

RISK ANALYSIS REPORT

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Introduction

The aim of this report is to highlight key areas of risk which are predicted to have a high impact on global welfare, as well as provide suggestions as to how this risk could be mitigated. The structure of the report is as follows - each risk will have a corresponding portfolio in which the risk is defined, and the report will explore the inciting factors which influence the likelihood and intensity of each risk. This report will also justify the risk's position on the list, and make suggestions to mitigate the impact or chance of each problem occurring.

It is a commonly accepted bias that individuals, and thus society at large, struggle to conceptualize high impact but low likelihood events. This typically means humanity is unprepared to cope with certain potential disasters, which can lead to significant tragedy and -loss of life. Some of the items on this list may have a low chance of occurring, but have a distinct lack of preventative measures and funding because of this. Bringing awareness to the risk these problems pose is another aim of this report. However, all risk areas in this report are high impact.

In considering which problem areas to prioritise, one must consider what moral framework to work under. There is ambiguity in what matters most to humanity in general, some consider quality of life more important than quantity, some wish to preserve different values or standards of living over other considerations. This report attempts to remain non-partisan, but adopts a framework which seeks to maximise the number of *quality* lives lived by everyone on the global, regardless of situation or location. The report also considered the risks under three main metrics, adopted by the same philosophy that guides the Effective Altruism community to which this report gives full credit for this framework. When choosing risk areas that needed attention, the report considered (1) how neglected the problem was, (2) how important or impactful the problem was, and (3) how solvable/tractable the problem was. The report finds the arguments justifying this framework convincing, and recommends those interested read more [here](#) and [here](#).

This report was made in around 6 weeks, as the topic took 2 weeks to write up and propose. Thus the research and models presented in this report, whilst all having data and citations to back them up, are a small part of a larger picture. Readers who are interested should continue to do more research on this area to reach a more definitive consensus on what are the most pressing risks our globe faces. This report gives no guarantee that the five risks presented in this write up are the most high risk and impact events which will shape the future of humanity within the foreseeable future, but they do represent problems that undoubtedly need addressing and will have a strong impact on many people.

This report was also part of a project which required a technical aspect in addition to an analysis section - so for each risk there is an attached model which investigates or attempts to solve a part of the problem using machine learning. Some problems were hard to model due to lack of data, the nature of the problem or simply the time restraints on the topic. Three that were specifically removed from the final report due to modelling problems are:

- The risk imposed from artificial intelligence.
- Nuclear security.
- The ongoing rise of antimicrobial resistance.

It is strongly recommended that readers interested in each of these areas continue personal research into each topic. Some starting points are [here](#), [here](#) and [here](#).

Climate change

Introduction

Climate change is a phenomenon which describes a change in the average weather conditions in a region over a long period of time. Scientists have observed a global trend towards a hotter climate that has been progressing since the mid-20th century [1]. Whilst there are many examples in Earth's history where the earth's climate has changed, most of which can be attributed to small variations in the Earth's orbit, the recent increases in temperature have a greater than 95% chance of being influenced by humanity [2]. It is thus incredibly important that society at large examine the influences and potential impacts that climate change will have on the environment.

Evidence for the problem

There is a significant amount of varied evidence for not only the existence of climate change - but the potential disastrous impact that it could cause globally. For example, a single literature review published in 2020, titled 'Overview of the Evidence and Reality of Climate Change' was able to cite 62 studies in their discussion of the various avenues in which scientists have observed data about the existence and danger of climate change [3]. Experts from relevant fields have been aware of the damage that climate change will cause to our environments for hundreds of years [4], and now are at a nearly 100% united consensus about its reality [5].

Some of the most damning pieces of evidence available in the discussion climate change are:

- **Seasonal Rainfall Variability:** The Indian summer Monsoon Rainfall has decreased about 1.6cm between 1871-2002. This is representative of a general decrease in heavy rainfall incidents in India [6].
- **Melting of glaciers:** There has been studies which demonstrate the glacial retreat of 82 glaciers, and the trend towards area shrinkage of around 7,090 glaciers [7]. Around 70% of small glaciers in East Georgia are now turning into snowfields or fully liquefied [8]. Data from NASA's Gravity Recovery and Climate Experiment show that Greenland has lost an average of 279 billion tons of ice between 1993 and 2019. Similarly, Antarctica is losing around 148 billion tons of ice per year [9].
- **Temperature Warming:** The planet's average surface temperature has risen around 2.12 degrees Fahrenheit since the late 19th century [10]. Most of the warming occurred in the past 40 years, with the seven most recent years being the hottest on record. Currently, 2016 and 2020 take the crown for the warmest years logged on record [1].
- **Warming Ocean:** The ocean has absorbed much of the effect of the temperature rising - the top 100 metres showing warming of around 0.6 Fahrenheit since 1969. The sea level rose about 20 centimetres in the last century. The rate of warming in the last two decades is nearly double that of the last century, and is constantly accelerating. [11]
- **Ocean Acidification:** Since the industrial revolution, the acidity of the ocean has increased by about 30%. [12]

Why is the problem happening

Scientists have attributed most of the effects of climate change due to the 'greenhouse gas' effect. When some gases are released into the atmosphere, they block heat from escaping [13]. Certain gases are long lived, and thus contribute to warming for a long time. Some of the main gases responsible for climate change are: water vapor, carbon dioxide (which has increased by 47% since the industrial revolution), methane (used a lot in agriculture) and nitrous oxide (used in fertilizer, fossil fuel combustion).

The majority of the gases are used to make power, leading to an incredible increase in the amount of these substances being released into the atmosphere. Usage of fossil fuels by big corporations is one of the strongest driving factors behind climate change [14].

Justification for position on this list

Neglectedness: Spending on mitigating this risk is higher than many others on this list, at between \$100 - \$1000 billion globally per year [15]. This, coupled with the high public awareness surrounding this risk, makes it much less neglected than many other problem areas. However, much of this funding is not focused on mitigating the extreme risks of climate change (widespread displacement of vulnerable people, food and water shortages etc) or is generally poorly allocated.

Impact: This risk area has the potential to impact many people on a large scale. There are several potential effects that climate change could incur, some of the most notable include:

- Great loss of animal life as habitats are changed by shifting climate [16].
- Widespread displacement of people on the scale of billions at worst estimates [17].

