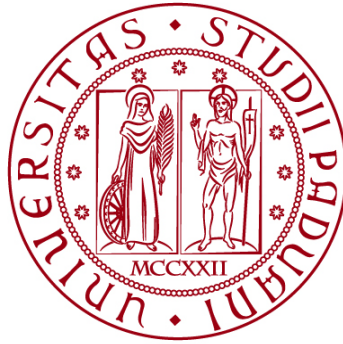




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**VULNERABILITY AS A TOOL FOR LEADING A
FAIR TRANSITION IN THE FIGHT TO
CLIMATE CHANGE**

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Abstract

Increase in frequency and intensity of natural events due to climate change is increasing socio-economic inequality in our societies. Vulnerability addresses how individuals, industrial sectors or systems are affected by such changes and can be used as a tool to guide decision making and planning of prevention and mitigation measures. We have evidence that poorer, more unequal societies suffer the most from climate change, to a point they fall inside a poverty trap. This is due to the self-reinforcing relationship between income disparity and vulnerability to climate change: unequal societies are more vulnerable to natural disasters, which in turn increase income inequality resulting in an even higher vulnerability. In this cases, inequality is further exacerbated.

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1 – Introduction

In the present days we are going through a global and radical transition of the energy system we rely on. The unconscious use of resources and the heavy reliance on fossil fuels coupled with a scarce consideration of the effects of our behaviour towards the environment lead to a series of consequences we call “(anthropogenic) climate change”.

We now know that going on the same way we did in the past 150 years poses a serious threat to the future of mankind and of our environment. Thus, the need of a transition to a more sustainable and carbon neutral energy system relying on renewable energy sources.

This transition, besides the engineering challenges, must consider also socio-economic and ethical aspects to ensure an equitable and just development of all the countries worldwide.

Climate change has already caused disparity, indeed the emission of a minority of nations resulted in distributed changes that affected the whole world, while the benefits coming from those emissions were limited to the few countries that produced them. Understanding how climate change is influencing socio-economic inequality is important to guide the fair transition we are foreseeing.

Therefore we need tools to help policy makers, politicians and engineers to make the most suitable choices. The necessity of these choices to consider social and ethical aspects imply a multidisciplinary approach beyond economics and engineering. One of such tools is vulnerability to climate change, an indicator of how an individual, a community or a system would react to the consequences of climate change.

2 – Objective

This report explores the concept of vulnerability as a key aspect of the relationship between climate change and inequality. The aim is to highlight how climate change-induced natural disasters may increase income disparity and poverty both within-country and between-country and why this is so.

Defining how vulnerability changes at different levels (within or between countries) and the parameters influencing it will help decision makers to act for its reduction, implementing interventions specific for the target, that would ensure adequate protection to climate change considering the current state of unequal susceptibility.

3 – The concept of vulnerability

3.1 – Definition of vulnerability

The IPCC Third Assessment Report defined vulnerability (to climate change) as:

“The degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.” (IPCC, 2001, p. 995) (IPCC Def. 1)

In the same paper follow the definitions of exposure, sensitivity and adaptive capability:

- **Exposure:** “The nature and degree to which a system is exposed to significant climatic variations.”

For example different geographical regions are exposed to different climate events with different frequency and intensity.

- **Sensitivity:** “The degree to which a system is affected, either adversely or beneficially, by climate-related stimuli. The effect may be direct (e.g., a change in crop yield in response to a change in the mean, range or variability of temperature) or indirect (e.g., damages caused by an increase in the frequency of coastal flooding due to sea level rise).”

Some factors that can influence the sensitivity to climate change are: physical and mental health and age (for socio-economic groups); extent to which products and services are affected by climate stimuli (for sectors); health, connectivity and robustness of the ecosystems (for ecosystems).

Together, exposure and sensitivity describe what is addressed as “potential impact”.

- **Adaptive capacity:** “The ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences.”

Some of the factors that could influence adaptive capacity are:

- access and ability to process information
- resources to invest in adaptation
- flexibility of a system to change in response to climate stimuli
- willingness to change and adapt
- ability of species to migrate or for ecosystems to expand into new zones
- available technology.

From this definition we can identify vulnerable regions, communities or sectors and by understanding how the three factors defining it are interplaying we can decide how to act and what to prioritize to decrease vulnerability.

3.2 – Vulnerability and climate change

Extreme weather events are of particular interest since they pose threat to lives and economies. Due to climate change we are experiencing an increase in intensity and frequency of the already occurring natural events thus increasing exposure and so vulnerability.

Natural events are generally labelled as “disasters” or “catastrophes” when there is a loss of lives and or a particular damage to infrastructures. Indeed extreme events always need to be considered as human-related, according to the effects they have on the society. As a matter of fact, for example, early warnings about oncoming weather events may decrease the human toll (decrease of sensitivity, decrease of vulnerability); while lack of insurance policies lead to a bigger impact on families and communities (decrease of adaptive capacity, increase of vulnerability).

