Emergenza Esclusi. The Emergency of the Socially Excluded
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The Two Worlds in the Anthropocene: A New Approach for Managing and Coping with Climate Change

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Cardinal Turkson, Bishop Sorondo, and distinguished members, I really feel privileged to be part of these important discussions. Early this year I spent about 10 weeks living in villages in India, starting from my home village in South India and travelling all the way up to the North and eating in women's huts like the one you see in Figure 1. Every ten days or so, I would retreat into nearby cities for air-conditioned rooms and other comforts. After shuttling back and forth about three or four times, living in villages for ten days and one day in a big city, I discovered that there are in fact two separate planets or two different worlds, if you may. And of course these two worlds are really co-dependent. Let me call the first one the Top 4 Billion, or T4B: these 4 billion human beings seem to behave as if they have unlimited access to fossil fuels. Unsustainable consumption is their problem. The worldwide discussions about slowing down environmental damage and climate change by reducing the carbon footprint, really applies to the four billion. I'm using the American definition for a billion, which is a thousand times a million. The other three billion, like the woman you see in the photo (Figure 1), the Bottom 3 Billion or B3B, lack access to fossil fuels. What they need is clean energy access. I think, if you read Jeffrey Sachs' book, you will note how energy access is critical for human well being.

This Vatican workshop is about the socially excluded and I must indicate where they belong in the *Two Worlds* model. The socially excluded living in peri-urban areas are still placed under the Top 4 Billion. There are perhaps about 1.5 billion that fall under the category of 'Socially Excluded' and I have included them under the Top 4 Billion, since they have access to fuel. However, they cannot afford it and this is a vital socio-economic problem which is beyond the scope of my paper. So, when we talk about human impacts on the climate, it applies just to the 2.5 billion living in urban areas who are primarily responsible for the emission of CO_2 (carbon dioxide) from fossil fuels, the major contributor to climate change. So what I found was that the 3 billion living in villages have been left behind with no access to modern sources of energy. Those who are living in the slums or shanty-towns of the world of the Top 4 Billion are really those who fled villages

Figure 1.

for better access to energy and well being. I talked to many who fled villages and I interviewed over three hundred women villagers, who are aspiring to move to cities for jobs or better education for their children.

Since climate change is one of the biggest issues in sustainability, let us place the *Two Worlds* discussion in the context of climate change. When we travel in cars we are burning fossil fuels. What comes out of the tailpipe is a colourless gas, we call it carbon dioxide. The problem with this carbon dioxide gas is that once you release it, a fraction of it stays for centuries and accumulates in the atmosphere. We have already accumulated over a thousand billion tons of fossil fuel CO_2 since the pre-industrial era. Skeptics argue that this carbon dioxide has varied in the past, so I'm showing the carbon dioxide concentration over the last 800 thousand years (Figure 2). Of course it has varied, but if you see where it says 'Present', it has shot up three times the normal variation of the last 800,000 years to 400 parts per million parts of air molecules, a record high. This gas, since there are a thousand billion tons of it, surrounds the planet like a blanket. Just like a blanket which keeps you warm on a cold winter night by trapping your body heat, this carbon dioxide traps the heat (infra red radiation heat) coming from the earth and the atmosphere above and heats the earth. This is well-known physics and there's no question about the science behind it. I have been studying this problem

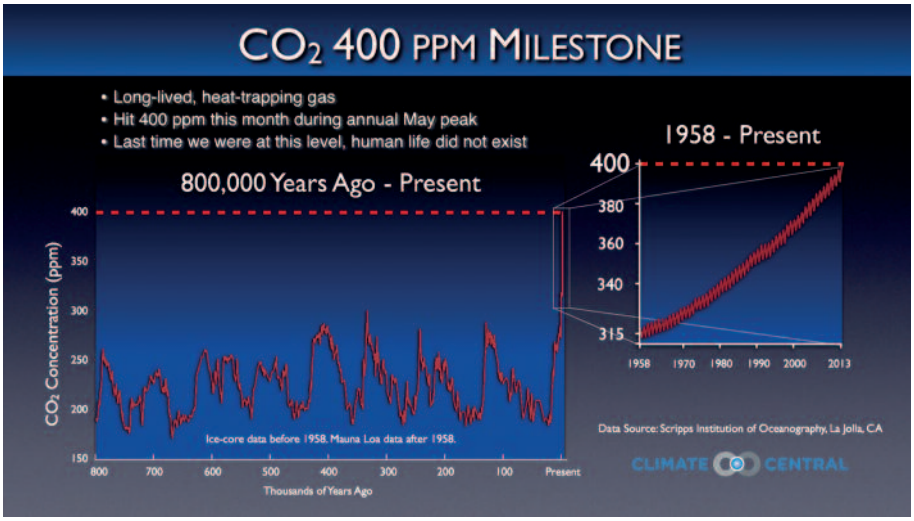

Figure 2. Reproduced from image in Climate Central webpage.

