

# Counterfactual Black Swans Workshop Summary Report

Hosted at Nanyang Technological University August 26-27, 2019

Workshop organizers: Yolanda Lin, David Lallemant, Susanna Jenkins



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#### **Executive Summary**

On the 26-27<sup>th</sup> of August 2019, twenty-eight researchers gathered from six countries for the first workshop dedicated to applying downward counterfactual thought in identifying extreme events to add to hazard catalogues. From October 2018 and leading up to the workshop, a team of researchers at NTU in the Asian School of the Environment (PI Dr. Susanna Jenkins, co-PI Dr. David Lallemant, and Dr. Yolanda Lin) had been developing a new framework that is specifically designed to identify events with the potential for disproportionate catastrophic consequences that may be missing from a past catalogue of events.

During this interactive and hands-on workshop, participants applied their subject matter expertise through a counterfactual lens in order to develop a number of case studies using this framework to uncover black swans in Singapore and beyond. The workshop consisted of nine presentations including an overview of the downward counterfactual methodology, counterfactual case studies, and related methods. We also created fifteen new counterfactual events through the Counterfactual Round Table session, and had many thought provoking discussions during multiple breakout sessions. Workshop participants were afforded a large degree of agency throughout the workshop – from direct involvement in setting the agenda for Day 2's open discussion sessions, to self-organizing around emerging ideas and projects over the course of the workshop.

Over the course of our many discussions, we identified a number of concrete outputs from this workshop. They include:

- A **special issue** journal on counterfactual thinking in hazard and risk analysis
- Producing public facing material, including multiple **blog posts**, **short videos**, **newspaper articles**, and other forms of non-academic outreach.
- Future proposal(s) around identifying large, complex problems, with early stakeholder involvement, that could bridge across multiple traditional discipline lines. We also discussed formalizing the analytical methods in more depth, studying black elephants (with levers for change to grey swans) on different time scales (10 year, 50 year, 100 year), a counterfactual events database, oral histories, and more.
- Building community through convening sessions at **upcoming conferences**, specifically, UR2020 and Cities on Volcanoes.
- Developing a **counterfactual toolkit hosted online** made readily available to researchers in this new counterfactual community, including key literature, methods, and facilitation materials, such as those from the Counterfactual Round Table exercise.

The Counterfactual Black Swans Workshop provided the groundwork necessary to establish and sustain a new community of research around counterfactual thinking in risk analysis, and we look forward to the progress on these outputs and emergent projects moving forward.

## 1. Introduction to the Counterfactual Black Swans Workshop

The Counterfactual Black Swans Workshop was hosted at Nanyang Technological University (NTU) on 26-27 August 2019. The workshop brought together over two dozen leaders in hazard and risk assessment, from across 6 different countries.

From October 2018 and leading up to the workshop, a team of researchers at NTU in the Asian School of the Environment (PI Dr. Susanna Jenkins, co-PI Dr. David Lallemant, and Dr. Yolanda Lin) had been developing a new framework that is specifically designed to identify events with the potential for disproportionate catastrophic consequences that may be missing from the past catalogue of events. The framework characterises the circumstances and probability of extreme events through the use of "counterfactual thought experiments." The application of a counterfactual thought experiment – the alteration of a past event in order to consider an alternate version of the present – offers a dynamic representation of history, one from which lessons-learned are no longer limited by a single realisation of history. By identifying them and quantifying the network of paths and feedbacks through which a natural hazard event becomes a disaster, we can turn "black swan" events (unforeseen, catastrophic events) into more manageable "grey swan" events, which are very rare but manageable, specifically because they have been foreseen.

During this workshop, participants applied their subject matter expertise through a counterfactual lens in order to develop a number of case studies using this framework to uncover black swans in Singapore and beyond. To provide a quick overview of the outcomes of this workshop, we have a recap "by the numbers" here:

- **28** participants from **6** countries gathered for the first Counterfactual Black Swans Workshop, establishing a new community of research in natural and man-made hazards
- **9** presentations on counterfactual thinking, case studies of counterfactual events, and related methods and ideas
- **15 new counterfactual black swan events**, a direct output of the internally developed counterfactual round table exercise on Monday afternoon
- **10 identified topics for journal papers** and the plan to propose a special issue journal on counterfactual thinking, led by Gordon Woo and David Lallemant
- At least 3 blog and newsletter posts about this method and the workshop
- 1 counterfactual toolkit to be completed in the coming months

The remainder of this report contains a summary of workshop presentations, discussions, outcomes, and future work.