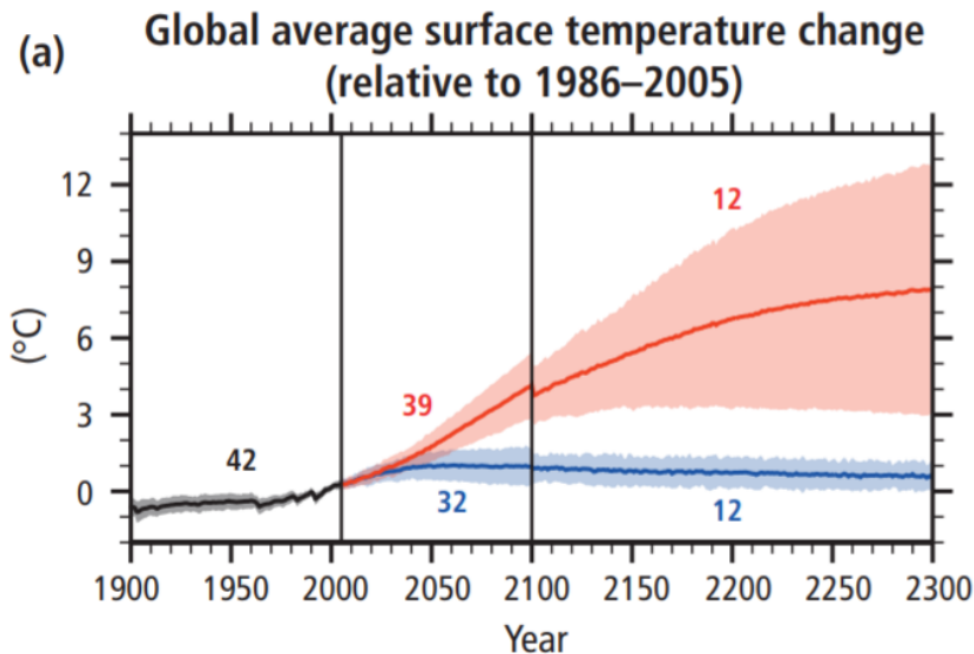
- Food and water shortages as crops suffer due to changes in climate [18].
- Greater likelihood of natural disasters [19].
- Shifts in the economy as outdoor work becomes harder, and more people are forced to move due to the rising sea from ice melts [15].
- Decreased global stability/conflict due to the aforementioned stressors [15].
- Toby Ord - author of *The Precipice*, a novel about existential risks to the planet suggests that there is about a 0.1% chance that climate change will make the earth uninhabitable for the human species, in which case humanity would likely face extinction [20].

Some of the most extreme predictions which estimate warming of 6 degrees or higher suggest that hundreds of millions of people could die from combinations of the above impacts [15].

Regardless, it is clear that climate change will have some negative effects on a large number of people.

Solvability: The issue has a substantial amount of funding as discussed, so there is a lot of tractable progress to be made in this field. There are many known avenues for progress with clear objectives, from political changes to increasing energy efficiency or finding new renewables which seem relatively straightforward to work on.

Future Predictions



This image from the IPCC (International Panel on Climate Change) Synthesis report, p 59. [21]. Demonstrates potential increases from several modelled temperature changes. The red represents a “high emission scenario”, and the blue a “stringent mitigation scenario”, with the solid line representing the mean result from models.

If countries stick to the minimum standards agreed to in the 2015 Paris Agreement, research suggests that we have a 50% chance of experiencing warming greater than 3.5 degrees, and a 10 % chance of experiencing temperatures greater than 4.7 °C by 2100 [15]. These numbers are relative to the standard in 1850 - 1900s. However, even if our emissions were cut off entirely, we would still have a 5% chance of eventually having temperatures rise by 6.6 degrees according to IPCC models [21]. This level of warming is where much of the more extreme consequences mentioned above in the justifications section become a reality.

Suggestions to mitigate risk

Some of the main areas which could assist in mitigating the risk posed by climate change are:

- Aiming to reduce emissions via advocating for changes to policy:
 - Lobbying governments to create policies which restrict emissions - carbon fee or taxes could be one system that could work.
 - One could also lobby against restrictions on nuclear energy, which is a low emission alternative to many other power sources.

One of the main causes of climate change is emissions, and one of the only ways to restrict the amount of emissions is through government imposed restrictions - making this a key way to mitigate climate change risk.

- Working in negative emission technologies - this refers to innovations which will allow us to remove carbon dioxide from the atmosphere to mitigate some of the warming effect. As discussed above, the amount of greenhouse gas in our atmosphere currently will still lead to increased risks, and it is unlikely that there will be a strict cut off in emissions anytime soon. Looking into technologies that can reverse greenhouse effects is thus an excellent use of time and resources.
- Investing in more research on what the extreme risks climate change could cause and allocating funding to preventing or creating systems around them. Right now not enough information exists to properly prepare for the displacement and food shortages that climate change might cause - it is important we start preparing for this potential now.
- Engineering clean energy alternatives - while there are several people also doing this, it is important to continue to support and improve these technologies so they are scalable and economically feasible. Once again, as emission levels are the key driving force behind climate change - and much of the reason behind use of fossil fuels is their cost effectiveness, we need to find a solution which provides an economic incentive to shift to clean energy.
- Advocacy for more low emission habits such as vegetarianism and widespread adoption of public transport. While the majority of emissions are produced by industry, data shows eating meat doubles one's carbon footprint [22] - and more dietary switches means less funding to agricultural industries - a large contributor to global emissions [23].
- Refusing to support companies with high emissions: most emissions are caused by large companies, and these businesses are profit driven. Boycotting these industries gives them an incentive to switch to cleaner fuel and prioritise low emissions.

Natural disasters

Introduction

Natural disasters are defined as major adverse events that result from natural processes from Earth. Some examples of natural disasters include: floods, hurricanes, tornadoes, volcanic eruptions, earthquakes, tsunamis, storms. There are several adverse effects that result from natural disasters - such as destruction of infrastructure, loss of life, and various economic flow on effects.