3.3 – Vulnerability and poverty

It is clear how disastrous events have different impacts on individuals, sectors and systems: some may be negatively affected while others may even benefit from it. This is due to different vulnerability within regions and countries. In any case, it can be stated that poor people are generally more negatively affected by climate change than the richer as a result of higher vulnerability. This said, we cannot say that higher vulnerability is a characteristic of the poorer strata of the society or of poorer countries in general; in fact, being vulnerability a function of multiple factors, the effects of climate change can be felt by wider social groups and economies.

We can highlight some interesting relationships between income and some factors influencing vulnerability in different countries, thus showing how poor people are more likely to be suffer the most from extreme events.

As we can see from Fig.1, in lower income, developing countries agriculture represents a bigger share of GDP than in richer economies. Dependence on natural resources, greater in lower income countries, results in a higher susceptibility to climate and weather changes. Potential effects (exposure and sensitivity) are bigger, causing an increase in vulnerability.

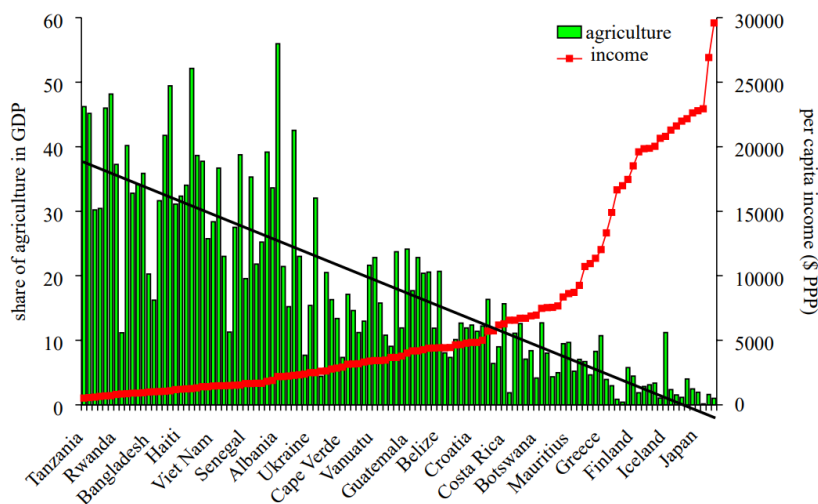


Figure 1 - The share of agriculture in GDP and per capita income in 1995. Notes: For all countries for which such data is available. Countries are ranked by per capita income. (Source: *Distributional aspects of climate change impacts*. Richard S.J. Tol et al.)

Temperature-income chart in Fig.2 shows how higher income per capita are associated to lower mean temperatures. Lower income countries are closer to their temperature tolerance limit. Moreover, even though climate models foresee a higher increase of temperature towards the pole than in the equatorial region, the resulting effect on the mean annual temperature is smaller than the initial temperature difference, Fig.6.

There's evidence that higher mean temperature will increase the gap in GDP between richer and poorer countries. Indeed, higher income, lower mean temperature countries are likely to benefit from an increase in temperature, while poorer, hotter countries will suffer the most being at or close to their temperature tolerance limit. (N.S. Diffenbaugh and M. Burke, 2019)

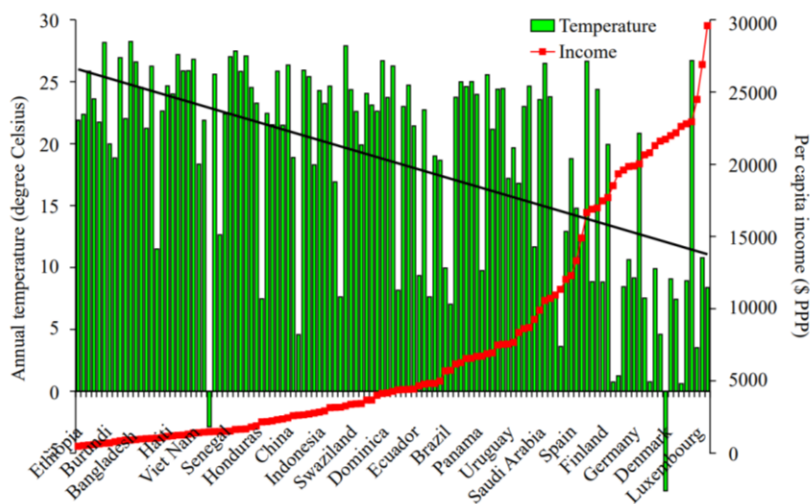


Figure 2 - Annual mean temperature for the period 1961–1990 and per capita income in 1995. Notes: For all countries for which such data is available. Countries are ranked by per capita income. (Source: *Distributional aspects of climate change impacts*. Richard S.J. Tol et al.)