Figure 1. Susanna, Yolanda, and Mark discussing counterfactual thinking over coffee

## 2. Downward counterfactual thinking: presentations and exercises

The first day of the workshop focused on downward counterfactual thinking as a framework and method. Related work and methods were also shared and discussed. Participants exercised the downward counterfactual method in an expert round-table activity, designed by the research team, to create 15 new counterfactual black swan events based on past disasters (or near-misses). Following this, participants had time to reflect on their experiences and the outcomes of the round-table activity. Day 1's discussion ended with the participants coming together to set the agenda for Day 2's Breakout Discussions, as well as exchange ideas for outputs from the two-day workshop and beyond. After hours, the participants gathered for dinner in downtown Singapore at the aptly named restaurant, The Black Swan.



Left: Counterfactual round table exercise. Right: Elly, Guillermo, and Feroz discussing over dinner at The Black Swan

#### 2.1 Participatory workshop design

David Lallemant and Susanna Jenkins opened the workshop with a warm welcome to all of the participants, especially those who had travelled across multiple times zones to join us. In particular, we wanted workshop participants to know that they were afforded a large degree of agency throughout the workshop – from direct involvement in setting the agenda for Day 2's open discussion sessions, to self-organizing around emerging ideas and projects over the course of the workshop. This participant-driven culture was especially crucial to directing the outputs of the workshop, of which we invited participants to identify based on their conversations and interests.



Figure 3. Susanna (left) and David (right) kicking off the workshop Monday morning

After a short welcome, we went around the room for everyone to introduce themselves with their name, affiliation, and the multiple hats that they wear. In this group, we had some individuals with overlapping applications, and some without; what they almost all had in common was experience working across discipline lines to address hazards and risk.

#### 2.2 Summary of presentations

We had the opportunity to hear from nine researchers working in hazards, disasters, and risk. Starting first with an overview of counterfactual thinking, we then saw a number of case studies applying the downward counterfactual framework to past events, and ended our presentation session with a number of related methods and ideas to fuel the rest of the workshop. We have included in this report an overview of each presentation and takeaways from each one.



Figure 4. Willy (left), Olivia (middle) and JC (right) giving their presentations to the participants

Counterfactual Black Swans: Background and overview (Yolanda Lin)

Yolanda started the day off with an overview of the counterfactual black swan framework with the aim of providing consistent definitions, illustrative examples, and a shared vocabulary for the rest of the workshop. She first went over the psychology research behind downward counterfactuals (imagining that a past event had gone worse). While upward counterfactuals are almost automatic for humans to engage in, according to Neil Roese (1997), downward counterfactuals are far more difficult and unnatural to most people. In the context of black swan events, downward counterfactuals are a useful thought exercise to reimagine the past as what could have been, if things had turned for the worse. Oftentimes, there are very small changes in past event parameters that could have resulted in significant, nonlinear effects in impact. These changes can be prompted by considering the role of, and changes in the following: human decision making, human error, time, location, energy release, coinciding events, cascading events, socio-political factors, technology, and serendipity. In this way, researchers can begin to address the missing gaps in our past events catalogue and protect against overfitting on the limited realizations and data we have witnessed. She then covered four case studies, applying downward counterfactual thinking in the Singapore context for the Hotel New World building collapse in 1986, Dengue Fever epidemic in 2016, volcanic ash transport from the Mt. Pinatubo eruption in 1991, and a peninsular Malaysia earthquake in 1922. Beyond using counterfactual thinking for expanding the past catalogue of events, she then ended with a few ideas for how to incorporate counterfactual thinking in consequence-driven analysis, and time-dependent risk analysis, risk communication, and identifying levers to change black swans and black elephants (complex risks that are known but not openly acknowledged, like a cross between a black swan and the proverbial elephant in the room) to grey swans, rare and extreme hazards that have been mitigated by preventative, robust systems.

#### Downward counterfactual search for extreme events (Gordon Woo)

Gordon discussed in more detail the beginnings of how we think about catastrophes and disasters, and the importance of engaging our imagination when thinking about what potential things could go wrong. He walked through some of the main case studies included in Taleb's 2007 book, *The Black Swan*, including the September 11 terrorist attack (and its predecessor, the 1999 Egypt-air flight), and the 2004 Indonesian tsunami. He also included counterfactual case studies on the 2011 Tohoku earthquake and flooding in the UK in 2013-2014. He drew specific attention to the problem of overfitting to the historical record and the value of stochastic modelling of previous events, rather than keeping a perfect memory of the past.