Defining the problem

- Flooding is defined as an overflowing of water onto land which is usually dry. They are typically some of the most common natural disasters [23] - between 1967 and 2013 the average cost of flooding in Australia has been estimated to be around 943 millions [25] - this is not even including the costs of flooding related deaths and injuries. Despite Australia being the driest inhabited continent on the earth, significant floods occur around the country almost every year.
- Storms are defined as 'the disturbance of normal conditions in the atmosphere'. More than 40 occur on average on the northwest coast of Australia annually. However, only an estimated 5 - 10% of these thunderstorms are considered severe [26].
- Earthquakes are defined as 'a series of vibrations induced in the earth's crust by the abrupt rupture and rebound of rocks in which elastic strain has been slowly accumulating.' In Australia, an average 100 earthquakes of magnitude 3 or more are recorded - with earthquakes over 5.0 magnitude only occurring every second year [27].
- Landslides are defined as the movement of a mass of rock, debris or earth down a slope. Between 1842 - 1997, around 73 people died in 42 landslides, and landslides have cost \$200 million in damage to buildings etc [28].
- Droughts are defined as 'a period of dry weather, especially a long one that is injurious to crops.' Since the 1860s a 'severe' drought has only occurred every 18 years in Australia [29].
- Wildfires are defined as 'any large fire that spreads rapidly and is hard to extinguish.' An average of 54.5 million hectares was burned due to bushfires in Australia each year [30].
- Volcanoes are defined as 'a vent in the earth's crust through which lava, steam, ashes, etc., are expelled, either continuously or at irregular intervals.' Even though Australia is home to nearly 150 volcanoes - none have erupted for approximately 4,000 years [31].

Why is the problem happening:

Natural disasters are varied in their cause and their form. Some of the most common natural disasters, listed in order of commonality, and how they occur are below:

- Flooding: There are a few different reasons floods occur, heavy rains where natural watercourses no longer have the capacity to support the excess water being the most common. Flooding could also be caused by dam failures, high tides, tropical cyclones or tsunamis [32].

- Storms: Storms form when warm air rises into cold air - the warm air then cools, which causes water vapor to form water droplets (condensation). The cooler air drops lower into the atmosphere, warms and then rises again. This process is what forms clouds [33].
- Earthquake: An earthquake is caused by sudden movement on a fault line - this is an area where tectonic plates meet. This sudden release of energy travels through the earth's crust and makes the ground shake.
- Landslide: Most landslides have multiple inciting actions. Slope movements occur when forces acting down-slope (gravity etc.) exceed the strength of materials that compose the slide. This usually happens because of rainfall, snowmelt, erosion, earthquakes, volcanic activity, or disturbance by human activities [34].
- Drought: Droughts can be natural - they have existed throughout much of human history, triggered by cyclical weather patterns. However, the fluctuating ocean and land temperatures, as well as altered weather patterns, that have been noted in recent years have been increasing the amount of droughts experienced globally - hotter surface temperatures lead to more evaporation. Excessive water demand due to higher population and agriculture also lead to droughts. Deforestation can also exacerbate droughts, as trees release moisture into the atmosphere into the atmosphere. This can also diminish soil quality and reduce the land ability to absorb and retain water [35].
- Wildfire: Fires need fuel, oxygen and heat. Several things can start fire - some of the most common things include human carelessness, lighting strikes, even as small as a spark from a train wheel. For these fires to then progress to wildfire however, you need wind, being on a slope, or having an abundance of fuel - or some combination of the three. Weather conditions like low rainfall, hot temperatures and fast winds all influence the severity of wildfire.
- Volcanic activity: Volcanoes erupts when magma rises to the surface - this molten rock is formed when the earth's mantle melts. This melting is influenced by movement of tectonic plates - and as magma is lighter than rock it rises towards the surface. Explosions occur due to pressure, or water interacts with magma and creates steam.

Justification for position on this list

Neglectedness: Natural disaster caused the United States \$306 billion in 2017 - making it an incredibly expensive area of risk - not even accounting for the danger it poses to lives and mental health [36]. In contrast, most countries spend significantly less on disaster prevention than response - with Australia in particular only dedicating around 11% of their budget towards disaster prevention and research [37]. Considering these factors, much more work could be done in fields of policy and research to assist in mitigating damage from natural disasters.

Importance: Natural disasters, as mentioned above, cost governments an immense amount of money when they occur, taking resources which could be used elsewhere to greater effect. In addition to this more economical perspective, this study reveals the average global death toll that can be attributed to natural disaster is 60,000 people - marking this area of risk as an area of significant importance [38]. Natural disasters also are responsible for much damage to infrastructure and personal housing - effects that have damaging long term effects on victims.

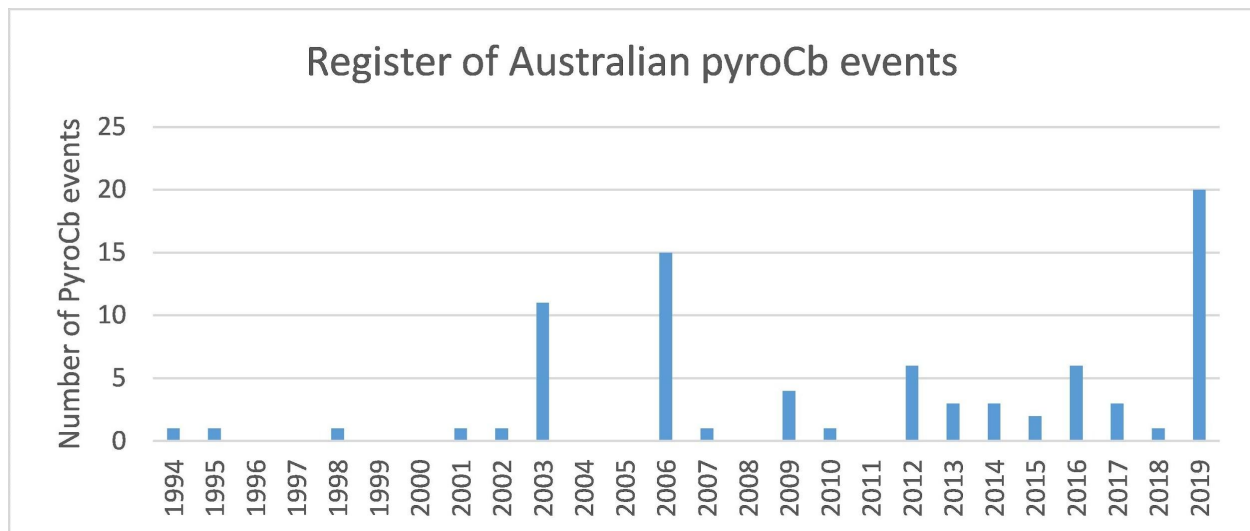
Solvability: There appears to be several avenues for exploration in this area. As so little budget is allocated to mitigation, there is a simple track for those with an interest in policy. There are also several ongoing technical projects that seem to be making tractable progress in this area, such as refitting at risk areas for seismic activities, or utilizing AI to predict when disasters will occur and the extremity of their effect.