for the last forty years and about five years ago I made a forecast that the planet is likely to warm by about 2°C not two or three hundred years from now, but in less than fifty years from now, by mid-century and by as much as 4°C by the end of this century. So you can ask, why should we care about 2°C, since the weather varies by about tens of degrees in days? Let me give you a perspective of this. I'm showing you (the left hand panel of Figure 3) the variation of the climate over the last 50 thousand years. Climate does vary on its own, significantly, but the problem is that we recovered from an ice age some twenty thousand years ago and were already in the warmest epoch in climate. The fundamental reason for our concern about warming is that we're heating the planet another 2°C. The right hand side shows another 4°C, so warming the planet from an already warm epoch will push the system beyond anything we or the natural system has experienced. We must point out, the planet has already warmed by about 0.8°C since the pre-industrial era, i.e., we are already close to half way up towards 2°C.

What does a warming of this magnitude mean to the socially excluded and to the Bottom 3 Billion? I want to take you through some examples.

Hurricanes

This is of course Hurricane Sandy (Figure 4), which travelled further north than any other storm, and you can see the devastation in the New

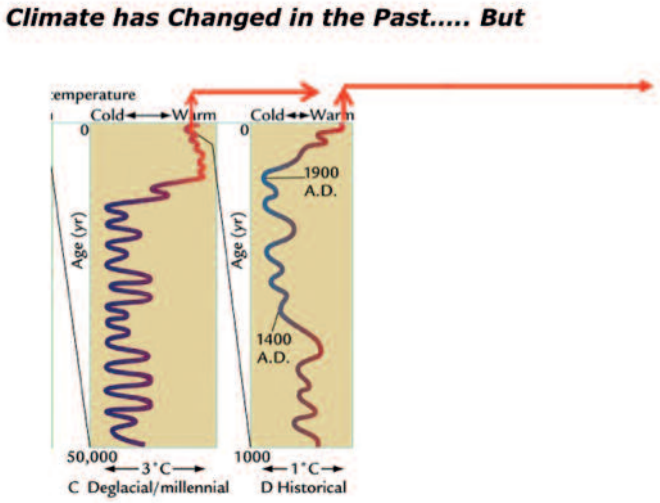

Figure 3. Adapted from W. Ruddiman's *Text Book on Climate*. The time series of temperatures ar an exact reproduction from Ruddiman. The red arrows are inserted by the author.

Figure 4. Downloaded from the Google webpage.

York area due to fires and floods. And the next (Figure 5) is the most recent one, Hurricane Haiyan, which hit the Philippines. Let us ask what is the connection between climate change and hurricanes? Hurricanes have their genesis in tropical oceans. The question that arises is: why not high latitude oceans? Because hurricanes need warmer ocean (warmer than 27°C) to fuel the intense winds. Since the planet including its oceans is warmer by about 0.8°C, the area over which hurricanes can get their energy as well as the area of travel before dissipation is expanding and the energy of the water which fuels the storms is also increasing exponentially with warming. We expect to witness more such intense hurricanes. And in fact there are simulations done by my colleagues (Dr Jeff Kiehl and his colleagues in the US) which show that if the planet heats well beyond 4°C we can see the hurricanes travelling almost up to the North Pole.

Figure 5. Downloaded from the Internet.

Floods

I'm showing you (Figure 6) the Himalayan floods in 2012. I was there until May, visiting villages in these regions. What is the connection of floods with climate change? As we know, warmer air pulls more moisture, that's

Figure 6. Downloaded from the Internet.

why summertime is more humid than winter. When you warm the air, it holds more moisture. This is a fundamental thermodynamic property of water vapour. So the rain in a warmer climate will be more intense. The second implication of warming is melting of snow packs and earlier melting of Himalayan snow packs and glaciers in the season. In fact in a workshop held in this Academy, a rather unique workshop on melting glaciers, we found out from our Austrian glaciologists that the Alpine glaciers have lost ¾ of their volume already, and the Himalayas is just starting to melt. The only major problem with the melting of the Himalayas is that it provides waters for the life-giving rivers of South and East Asia: the Indus, the Ganges, the Brahmaputra and the others rivers in South and East Asia, including the Yangtze River. The early melting and intense rainstorms can give rise to flash floods. In addition, when over 50% of the glaciers have melted the river flow can start to decrease.

