Climate change and social inequality

By: S. Nazrul Islam and John Winkel *

Summary:

This paper offers a unifying conceptual framework for examining the relationship between climate change and “within-country” inequalities, referred here as “social” inequality. Based on the available evidence, the paper conceptualizes this relationship in the form of a vicious cycle, whereby initial inequality causes the disadvantaged groups to suffer disproportionate loss of their assets and income due to the adverse effects of climate change, resulting in greater subsequent inequality. The paper identifies three ways in which the inequality aggravating effect of climate change materializes: (a) increase in the exposure of the disadvantaged groups to the adverse effects of climate change; (b) increase in their susceptibility to damage caused by climate effects; and (c) decrease in their ability to cope and recover from the damage. The paper presents evidence from all across the world and three case studies to illustrate the processes above. It points to future research necessary to fill the gaps in evidence and to the necessity of policies to break the above vicious cycle.

* The authors are affiliated with the Development Policy and Analysis Division (DPAD) of the United Nations Department of Economic and Social Affairs (UN/DESA). Views and opinions expressed are those of the authors and do not necessarily reflect those of the United Nations.
1. Introduction

Inequality has been a constant issue in the climate change discussion. However, the focus so far has been on inequality across countries. Thus, debates have raged and are still raging over differences across countries regarding the climate change “burden” with respect to the responsibility for causing climate change and consequently with respect to the responsibility for mitigation (and adaptation) efforts. The Rio principle of “common but differentiated responsibility (CBDR)” was adopted to resolve the burden issue in general. However, it is difficult to say that the issue has yet been satisfactorily resolved. As a result, climate discussion continues to focus on inter-country inequality. By contrast, the relationship between climate change and within-country or social inequality has not received as much attention.

To be accurate, there were attempts to incorporate within-country inequality in the mitigation discussion. Some researchers did draw attention to the fact that people within a country differ with respect to their GHG emission, and hence the mitigation burden should be distributed not according to country but according to individual (see, for example, Chakravarty et al. 2007). Accordingly, they proposed a GHG emission cut-off and suggested imposition of the mitigation burden on all individuals who were above that cut-off, irrespective of the country in which they lived. Of course, it is possible to aggregate the individual burdens to the country level and revert the discussion to the cross-country framework. However, the resulting cross-country distribution of the burden would then incorporate the within-country inequality dimension.

Though sensible from many viewpoints, the above proposal did not receive much traction, in part, due to the difficulties in measuring GHG emission at the individual level. The international discussion of climate burden therefore continues to be conducted in terms of volumes or averages of GHG emissions at the country level. Furthermore, with the switch to the “voluntary principle” – as embodied by the Paris Agreement – the issue of accurate determination of burden has become somewhat moot. In short, the attempts to incorporate within-country inequality with regard to the cause of climate change in the mitigation discussion did not go too far.

The within-country inequality with regard to the impact of climate change received, as of now, even less attention. The discussion of impact was focused initially on its physical side, i.e. on the impact on nature. With time, the social impact received attention, and evidence was presented regarding the relationship between climate change and poverty. However, the interlinkages between climate change and within-country inequality have not yet been fully explored. This paper aims at overcoming this weakness.

Even in the within-country context, there are many types of inequalities to consider. To make its scope clear, this paper distinguishes inequalities of three levels. At the deepest level are the “primary inequalities,” such as inequalities with respect to asset (capital), race, gender, ethnicity,
religion, and age. Primary inequalities give rise to “secondary inequalities” -- inequalities at the intermediate level -- such as inequalities with respect to income and political power. Primary and secondary inequalities together give rise to “tertiary inequalities,” which are the inequalities at the surface level, such as inequalities with respect to education, health, housing, access to finance, public services, etc. There are obvious direct and feedback relationships among inequalities of these three levels. This paper focuses on inequalities at the primary and secondary levels, and alludes to tertiary inequalities, as and when necessary. However, it does not deal with the policy issue of how the inequalities can be reduced.

Also, the paper uses the term “social inequality” to refer to the within-country inequalities. This is first in the interest of parsimony. Second, the term “social inequality” gets to the heart of the matter more directly and intuitively than the term “within-country inequality” does. Third, regional (spatial) inequality within a country often overlaps with inequality with regard to race, ethnicity, and religion, and finds expression in the form of inequality in income and assets. Hence, it can also be subsumed under social inequality.

Earlier researchers already noted that climate change aggravated inequality, and they provided evidence in support of this claim. However, in absence of a unifying conceptual framework, the evidence has retained a scattershot character. The main contribution of this paper lies in proposing a unifying conceptual framework for studying the relationship between climate change and inequality. This framework helps to present and see the available evidence more meaningfully, identify the gaps in evidence, and point to the future research necessary to fills these gaps. It also helps the policy discussion that may follow.

Based on the available evidence, the paper conceptualizes the relationship between climate change and social inequality in the form of a vicious cycle, whereby initial inequality makes disadvantaged groups suffer disproportionately from the adverse effects of climate change, resulting in greater subsequent inequality. The paper distinguishes three processes through which the above process unfolds. First, inequality increases the exposure of the disadvantaged social groups to the “adverse effects of climate change” (“climate hazards,” for short). Second, given the exposure level, inequality increases their susceptibility to damages caused by climate hazards. Third, inequality decreases their relative ability to cope with and recover from the damages they suffer.

The discussion of the paper is guided by the above analytical framework. Section 2 reviews the progression of the climate discussion from its focus on the impact on nature to the impact on poverty and livelihood, and then on to the impact on inequality. Section 3 presents the analytical framework. Sections 4 and 5 review the evidence regarding inequality’s effect on exposure and susceptibility, respectively, and Section 6 reviews the evidence on inequality’s impact on the ability to cope and recover.
In its final part, the paper presents three case studies. The first focuses on the experience of hurricane Katrina in the USA and shows how inequality increased the exposure and vulnerability of low income and predominantly African-American population to hurricanes, and how they also found it more difficult to cope and recover during and after the hurricane hit New Orleans (Section 7). The second case study focuses on the experience of Bangladesh, showing how inequality forces low income people to live in more flood and cyclone prone areas and suffer disproportionately when these climate hazards actually materialize (Section 8). The third case study focuses on the Sahel region of Africa that is suffering from severe water loss and desertification. It shows how the disadvantaged groups suffer from greater exposure and susceptibility and how they also have less means to cope and recover (Section 9).

The concluding section (Section 10) summarizes the findings in a tabular form showing which particular type of inequality plays what type of role in determining exposure, susceptibility, and ability to cope and recover, and through which particular mechanisms. The discussion of policies needed to break the vicious cycle between climate change and social inequality can take this table as a point of departure.
2. Evolution of the discussion of the social impact of climate change

2.1 Initial focus on the physical impact

The discussion of climate change was originally focused on its physical impact. Relatively less effort was made to trace out the implications of this physical impact for the livelihood and social position of the affected people. As Skoufias (2012, p. 2) put it, “while the eyes of the world have been riveted on polar bears, Antarctic penguins, and other endangered inhabitants of the Earth’s shrinking ice caps, relatively few researchers have turned serious attention – until recent years – to quantify the prospective long-term effects of climate change on human welfare.”

2.2 Discussion of effects of climate change on poverty and livelihood

Over time the broader social impacts of climate change and their feedback effects received more attention. An early study in this regard has been the report brought out by the World Bank (2002) and presented at the 8th conference of the UNFCCC. It noted that climate change was making achievement of MDGs difficult by reducing access to drinking water, reducing food security, and through adverse health effects.