Future Predictions:

While it is true the number of casualties due to natural disasters have been falling - there were millions of deaths earlier in the century in comparison to a 60,000 average as reported in 2014, there are also the exacerbating factors of a higher population, a increasing gap between the wealthy and the poor, and the worsening effects of climate change which contribute to risks posed by natural disasters getting higher [25]. It is also observed that as more hazards increase, measures to mitigate or prevent disaster will become more and more difficult [39].

According to the Natural Disaster Royal Commission, a combination of direct and indirect disaster annual costs are projected to increase from around 18 billion to 39 billion by 2050, without accounting for the rise in risk posed by climate change [40].

In addition to the evidence above, this graph is a register of the number of firestorm events recorded in Australia, which shows a general increase as time passes.

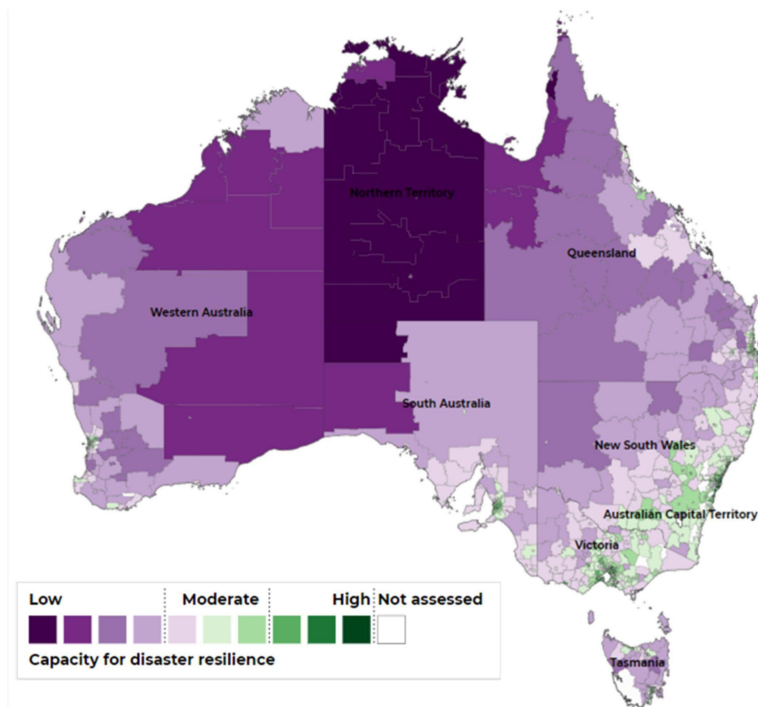


Graph produced using Table S3 (Register of Australian pyroCb events) contained in 'Supporting Information' from Giovanni Di Virgilio et al, 'Climate Change Increased the Potential for Extreme Wildfires' (2019) 46(14) Geophysical Research Letters

Suggestions to mitigate risk

- Analysis by the Pew Research Centre has shown that in America, states who invested in natural disaster prevention saw between a \$7 - \$3 dollar return on every dollar spent - suggesting that governments have a strong financial incentive to invest more in disaster prevention [41].

- Most countries have no central unit for coordinating risk mitigation initiatives, so working to create department's like this in government would be helpful in better planning and responding to disasters [42].
- As climate change directly impacts the intensity and likelihood of natural disasters, many of the suggestions to lower emissions and change policy are also applicable in this instance.
- Looking into some of the most at risk areas, and then taking steps to reduce the vulnerability of these structures. As these areas are at the highest risk, they will most likely be worst affected by any potential disaster - and should thus have priority. Below is a map showing areas and their subsequent capacity for disaster resilience.



The above graph is attributed to the Natural Disaster Royal Commission [40].

- Ensuring certain buildings with very vulnerable individuals in them, such as schools and hospitals, are not only built in low risk places but are engineered to be resilient to disasters. Children, the sick and elderly are more likely to be negatively affected in disasters, and thus should have priority care [43].
- Ensuring that all new buildings and projects have disaster mitigation in mind when they go ahead, and assisting this processing with government supported training programs for businesses.

Mental health

Introduction

Mental health is one of the fastest growing health concerns faced globally. While this issue has likely always been an important and relevant area for concern in society, in recent years there has been much more acknowledgement of mental health as a health risk to all individuals.

Having good mental health is integral to living a quality life, as it impacts a person's ability to not only succeed in study, work but form relationships, and even to make decisions on a daily basis. Bad mental health is inherently negative on an individual level, but also has far reaching consequences on global welfare and productiveness.

Defining the problem

According to a report by the World Health Organisation on risks to mental health, a commonly used definition of good mental health is “ ... a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community” [44].

A poor mental health then, is one that fails to meet this definition. Some of the most common disorders associated with a poor mental health are depression, anxiety, bipolar, dissociative disorders, behaviour disorders and general substance use disorders [45].