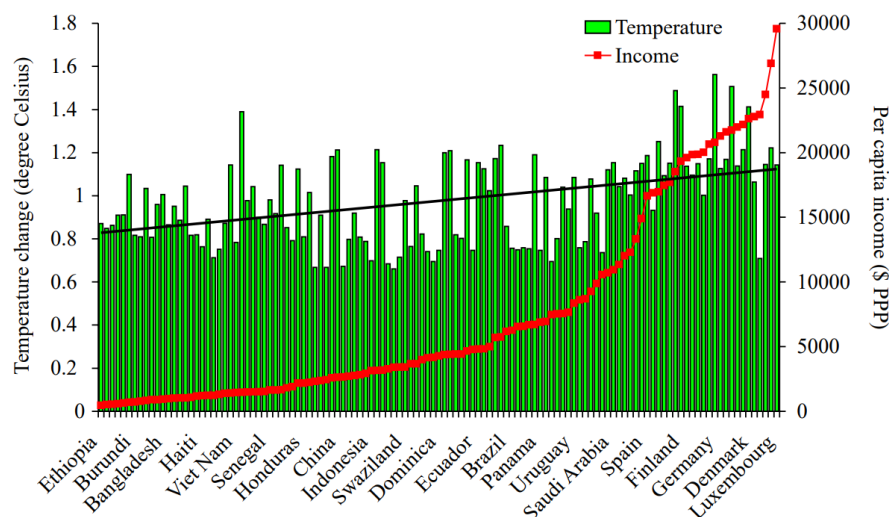


Figure 3 - Change in the annual mean temperature for a one degree global warming and per capita income in 1995. Notes: Annual mean temperature change is averaged over 14 GCMs. Countries are ranked by per capita income. (Source: *Distributional aspects of climate change impacts*. Richard S.J. Tol et al.)

Another aspect to consider is the lower adaptive capacity of lower income countries. They have fewer technologies from still hotter countries to employ to counteract the effect of climate change. On the other hand, higher income countries can rely on bigger investments in prevention measures and better, mature technologies, therefore limiting the negative effects of potentially catastrophic natural events. This implies higher vulnerability for countries with a poorer economy.

4 – Poverty trap

We explained how vulnerability is used as an indicator to assess how much and in which way an individual, a community or a system will be affected by climate change. We understood how societies with higher income inequality present a greater difference in vulnerability within themselves. Indeed, unequal societies are more susceptible and less able to adapt to increased intensity and frequency of natural events.

On the other hand, natural disasters themselves increase income inequality. The lower income tail of the society struggles the most to recover after natural disasters. The increase in frequency and intensity leads to a state of permanent reconstruction where most of the economic and humanitarian efforts are dedicated to recovery, leaving little or no margin for the implementation of adaptation and mitigation strategies. The cumulative effect of repeated exposure is an increase in income disparity.

The mutual correlation for which inequal societies are more vulnerable to natural catastrophes which in turn enhance inequality lead to what is known as a poverty trap where poorer, lower income groups are not able escape their status and inequality is exacerbated.

In this context, developing societies are likely to be negatively affected the most by climate change and the effort they do in improving their economies may not be sufficient to prevent the negative consequences of natural events to a point in which they are not able to escape the poverty trap. This is further supported by research on the trend of damage risk with income.

Kellenberg and Mobarak (2008) showed how there is a non-linear relationship between risk associated to floods, landslides and windstorms and per capita income. In the first stages of increase in income also risk increases before decreasing after a turning point. This inverted-U trend of risk needs to be considered in decision making. The goal of developing economies of eliminating poverty should take into account the higher risk of damage associated with certain natural events. Thus, decision maker should focus on economic development and risk prevention at the same time, reaching a trade-off in investments towards strengthening the economy and reducing damage risks.

5 – Conclusions

The need to cope with and mitigate the effects of climate change on our societies and economies is driving the transition we are in today. A deep understanding of the consequences and the socio-economic mechanisms related to climate change is of crucial importance to develop coping strategies and adaptation measures able to provide just benefit to everyone.

Although it is commonly thought that the effects of climate change are equally shared different individuals, sectors and systems present unequal vulnerability, thus exposing them to different damage risk. This entails that the efforts made to contrast negative effects need to be evaluated according to specific conditions to ensure equal socio-economic development: poorer strata of the society deserve more attention, developing economies must bear in mind increasing risk of damage due to particular natural events in the first stages of economic growth.

The detailed study of the pattern of vulnerability across a region comes particularly important in decision making. In fact, knowing what makes a group of people or an industrial sector more susceptible, whether it be a high potential impact (high exposure or sensibility) or low adaptive capacity, gives a guideline to decide what action should be taken and what is to prioritize.

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