Droughts and Fires

The prediction is that regions which get rain will get more rain and regions which are dry, like the subtropics (Sahara is part of the subtropics) will

get drier. The area I live in, southern California is borderline sub-tropics. California is projected to get drier and the California experience is that as the air gets drier, the fires become more intense. I have personal experience California. Just this summer, I planned a vacation with my family in Yellowstone and we had to nearly cancel it, because of the fires. They were raging in Yosemite (further westwards from Yellowstone park in northern California) and spared Yellowstone. We expect more such fires in California. The problem with the fires is that the trees hold enormous amounts of carbon, so the carbon dioxide we put from fossil fuels heats the air, causes more fires, and releases more carbon dioxide. In addition, when the trees burn off, it exposes the soil below to sunlight which will dry it further. If this begins to happen worldwide, it will become an amplifying force of global warming.

How do we solve the problem? We have so far warmed about 0.8 (8/10) of a degree C, since the last two hundred years. We are expecting a warming which is three times that during this century. Fortunately there is still time left to reduce the magnitude of the warming and limit it to a maximum of 2°C. World leaders are advocating cutting down fossil fuel consumption by calling for *decarbonisation and reduction of the carbon footprint*. But fossil fuel consumption and atmospheric loading of CO_2 continues to increase. My studies suggest that 1/3 of the warming is caused by four other pollutants: 1) methane, which leaks out of waste dumps, natural gas, fires; 2) black carbon, which is a particle and is the dark stuff that comes out of diesel trucks and fires; 3) Ozone produced in the lower atmosphere by air pollutants; 4) Hydrofluorocarbons (HFCs) used as refrigerants. Black Carbon is the second largest warming agent, next to CO_2 and methane is the second largest greenhouse gas warmer next to CO_2. Collectively these 4 warming pollutants are referred to as Short Lived Climate Pollutants (SLCPs), because their lifetime in the atmosphere is short compared with the century or longer lifetime of CO_2. The air pollution from sources that emit the SLCPs also causes deaths in millions, destruction of crops in millions of tonnes, melts snowpacks and glaciers worldwide.

The good news is there are technologies to cut their emissions rapidly so we can slow down the warming caused by the other 1/3 of the warming agents within our life times. We basically have two knobs: one knob is dialling down the carbon dioxide and that is a Top 4 Billion problem – the Bottom 3 Billion have almost nothing to do with this carbon dioxide problem. The other knob we have is to reduce the short-lived pollutants and these SLCPs are anywhere between 25 to 4000 times more potent (per tonne of emission) than carbon dioxide and they don't live long, so we can get almost immediate relief, within 10 to 20 years.

I don't expect you to follow this graph (Figure 7) but what we found is that cutting down carbon dioxide, which has to be done, by the Top 4 Billion, is not going to have much of an effect until about 50 years, because of its long lifetime. Meanwhile, climate is rapidly rising. To prevent this 2°C warming in the next 30 to 40 years the most effective, as well as practical way is to cut these other pollutants. We have proposed it to the United Nations Environment Program and they listened. Many nations and leaders including former US Secretary of State, Hillary Clinton, have formed a coalition: the Climate and Clean Air Coalition. Now over thirty nations have joined the coalition and are taking major efforts to reduce the emission of these pollutants. The mitigation of global warming through SLCPs reduction is now widely accepted (by over 30 countries) as a viable and practical policy option.

The main appeal of the SLCPs mitigation strategy is that we don't have to wait for 100+ nations to sign on a piece of paper. Individually we can take steps from the bottom. In what follows, I would like to share with you my attempt at a bottom-up approach for mitigating SLCPs: 1) Reducing emissions of black carbon from rudimentary cook stoves that burn firewood and dung; and 2) Reducing emissions of black carbon from the transportation sector.