Some studies had a more limited geographical focus. For example, Paavola (2008) focused on the Morogoro region of Tanzania; Somanathan and Somanathan (2009) on India; and Gentle and Narayan (2012) on mountain communities in Nepal. Many studies focused on poverty impacts in specific sectors, such as agriculture (see for example, Ahmed, et al., 2009; Hertel, et al., 2010; Hertel and Rosch, 2010; and Müller, et al., 2011)) or in particular areas, such as urban areas (see for example, Satterthwaite, et al., 2007; Douglas et al., 2008; and Hardoy and Pandiella, 2009).
From broad evidence of the effects of climate change on poverty, research gradually moved to investing the mechanisms through which these effects work. The concept of Share Socio-economic Pathways (SSP) was used to consider the human development aspects of climate change. Hallegatte, et al. (2014) identify four channels through which households may move in and out of poverty – prices, assets, productivity and opportunities – and examine the effect of climate change on each of these. Lichenko and Silva (2014) provide a synthesis, noting that the connections between climate change and poverty are, “complex, multifaceted, and context-specific.” Hallegatte, et al. (2016) provides comprehensive guidance on joint solutions so that poverty reduction policies and climate change mitigation and adaptation policies can reinforce each other.

The contribution of the Working Group II to the IPCC periodical Assessment Reports (AR) also gradually increased its focus on the human dimensions of the climate change impact. Working Group II’s contribution to AR5 (particularly Chapter 13) provides an extensive review of the evidence, both statistical and anecdotal, and from all parts of the world, regarding the dynamic interaction between climate change, livelihoods, and poverty.

2.3 From poverty to inequality effects of climate change

Not surprisingly, the discussion of the impact of climate change on poverty often extended to the impact of climate change on inequality. AR4 already noted that “socially and economically disadvantaged and marginalized people are disproportionally affected by climate change” (IPCC 2014, p. 796). Similarly, Skoufias (2012, p. 6) notes that “climate change impacts tend to be regressive, falling more heavily on the poor than the rich.” In the context of the effects of climate change on Brazil, the study notes that “there is significant variation, with already poor regions being more affected than prosperous regions” (Skoufias, 2012, p. 5).

References to inequality are more frequent in the AR5 WGII report. Its overall conclusion is that climate change exacerbates inequalities (IPCC 2014, p. 796). It notes that socially and geographically disadvantaged people – including people facing discrimination based on gender, age, race, class, caste, indigeneity and disability – are particularly negatively affected by climate hazards (IPCC, 2014, p. 796). As noted above, exacerbation of inequality can happen through disproportionate erosion of physical, human, and social assets. AR5 WGII finds evidence with regard to each. Even climate change adaptation expenditure is often found to be driven more by wealth than by need, so that these expenditures end up aggravating inequality (Georgeson, Maslin et al. 2016).
2.4 Deficiencies of the discussion of the linkages between climate change and inequality

Despite the progress above, the discussion of the interlinkages between climate change and inequality suffers from several deficiencies. The most important of these is the lack of a unifying conceptual framework. As a result, the evidence presented has a scattershot character. AR5 itself recognizes this deficiency, noting that “despite the recognition of these complex interactions [between climate change and inequality], the literature shows no single conceptual framework that captures them concurrently” (IPCC, 2014, p. 803, italics added).

Second, the evidence provided so far is often of indirect and conjectural nature. In many cases, the discussion remains limited to general statements. Often the evidence provided is location and impact specific, and extrapolations are made on its basis. Relatively few studies have attempted to examine directly the effect of climate change on inequality.

This paper aims at addressing some of the above weaknesses. In particular, it offers a unifying conceptual framework for the discussion of interlinkages between climate change and social inequality. Such a framework helps to present the evidence in a more logical, organized, and meaningful way. It also helps to identify the gaps that exist in the evidence gathered so far, and thus to point out future directions of research necessary to fill these gaps.
3. Analytical Framework

3.1 “Climate change – inequality” vicious cycle

The evidence gathered so far suggests that climate change and inequality are locked in a vicious cycle, whereby climate change hazards aggravate inequality (Figure 1). The way this cycle works is as follows. Multidimensional inequalities lead to increased exposure and vulnerability of the disadvantaged groups to climate hazards. As a result, the disadvantaged groups suffer disproportionate loss of income and assets (physical, financial, human, and social), making inequality worse, and thus perpetuating the cycle.

**Figure 1: Inequality and climate change vicious cycle**

The scheme in Figure 1 does not take into account the feedback effect of inequality on climate change. It rather treats climate change effects as external (or exogenous). However, as discussed in detail in Islam (2015), inequality exacerbates climate change in different ways. For example, among developed countries those with higher inequality tend to have higher per capita levels consumption and waste generation, leading to greater levels of GHG emission. Higher economic inequality also leads greater political inequality, which conduces to adoption of more GHG-intensive consumption and production patterns, thus aggravating climate change (to be elaborated further later).
Once this feedback effect is taken into account, climate hazards become, in part, internal (or endogenous), and we get a reinforced vicious cycle between inequality and climate change (Figure 2). Though this feedback effect is important, it is not discussed in this paper (to keep its scope manageable). Instead, the paper focuses on examining the direct loop.

Figure 2: Reinforced vicious cycle between inequality and climate change

![Diagram showing the cycle between inequality, climate hazards, and policies skewed toward GHG-intensive consumption and production]

3.2 Three effects of inequality

Evidence and introspection show that inequality exerts its adverse effect on the disadvantaged groups through the following three effects (Figure 3):

a) increase in the exposure to climate hazards,
b) increase in the susceptibility to damage, and
c) decrease in the ability to cope and recover.
Inequality increases the exposure of the disadvantaged groups to climate hazard. For example, inequality frequently compels the disadvantaged groups to live in areas that are more prone to climate hazards, such as flooding, erosion, cyclones, etc. Similarly, inequality makes the disadvantaged groups more susceptible to the damages caused by climate hazards. For example, of the people living in coastal areas, disadvantaged people living in houses built with flimsy materials suffer more damage due to flooding and hurricanes than those who can afford to build houses with strong materials (brick and concrete). Finally, inequality decreases the ability of the disadvantaged groups to cope and recover. For example, while the rich may buy insurance and thus get compensated for the losses, the poor cannot afford such insurance and thus have to absorb the entire loss, undermining their asset position.

3.3 Economic and political channels of influence of inequality on differential effects of climate change

The three effects of inequality noted above can be transmitted through two channels, namely the economic channel and the political channel (Figure 4). The economic channel works through reduction of private resources available to the disadvantaged groups. For example, in an unequal society, the disadvantaged groups have less income from their own resources, and hence they cannot but be more exposed and susceptible to climate hazards and be less capable to cope and recover.
The political channel, on the other hand, works through the state power. In an unequal society, the rich and powerful (who own most of the productive assets of the country) usually capture the state and skew the policies in their favour. As a result, the disadvantaged groups receive relatively less of public resources to deal with climate hazards.

**Figure 4: Economic and Political transmission channels of the effects of inequality on disadvantaged groups**

Boyce (1994, 2003) offers a formalization of the political channel through which inequality aggravates environmental degradation, including climate change. He points out that in reality social decisions are not based on maximization of the simple sum of utilities of different members of the society. Instead they are based on a weighted sum, in which the utilities of the rich and the powerful get greater weights, resulting in Power Weighted Social Decision Rule (PWSDR). Unfortunately, the GHG-intensive activities serve more the utilities of the rich and the powerful, who can also shield themselves from the adverse effects of climate change through greater protection. As a result, inequality leads to public policies that leave the poor and other disadvantaged groups more exposed and vulnerable to climate hazards. As noted earlier, even adaptation policies often benefit the rich and powerful more than the poor and disadvantaged.

**3.4 Direct physical vs. indirect, market-mediated effects of climate hazards on the income and asset position of the disadvantaged groups**

Finally, the evidence and introspection also show that the disadvantaged groups suffer disproportionately from both direct and indirect effects of climate hazards (Figure 5). For
example, the destruction of crops by climate change induced flooding is a direct effect. However, the flood may also cause the general food price level to rise, causing additional difficulties for the disadvantaged groups, who have to buy food from the market. Similarly, climate hazards may lead to rises in insurance premiums, making it even harder for the disadvantaged groups to buy insurance coverage.