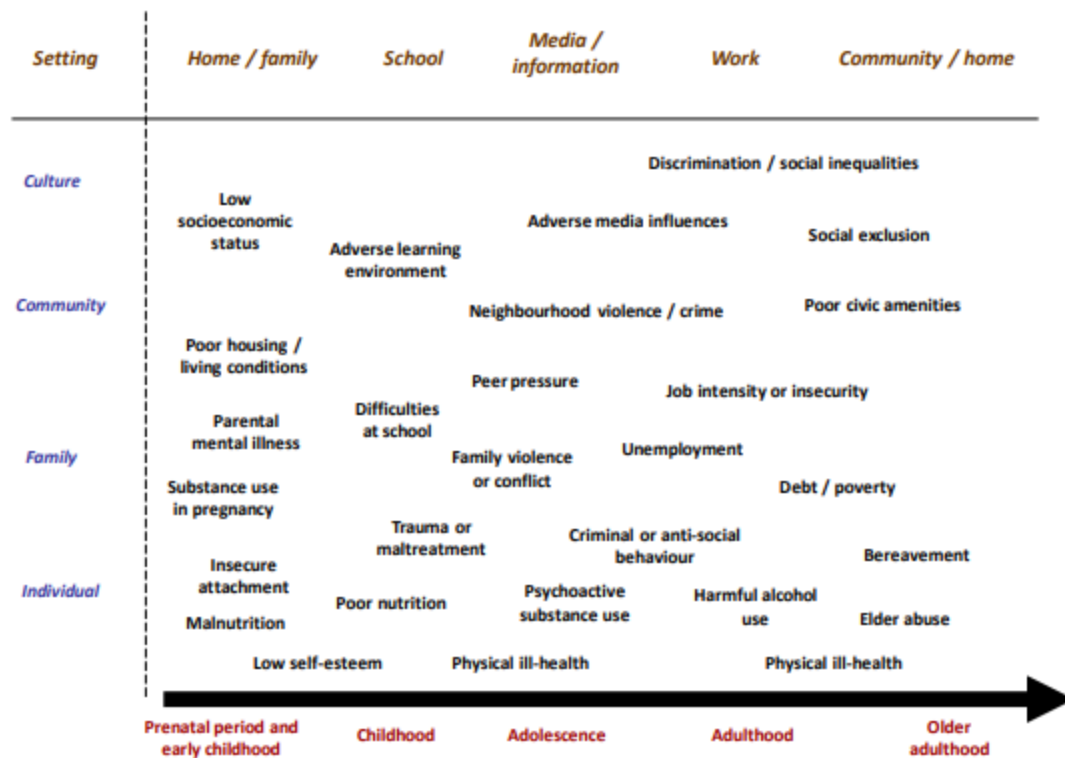
Why is the problem happening

According to the World Health Organisation, some of the main determinants of an individuals mental health and well-being are:

- Individual attributes and behaviours: this point encompasses all of a person's natural and learned ability to regulate their thoughts and feelings in day to day life. It also includes their capacity to deal with society - engaging with others and practising empathy and social intelligence. These factors can be influenced by biological factors such as down's syndrome or other intellectual disabilities.
- Social and economic circumstances: Much of an individual's mental health is determined by their financial situation and opportunities, as well as the social influences in their life(friends, family or peers).
- Environmental factors: This refers to the wider socio cultural and geopolitical environment that people live in. This encompasses access to basic commodities and services, as well as discrimination, exposure to trauma and general exposure to 'predominating cultural beliefs, attitudes or practises)[45].

Below is an image which goes into detail of an overview of the risks to mental health over an individual's life.

Figure 2 Schematic overview of risks to mental health over the life course
(Adapted from: Foresight project, 2008; Kieling et al, 2011; Fisher et al, 2011)^{4 5 6}



Graph taken from World Health Organisation report [45].

Justification for position on this list

Neglectedness: Current spending on mental health is around 6.5 billion annually in Australia [46] - but this figure changes dramatically country to country, depending on their medical systems. More than 33% of countries globally spend less than 1% on their health budget annually to mental health [47].

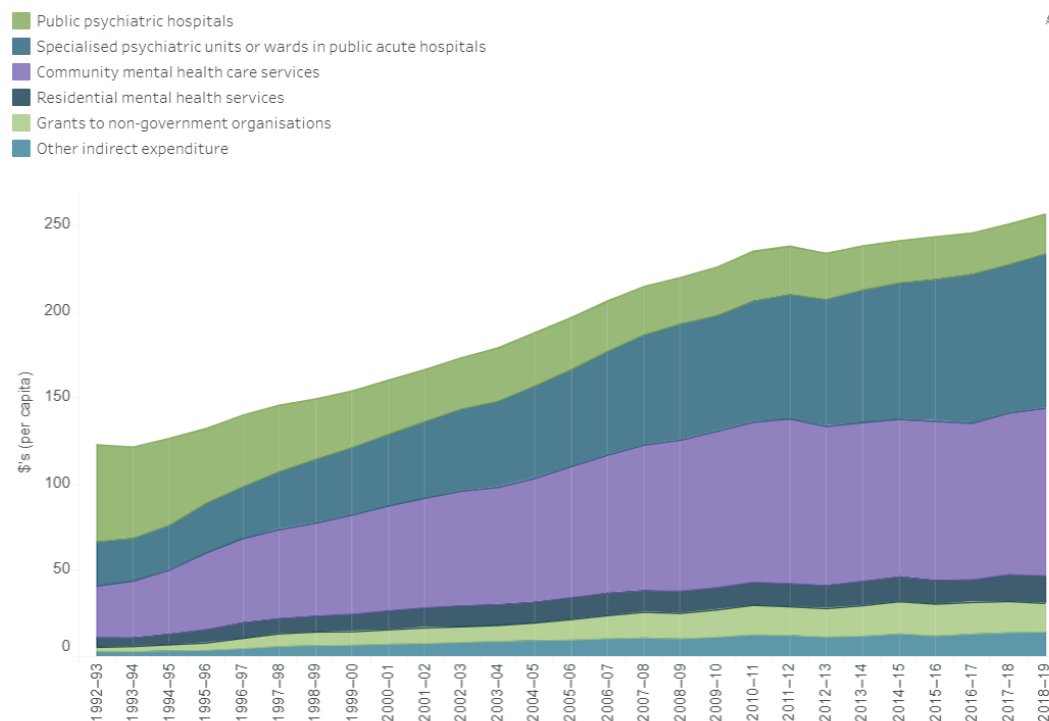
Importance: Depression is one of the leading causes of disability globally [48]. Suicide is the second leading cause of death among 15-29 year olds according to the World Health Organisation [49]. Nearly one in two people in the US will suffer from some mental health disorder or another in their lifetime, and 1 in 5 people in america are currently living with a mental illness [50]. According to the National Alliance on Mental Illness, untreated mental illness costs the US over 100 billion in lost productivity, so the issue expands into the economic realm as well as the medical sphere. A study done on residents of California found that only 32% of those who had mental illness and were uninsured got treatment, and less than 12% felt that the treatment was adequate [51]. Considering how disproportionately mental illness affects those under the poverty line this is a considerable issue. All of these factors point to how impactful and important mental health is.