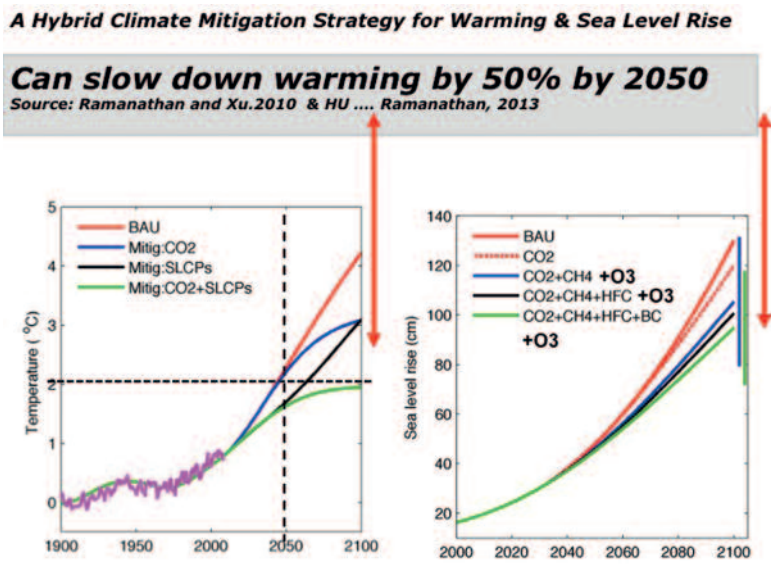

Figure 7.

I was living behind this woman's hut (photo in Figure 1) in central Himalayas. I went there in the morning, as she was cooking in the smoke-filled kitchen. I took her outside and showed her how the smoke is escaping to the air outside into the Himalayas and she was surprised. There are 160 million such homes along the Indo-Gangetic plains burning firewood from the forests just to meet basic needs such as cooking and heating. The next satellite image (Figure 8) shows this haze filling the entire subcontinent like a river of pollution. Over the last two decades, we have demonstrated that this soot (black carbon) absorbs the sunlight, heats the glaciers, disrupts the monsoon and cuts down enormous amounts of sunlight to the oceans so the whole monsoon is slowing down.

I have personal experience with solid biofuel cooking, I have seen my grandmother's kitchen filled with smoke from burning dung and wood and still have vivid memory of her nerve-racking cough after each cooking session. There are over 2.7 billion people who are still forced to burn firewood

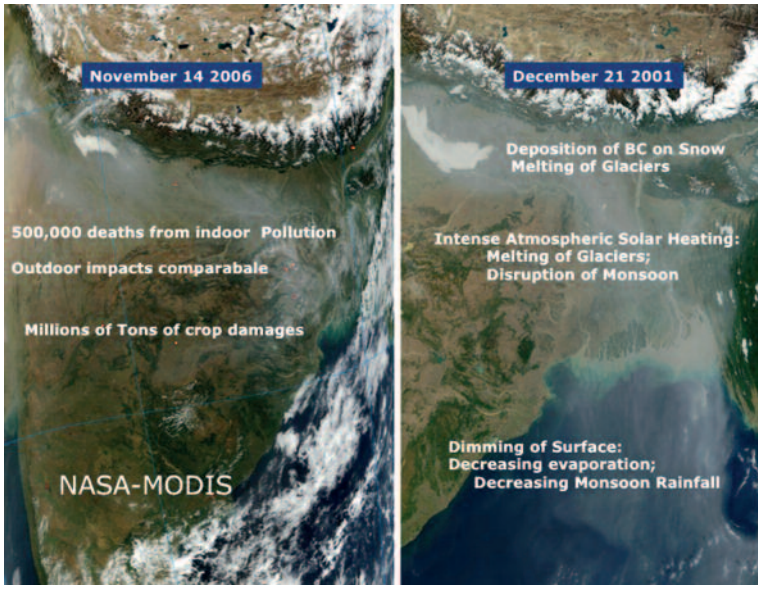

Figure 8. Atmospheric Brown Clouds over S. Asia and the surrounding Ocean and the Himalayan Range. The particles in the brown cloud extend from the surface to as high as 3km over the subcontinent during the winter season. It shows satellite data for one day for 2006 (left panel) and 2001 (right panel). The left panel summarizes impact om health and agriculture and the right panel on monsoon rainfall and Himalayan glaciers and snow packs.

for cooking. About 4.2 million die each year from the cooking smoke. The household air pollution kills about 3.5 million. When that smoke escapes outdoors, it is inhaled by the Top 4 Billion and kills about 1 million in the Top 4 Billion, so the two are co-dependent. That's the bad news. The good news is we know how to solve this problem.