3.5 Different types of inequalities

In the voluminous discussion on climate change, many different types of inequality have been put forward as relevant. To make the scope of this paper clear, it distinguishes inequality at three levels. At the deepest level are the “primary inequalities,” such as inequalities with respect to asset (capital), race, gender, ethnicity, religion, and age. Primary inequalities give rise to “secondary inequalities.” For example, asset inequality directly leads to income inequality. Asset inequality is also the most important determinant of political inequality. Income and political inequalities can therefore be examples of inequalities of the intermediate level. Primary and secondary inequalities together give rise to “tertiary inequalities,” which are the inequalities at the surface level, so to speak. These include inequalities with respect to health, education, housing, access to finance, public services, etc.

Among all primary inequalities, the inequality with regard to assets has a special role. Assets, in turn, can be of different types, such as physical, human, financial, and social. As noted above,
assets generate income. This is obvious for physical, human, and financial assets. However, even the worth of social assets is determined to a large extent by whether or not these can be translated -- directly or indirectly – into income at times of necessity.

The inequalities of the three levels are related through feedback connections too. For example, while assets generate income, they themselves are the outcome of accumulation of saved income. This is obvious for physical, human, and financial capital. However, building up social capital also requires income. Similarly, while asset inequality gives rise to political inequality, the latter may aggravate the former through the PWSDR noted above.

This paper focuses on the relationship between climate change and the primary and secondary inequalities. It alludes to tertiary level inequalities too, as and when necessary. However, it does not go into their details and leaves them for papers focused on policies.

Finally, the paper uses the term “social inequality” to refer to the within-country inequalities. This is because, first, it is more parsimonious. Second, the term “social inequality” gets to the heart of the matter more directly and intuitively than the term “within-country inequality” does. Third, regional (spatial) inequality within a country often overlaps with inequality with regard to race, ethnicity, and religion, and finds expression in the form of inequality in income and assets. Hence, it is not unreasonable to subsume it too under the term social inequality.

Other classifications of inequality are also available, and they have their usefulness for particular contexts and purposes. For example, a distinction is often made between inequality in opportunity and inequality in outcome. In terms of the classification above, the latter is close to inequalities of the tertiary level, while the former is close to primary and secondary inequalities. Sometimes, the term “structural inequality” is used to refer to inequality in assets. This would make it a particular type of primary inequality. The use of different terminologies should not be a problem, as long as their meaning is made clear.

3.6 Different types of climate hazards

As noted above, this paper uses the expression “climate hazards” as a short hand for the “adverse effects of climate change.” This is for parsimony, and not to deny that there can be adverse climate events that are not caused by climate change. It may be noted in this context that increased climate variability is one of the well-recognized consequences of climate change. Hence, the expression “climate hazards,” as used in this paper, includes “climate variability” in it. Also, there are natural disasters – such as earthquakes and tsunamis -- that are not caused – at least not directly -- by climate change. These also often end up having inequality aggravating effects, similar to those of climate hazards. However, the paper does not include their discussion in its scope.
In answering how inequality affects exposure, susceptibility, and ability to cope and recover, it is useful to identify and classify the “climate hazards”. One way to do so is presented in Figure 6.

**Figure 6: Classification of climate hazards**

- **Climate hazards**
  - Sea level rise, submergence, salinity, coastal flooding and erosion
  - Desertification, drought, heatwaves, scarcity of water
  - Extreme weather events: cyclones, hurricanes, tornadoes, etc.

In this classification, hazards are divided into three categories, depending on their particular impacts and the ways in which they manifest. The first of these has the general characteristic of increase in water. The second, decrease of water. The third comprises extreme weather events. However, there are other ways of classifying the climate hazards too.

Climate change itself is a slow process. However, the hazards that this slow process is creating have different time frequencies. From this perspective, climate hazards may be classified into fast and slowly occurring hazards. Examples of slow onset hazards include sea level rise and desertification. By contrast, extreme weather events, such as cyclones, floods, heatwaves, etc. are examples of fast onset hazards. Climate hazards may also be looked from the viewpoint of spatial scope and be classified into “local” and “global.” Again, the extreme weather events – such as hurricanes and flooding – are generally of local scope, though very intense. By comparison, sea level rise, salinity intrusion, and desertification are generally of much larger spatial scope.
3.7 Analytical framework and discussion of the paper

Having set out the analytic framework above, it is now possible to consider the evidence regarding inequality aggravating effects of climate change. The discussion of the evidence is organized using the proposed analytical framework. Thus, it classifies the evidence in terms of effect on exposure, susceptibility, and ability to cope and recover. In some cases, the evidence represents combination of several effects. These are mentioned at the end of section 6.

The evidence presented often concerns extreme weather events. This is in part because these events have sharp cut-off points regarding their timing. Also, they draw more attention and are more amenable to before-and-after impact study. By contrast, the slow-onset hazards are more diffuse and prone to confounding factors. However, that does not mean that slow onset hazards are less important from the viewpoint of the inequality reinforcing effect of climate change.
4. Effects of inequality on exposure to climate change hazards

In general, exposure tends to be determined primarily by location of dwelling and work. Given the location, however the exposure is influenced by the nature of work and livelihood. Both economic and political channels of influence of inequality play a role in determining the location and livelihood.

4.1 Greater exposure to flood, erosion, salinity, mudslides, etc.

According to Neumann et al. (2015), a significant part of the population in developing regions live “low-elevation coastal zone” and 100-year flood plain, and their number is increasing in both absolute terms and as proportion of the population (Table 1). A large percentage of the populations of low elevation coastal zones are rural – 84 per cent in Africa, 80 per cent in Asia, 71 per cent in Latin America and the Caribbean and 93 per cent in the least developed countries. In general, coastal and near-shore habitats are expected to be exposed to greater effects on their ecosystems as a result of climate change and climate variability (Barbier, 2015). Generally, it is the poor and other disadvantaged groups, who find themselves compelled to live in these areas, because they cannot afford to live and earn their livelihood in safer areas.

<table>
<thead>
<tr>
<th>Region</th>
<th>Population</th>
<th>Low elevation</th>
<th>100-year flood plain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region</td>
<td>2000</td>
<td>2030</td>
<td>2000</td>
</tr>
<tr>
<td>Africa</td>
<td>811</td>
<td>1562</td>
<td>54</td>
</tr>
<tr>
<td>Asia</td>
<td>3697</td>
<td>4845</td>
<td>461</td>
</tr>
<tr>
<td>Latin America &amp; Caribbean</td>
<td>521</td>
<td>702</td>
<td>32</td>
</tr>
<tr>
<td>Total</td>
<td>5029</td>
<td>7109</td>
<td>547</td>
</tr>
<tr>
<td>Least Developed Countries</td>
<td>645</td>
<td>1325</td>
<td>93</td>
</tr>
<tr>
<td>World</td>
<td>6101</td>
<td>8626</td>
<td>625</td>
</tr>
</tbody>
</table>

Source: B. Neuman et al., 2015, tables 4 and 5 (scenario B). Scenario B is based on projections from UN population data at the “low end” of global population growth, meaning global population is expected to be 7.8 billion by 2030. It also assumes inclusive social, political and economic governance. In other words, the most generous of the four scenarios examined in the paper – the other three have higher estimates.
It is also instructive that more people now live in deltas, which are frequently subject to flooding of both types -- coastal flooding due to sea level rise and river flooding due to higher precipitation (Table 2). Researchers find that more of the people living in the precarious parts of the deltas belong to the disadvantaged groups (Lou et al. 2015 and Brouwer et al. 2007).