Solvability: The main barriers to progress in this area seem to be lack of awareness and education, as well as a lack of funding by the government, both which are seemingly tractable and relatively straightforward to solve. However, other issues such as in research into medications, this report is highly uncertain how solvable they are.

Future Predictions:

There are several new technologies which are currently being investigated which may assist in identifying a prediction of a person's likelihood of suffering from some sort of mental health disorder. These approaches use machine learning to take a snapshot of a person's clinical history and identify if they are likely to suffer from some sort of mental health problem. In addition to seeking out people in need, these algorithms can help identify some of the core influencing factors which make one more likely to be mentally ill, which can give guidance to professionals on what factors need the most attention in fixing or accounting for.

More generally, levels of education and government spending have been increasing significantly in the last few years, which suggests a positive trend towards trying to support those who suffer from mental health issues. Mental health spending was at \$420 per person, an significant increase overall from \$396 in 2014. Below is a graph which shows spending trends per capita since 1992 [46].



That being said, there have been general increases in the amount of reported mental illness, however how much of this is due to less social stigma surrounding seeking help or worsening mental health is unknown. 1.5 million more people stated that they experienced mental illness in 2017 than in 2016 in a US study by Mental Health America. The same study found that suicide ideation was also increasing, 0.15% from 2016 - 2018 in particular [52].

Suggestions to mitigate risk

- Especially considering the recent stress caused by lockdown, more money needs to be put into mental health by the government to allow for more medicare governed therapy sessions, and similar initiatives. As discussed above, mental health disproportionately affects the poor - so governments need to have systems in place to support those who can not afford treatment.
- More education in schooling about recognising and destigmatising mental health problems. Education on mental health means that more people understand it, and have less shame associated with coming forward and seeking help. Considering some of the disparity in suicide rates, perhaps some content directly targeted at at risk groups (LGBTQI people for example), would also be particularly effective [49].
- Working to minimise the gap between the poor and wealthy to reduce high rates of mental illness exacerbated by poverty.
- More researchers into neuroscience and psychology to help determine the cause and best treatments of some of the most common mental health disorders.
- Sending more aid and professionals to third world countries where they have less access to mental health services.

Civil disillusionment

Introduction

While arguably negative in itself, a discontent population exacerbates and leads to several other widespread problems. Distrust in politicians have led to some of the most violent social upheavals in history - while disillusionment with society can lead to several mental health problems. Online propaganda and misinformation makes people violent and skeptical of scientists, as well as leading to increasingly polarized political binaries. In this risk portfolio we explore the cause behind these examples of disillusionment and how it can lead to unrest.

Defining the problem

There are several smaller problems which this report aims to explore under the general banner of civil disillusionment. They are:

- Distrust in experts: In recent years, the public distrust in scientists has been on the rise [53]. From anti-vaxxers to the hundreds of misleading dieting claims easily accessible through the internet, there is a general cultural trend which embraces misinformation and is skeptical of research.
- Rejection of current politics: The majority of Americans believe that their trust in the federal government - and each other incidentally, has been shrinking [54]. This speaks to both the growing dissatisfaction in governments and in the effect of an ever widening gap between the politics of the left and right.
- Civil unrest: There have been many examples of intense social movements in recent years, with protests continuing even in pandemic times. The intensifying force of other

risks in this report have culminated in several movements calling for changes in the status quo, and coinciding violent uprisings. Whether or not these protests are justified, their existence speaks to an issue in civilian happiness and underlying, systematic issues.

Why is the problem happening

There are several possible reasons for the increasing phenomenon of civil disillusionment, some general and some tied to specifics. Some potential culprits are expanded on below:

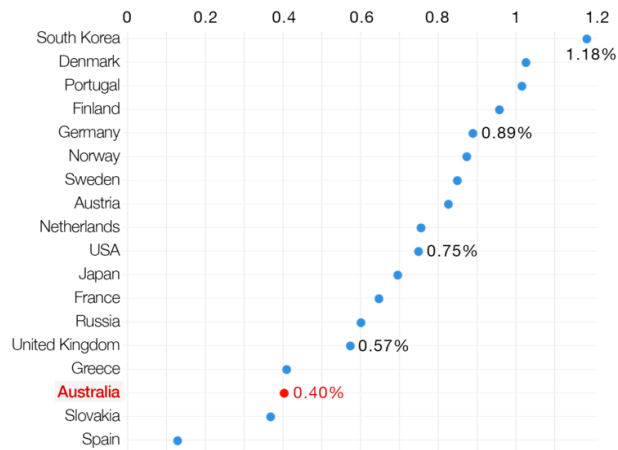
- The media: There's several instances which have stuck in the public eye which has influenced public perception of science negatively - Chernobyl and the Challenger space disaster spring to mind immediately. The way that the media paints these disasters influence public trust immensely. The desire for journalism to give "both" perspectives in a debate, whilst admirable on the surface, sometimes creates the illusion of a scientific debate - climate change is an example of this. This creates the idea in the public eye that scientists are confused or divided. The media also plays an integral role in adding to distrust in politics and exacerbating political divide, as they often present an exaggerated or biased view of events in order to better appeal to their viewers - as profit based organisations are incentivised to do.
- The internet: The internet gives a voice to everyone, and also provides a way for like minded people to connect. This has many positive effects, but also allows extremist groups to congregate and advertise their beliefs. This phenomenon can heighten peoples distrust in authority, and radicalise their political perspectives as they fall into social bubbles online. Misinformation also plays a part in a general distrust in society - research shows that most people struggle to tell the difference between misinformation and facts [55].
- Political incompetence - an increasing number of voters feel that politicians are not doing the job correctly, and feel they have to take action into their own hands. This contributes to civil unrest and a general distrust of politicians. Many people feel that current experts or leaders are not prioritising the correct things or are motivated by a sense of personal profit or greed rather than a want to do the best by their people.