#### Montserrat volcano counterfactual 'runaway explosion' (Willy Aspinall)

Willy focused on a case study of the Montserrat volcano and its eruption activity from 1995 to 2010. He pointed out that some volcanologists tend to assume that the worst thing that has happened in a volcano's history is the worst thing that can be expected in the future. In the accessible onland volcanic deposits on Montserrat, there was no recognized record of a previous major explosive eruption. Thus, when the eruption crisis started, some argued that such an event was implausible; other scientists were less sure, and this led to differences of opinion as to risk levels. But what exactly was the probability of one of a sequence of more modest volcanic explosions turning into a runaway large explosion, by tapping a deeper 'magma chamber'? Willy demonstrated that the UNINET Bayes net software can be used to perform a counterfactual analysis for the probability of just such an unprecedented event. Interest in this tool and approach was followed up after the workshop through a tutorial demo of the UNINET software.

#### Parametric earthquake risk transfer (Guillermo Franco)

Guillermo offered a summary of how parametric solutions can help fill the insurance gap – the percent of uninsured losses, seeing as only about 30% of the financial loss derived from disasters is covered by some formal financial mechanism. Traditional insurance is expensive and complicated to deploy, which contributes to why this insurance gap is so large in most places of the world. Parametric solutions have been used in the insurance industry since at least the 1990s, and offer a new avenue to address this problem. Instead of using claims adjustors to assess the damage after an event, parametric insurance – the "cat-in-a-box" device – uses measurements to determine when and how much to pay. This means that the cost of these products can be competitive against traditional solutions in the long run, though it isn't yet, and it can provide a much faster response, which is critical for emergency operations. The governments of Mexico, Peru, Colombia, Chile, several Caribbean and Pacific island nations, as well as several corporations are using these tools to hedge earthquake, flood, and hurricane risks. He cautioned the group against the reality of the insurance industry: if a more complete past catalogue means higher costs, the pushback against adopting counterfactual thinking will be something we should be prepared to encounter.

#### Risk perceptions in social media (Olivia Jensen)

Olivia provided an introduction to her work, aimed at closing the gap between public understanding of risk and expert knowledge about risk. By bridging this current gap, public safety and resilience can be improved. People have different perceptions of risk, and tend to both overand under- estimate risk. They also have different risk thresholds; even for risk experts, their professional standards may not translate into their lives as citizens. The LRF World Risk Poll is a current initiative to understand what people in the world worry about and what they think are the top risks. If we can understand peoples' perception of risk, and the actions they take to mitigate this risk, then we can work out how to move forward with resilience. The Risk Pulse Monitor is a real time measurement of what people are worrying about or their perspective of risk. It analyses the language people are using on social media, and you can begin to test things like: can you plant seeds into the public domain, and then measure again the language that people are using to talk about risk?

#### The pressure and release framework (JC Gaillard)

JC discussed the Pressure and Release Framework (PAR) developed by I. Davis in the 1970s but popularised by the book 'At Risk' in the 1990s. This is probably one of the best known theoretical frameworks to unpack the root causes of disasters. It has been widely used among scholars of disaster studies and practitioners of disaster risk reduction who have tweaked the original diagram into multiple cognate versions. This framework offers an opportunity for counterfactual reflection on the root causes of an event such as the July 2000 Payatas disaster. It allows one to unpack why the disaster occurred in the first place and to also identify pathways towards safety. Progression towards safety entails securing safe location and sustainable livelihoods for people at risk or affected, reducing the dynamic pressures that have put these people in harm's way, and, ultimately, addressing the underlying factors that affect the broader distribution of power and resources within society. Perhaps this could be used in concert with counterfactual thinking to come up with counterfactual reflections on the root causes of disasters.

Using Pro and Pre-mortems (Gareth Byatt)

Gareth shared with us the method of using Pro and Pre-mortems, which are about imagining how things could go badly wrong before you start (Pre-mortem) or exceedingly well (Promortem). In essence, you look at possible scenarios and agree on which 'trigger points' to watch for. It is a form of "prospective hindsight" and it is, in effect, a forward-looking counterfactual review, and was a fascinating complement to the ideas and discussion around the theme of the workshop.