**Table 2: Deltas in developing regions (in countries with population greater than 2 million people)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Population living in deltas (2015 estimates, in millions)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Africa</strong></td>
<td></td>
</tr>
<tr>
<td>Nile (Egypt)</td>
<td>49.2</td>
</tr>
<tr>
<td>Niger (Nigeria)</td>
<td>31.5</td>
</tr>
<tr>
<td>Limpopo (Mozambique)</td>
<td>4.4</td>
</tr>
<tr>
<td><strong>Asia</strong></td>
<td></td>
</tr>
<tr>
<td>Ganges-Brahmaputra (West Bengal-India/Bangladesh)</td>
<td>166.2</td>
</tr>
<tr>
<td>Mekong (Viet Nam)</td>
<td>35.2</td>
</tr>
<tr>
<td>Changjiang (Yangtze)(China)</td>
<td>33.1</td>
</tr>
<tr>
<td>Pearl (China)</td>
<td>27.1</td>
</tr>
<tr>
<td>Huang He (Yellow)(China)</td>
<td>16.6</td>
</tr>
<tr>
<td>Chao Phraya (Thailand)</td>
<td>16.4</td>
</tr>
<tr>
<td>Red (Hong)(Viet Nam)</td>
<td>16.1</td>
</tr>
<tr>
<td>Irrawaddy (Myanmar)</td>
<td>12.1</td>
</tr>
<tr>
<td>Krishna (India)</td>
<td>6.8</td>
</tr>
<tr>
<td>Godavari (India)</td>
<td>5.9</td>
</tr>
<tr>
<td>Mahanadi (India)</td>
<td>4.5</td>
</tr>
<tr>
<td>Indus (Pakistan)</td>
<td>4.4</td>
</tr>
</tbody>
</table>

*Sources: Woodroffe, 2010, Overeem and Syvitski, 2009.*

In addition to flooding and erosion, the people living in coastal areas and in deltas also suffer from salinity intrusion (Dasgupta, et al., 2014 and Rabbani et al. 2013). Shameem et al. (2014) estimate that 70 per cent of farmers in some coastal areas partially or fully ceased farming due to high levels of salinity. Due to their concentration in coastal areas and deltas, the disadvantaged groups are thus more exposed to salinity intrusion caused by climate change.

Greater exposure of the disadvantaged groups to climate hazards is particularly prominent among urban populations. An example of this can be observed in Dhaka, Bangladesh where Braun and ABheure (2011) find that slum dwellers are more likely to be living in areas prone to natural hazards. In general, many slums are located in low-lying land at high risk of flooding.

In many Latin American countries disadvantaged groups are found to set up their dwellings along risky hill slopes, exposing them to mudslides that are becoming more frequent due to climate change (Painter, 2007).
4.2 Greater exposure to drought, heatwaves, water scarcity, etc.

About 40 percent of the Earth’s land surface and 29 percent of the world’s population live in arid, semi-arid, and dry sub-humid aridity zones, which are facing additional challenges due to climate change (Table 3). There is a larger concentration of poor and other disadvantaged groups of people (such as pastoralists and ethnic minorities) in these areas (WRI, 1997).

**Table 3: Dry lands populations (estimations as of 1995)**

<table>
<thead>
<tr>
<th>Region</th>
<th>Population (million)</th>
<th>Dry lands population (million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Africa</td>
<td>720</td>
<td>326</td>
</tr>
<tr>
<td>Americas &amp; Caribbean</td>
<td>1093</td>
<td>182</td>
</tr>
<tr>
<td>Asia</td>
<td>3451</td>
<td>1475</td>
</tr>
<tr>
<td>Developing Regions</td>
<td>4533</td>
<td>1983</td>
</tr>
<tr>
<td>World</td>
<td>5702</td>
<td>2130</td>
</tr>
</tbody>
</table>

*Source: WRI, 1997.*

Two thirds of the global population is estimated to live under conditions where water is severely scarce for at least one month of the year (Mekonnen and Hoekstra, 2016). This exposure is expected to increase with climate change. For example, the number of people exposed to droughts could rise between 9 and 17 per cent by 2030 under scenarios where emissions growth rates aren’t reduced (Winsemius, et al., 2015). Drought exposure is also higher in rural versus urban areas (43 per cent versus 32 per cent, respectively). Given larger concentration of the poor in rural areas, this implies greater exposure to draught for the disadvantaged groups of people.

Cross-country data also points to greater exposure of the disadvantaged to water scarcity. In countries with lower human development indexes (HDI) versus higher, exposure is much greater (50 per cent of low HDI countries exposed versus 14 per cent of very high HDI countries) (Christenson, et al., 2014). Given the higher rates of households engaged in agricultural production in rural areas and low income countries, further increased rates of exposure of these households’ livelihoods to droughts can be expected.

4.3 Effect of inequality on exposure via the political channel

Often the compulsion to live in these precarious areas is of politico-administrative nature, reflecting the political channel of transmission. For example, Mutter (2015) notes that both economic and administrative restrictions led to the concentration of large numbers of disadvantaged people in Irawaddy delta that was hard hit by the cyclone Nargis in 2008. Gender inequality also plays a role in determining exposure to climate hazards. Rural women’s lower asset positions as well as land tenure arrangements and social restrictions limits the land
available to them. This leads women farmers to work on more marginal land which is exposed to greater climate related hazards (Perez, et al., 2015). Often economic and political factors interact and combine to influence the location decision and exposure outcome. For example, economic and racial factors combined in creating the large concentration of poor African American people in the low lying districts of New Orleans before hurricane Katrina (Mutter 2015).

4.4 Livelihood pattern and exposure

Given the location, other factors influence the exposure. Important among them is occupation – for example, whether or not somebody works outdoors and the degree to which the occupation is climate and weather dependent or not. Needless to say, inequality plays an important role in choice of occupation and livelihood too.
5. Effects of inequality on susceptibility to damages caused by climate change

Given the same level of exposure, the disadvantaged groups are generally more susceptible to damage from climate hazards. For example, of the people living in the same floodplain, those with houses constructed of flimsy materials are more susceptible to damage from flood than those with houses made of sturdy materials. Similarly, in an arid area, people having air conditioning are less susceptible to health damages from excessive heat than those who do not have air conditioning. The livelihoods that the disadvantaged groups find compelled to pursue may increase their susceptibility climate hazards.

Confirming the above, Wodon et al. (2014) report that the poorest households in five MENA countries -- Algeria, Egypt, Morocco, Syria, and Yemen – experienced higher losses of income, crops, livestock and fish caught as a result of climate related changes than did the rich households. Lost income reported for the lowest income households was more than double the rate than for the richest (46.37% vs 20.72%). Similarly, Gentle et al. (2014) find that poor households in the middle hills region of Nepal are more susceptible to damages from climate hazards than the wealthy households. Hill and Mejia-Mantilla (2015) show that the poorest farmers in Uganda lost greater shares of income from limited rainfall than the average farmer because of limited options for changing crop patterns, limited ability to apply water saving technology, and limited access to agricultural extension services and water storage sources (UNDP, 2006). Patankar (2015) shows that poorer families in Mumbai required repeated repairs to their homes to secure them against 2005 flood damage, and the cumulative cost often proved much greater as proportion of their income than it was the case for the rich. It is notable that despite lower levels of exposure to Hurricane Mitch in Honduras by poor relative to non-poor households, the poor households reported considerably higher asset loss – 31 per cent for the poor versus only 11 per cent for the non-poor (Carter, et al., 2007).

The poor and other disadvantaged groups are more susceptible in part because of lack of diversification of their assets. For example, the urban poor tend to have their savings in the form of housing stock, which is vulnerable to floods (Moser, 2007). On the other hand, the rural poor often have their savings in the form of livestock, which are susceptible to succumbing to droughts (Nkedianye, et al., 2011). This contrasts the situation of the wealthier households, who are able to diversify their assets, both spatially and financially and are therefore less susceptible to hazards. The greater levels of damage as well as the more limited diversification of savings and assets feed into greater inequality of assets as a result of climate hazards. Greater susceptibility of the disadvantaged groups can therefore lead to widening of future inequality, as children of the poor families are left with diminished future capacities.
5.1 Gender and age inequality and susceptibility

Macchi, et al. (2014) note that lower caste families, women and other marginal groups in Himalayan villages in northwest India and Nepal are more susceptible to climate related effects and are also less able to adapt. The fact that women in many countries are tasked with collecting firewood means that they are both subject to greater exposure as well as susceptibility to damage from climate hazards (Egeru, et al., 2014). Perez, et al. (2015), using household surveys and village focus group studies conducted across nine countries in Africa, find that there are a number of issues affecting women that make them more susceptible to impacts from climate change than men. Among such issues are: limited control of land (in terms of both quantity and quality of land); less secure tenure; less access to common property resources; less cash to obtain goods or services; and less access to formally registered, public and private external organisations that foster agriculture and livestock production. Sherwood (2013) finds that prolonged drought can create poverty traps for women in Gitiamba, Kenya, particularly poverty of time and energy.

