gannon@lse.ac.uk;

[2] University of Barotseland, Mongu, Zambia;

[3] The Botswana Institute for Technology Research and Innovation, Gaborone, Botswana;

[4] The African Collaborative Centre for Earth System Science, University of Nairobi, Chiromo Campus Riverside Drive, Nairobi, Kenya;

[5] Wageningen Environmental Research, WUR, 6708 PB, Wageningen, The Netherlands

The Research Design

This paper employs a mixed-method design, which develops understanding of business experience of El Niño associated hydrological disruption through multiple lines of enquiry. We adopt an approach based on the paradigm of pragmatism, which enables the research to deliberately avoid polarizations around the quantitative vs qualitative, positivist vs constructionist debates, and to benefit from the strengths of both approaches[1–3]. Hydrological responses, observed through in-situ and remotely sensed time-series of precipitation, river flow and lake levels, provide physical insights to impact pathways and shape a more coherent understanding of social interactions with the resulting resource disruption. Quantitative and qualitative data outputs from the social research component allow quantification, while prioritising depth and detail. The approach retains sufficient flexibility to permit the emergence of unanticipated findings and to allow research informants to construct a meaningful characterization of their experience of El Niño associated disruption and its challenges for their business. This supplementary material clarifies the methodological features of the social research component of the overall research design.

Key informant interviews

As detailed within the main text, to guide the design of the MSME survey and to contextualise and triangulate MSME perceptions of the El Niño event, key informant interviews were conducted in each case study country among actors in positions of leadership, responsibility and oversight with respect to preparing for and managing El Niño related impacts, including among businesses. Recruiting participants topic-blind has been advanced as a means of avoiding unintended framing effects in environmental research. However, such approaches are not easily reconciled with the ethical research criterion of informed consent. Thus, in this research, the general remit of the research and its aims were detailed to informants at the start of the interview, yet care was taken to present this information in as neutral and non-directive a format as possible. Making participants aware of the broad research objectives created the opportunity for the respondents themselves to direct discussion towards avenues that they deemed to be especially important. As such, this approach was compatible with a more flexible interview design, which can help ensure that, as far as possible, participants are able to define the issues, reflect their own priorities and shape the interview agenda themselves. This is in contrast to a pre-determined and fixed interview protocol which presumes that researchers have the greatest knowledge of what questions need to be asked and in what form [4,5].

To balance the desire for a less structured approach to research interviews, with the need to provoke discussion and to ensure that the interviews would help explicate the research questions, a semi-structured, rather than unstructured, interview approach was pursued. Questions were intended to serve as entry points into the discussion, but not be definitive of the format of the interview. The interview protocol therefore served as a rudimentary guide for the researchers, rather than as a prescriptive schedule. Which questions were asked, in which way and in what order also varied. And participants were encouraged to intervene in lines of questioning if they felt alternative avenues could prove more fruitful. More open lines of questioning were pursued first[6,7], as researchers sought to gain an understanding of participant's engagement with El Niño within their own frame of reference[8–10]. As well as building trust, respect and reciprocity between the researcher and researched, such an open approach can strengthen the research process by encouraging greater cooperation[11] and potentially by taking the research in new and more meaningful directions. When more general avenues of enquiry had been exhausted, more specific and focused lines of questioning often followed. Care was taken to ask questions in as neutral a format as possible, however, audio-recording and transcribing the interviews offered the opportunity to reflect on any ways in which the research team may have unduly influenced or framed a response. Because the questions were not fixed, themes could be adapted to accommodate diverse entry points into thinking about the research subject, with participants who experienced diverse relationships with the topic.

As is common in social research, key informants were sampled through a combination of purposive and snowball sampling strategies. Informants from pertinent professional groups were identified at the outset of research. These initial informants were then asked to suggest other potential respondents, often including participants who they anticipated may have different perspectives and experiences to their own. Particular effort was made to sample informants who were frequently mentioned by other participants. The final sample was comprised of members of local and national government departments, NGOs, consultancies, business and industry associations and relevant local university departments. The key informant interviews prioritised depth of insight. Nevertheless, in this research we also present a large sample of interviews, which offered good opportunity for comparison, for cross-checking insights and for triangulating ideas and concepts[12].

As a research method that seeks to be open and sensitive to the empirical data, without forcing it to 'fit' pre-conceived theory or concepts, a grounded analytical strategy was adopted[13]. This involved iterative coding phases and concurrent constant comparison analysis, through which the data were repeatedly compared, contrasted, interpreted and reinterpreted to develop and refine themes emerging from the interviews pertaining to the research questions[14]. The final coding schedule was structured around five main categories: Impacts; responses; warnings and climate information; confounding and compounding factors; and references to other extreme/El Niño events. The corpus of interviews reached a degree of thematic and theoretical saturation, since, broadly speaking, new themes stopped emerging from the data with the addition of new interviews.