Justification for position on this list

Neglectedness: This area is seemingly quite neglected. Not much public spending is put into neither science nor education, both of which seem relevant to an aspect of the civil disillusionment [56]. Other aspects are hard to measure quantitatively, but seem to be difficult to influence directly. The below graph is the amount Australia spends on research and development in comparison to other countries [56].

Government R&D spending as a % of GDP

Federal expenditure on research and development in OECD countries, 2015



Source: OECD.Stat government budget outlays for R & D
GDP figures taken from EconomyWatch

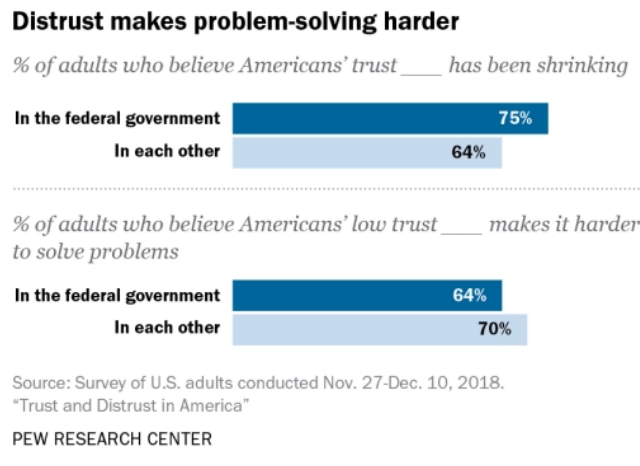
Importance: The World Economic Forum's Global Risks report has placed both youth disillusionment and public distrust in science as some of the top risks impacting the globe in the coming years [57]. A lack of distrust in science leads to dangerous flow on effects, one of the most notable being the rising anti-vaccination movement. Measles had almost been eradicated by the 2000s, but outbreaks started recurring - such as the Kansas 2018 outbreak in which unvaccinated families were key to spreading the disease [58]. A key factor in this was the distrust in the absolute scientific consensus that vaccines are safe and do not cause autism. A similar story can be said of climate change, which had a whole host of risks discussed earlier in this report. A lack of trust in the scientific consensus reached underpins a lot of the reasons policy has not moved faster. A lack of faith in government leads to an inability to let governments implement structural reforms, and run at an optimal, fair level. This affects every decision made in parliament, and the ability of the government to mitigate other risks, marking it as extremely important [59].

Solvability: Lots of the underlying reasons for this unrest are fairly significant and hard to change. There has been much discussion about the public distrust in experts and increasing civil unrest, and while there are some suggestions on how to proceed, much work needs to be done to fix these problems entirely. That being said, there are some things that can be done to mitigate risk, as discussed below, so it is not impossible to impact.

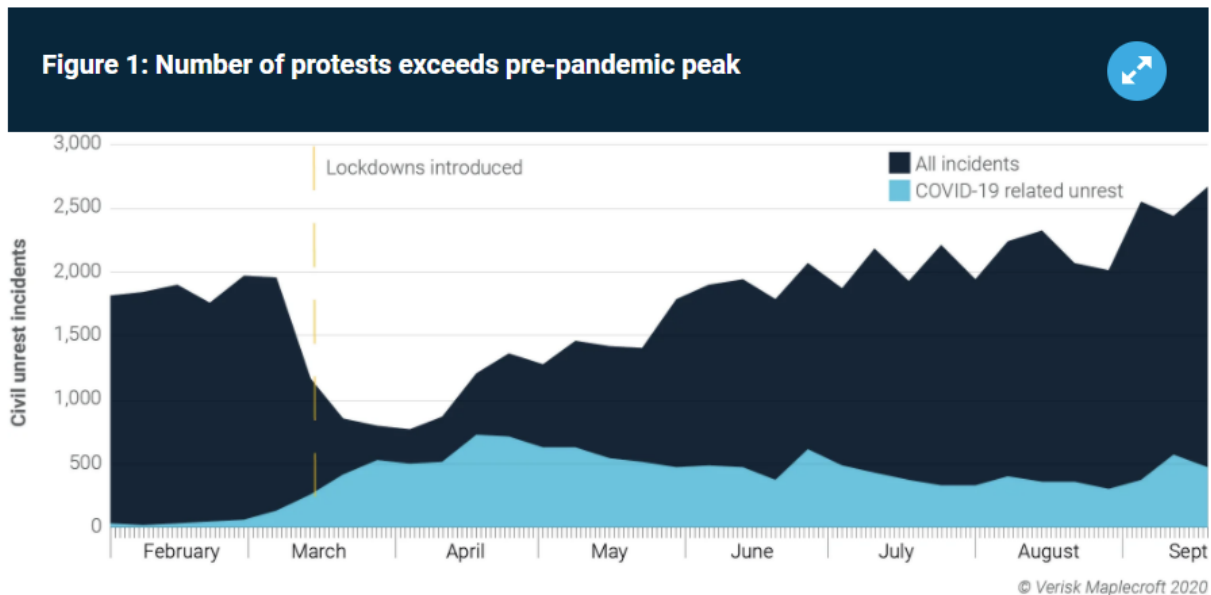
Future Predictions:

As mentioned above, there has been a worsening trend in all aspects mentioned in this profile. On the topic of a weakening of public trust in science, a study in 2006, 41% of respondents expressed a 'lot of confidence' in higher education - contrasted with 14% in 2014 [60][61]. On a similar track, there was a 50% increase in people believing science has "made life more difficult" from 2009 to 2015 [62]. These numbers are concerning, as they seem to point towards more and more distrust in science as time goes on.

It is a similar story with trust in the government. An increasing number of Americans believe that trust in the government is shrinking, the figure below based on research from the Pew Research Centre [54].



This is also true of a rising amount of civil unrest - data shows an expected increase in protests is expected by 75 countries by late 2022. Much of the unrest is being further exacerbated by the stress of the pandemic, as there have been a rise in protests consistently after lockdowns were introduced [63].