IPCC (2014, p. 796) notes that climate hazards increase and heighten existing gender inequalities. This happens because in many cases the women have to perform tasks that are more exposed to climate (such as fetching water from afar or gathering fuelwood from forests). It also reports that flood related mortality in Nepal among girls was twice as high as for women (13.3 per 1000 girls). The mortality was also higher for boys than for men (IPCC, 2014, p. 807-808). These differential impacts apply across a variety of disadvantaged groups. For example, it was found in Vietnam that the elderly, widows, and disabled people, in addition to single mothers and women-headed households with small children, were most vulnerable to floods and storms and slow-onset events such as recurrent droughts (IPCC, 2014, p. 808-809).

5.2 Ethnic inequalities and susceptibility

The degree of susceptibility often depends on the mode of livelihood, gender, age, ethnicity and race. Matin, et al. (2014) provide evidence showing that dominant ethnic groups are able to control resource management and resource use at the expense of other ethnic groups, exacerbating susceptibility of the latter. In Myanmar, poor and minority farmers who make up the bulk of the population in the Irrawaddy delta -- an area that was significantly more exposed to Cyclone Nargis in 2008 -- were more susceptible to damages due to lack of effective warning systems and infrastructure and therefore suffered the most in terms of lost lives, incomes and assets as a result of the cyclone Nargis (Mutter, 2015).

IPCC (2014) notes important role of social positions of different groups in determining the impact of climate change. For example, in many places in Latin America Afro-Latinos and indigenous groups were found to suffer from disproportionate climate effects. (IPCC, 2014, p.
Moreover, differential effect of climate change with respect to race is found in both developing and developed countries, although in both cases low income status may also be intertwined with race and ethnicity status.

5.3 Inequality and susceptibility to health damages

One of the important ways in which inequality increases susceptibility of the disadvantaged groups is through health effects of climate hazards. Hallegatte, et al. (2016) finds that the poor are more susceptible to the diseases that many climate hazards help to spread, including malaria and water borne diseases that cause diarrhoea. This may be due to several reasons. For example, they may be forced to live closer to malaria breeding grounds. They may not have access to piped water sources, forcing them to drink water containing pathogens during floods. For example, residents of low-income slums in Mumbai report greater levels of flooding during the monsoon season, resulting in increased reports of diseases (Hallegatte, et al., 2016). Similarly, disadvantaged people suffer more adverse health effects from heatwaves and high temperatures, because they cannot afford heat alleviating amenities, including air conditioning.

The children and elderly are particularly affected by the adverse health effects of climate hazards. This is not surprising, given their relative fragility. Hallegatte, et al. (2016) reports greater incidence in ailments among children following floods in Ho Chi Minh City.

Heatwaves have notable effects on the elderly, particularly as they are already more likely to suffer from chronic illnesses, such as coronary heart disease or respiratory diseases that can be exacerbated by heat (Hutton, 2008). Elderly people are also more susceptible to greater health effects from floods and are less able to relocate in the event of disasters (Hutton, 2008). Elderly residents of Limpopo, South Africa lacked access to the necessary labour to construct their houses to withstand flooding and therefore their dwellings suffered greater damage (Khandlhela and May, 2006).

Effects on health were noted as a particular concern with regards to impacts of climate change on indigenous populations in Latin America. This has occurred through changes that allow diseases to spread in areas where they could not previously thrive that have led to increases in rates of respiratory and diarrhoeal diseases. It has also exacerbated nutritional issues, which has further feedback effects on health outcomes for these populations (Kronik and Verner, 2010).

The greater susceptibility to health effects frequently undermines the income and asset position of the disadvantaged group in both short run and long run. In the short run they may suffer from loss of productivity, employment and income. In the long run they suffer from loss of human capital (from lost school days, the development of chronic conditions such as stunting, and from
general health and growth impacts, even future morbidity and higher mortality) (Somanathan, et al., 2014; Li, et al., 2016; Zivin and Neidell, 2014).

5.4 Indirect market based effects of inequality on susceptibility

The disadvantaged groups often prove more susceptible via the market and price changes. In the rural areas, the poor and other disadvantaged households generally do not own much land and thus are net buyers of food. As a result, they suffer more from food price increase resulting from climate hazards. By contrast, the wealthy households, owning surplus crop available for sale, may even benefit from the food price increase. In the cities, the poor and disadvantaged groups obviously suffer due to rise in food prices, and since expenditure on food comprises a much larger share of their budget than it is the case for the rich, they suffer disproportionately more (Ivanic, et al., 2012). According to Hallegatte et al. (2016, p. 56), the poorest households in the developing world spend between 40 and 60 per cent of their income on food and beverages, compared to less than 25 per cent of wealthier households.

5.5 Agriculture versus Pastoralists

There are also differences in susceptibility of different population groups, depending on whether they are engaged in agricultural activities or they are pastoralists. This refers both to the types of climate related effects, such as changes in rainfall that may affect crops or forage for grazing animals in different ways, and to the different lifestyles of the two groups. For example, on the one hand, pastoralists’ housing maybe temporary, or less sturdy meaning that they are more exposed to the elements. On the other hand, their way of life may limit their susceptibility because of their ability to relocate if local conditions are not conducive to their lifestyle.
6. Effects of inequality on the ability to cope and recover

Coping and recovery are the third channel through which the “inequality-climate change” vicious circle works. Inequality implies less resources for the disadvantaged groups to undertake coping and recovery measures. These resources can generally take four forms: (i) households’ own resources, (ii) community resources, (iii) resources either provided by non-government organisations (NGOs) or private companies or citizens, and (iv) public resources provided by the government. Disadvantaged groups are likely to be lacking in some, if not all of these resources that are necessary for coping and recovery. As a result, their situation worsens further.

6.1 Recovery trajectories

One way that this plays out is through the recovery trajectory of different groups. In the wake of a disaster, even if one assumes equal exposure and susceptibility to damage between richer and poorer households (which has been demonstrated not to be the case in the two preceding sections) the rate of recovery can be an important factor in inequality. If both rich and poor households recover at the same rate, then inequality will remain constant (see Figure 8). On the other hand, if either rich households are able to recover faster and increase their income further (see Figure 8.a) or poorer households see their earnings growth decline (see Figure 8.b) then inequality will increase.

Figure 8: Differential rates of recovery from climate disasters of wealthy and poor households (based on Mutter (2015) Technical Appendix 1)
There is considerable evidence that the poor see slower recoveries from more pronounced impacts (Verner, 2010; Carter, et al, 2007; Kraay and McKenzie, 2014; Ravallion and Jalan, 2001). These differential recovery rates contribute to increasing inequality. Barbier (2010) and Barrett et al. (2011,) show that the lack of resources forces the poor and other disadvantaged groups to cope with climate hazards in such detrimental ways as put their future adaptive capacity at risk. McDowell and Hess (2012) also reach similar conclusions. In the following, we consider how inequality reduces resources of different types and how that affects their coping and recovery ability for the disadvantaged groups.

6.2 Own resources

Differences in an individual or household’s own resources are obviously an important factor in the ability to cope and recover from climate hazards.

Insurance as a coping and recovery mechanism

An important issue related to coping and recovery is that of insurance. Different groups of the population differ with respect to availability of insurance, which plays an important role in how they can deal with the climate hazards affecting them. Unfortunately, lack of own resources often prevent the poor and the disadvantaged groups from buying necessary insurance. For example, Verner (2010) reports from Latin America that asset losses by households with higher income levels are much more likely to be insured.
Mosely (2015) identifies microinsurance as a possibly viable way of extending coverage to those on the lower end of the asset and income distributions. Microinsurance is generally targeted toward disadvantaged groups and tends to focus on particular risks, most frequently health, but more recently including weather related shocks. The more recent weather related microinsurance schemes have focused on insuring against lack of rainfall as opposed to previous schemes that insured against lack of agricultural income and which were subject to moral hazard. Beneficial impacts of these schemes have been reported, for example, the BASIX rainfall insurance scheme operated in India has been shown to increase both investment by clients and stability of income. However, unlike micro-credit schemes, micro-credit still faces formidable challenges and has not attained necessary expansion of coverage.