Survey of Micro, Small and Medium Enterprises (MSMEs)

The survey administered to micro, small and medium enterprises had quantitative and qualitative components, structured through a range of open and closed questions. To increase comparability, some of these questions were informed by earlier survey tools [e.g. 15,16]. The questionnaire was piloted, following which small adjustments, for example in the language used, were made to the survey instrument, to ensure that in the collection of objective information – such as the number of power outages a business had experienced – all respondents had the same understanding of what was to be reported. However, the qualitative components of the survey were designed to be more open-ended,

and to avoid implying a particular style of response is required, which could prematurely close down participants' responses. Indeed, in some instances a degree of ambiguity in the open-ended questions was permissible, helping to increase the opportunity for participants to be able to react to questions on their own terms and to provide more meaningful accounts. As in the case of the key informant interviews, these qualitative survey components were designed to provide opportunities for participants to raise their own agenda through the survey and to signal personally salient experiences and insights, that we might not otherwise have known to ask about [c.f. 5].

Reflecting the key informant interview design, the MSME survey first sought to pursue more general lines of questioning that would 'set the scene' for analysis. As such, to allow for a more realistic assessment of the degree of importance MSMEs afforded different challenges, at the start of the survey MSMEs were asked more general questions about their business and the challenges they faced in their business environment. Only then were they asked more specifically about their experience of climatic events and of water supply disruption/electricity supply disruption/flooding. Equally, information sheets provided to participants at the start of the research, to share contact details of the research team, did not reference El Niño, climate or water/electricity supply disruption/flooding directly, to avoid framing the research around particular issues early in the interview process. With the same aim, the survey was enumerator administered, to ensure that participants did not have the opportunity to skim the entire survey – and then become unduly influenced by later questions – before answering these early questions.

Enumerators were also trained to take care to minimise these framing effects with respondents in the early stages of respondent recruitment and questioning. Indeed, to increase consistency within the data set more broadly, enumerators participated in day-long training sessions on the aims and administration of the interview protocol. This also included training on the scope of the study, and the design of the survey tool, as well as on sampling, processes of consent and how to record both closed-ended questions through codes, and qualitative data in response to more open-ended questions. Feedback from the teams following these training sessions and from their initial piloting of the survey, was instrumental to refining the survey tool and this training also allowed enumeration teams in each country to demonstrate a methodical and consistent approach to data collection. Nevertheless, in order to identify any inconsistencies, gaps or instances of enumerator error, the research teams also went through the survey line-by-line and sought clarification from enumerators where necessary.

Through administering the surveys, the enumerators inevitably had potential to attain a greater qualitative understanding of business experiences of load shedding/water supply disruption/flooding than could be accessed from the survey results alone. Recognising this, we also encouraged the enumerators, most of whom were educated to Masters level in related disciplines, to act more broadly as researchers and to record their own qualitative reflections, to 'fill in the gaps', to help us to understand why the respondent may have answered the questions on the survey in the way they did. This additional interpretative insight was collected alongside each survey, however, enumerators also completed their own post-enumeration survey; the responses of which were used to triangulate themes, alongside the qualitative data from the key informants and the survey itself.

Because of the diverse nature of MSMEs, in order to examine country specific consequences of El Niño and to gain broader overall insight into the scope of El Niño impacts, in this research we selected nationally salient sectors of the economy to survey. Selection criteria included anticipated exposure to disruption, contribution to the national economy, importance to national economic strategic direction and contribution to female employment. Across sub-Saharan Africa, agribusinesses make important contributions to GDP and to the region's value added in manufacturing and services[17]. Estimated to contribute around 20% of GDP to the Zambian economy[18] and 26% to the Kenyan economy[19], agribusinesses therefore formed the primary focus of the sample in Lusaka and Nairobi.

In Lusaka, this sample was supplemented by a number of other processing, retail and trade businesses, while in Nairobi, MSMEs within the transport sector were also included. Although still very important to the livelihoods of the rural poor, agriculture makes a more limited contribution to GDP in Botswana. Here the service sector was prioritised, and – since tourism is believed to be one of the most important avenues for achieving the national priority of economic diversification and makes a large contribution to service exports[20,21] and female employment[22] – accommodation and hospitality industries were given particular consideration. Final sector selection was informed by key informant interviews, as well as literature review.