Suggestions to mitigate risk

- More scientific literacy promoted in schools - much of the issues coming from a lack of trust in science is made worse by a lack of public understanding about how scientists function, the meanings of theories and hypotheses in a scientific context, an unappreciation of the importance of peer review and so on. More scientific literacy would

give a new context to how people approach and understand the world and prevent anti-science ideas from taking root in a newer generation.

- Increasing incentives for politicians to be more transparent with citizens - and encouraging them to spend more time increasing their public image.
- Introducing safe-guards and restrictions on the internet to catch misinformation and disbanding extremists groups online. This could be achieved through the use of artificial intelligence, and tightening content allowances on social media sites.
- More research into how governments can promote a trusting relationship with their people, and how to best combat violent civil unrest while still promoting the free will of individuals to protest and express their ideals.
- More public fundraising and initiatives supporting scientists and publicly painting science in better light - much of the negative associations with science seemingly rises from bad media presence, therefore utilizing media to raise public perceptions should also be effective.

Global catastrophic biological risks

Introduction

Diseases have swept our globe throughout history, consistently leading to massive amounts of death and catastrophe. This is a fear which was exacerbated by the increasing globalisation and interconnectedness of the world through trade, allowing disease to spread much faster than any other point in history. This, in addition to the march of biotechnological progress which allows society to create even more deadly engineered viruses than before, set the stage for pandemics being a considerable risk to humanity even before the widespread disaster wrought by the COVID-19 pandemic.

Defining the problem

In addition to the current coronavirus pandemic, there have been several examples of devastating diseases throughout history. Some examples of the worst are below:

- The Plague of Justinian: this disease occurred between 541-542 CE, and the initial outbreak is estimated to have killed around 6 million (3% of the world population at the time). It was theorised that it originated in Asia and then spread around the Byzantine Empire around the Mediterranean.
- The Black Death: Occuring in 1335-1355 CE, this outbreak killed around 20-75 million people - which was around 10% of the world's population. This outbreak is widely attributed to much of the political upheaval that followed this time.
- The Columbian Exchange: Occurring in 1500-1600 CE, this refers to a series of pandemics including smallpox and paratyphoid that was passed by colonists to Native American population. Shockingly, it is estimated to have been responsible for the 80% depopulation of Mexican native populations over the 16th century, and up to 98% depopulation in the Americas.

- The 1918 Influenza Pandemic: Occurring in 1918 CE, this pandemic killed around 50-100 million, which was around 2.5 - 5 % of the global population. For comparison, this is likely more than the casualties from either World War. [64]
- The Coronavirus Pandemic: This pandemic has currently killed 2.9 million people at time of writing and has likely had long lasting effects on the global economy and mental health [65].

Why is the problem happening

Diseases all have different origins and root causes, as well as exacerbating factors which allow for their mass transmission - including their ideal survival temperature, how contagious they are, the infection period and time were subjects a symptomatic/asymptomatic.

However, there are some factors aside from the nature of the disease that influence the likelihood of a pandemic - both positively and negatively. Some factors which point to pandemics being less impactful/likely are:

- A healthier and more wide spread population.
- Better hygiene and sanitation than in the past.
- More understanding of how disease is transferred and how to create vaccines/treatments.

However, there are also some other factors which points to pandemics being more likely:

- Trade allows for much faster and wider transmission, via air and trade travel for example.
- Greater population density.
- Larger animal reservoirs than other points in history.
- Biotechnical advancements increase likelihood of artificially engineered diseases.

Justification for position on this list

Neglectedness: In March 2020, the estimated expenses spent globally on reducing global catastrophic biological risks in general was estimated at 1 billion by 80,000 hours [64]. No doubt many resources will be allocated to this area due to the current coronavirus pandemic, however, the intensity of which the global was affected by this disease demonstrated a neglectedness prior to this disaster - so it is important to ensure these resources are allocated to the correct causes.

Importance: Pandemics represent not only an incredible global risk as observed by our recent experience in the coronavirus pandemic and a history of similar plagues, but an existential risk if engineering correctly - making it of incredible importance the proper measures be taken to mitigate risks. As discussed above, one disease has caused more global deaths than both world wars. In addition to this, global biological disasters impact the mental health of everyone, especially those who are forced into isolation or quarantine, or who have lost loved ones to disease. Biological disasters also affect trade and the economy, putting those in poverty under even more financial stress.

Solvability: There seems to be several avenues of research to pursue in this area, with many political and scientific avenues in need of adjusting and more input. More research being done

on how diseases spread, as well as more funding being put into increasing global sanitation and correct hygiene are some areas which have a clear path of action.

Future Predictions:

Some scientific work that has been done on modelling the chance of an extinction level risk caused by pandemic pathogens. There is a general estimate that the risk of extinction per century via this method is around 0.00016% to 0.008% [66].

Overall, given such recent and radical changes to public perception of pandemic risk, it is difficult to predict how the future risk of such an event will be adjusted after the global recovery from coronavirus.

Suggestions to mitigate risk

- More researchers in synthetic biology, biological sciences or chemistry in general. These areas have a strong relevance to the field of disease and biological catastrophe, and so encouraging more research in this area will result in more expectations available to advise on risk mitigation.
- More people in policy with an emphasised interest in biosecurity and biodefense. While a more niche field of interest than many politicians have, ensuring that there are experts in power with an understanding of the risk posed by both natural and unnatural disease is integral in having fast acting experts in times of crisis, as well as having powerful advocates for preventative action.
- More research and funding for specifically pandemic related companies, or health security focused institutes in general. A good example of such a company is "The Centre for Health Security".
- More money dedicated to raising standards of hygiene and sanitation globally, to reduce likelihood of disease spreading. The increasing standards of hygiene has been a highly influential factor in the minimization of death via disease seen over recent history - so promoting it globally is likely to have the same effect.
- More advocacy for regulations surrounding animal handling and storage to reduce the likelihood of diseases transferring from animals to humans - many pandemics and otherwise dangerous diseases have originated from bad practise in animal handling [67]. Therefore, having policy directly addressing this issue is important in safeguarding against catastrophic disease.

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