**Conflicting choice between physical and human capital**

In coping with climate hazards, the poor and disadvantaged groups often face a difficult choice between protecting their human capital (health and education) and preserving their physical capital. In view of absence of health insurance, these households face large expenses when hit by diseases in the wake of climate hazards. To meet these expenses, they often sell physical assets, thus undermine their future income earning ability (Clark and Dercon, 2015). In addition, poor households in Ethiopia were forced to sell assets during periods where their finances were stressed by drought whereas the more well-off households were not (Little, et al, 2006). After the famines in Ethiopia in 1984-1985, it took a decade for asset-poor households to bring livestock holding levels back to pre-famine levels (Dercon, 2004). On the other hand sometimes poor households reduce their consumption in order to resist asset sales and preserve productive assets (Carter, et al., 2007). This reduction in consumption however can have deleterious health and education outcomes, particularly for children. As mentioned above, this can also lead to transmission of intergenerational inequality (Baez, et al, 2010; Mancini and Yang, 2009).

Similarly, if children are taken out of school, even if this is only as a result of a temporary shock, in Mexico it was found that they are 30 per cent less likely to complete primary school than those children that stay in school (de Janvry, et al., 2006). In Sub-Saharan Africa, asset-poor households are more likely to provide their children with lower-quality nutrition and are less likely to take sick children to medical consultations following weather shocks. This can have long term impacts on these children and their prospects for development (Hallegatte, et al., 2016). In addition, lower income households that have been exposed to weather related risks have been found to be more risk averse, which can impact future income and asset accumulation. These households tend to reduce investment in productive assets and choose low-risk, low return activities (ibid.). All of these patterns are linked to worse outcomes for disadvantaged households and as a result, inequality rises.
6.3 Common property and social resources

Common property resources shared by the community can be an important part of coping and recovery. The poor may treat access to ecosystems as a de facto asset in that they may use goods derived from local ecosystems such as crops, timber and fish for self-consumption, or for the purpose of smoothing income shocks (Barbier, 2010). For example, coastal populations in Bangladesh with closer proximity to mangrove reserves were better able to cope in the wake of Cyclone Aila (Akter and Mallik, 2013). On the other hand, Perez, et al. (2015) note women’s more limited access to common property resources as factor that results in differential impacts from climate change hazards.

The availability and access to social capital can provide households that may have limited access to other resources the means to cope with climate hazards. For example, Braun and Aßheure (2011) find that social capital plays an important role in the ability to cope with floods in Dhaka, Bangladesh.

Ecosystem services as a coping mechanism

Howe et al. (2013) surveyed literature on climate change and ecosystem services and they point to effects on hazard regulation and soil and water regulation in low elevation coastal zones and dryland margins as the main avenues of effect on lower income households. Continuously growing resource stocks such as fish and timber are less sensitive to weather fluctuations than annual crops, which may aid resilience. The use of these types of ecosystem resources can act as coping mechanisms for periods of reduced income, but this can lead to over-extraction and reduced sustainability of these ecosystems (Hallegatte, et al., 2016). Climate change’s effects on these ecosystems will affect their livelihoods and their coping capacity. This may also exacerbate inequality in some regions depending on the degree to which different groups make use of ecosystems for their incomes. Households in tropical and subtropical smallholder systems derive considerable fractions of their incomes from ecosystems, ranging from around 55 per cent in South Asia to 75 per cent in Sub-Saharan Africa. In these communities in Latin America, South Asia and East Asia, the top quintile relies on these services to a lesser degree than all other quintiles, meaning that the highest income residents are least exposed to effects on these ecosystems (Noack, et al, 2015).

6.4 Public resources

The use of public resources for coping and recovery is frequently a function of political dynamics of the society and which groups are in a position to direct resources to their communities. We see examples of this in the case study of New Orleans highlighted below.
whereby resources for recovery were directed to areas with wealthier and whiter populations, despite greater damage in some other areas.

******

The three sections above presented evidence of the inequality aggravating effect of climate change working through increase in exposure and susceptibility and a decrease in the ability to cope and recover. There is also evidence that represents combination of the above ways, without distinguishing the role of the specific ways. For example, using a disaggregated General Equilibrium (GE) model for Ethiopia, Mideksa (2009) concludes that climate change will reduce agricultural production and output in sectors linked to agriculture, and will also raise the Gini coefficient of inequality in the country. Dennig, et al. (2015), running a variant of the Regional Integrated model of Climate and the Economy (RICE), point to greater vulnerability of lower income households to climate change versus higher income households and consequent increases in inequality. Yamamura (2013), using a panel dataset of 86 countries over almost 40 years, finds that the immediate effect of natural disasters – including those related with climate change – is to increase inequality. Verner (2010) shows that the inequality enhancing effect of the natural disasters tends to persist.

Overall, the evidence of inequality aggravating effect of climate change is quite strong. However, in order to make this effect more vivid and concrete, the paper presents in the following three case studies. The first focuses on the experience of hurricane Katarina, the second on floods in Bangladesh; and the third on the water scarcity and desertification in the Sahel region of Africa.
7. Experience of Hurricane Katrina in New Orleans

The experience of Hurricane Katrina illustrates the inequality aggravating effects of climate hazard in the context of a developed country. In particular, it shows how income and racial inequality combined to increase the exposure and susceptibility and decreased the ability to cope and recover by disadvantaged groups comprising mostly the poor African American residents of the city.

7.1 Exposure

Economic and racial inequalities combined to cause the poor African American people to comprise the majority of the residents living in low-lying vulnerable parts of the New Orleans city. By contrast, the wealthier and white residents were more likely to live literally on higher ground (Figures 9, 10, and 11). Both economic and politically mediated influences of inequality, including discriminatory practices, combined to produce this particular spatial distribution of the population. Populations that were in areas damaged by the Hurricane were twice as likely to be African-American (Shrinath, et al., 2014).

Katrina also illustrates the effect of inequality via the political route. While the districts inhabited primarily by white wealthy households had better protective infrastructure, even if their elevation was also low. By contrast, less attention was paid to protection of the areas inhabited by the poor African-American. In fact, it can be argued that the Industrial Canal that runs along the west of the Lower 9th Ward was placed in that particular location because of limited political power of the residents of that area. While other critical infrastructure failed in the hurricane, parts of the Industrial Canal were among the first to fail (Mutter, 2015).
Figure 9: New Orleans Elevation by Neighbourhood

Figure 10: Population identifying solely as African American in New Orleans, 2000

Source: Greater New Orleans Community Data Center

7.2 Susceptibility

The poor African-American and other disadvantaged groups were also more susceptible to damages caused by Hurricane Katrina. The housing stock in New Orleans is considerably older than average, with 41 per cent of houses in 2013 being built before 1949, partly as a result of historic preservation laws (Shrinath, et al, 2014). Houses of the poor African-American and other disadvantaged groups were not only old but also fragile, so that these were totally damaged by the inundation.

Overall, the elderly people were the most impacted by the Hurricane as they were less able to relocate to avoid the damage and were most susceptible to the health related impacts. More elderly white residents were killed, but when demographic issues are taken into account, elderly African-Americans were the most affected (Mutter, 2015).

In general, poorer and minority populations were less able (and in some cases less willing) to relocate given the pre-storm warnings and were therefore more likely to suffer injuries and death. The lack of ownership or access to means of transportation was one significant factor in the probability of relocation. Another significant factor was resources to secure a dwelling to relocate to, both financially and socially. Altogether this resulted in these populations suffering greater degrees across the spectrum than wealthier and white households.

7.3 Coping and Recovery

There were also considerable differences in both opportunities and outcomes for the two groups, with African-American residents much more likely to be poorer and unemployed and also with more limited access to well rated schools, health services and transportation (Mutter, 2015; Finch, et al., 2010).