Surveys were conducted in August 2016 in Lusaka, in September 2016 in Nairobi, and in November 2016 in Gaborone. As specified in the main paper, in the time available to allow near-real time consideration of MSME experience of disruption, in Nairobi it was not possible to obtain a suitable list of businesses to derive a true random sample. Enumerators therefore developed a sample frame of businesses in different areas of the city, to achieve a good geographical distribution. In Botswana, we sampled MSMEs from a list of accommodation enterprises obtained from the Department of Tourism as well as from a list of hair salons and restaurants obtained from Gaborone City Council. In Zambia, a list of eligible agribusinesses was obtained from the Central Statistics Office (CSO), as well as a list from the Patents and Companies Registration Agency (PACRA). Because of the dependence on sample frames from government agencies, in Botswana and Zambia, businesses surveyed in this research reported operating within the formal sector. Economies in sub-Saharan Africa are typically characterized by a small number of medium and large enterprises and a large number of micro and small enterprises[23] and our sample broadly reflected this structure.

References

1. Creswell JW, Plano Clark VL. *Designing and Conducting Mixed Methods Research, 2nd Edition*. London, UK: SAGE Publications; 2011.
2. Gage NL. The Paradigm Wars and Their Aftermath A "Historical" Sketch of Research on Teaching Since 1989. *Educational Researcher*. 1989;18(7):4-10. doi:10.3102/0013189X018007004.
3. Tashakkori A, Teddlie C. *Mixed Methodology: Combining Qualitative and Quantitative Approaches*. London, UK: SAGE Publications; 1998.
4. Oliver M. Changing the Social Relations of Research Production? *Disability, Handicap & Society*. 1992;7(2):101-114. doi:10.1080/02674649266780141.
5. Shanklin E. When a good social role is worth a thousand pictures. In: Wagner J, ed. *Images of Information*. Beverley Hills, CA: SAGE Publications; 1979:139-145.
6. Johnson JC, Weller SC. Elicitation Techniques for Interviewing. In: Gubrium JF, Holstein JA, eds. *Handbook of Interview Research*. London, UK: Sage; 2001.
7. Krueger RA, Casey M. *Focus Groups 3rd Edition: A Practical Guide for Applied Research*. London, UK: Sage; 2000.
8. Bostrom A, Morgan MG, Fischhoff B, Read D. What Do People Know About Global Climate Change? 1. Mental Models. *Risk Analysis*. 1994;14(6):959-970. doi:10.1111/j.1539-6924.1994.tb00065.x.
9. Mertens DM. *Research and Evaluation in Education and Psychology*. London, UK: SAGE Publications; 2015.
10. Ponterotto JG. Qualitative research in counseling psychology: A primer on research paradigms and philosophy of science. *Journal of Counseling Psychology*. 2005;52(2):126-136. doi:10.1037/0022-0167.52.2.126.
11. Chambliss D., Schutt R. *Making Sense of the Social World: Methods of Investigation, Fifth Edition*. London, UK: SAGE Publications; 2016.
12. Tongco MDC. Purposive Sampling as a Tool for Informant Selection. *Ethnobotany Research &*

Applications. 2007;5:147-158. doi:http://hdl.handle.net/10125/227.

13. Birk M, Mills J. *Grounded Theory: A Practical Guide*. London, UK: SAGE Publications; 2011.

14. Charmaz K. *Constructing Grounded Theory*. London, UK: SAGE Publications; 2006.

15. World Bank Group. Enterprise Surveys. http://www.enterprisesurveys.org. Published 2017. Accessed March 22, 2017.

16. Scott A, Darko E, Lemma A, Rud J. How does electricity insecurity affect businesses in low and middle income countries? *Overseas Development Institute Report*. 2014;(July).

17. Chikwama C. *Agriculture and Growth: Agriculture and Growth Evidence Paper Series*.; 2014. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/321107/Agri-growth1.pdf.

18. World Bank. Agribusiness Indicators: Zambia. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/26224. Published 2012.

19. World Bank. Agribusiness Indicators: Kenya. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/16669. Published 2013.

20. Jefferis K, Sejoe S. *Economic Review, Second Quarter April-June 2016, Econsult Botswana*. Gaborone, Botswana; 2016. http://www.econsult.co.bw/tempex/file/Econsult Review 2016 2nd Quarter.pdf.

21. Botswana Government. ECONOMIC DIVERSIFICATION DRIVE: Medium to Long-Term Strategy, 2011-2016, Ministry of Trade and Industry, July 2011. 2011. https://unfccc.int/files/adaptation/groups_committees/adaptation_committee/application/pdf/20151002_botswana.pdf.

22. van Klaveren M, Tijdens K, Hughie-Williams M, Martin NR. An Overview of Women's Work and Employment in Botswana. Decisions for Life MDG3 Project Country Report No. 5. 2009. http://adapt.it/adapt-indice-a-z/wp-content/uploads/2014/09/klaveren_-tijdens_-williams_-martin_2009.pdf.

23. Crick F, Gannon KE, Diop M, Sow M. Enabling private sector adaptation in sub-Saharan Africa. *WIRES Climate Change*. 2018;9(2).