We started Project Surya (www.projectsurya.org), teaming up with social scientists led by Mr. I Hafeez Rehman of TERI, India and engineers led by my daughter, Nithya Ramanathan, who is a wireless technologist and started an NGO (Nexleaf) to work with us on this problem of her great-grandmother. Our objective was to document this cooking, find out which technology helps, and replace it. I'm not going to go into detail but we were able to use cell phones and wireless technologies developed by Nithya to bring down the cost of data collection and do the measurements on a mass scale. Mr Hafeez Rehman and his group tested various cook stoves and developed a particular cook stove technology that still uses firewood (since it comes at no cost to the impoverished women) with a solar operated fan, but reduces the fuel use by a factor of two and cuts down the black carbon emissions by 90%. So it almost took care of most of the pollution problem, but the problem with our technology is that it is too expensive. The improved cook stove cost 70 USD, which is about six weeks of a villager's paycheck. Another major source of pollution and black carbon is the kerosene lamp used for lighting the homes, and we replaced them with solar lamps. So far Surya team members in India have deployed these new technologies in about 1,000 homes.

We have teamed up with the biggest rural bank in India, which gives each woman a loan to buy the stove and solar lamp. The stove temperature is monitored by the cell phone-based sensor and the duration of cooking is inferred from the stove temperature as a function of time. The cooking time is converted to the amount of reduction in CO_2 emissions and in black carbon emissions. The mitigated emission is converted into dollars and the climate credit earned by each woman is sent to her bank account in the bank which loaned her the stove and lamp; she uses this climate credit amount to pay off the loan and interest. Once this procedure is verified during a trial period of two years, Surya will connect each woman to the international voluntary carbon market. We have just started this with 500 homes. Our hope is that after the trial period, the approach can be scaled up to millions of homes. So basically the climate credit money would come from the Top 4 Billion, signing on to the voluntary markets, and offsetting their footprint.

We are also starting a joint programme between California and India, because California has taken pioneering steps to cut its pollution, particularly

black carbon emissions from diesel transportation. California will share its expertise in cutting down global warming pollution from its cars and trucks. We are hoping that such bottom-up approaches will complement the top-down approaches for cutting down CO_2 emissions by the Top 4 Billion.

I want to come back to the *Two Worlds* issue and connect the dots between the various issues I discussed. So let's go back to this Top 4 Billion and Bottom 3 Billion. The carbon footprint of the T4B (I put within parentheses 2.5 B, because remember what I said, the 1.5 billion living in the peri-urban areas can access fossil fuel but can't afford it) – is the biggest threat to B3B's sustainability. They are emitting about 36 billion tonnes per year and scientists like me and other international agencies estimated they have to cut it down by at least 50% for us to have any chance of keeping the warming under control. So the only option we have, either the T4B's carbon footprint must decrease – in other words, they should consume less – or, if they don't want to reduce their consumption, they need to go to renewable energy. So those are their two options. And just to understand, before I take you to the B3B problem, Figure 9 shows the energy consumption (from World Bank publication), so you can see the B3B consume less than 5% and the T4B consume the rest of the 95%. But in the T4B, if

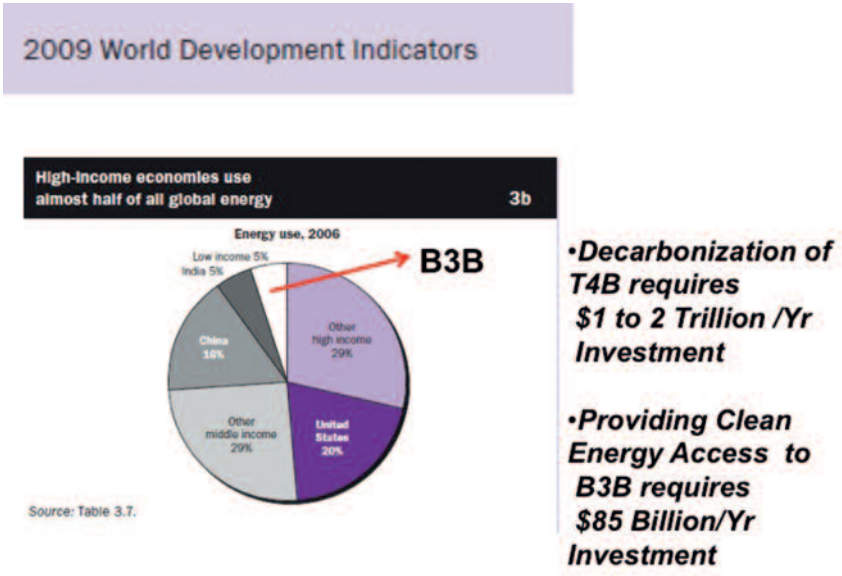

Figure 9. The pie chart is from World Bank Report: World Development Indicators 2009.