The slow rescue efforts further exacerbated the damages and overall impacts of the storm, and given the populations most affected, contributed to greater inequality in impacts. Post-storm recovery efforts, particularly the broad city-planning level efforts, continued the trend of increasing inequality. The focus of rebuilding efforts tended to be on wealthier areas. A large scale plan to rezone parts of the city and build new developments neglected the poorer and minority residents’ neighbourhoods and their infrastructure and service needs (Mutter, 2015).

There was also a considerable demographic shift as a result of the Hurricane. While many people of all ethnicities fled the impacts of the storm – both pre and post-storm – there was a significant difference in return rates (Figure 11). Almost 100,000 African-American residents had not returned to Orleans Parish (the city of New Orleans, not the New Orleans metro area) by 2013, versus around 11,500 white residents. This shifted the proportion of the population in the city
that was African-American from 66.7 per cent in 2000 to 59.1 per cent in 2013 (Shrinath, et al. 2014). Social vulnerability and rates of flooding were connected with rates of return three years after the hurricane. Low levels of flooding and low social vulnerability was correlated with high rates of return (93-100 per cent) versus high levels of flooding and high social vulnerability which resulted in much lower rates of return (50 per cent) (Finch, et al., 2010).

**Figure 11: Population identifying solely as African American in New Orleans, 2010**

The overall demographic change reflects a combination of factors including important feedback loops between recovery planning and return of residents. Residents of poorer and more predominantly African-American neighbourhoods were less likely to see their services return and their infrastructure repaired quickly. This resulted in fewer people returning to these areas given their continued state of disconnection and disrepair. This then justified limiting the expenditures on those areas by those planning recovery efforts as part of efforts to direct recovery spending and manpower to areas with larger concentrations of people (see Figure 12). This resulted in perpetuation of inequality both through slower recovery of assets and livelihoods, and through conditions of structural inequality. Poorer and minority residents had

less access to the political processes that were involved in the recovery process. This limited their ability to dedicate recovery efforts to cover the areas where they lived.

**Figure 12: Feedback loops between recovery and rates of return**

It is interesting to note that the Lakeview neighbourhood (see Figure 9, upper left) is also one of the neighbourhoods with the lowest elevation in Orleans Parish, and yet it was able to recover much quicker than other areas. This is in part due to the relative wealth of that neighbourhood. The ability to return to the city also had more persistent effects, as those that were able to return had better labour market outcomes than non-returnees (Groen and Polivka, 2008). This is part of the overall feedback, as those who did not return were much more likely to have experienced severe damages (in monetary terms) from the storm (ibid).

Thus the Katarina experience illustrates how economic and racial inequalities combined to increase the exposure and susceptibility to damages, and how these inequalities resulted in a recovery process that bypassed many of the people who were most affected by the hurricane.
8. Flooding in Bangladesh

Flooding in Bangladesh provides another illustration of the inequality aggravating feature of climate change. Being a delta, overflow of rivers on to the floodplains is a natural and expected phenomenon in Bangladesh (Figure 13). However, climate change is aggravating flooding in several ways. First it is leading to increased volume of summer rainfall (see figure 14 on flooding levels during the 1998 flood). Second, the rising sea level is reducing the gradient, slowing down the pace of recession of floodwater. Rising sea level is also causing coastal flooding and erosion. Climate change is also increasing the number, scope, and intensity of the cyclones hitting its coast. While the entire country is the victim of these adverse effects, it is the poor who are bearing the brunt. Inequality increases their exposure and susceptibility and their ability to cope and recover.

Figure 13: Flood prone areas in Bangladesh, by flood type

Source: Bangladesh Agricultural Research Council
8.1 Exposure

An estimated 20 to 25 per cent of the country is flooded in a normal year, and up to 60 per cent of the country can be flooded under a “100-year” flood event (as happened in 1998). Bangladesh
is notably exposed with 2.3 per cent of its population, amounting to almost 3.5 million people, expected to be affected by river floods in a given year with 4.75 per cent of its GDP affected by inland flooding. The number of people exposed to normal flooding is expected to increase to 9.1 million people by 2030 under moderate climate change, with 2 million of that increase coming from population growth and socio-economic change, and 3.6 million from climate change (Luo, et al., 2015). Under a 4°C warming scenario, by 2040 the combination of sea level rise and storm surges means that an average 10-year return cyclone in Bangladesh could flood an area 80 per cent greater than what would currently be flooded (World Bank, 2013). Roughly the same number of people were exposed to storm surge related coastal flooding during cyclone Sidr in 2007 as are exposed to yearly river floods, and that could increase to 10 million under a scenario of combined climate change and population growth (Dasgupta, and others, 2010).

In general, poorer populations tend to face greater exposure to flooding as a result of their settling in more flood-prone areas. For example, 25 per cent of poor households were exposed to the effects of Cyclone Aila in 2009, versus 14 per cent of non-poor households (Akter and Mallick, 2013). In case of the 1998 flood, 75 per cent of the poor were exposed to the floods, compared to 71 per cent of the non-poor (del Ninno, et al., 2001).

8.2 Susceptibility

The poor and other disadvantaged groups of Bangladesh are not only more exposed to floods, they are also more susceptible to the damages that flood cause. Forty-two per cent of the poor report loss of household income as a result of flooding versus 17 per cent for the non-poor (Brouwer, et al. 2007). The poor also reported greater number of houses with structural damage in the wake of Cyclone Aila. Furthermore, the poor also reported higher levels of damage in dollar terms. This paradoxical outcome was the result of the fact that houses of the poor were constructed using very flimsy materials, so that these houses suffered considerably greater damage that those of the richer households’ houses built of sturdier materials (Hallegatte, et al., 2016).

Furthermore, the poor also suffered more injuries and deaths, thus hurting their both current income and future income earning potential, aggravating inequality (ibid.). In the wake of the 1998 floods, there were higher reported rates of diarrhoea among lower income groups. This was in part due to the fact these groups did not have access to tap water and thus had to drink contaminated floodwater (Hashizume, et al., 2008).

8.3 Coping and recovery

The Bangladesh experience shows that, along with greater exposure and susceptibility, the poor and other disadvantage groups of Bangladesh also have less ability to cope and recover. For
example, in the wake of the 1998 floods, poorer households were forced to borrow greater fractions of their income and at higher rates than wealthier households in order to survive and rebuild (del Ninno, et al., 2001). This resulted in greater debt burdens, thus limiting further limits their efforts to build up assets and human and physical capital.

Furthermore, the poor are often forced to sell assets or over-extract local resources for the purposes of short-term survival in the wake of a crisis or disaster, whereas the wealthier have more consumption smoothing options (Hallegate, et al., 2016). Coping strategies differ, depending on the circumstances. As noted above, some groups may actually resort to asset smoothing, if possible, in the wake of disasters. There is evidence, in this case of impacts on consumption, that wealthier households were able to maintain their calorie consumption in the wake of the floods regardless of whether they were exposed or not.

In view of their limited ability to cope and recover, the poor and disadvantaged groups in Bangladesh often have to face the choice between the options of selling assets or reducing consumption. Poor households who were exposed to 1998 flood reduced their calorie intake by 11 per cent. As a result, 48 per cent of poor households reported to be food insecure as opposed to 16 per cent of all households (del Ninno, et al., 2001). Thus they end up losing either their physical capital or their human capital. Either way, climate hazard weakens position of the poor and other disadvantaged groups further.
9. Water scarcity and desertification in Sahel region

The Sahel region of Africa covers a swath of land across northern Africa, running from Senegal in the west to the horn of Africa in the east. Its boundaries are generally accepted to run along the southern edge of the Sahara desert to the north and the Sudanian savannah to the south. It is predominantly a semi-arid landscape, parts of which suffer from frequent droughts.

The region suffered a dramatic change in climate between the early 1970s and the late 1990s, with a decline in average rainfall of more than 20 per cent (Hulme, et al., 2001) (see figure 16). While initially the change in climate was attributed to overgrazing and other direct human effects on land degradation leading to desertification, more recently it has been established that the change in rainfall was largely owing to broader changes in global surface temperatures (Brooks, 2006).