• Exploring methods and ideas for counterfactual analysis (David Lallemant)

David presented a series of ideas focused on (1) analytical methods for counterfactual analysis and (2) potential applications and future work. Specifically, he explained how the issue of overfitting to a short and overly constrained historical record could be addressed through Bayesian calibration techniques, where past events are treated as uncertain to account for counterfactuals. Sensitivity analysis can further be used to explore the factors that may be associated with extreme events. David further described some ideas for the application of counterfactual analysis to serve as platform for further discussion in the workshop. This included (i) consequence driven analysis rather than hazard driven analysis, (ii) time-dependent risk analysis (i.e. future counterfactuals), (iii) risk auditing and calculating the benefits of riskreduction interventions, (iv) black elephants of south-east Asia (i.e. potential catastrophic events that we know about but are not discussing or addressing) and real-time counterfactual analysis for worse-case scenario preparation.

#### Baby black elephants (Kathy Cashman)

This year's July 3<sup>rd</sup> Stromboli paroxym could be considered a near miss. The eruption happened in the afternoon; if it had happened just a few hours later, there might have been many more fatalities since this is a popular tourist location in the evenings. INGV had very limited warning:

they thought that the volcanic activity was well-understood and regularly monitored. Stromboli is a known active volcano, so the activity itself was expected, but this level of hazard was not. Kathy offered that perhaps this is yet another relative of the black swan: a baby black elephant, an event whose risk is actively present and expected, but whose variations may go undiscussed.

## 2.3 Counterfactual Round Tables

The workshop session "Counterfactual Round Tables" was designed to guide participants through a group process of building a counterfactual black swan from a past event. Starting with one participant, the "event expert" describes a past event, using supporting materials (maps, figures, etc) as needed. Other participants are invited to ask clarifying questions, and finally all participants engage in counterfactual thinking to devise ways in which this event could have been worse. We provided prompt cards (Figure 5) around the table to help guide downward counterfactual thinking. Participants then discussed their various counterfactual ideas and grouped their thoughts, written on post-it notes, onto a poster board in order to build a narrative around one or more counterfactual versions of their event. This process was then repeated for all participants at the table, with one past event per participant. The activity had a facilitator at each table, and there were three participants per table. The resulting counterfactual black swans were then shared during an informal coffee break poster session following the activity, and afterwards we also invited general impressions and feedback to share with group as a whole.



Figure 5. Twelve prompt cards developed for and used during the Counterfactual Round Table activity.

Past events used in this exercise included:

- Tropical Cyclone of 1879 near Shanghai
- Central Sulawesi Disaster of 2018
- Batanes, Philippines earthquakes in 2019
- 2010 Port-au-Prince earthquake
- Mt. Pinatubo eruption in 1991
- Chernobyl nuclear catastrophe of 1986
- Muisne, Ecuador earthquake in 2016
- Payatas debris flow in 2000
- 1980 eruption of Mount St. Helens
- Tropical Cyclone Giselle in 1968
- 2007 Jakarta Floods
- Tropical storm Washi (2011) and Typhoon Bopha (2012)
- Montserrat Volcano (1997)
- Vulcano near-miss non-eruption of 2004
- Merapi eruption in 2010

The exercise, which was newly developed and implemented formally for the first time at this workshop, provided many insights for both the past disasters (and non-disasters) as well as for the process of counterfactual thinking in the context of risk analysis.



Figure 6. Tian Ning (right) facilitating the downward counterfactual exercise with experts Kathy, Angelo, and Willy (left to right)

Many participants voiced surprise at the difficulty in pushing back against the automatic "upward" counterfactual thinking, wanting instead to engage in finding ways that the situation could have been better. They needed to consciously remind themselves to think downwards instead, which supports our decision to design a facilitated group exercise around this process. For the case of many past events that are already considered the "worst case scenario," such as the Mount St. Helens eruption in 1980, or the 2010 Port-au-Prince earthquake, participants noted that this was especially challenging – but, as we saw, *possible* after a round of counterfactual thinking.

In the discussion that followed, we heard a strong theme around human exacerbation of the disaster, and how human decision making has a major impact either for better or for worse. For example, in some cases, false rumors that spread out of control impeded efforts for an effective

evacuation. These partial truths, fanned by the horsepower of modern social media, could have very real and serious impacts. We also discussed the need to differentiate between a "false alarm" – an alarm put out accidentally without any real threat behind it – and an unfulfilled alarm – one that did not result in the realization of the threat. We also questioned, is there a threshold in the magnitude of the hazard beyond which the human factor has lessened importance?