you leave out the socially excluded, most of the energy is consumed by about 1/3 of the population, so 2/3 are left behind. Interestingly, decarbonization the T4B requires about 1 to 2 trillion USD per year (International Energy Agency estimate) – this is, again, in American units, a thousand billion USD per year – whereas providing clean energy access to the B3B requires 85 billion USD per year (from IIASA publication by Shonali Pachauri and others), ten times less. These are the rural areas. These are not my estimates, they come from the International Energy Agency and IASA and other institutions. So the scale of the problem, in terms of the money required, is much less to solve the energy access problem for B3B. As you may know, *Sustainable Energy for All* is a movement started by the UN with the personal interest of Secretary-General Ban Ki-moon. The issue we have to remember is that the B3B will soon become the B5B (due to increase in population from 7B to 9 Billion), unless we do something about it, by 2050. If the B3B follow our unsustainable example of fossil fuel consumption, their carbon footprint will increase from less than 1 tonne per year to 4.5 tonnes per year, which is the global average footprint, and their emission alone will grow to 23 billion tonnes. This means the T4B not only have to cut theirs by 50%, they have to figure out what to do about the B3B's 23 billion tonnes per year, because at 23 billion tonnes per year the warming occurring by our expectations would exceed 4°C.

So the case I'm making here is that the T4B for their own sustainability have to help B3B with renewable energy access. Because, when the climate warms by 4°C everyone is going to be affected. We need to help the B3B on the sustainable energy pathway. I discussed the examples of cooking and lighting. I will now add micro-grids of solar power for farming and other small-scale industrial needs, i.e., instead of highly polluting diesel pumps to extract water for irrigation, deploy solar water pumps, which are readily available. The reason I added the farming is that most villages in India can afford to have only one crop per year due to energy and water limitations. The one crop per year, since they have only 5 to 10 acres each, is barely enough to meet their own food demand. They need the second and third cropping for extra income: education, buying other goods, and health care. Their water comes from digging below, irrigation. Amazingly, whereas solar is too expensive for us, for the villagers, solar micro-grids are a much better option since they don't have other power infrastructure. Just to give you an example, there is a school just next to my grandfather's village home. I'd been visiting there in the last 10 years and I had bought them a TV, a computer and two fans: none of them were being used because in that village electricity comes for only three hours every day and the villagers don't

know, which three hours. Sometimes it comes at midnight, sometimes early morning. So I bought them a solar photovoltaic system to power the computer and fans. It cost only 400 USD. That was enough to power the computer, the TV and the two fans. The amazing thing was, I didn't have to go to America or Europe or China to buy that solar system, it was available within just five miles. So solar has penetrated deep into rural areas. Again the problem is affordability. This is where I feel bringing climate change as one other rationale on the table could provide powerful reasoning to have distributed solar systems in the B3B world.

The last topic I want to comment on is the food waste issue. I'm working with the UN Environment Programme and I was shocked to hear that 1/3 of the food produced never reaches the table or the stomach, it's wasted. And we are putting 3.3 billion tonnes of CO_2 per year to produce that wasted food. So saving that food waste not only would feed the B3B, but that 3.3 billion tonnes of CO_2 emitted to produce that food is 1/6 of the CO_2 we have to reduce! So that is another big low-hanging fruit in terms of climate mitigation.

The 2.5 billion (among the Top 4 Billion) is occupying most of the eco-space on the planet, and the B3B occupies a tiny corner, with very little access to energy. I'm hoping that by 2050 we shall be at the stage where everyone has equal access. In such a unified world, the B3B will morph into M5B, the Middle 5 Billion, living on renewable energy enjoying equal access as the Top 4 Billion.

I see an optimistic picture because we can slow down the warming with these other pollutants causing 1/3 of the warming to take care of a near-term threat, while simultaneously bringing down the carbon dioxide emissions to take care of the long-term climate change problem. However, no matter what we do, we are likely to get about 2°C warming, which is unprecedented. To do that, first of all we must prepare those who are going to suffer the most, this is the B3B plus the 1.5 billion, we heard from Mr Grabois, living in peri-urban areas. As a society we have to inform them, prepare them and develop ways to protect them from climate change-related extreme events.

Thank you.