The region is also notable for having considerable climate variability with relatively extreme shifts between wetter and drier periods. Much of the region also has a high frequency of droughts, over longer time scales (see figure 17). Despite these trends, there is still considerable debate as to the prospects for the effects of climate change, with some areas expected to see increased desertification, other areas expected to see increased rainfall, and some areas uncertain (Met Office Hadley Centre 2010).

9.1 Exposure

Much of the agricultural activity in this area is rain-fed, particularly for asset and income poor farmers. The changes in rainfall noted above have also been accompanied by greater climate variability, particularly increases in summertime and wintertime maximum temperatures (Ben Mohamed, 2009). The evidence for greater exposure to droughts by poorer households in the Sahel region varies by country, with Ethiopia, Nigeria and Senegal showing notable increases and Burkina Faso and Niger showing minor and moderate non-poor biases, respectively (Winsemius, et al., 2015). The percentages of people exposed to drought overall are expected to rise considerably across much of West Africa under high emissions scenarios (ibid.). At the same time, some parts of the Sahel are expected to see increases in rainfall – which will likely result in expansion of agriculture and further displacement of pastoralists (Brooks, 2006).

9.2 Susceptibility

The Sahel is also relatively unique in its coexisting populations of households deriving their livelihoods from agriculture and a sizeable pastoralist population. Overall, the considerable portions of the population in the region are engaged in these or related activities. For example, it is estimated that 90 per cent of all land under cultivation in Mali devoted to subsistence farming
and nearly 80 per cent of the labour force is devoted to either agriculture or fishing (Holthuijzen and Maximillian, 2011). Pastoral communities, which tend to be located in the northern part of the Sahel, appear to be particularly susceptible to climate change owing to greater levels of exposure, more limited coping capacity and instability of their livelihoods (Heinrigs, 2010). In addition, these groups are also susceptible to impacts from desertification as a result of the interaction between climate change and local land use practices (Hein, et al., 2009).

In general, poor farmers tend to be more susceptible to the effects of desertification given their more limited ability to mobilize the necessary resources to adapt to lower levels of rainfall. Existing unequal arrangements that already prioritize water access by private landholders over family farmers means that reductions in available water due to climate change will only exacerbate this inequality (Cotula, 2006). Desertification, increased droughts and land degradation have been implicated in increased income inequality as well as decreases in food security (Abdi, et al., 2013). Many households in the region also rely exclusively on agricultural income, which, given the predominantly rain-fed nature of agriculture in the region, makes them particularly susceptible to climate change and climate variability impacts (Heinrigs, 2010). Lower income households, those with fewer assets, worse health and less education along with those headed by women, have all been shown to be more susceptible to the effects of climate variability and climate change, particularly desertification (Adepetu and Berthe, 2007).

Figure 15: Sahel Precipitation Anomalies 1900-2013

Sahel precipitation anomalies 1900–2013

June through October averages over 20–10N, 20W–10E. 1900–2013 climatology
NOAA NCDC Global Historical Climatology Network data

Source: NOAA Global Historical Climatology Network Data
Figure 16: Water Scarcity in the Sahel 1951-2004

Source: Scholl (2012)
9.3 Coping and recovery ability

It is interesting to note that there are hypotheses that attribute the rise of pastoralism in the region as an adaptive mechanism to, “respond to a rapidly changing, and increasingly unpredictable environment,” (Marshall and Hildebrand, 2002, cited in Brooks, 2006) and past movements appear to be driven by “arid crises” (di Lernia, 2006, cited in Brooks, 2006). Pastoralists in some countries have been marginalized as part of efforts towards economic development (Holthuijzen and Maximillian, 2011). There is notable horizontal inequality between some minority pastoralist populations, such as the Tuareg (Straus, 2011). In addition, population growth and urbanization have increased pressure on food supplies leading to projections of food insecurity for more than 40 per cent of the population (Verhagen, and others, 2003).

In food producing regions in Burkina Faso, adverse rainfall conditions contributed to household participation in non-farm activities (D’haen, et al., 2014) - an adaptive response, but also a change in livelihoods having other potential spillover effects. In general, those who were able to diversify their incomes saw increases in wealth, pointing to this as a worthwhile strategy (Mertz, and others, 2011). At the same time, despite other agricultural adaptation measures, thirty nine per cent of the Burkinabe population remains susceptible to considerable impacts from rainfall variation, forcing migration as another adaptation (Barbier, et al., 2009). There are also instances of divergent coping and adaptation strategies of different populations. In Niger, methods of coping that are favourable to agricultural populations have been detrimental to pastoralists with agricultural activities near pastoralist water resources prioritized (Snorek, et al., 2014). Thus in the Sahel region climate change is aggravating many horizontal inequalities in addition to aggravation of inequality in terms of income and assets.


10. Concluding remarks

This paper considered the interlinkages between inequality and climate change. It conceptualized the relationship between the two as a vicious cycle, whereby initial inequality makes disadvantaged groups suffer disproportionate loss of their income and assets, resulting in greater subsequent inequality. It showed that inequality exerts this influence through three concrete processes, namely (i) increased exposure of disadvantaged groups to climate hazards, (ii) increased susceptibility to damage, and (iii) decreased ability to cope with and recover from the damage. The findings of the paper may be summarized in the form of the following table (Table 4). It rates – using three broad categories, namely “dominant,” “important,” and “less important” -- the role of different types of inequality in determining exposure, susceptibility, and ability to cope and recovery. It also points to some of the important mechanisms through which the role is played out.

As can be seen from Table 4, income and asset inequality plays the dominant role in determining the exposure of the disadvantaged groups. It also plays the dominant role in determining their ability to cope and recover. Inequality regarding race, ethnicity, and religion also play an important role in determining the exposure. However, inequality regarding gender and age has relatively less role in determining the exposure to climate hazards.

Table 4: Summary of interlinkages between inequality and climate hazards

<table>
<thead>
<tr>
<th>Type of inequality</th>
<th>Exposure</th>
<th>Susceptibility</th>
<th>Ability to cope and recover</th>
</tr>
</thead>
<tbody>
<tr>
<td>Income and asset</td>
<td>Dominant role (location decisions)</td>
<td>Important role (poor dwelling conditions and other micro-infrastructure, such as source of drinking water)</td>
<td>Dominant role (lack of resource availability, both private and public)</td>
</tr>
<tr>
<td>Gender</td>
<td>Less important role</td>
<td>Important role (functions performed, such as women having to fetch water and firewood)</td>
<td>Important role (resource availability)</td>
</tr>
<tr>
<td>Age</td>
<td>Less important role</td>
<td>Dominant role (children and elderly being more fragile)</td>
<td>Important role</td>
</tr>
<tr>
<td>Race, ethnicity, religion</td>
<td>Important role (politico-administrative restrictions regarding location)</td>
<td>Important role (politico-administrative restrictions regarding occupation choice and tasks performed)</td>
<td>Important role (discrimination regarding access to public resources)</td>
</tr>
</tbody>
</table>
Gender and age however play an important role in determining the level of susceptibility. So far as the health effects are concerned, age inequality plays the dominant role. Inequality regarding income and assets and regarding race, ethnicity, and religion also play an important role in determining the level of susceptibility.

With regard to ability to cope and recover, the dominant role belongs to income and asset inequality. However, inequalities with regard to gender, age, race, ethnicity, and religion also play an important role.

The summary is presented mainly in terms of the primary and secondary level inequalities. However, as noted earlier, the implications for the tertiary level inequalities can be worked out easily and be used as a point of departure for discussion of policies that can break the vicious cycle and both reduce inequality and build resilience against climate change.

The research on social impact of climate change has only recently moved from focusing on poverty to paying attention to inequality. Direct evidence on impact climate change on inequality is therefore still scarce, in part because rigorous measurement of social inequality is a challenging task, though impressionistic observations are not difficult to make. However, more precise and quantitative evidence on the inequality aggravating effect of climate change is emerging more forcefully, and the conceptual framework presented in this paper may prove helpful for further research in that direction.
References


Luo, Tianyi, Andrew Maddocks, Charles Iceland, Philip Ward and Hessel Winsemius (2015). World’s 15 Countries with the Most People Exposed to River Floods. World Resources Institute