In discussing many of the technical details of the events, a number of very personal, human stories emerged, sparking a continued conversation around collecting oral histories around many of the past experiences of the more experienced researchers in the room.



Figure 7. Examples of Counterfactual Round Table outputs

## 2.4 Goals and output setting

As a group, we built a list of topics we were interested in exploring further, together, during the second day of the workshop in the two open discussion sessions scheduled in the AM. The group also identified a number of interesting outputs to consider for this work. A few major themes kept recurring during this session: talk of the importance of bridging the gap between academia, and industry, how to move forward from what we have been doing, and thinking of how to make things worse. The discussion session topics and outputs are described in detail in the next section of this report.



Figure 8. Discussion of goals and outputs for the workshop

#### 3. Breakout discussions

Participants had direct agency in setting the agenda for Day 2's open discussion sessions. We held five breakout sessions on Tuesday morning to cover the following topics: (1) putting together a special issue journal on counterfactual thinking in hazard and risk analysis, (2) future conference sessions, (3) methods and toolkits, (4) consequence-driven analysis, and (5) public facing options.



Figure 9. Chris Newhall contributing during the breakout discussion. Photo Source: Antoinette Jade/Earth Observatory of Singapore.

#### 3.1 Special issue journal on counterfactual thinking in hazard and risk analysis

To address the growing number of ideas that had been generated through discussions during Day 1, and counterfactual case studies developed during the Counterfactual Round Table exercise, we centered one of the breakout discussions on the idea of developing a special issue journal on counterfactual thinking in hazard and risk analysis.

This sub-committee discussed potential journal avenues, scope of the special issue, potential paper topics amongst those at the workshop, and a timeline to pursue this output. They also identified a joint desire to build a community literature library, to collect key work related to this topic. There was also the suggestion to build a case study library, or some kind of online platform for sharing events and building counterfactuals.

The proposed special issue will focus on counterfactual thinking and "what ifs," from both the development of additional methods and tools to engage in counterfactual thinking, as well as highlighting case studies that apply this method when re-analyzing past events.

The group decided to begin soliciting journals and identifying guest editors for the special issue immediately in order to advertise the special issue by December 2019 at the American Geophysical Union (AGU) Annual Meeting, request abstract submissions by May 2020, with submissions ready by September 2020, for publication from December 2020. This effort will be led by Gordon Woo and David Lallemant. They will be in contact with the suggested authors of the ten paper outlines proposed in this workshop. They also welcome additional paper proposals.

### 3.2 Relevant conferences and potential conference sessions

We hope that this workshop is the start of a new community of researchers centered around the application of counterfactual thinking in the context of extreme events, hazards, and risk. As a

widely multidisciplinary (researchers from many different disciplines) and interdisciplinary (researchers whose work is housed across multiple difference disciplines) group, spanning volcanology, earthquake engineering, risk, insurance, human geography, risk communication, and more, we wanted to dedicate one of our open discussions to identifying potential conferences venues at which our community could 1) reconvene in the future, 2) showcase our work through hosting a session, and/or 3) host another workshop to coincide with an existing conference.

During this discussion, we also touched on the difficulties of working in interdisciplinary settings in academia, noting the misalignment between the work we pursue and traditional department lines, around which performance metrics are often structured. This is a noted reality that younger researchers must navigate, and the more senior members of this discussion cautioned them to be aware of it.

As an output of this discussion, we compiled a list of relevant conferences that may be of interest to this community, and identified a few mechanisms that we could utilize in order to plan a panel or session at one of these conferences. We also identified the need to establish an avenue to collect the experiences and advice of others in the group to help guide decisions around which conferences to attend, seeing as there are a great number of available venues and limited time and funds to explore them all personally. Through the same avenue, we can keep each other updated on which conferences have upcoming open calls for proposing a panel, session, or workshop, as well as which ones we plan to attend or present at as individuals.

#### 3.2.1 List of relevant conferences

- American Geophysical Union Annual Meeting, December 2019, San Francisco
- Understanding Risk, May 2020, Singapore
- Cities on Volcanoes, May 2020, Crete
- European Geosciences Union General Assembly, May 2020, Vienna
- Asia Oceania Geosciences Society Annual Meeting, 2020
- United Nations Conferences (UNDR, WMO, WHO)
- International Sociological Association
- I-REC (Information and research for reconstruction)
- IDRiM (Integrated Disaster Risk Management)
- IFRC (Red Cross)
- IRDR (Integrated Research on Disaster Risk)



Figure 10. Olivia, Tian Ning, and JC (left to right) during the breakout discussion session. Source: Antoinette Jade/Earth Observatory of Singapore.

## 3.3 Methods and toolkits

This breakout discussion focused on how to harness the conceptual foundation of counterfactual thinking through available methods, and identify the necessary toolkit(s) needed to pursue this work. The purpose of such a toolkit is to provide an accessible way to put this theoretical concept of counterfactuals into something actionable. It can serve as mental and computational scaffolding to aid in engaging with the unfamiliar challenge of downward counterfactual thinking.

In particular, much of the work that has been done on counterfactuals so far is largely theoretical and qualitative. There is still much work to be formalized and accomplished from a quantitative perspective. Willy Aspinall had highlighted the use of UNINET to implement Bayesian network analysis in his case study on counterfactual Montserrat scenarios in his presentation from Day 1. What other existing tools could be applied in this context, and what tools might we need to develop moving forward?

The group brainstormed a number of relevant methods and tools, listed below:

- Bayesian Networks, UNINET software
- Bow Ties
- Premortems
- Palisade suite software
- 'Model risk' software by David Vose
- Existing R or Python packages
- EXCALIBUR software for structured expert elicitation.
- Counterfactual Round Table exercise from Day 1

This toolkit will be formalized and hosted online, and made readily available to the counterfactual black swans community. We envision that this toolkit list will continue to grow in time through the valuable contributions of this new community of practice.

### 3.4 Consequence-driven analysis

The current state of risk analysis uses the metrics of numbers of deaths, persons affected, and economic loss as ways to quantify disasters. This breakout discussion focused on what threshold of consequence, and by what measurement, can be used to drive future analysis. That is, rather than performing research in a very forward fashion – identifying a hazard, and propagating its effects and impacts from there – we want to lay the groundwork for building a framework around consequence-driven risk analysis. For this, we ask the questions: what consequences truly matter, what outcomes would be unacceptable to the stakeholder(s)?

The result of this conversation was a reiteration that different stakeholders will have different risk tolerances, but on the whole, we need to build early stakeholder involvement into our research work flows to drive meaningful, impactful research. This can be done through stakeholder consultations and stakeholder engagement in the development of strategies as the research continues. We also discussed how the consequence-driven analysis could be used to bridge across multiple disciplines. By identifying a large, central, complex problem – for example, food security for a small urban island – each researcher could use their own lens, their own toolkit to uncover what root hazards could breach that consequence threshold in the short-, mid-, and long-term time frames.

#### 3.5 Public-facing options

Not wanting to be constrained to the academic sphere, we also brainstormed venues to disseminate our work and these ideas beyond the typical avenues of a journal publication and conference presentation. The group collectively identified appropriate news venues who may be interested in the event and outcomes of the workshop: the Earth Observatory of Singapore's blog, Gareth Byatt's <u>Risk Insight newsletter</u>, the <u>NTU Disaster Analytics for Society Lab blog</u>, personal tweets. We also identified a number of public-facing avenues for highlighting the intellectual contributions and potential around counterfactual thinking, including Understanding Risk (World Bank), Brink, RIMS, the Natural Hazards Observer, Alert Net, Relief Web, and traditional news media such as <u>The Straits Times</u> in Singapore.



Figure 11. Susanna capturing key points from each of the breakout discussions

#### 4. Conclusions and next steps

In these two days, we had the great opportunity to learn from and engage with disaster researchers from a number of different fields, continents, and experiences. We explored the use of counterfactual thinking in the work that we are currently pursuing, and the potential for applying it in the work that we plan to pursue in the future. Below, we summarize the key takeaways, identified outputs, and offer final workshop conclusions

#### 4.1 Key takeaways

There were a number of recurring themes and points that weaved in and out throughout our two days. They include:

- Removing barriers to insights offered by counterfactual thinking: Downward counterfactual thinking is challenging to engage in, but offers valuable insights for imagining how things could have been worse, and offers a way to complete the past catalogue of events. As this is seen as valuable, there is also a need to provide additional scaffolding through a counterfactual tool kit to help researchers and other stakeholders engage in downward counterfactual thinking.
- Oral histories: One of our favourite things to have come out of this workshop was how many interesting, engaging, hard-to-believe stories we had between the participants in the room. In many cases of disasters, the positive human actions from human decisions, as well as the negative or absent human actions from human actors, can be the critical limit between something bad and something catastrophic. And yet, many of these stories are not published or recorded and will be lost over time or not available across space.
- **Risk communication:** Many discussions centered around the challenges of communicating risk between scientists and the public, what happens when that risk is miscommunicated, and worst-case-scenarios that can unfold when rumors and misinformation begin to run out of control. And, while we may be interested in these tools and approaches, we must seek to understand the context of stakeholders who may have competing interests to balance, such as economic or political pressure, as well as competing risks that may appear more pressing than extremely rare, but high impact, events.
- Building a community of practice: Over the course of the workshop, we saw that this newly established community of practice would need additional support in order to continue into the future and develop the many ideas that cropped up during the workshop. There are also a number of individuals who could not take part in the workshop but would be valuable members of this community. Building a community of practice should be an intentional and deliberate decision, and take the active participation and ownership from all of us in the room.

### 4.2 Identified outputs

Over the course of our many discussions, we identified a number of concrete outputs from this workshop. They are:

- **Special issue:** We plan to put together a call for a special issue in 2020.
- **Counterfactuals-team on Slack:** 28 participants from 6 countries gathered for the first Counterfactual Black Swans Workshop, establishing a new community of research in natural and man-made hazards. To continue this energy and build this community, we established a Slack workspace to stay in touch with the progress from this workshop. We

hope that this is the start of a growing community of researchers. Important messages will also be sent to the wider group by email.

- **Public-facing material:** We have gathered a number of avenues to send our counterfactual message beyond this academic workshop, including blog posts, short videos, newspaper articles, and other forms of non-academic outreach. So far, we have three outreach pieces in <u>The Straits Times</u>, <u>Risk Insight newsletter</u>, and <u>Disaster Analytics for Society Lab @NTU blog</u>
- Future proposal(s): We generated a few ideas around identifying large, complex problems, with early stakeholder involvement, that could bridge across multiple traditional discipline lines. We also discussed formalizing the analytical methods in more depth, and studying black elephants (and levers for change to grey swans) on different time scales (10 year, 50 year, 100 year), a counterfactual events database, oral histories, and more.
- **Conferences:** There are a number of exciting conferences coming up. We specifically identified two of interest to our group in the next year: UR2020 and Cities on Volcanoes. Specifically, the call for session proposals of UR2020 will be open soon (late 2019), and this community plans to have a healthy representation of this method at this international, interdisciplinary, and cross-cutting (e.g., academics, practitioners, government) venue.
- **Counterfactual toolkit:** This will be hosted online and made available to researchers in this new counterfactual community. We'll include key literature, identify useful analytical methods, suggestions for relevant conferences and journals, and any facilitation materials we develop (such as the materials from Session 1: Counterfactual Round Tables).

#### 4.3 Conclusion

As the two-day workshop wrapped up, we had generated far more questions than we had answered: a good measure of success! We are excited to see these projects continue, and to tend to this newly established group of researchers who are engaged in downward counterfactual thinking in risk analysis.



Figure 12. The Counterfactual Black Swans Workshop participants

#### Acknowledgements

This workshop was funded by the National Research Foundation Singapore as part of the Systemic Risk and Resilience Initiative. The concept of the idea for this work was inspired by and built upon the work of our active collaborator, Gordon Woo, who was also instrumental in helping this workshop come together.

We would like to thank Mary Lim for her tireless efforts in helping ensure the logistics of flights, hotels, and other purchases went smoothly. Additional thanks also go to Aishah Binte Kasmadi, who ensured that we were well fed and caffeinated throughout the two-day workshop.

Finally, thank you to all of our facilitating team and other volunteers: Feroz Khan, Tian Ning Lim, Maricar Rabonza, Gizem Mestav, Elly Tennant, and George Williams. The workshop could not have run smoothly without all of your help in both running and documenting the event.

ASE: Asian School of the Environment ICRM: Institute of Catastrophe Risk Management NTU: Nanyang Technological University NRF: National Research Foundation Singapore EOS: Earth Observatory of Singapore RMS: Risk Management Solutions RSIS: S. Rajaratnam School of International Studies: Centre for Non-Traditional Security Studies IPUR: Institute for the Public Understanding of Risk at the National University of Singapore

## Appendix 2: Participants list

	Name	Affiliation(s)
1.	Adam Switzer	EOS, ASE, NTU
2.	Angelo Paolo L. Trias	RSIS, NTU
3.	Audrei Ybanez	University of the Philippines
4.	Benoit Taisne	EOS, ASE, NTU
5.	Brian McAdoo	Yale-NUS College
6.	Chris Newhall	Former USGS and EOS
7.	David Lallemant	EOS, ASE, NTU
8.	Elly Tennant	EOS, NTU
9.	Feroz Khan	EOS, NTU
10.	Gareth Byatt	Consultant
11.	George Williams	EOS, ASE, NTU
12.	Gizem Mestav Sarica	ICRM, NTU
13.	Gordon Woo	RMS, ICRM
14.	Guillermo Franco	Guy Carpenter
15.	JC Gaillard	University of Auckland
16.	Kathy Cashman	Bristol University
17.	Maricar Rabonza	ASE, NTU
18.	Mark Bebbington	Massey University
19.	Nathaniel Tan	IPUR, NUS
20.	Olivia Jensen	IPUR, NUS
21.	Richard Ybanez	University of the Philippines
22.	Sebastian Biasse	EOS, ASE, NTU
23.	Susanna Jenkins	EOS, ASE, NTU
24.	Tan Jen Jen	NRF
25.	Tian Ning Lim	ASE, NTU
26.	Tiaw Kay Siang	NRF
27.	Willy Aspinall	Bristol University
28.	Yolanda Lin	ASE, NTU



Counterfactual Black Swans Workshop Agenda

26-27 August 2019

TR-21, The Arc, Nanyang Technological University, Singapore

Day 1: Monday, 26 August 2019					
8:15am	International participants meet at NEC lobby				
8:45am 9:00am	Registration at TR-21 in the Arc at NTU Coffee, tea, and pastries				
9:00am 9:15am	<b>Opening welcome</b> David Lallemant and Susanna Jenkins				
9:15am 9:45am	Introductions				
9:45am 10:15am	Introduction to counterfactual black swans Yolanda Lin				
10:15am 10:30am	Coffee break				
10:30am 11:15am	<ul> <li>Counterfactual case studies</li> <li>Gordon Woo: Downward counterfactual search for extreme events</li> <li>Willy Aspinall: Montserrat volcano counterfactual 'runaway explosion'</li> </ul>				
11:15am 12:15pm	<ul> <li>Related work and methodologies</li> <li>Guillermo Franco: Parametric Earthquake Risk Transfer</li> <li>Olivia Jensen: Risk perceptions in social media</li> <li>JC Gaillard: The Pressure and Release Framework</li> <li>Gareth Byatt: Using Pre-mortems</li> <li>David Lallemant: Exploring methods and ideas for counterfactual analysis</li> </ul>				
12:15pm 1:15pm	Lunch				
1:15pm 3:00pm	Session 1: Counterfactual round tables Desired outcome: Build and present a collection of case studies based on past events and counterfactual black swan versions of those past events; feedback on the process and methodology				
3:00pm 3:30pm	Coffee break + group photo				
3:30pm 5:00pm	Session 2: Setting goals and outputs Desired outcome: Identify a set of outputs from the workshop based on the interests, intersections, and goals of the participants, both during the two days and following the workshop, including setting the agenda for Sessions 3 and 4.				
6:45pm 9:30pm	Dinner at The Black Swan (19 Cecil St, Singapore 049704) Meet in front of NEC at 6:15 to carpool, otherwise meet at restaurant				







# Counterfactual Black Swans Workshop Agenda 26-27 August 2019

TR-21, The Arc, Nanyang Technological University, Singapore

Day 2: Tuesday, 27 August 2019					
9:00am 9:15am	<b>Re-cap of Day 1 and agenda for the day</b> David Lallemant and Susanna Jenkins				
9:15am 10:30am	Session 3: Breakout sessions Topic(s) to be set in Session 2, including but not limited to: - Special Issue Journal - Methods, alternatives, and integration				
10:30am 11:00am	Coffee break				
11:00am 12:00pm	Session 4: Breakout sessions Topic(s) to be set in Session 2, including but not limited to: - Establishing a community of practice [working group] - Consequences of interest				
12:00pm 1:00pm	Lunch				
1:00pm 2:45pm	Session 5: Tools to move forward Desired outcome: Compile resources needed and/or available to conduct the research goals and outcomes identified in Session 2, and action items moving forward				
2:45pm 3:00pm	Coffee break				
3:00pm 4:00pm	Wrap-up and Farewell				
4:00pm 4:30pm	Tour of the Earth Observatory of Singapore (optional)				

