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Science for Poverty Eradication and Sustainable Development: a Call for Action

PROCEEDINGS

Introduction

With great pleasure I introduce the present volume with the conferences and articles regarding the international symposium that had the main purpose to discuss how Science can contribute regarding one of the main pressing issues of humanity: poverty and sustainable development. Hosted by the Brazilian Academy of Sciences (ABC), this meeting was organized by the Global Network of Science Academies (IAP), more specifically by the Science for Poverty Eradication Committee of that organization. The idea was to congregate a panel of specialists in different fields to presents their views on this problem as part of an effort to engage Science Academies in the global effort to eradicate poverty and transform economies through sustainable development.

The meeting was a great success! Held at the Instituto Nacional de Pesquisas da Amazonia (INPA) in Manaus between 03-05 December of 2014, o total of 24 researchers from different countries have expressed their views on the problem (http://www.abc.org.br/en/evento/international-conference-science-for-poverty-eradication-and-sustainable-development-a-call-for-action-2/). The presentations were organized in five sessions: Science for Food Security: Tackling the Challenge of Feeding the World; Science for Water Security: Enhancing Global Access to Water; Science for Health: Ensuring Universal Access to Health; Building Equity through Social and Economic Policies and Science for Poverty Eradication and Sustainable Development. In this last one, different academicians from different countries have had the opportunity to present their views on various issues concerting this topic. All have been invited to participate in the present volume.

Following the five sessions, this publication has divided the contributions received in two main categories: conferences and articles. We have given the liberty to the authors to choose their preference in exposing their ideas. All contributions are published essentially as they were received.

I would like to express my gratitude to all authors that were able to contribute to this publication. Hopefully this volume will circulate among researchers and policy makers and help to tackle the complex issue in promoting economic development to ease poverty in a sustainable way.

Alexander W. A. Kellner
National Museum/UFRJ
Brazilian Academy of Sciences

SESSION 1 - Science for Food Security: Tackling the Challenge of Feeding the World

Chair: **Claudio Bifano** (Venezuelan Academy of Sciences)

Food Security in the Middle-Income World

Linxiu Zhang (Centre for Chinese Agricultural Policy of the Chinese Academy of Sciences)
Conference

Good morning everyone. It´s my privilege to start the first presentation. I´ll try not to bore you but inspire you to stay on until the last minute of this conference. What I´m going to present is Food Security in the Middle-Income World - the case of China and other fast-growing Middle-Income Countries. I´m from the Chinese Academy of Sciences. But the work that I present here represents the work of my entire research group that involves researchers both inside and outside of China.

What I´m going to talk about on food security is really my understanding as an economist - The concept of traditional of food security, and then food security in the middle-income world and China is used in some cases to compare. Then I will mainly be trying to lay out the challenges and opportunities in meeting the nutritional security. I am not talking about enough calories or something – but micronutrient deficiency.

Traditional food security in phase one of economic development, that we often talk about means: countries in start phase one of economic development are characterized by poor, malnutrition, food deficit and high prices, and access is difficult. That was a characteristic of the first stage of development.

And then the food security in those kinds of contexts would be about having adequate supply of affordable food. And each household or each nation´s population would have throughout the year, ensured healthy and productive life – that's the economic growth path of the development. And insufficient calories and proteins are the main characteristics – because we know that without enough calories would result in poor health, increase morbidity and the stunting and wasting. On the way here, I was talking to my South African colleague on the same issue about really what kind of stunting the situation... of course wasting as well as chronic diseases are compared, and then that we know negatively affects income and leading to the poverty trap - that´s the first stage.

To explain the source of problem of households, the economic access was one issue. Then economic access for the really poor really depends on income and food prices. When prices are low, people can afford to eat and then when income rises then food is even more affordable. That´s what we have been working for – that in the first stage we have to work hard on this, tackling on access issue, by two fronts, increasing income and lowering food prices. Then in that economic stage, the route of success really, when the economy starts to offer the poor – we have increasing income, falling prices, falling prices and that is the stage one of transformation, the economy leads to urbanization, by mainly enjoying the low wage manufactures. And urbanization in phase one involves some temporary migration and some permanent ones. And there would really also be that wages are raising, increasing income and raising consumption. That vicious circle begins pushing economy to the middle income. Middle income level. Like what we are seeing in China. This is really graphical illustration of the importance of green revolution and how it contributes to the two, lowering food prices, with increased agricultural investments in to and the favorable food policies – I mean farm policies reformed and subsidies there. The effects are really: the higher the income for agricultural household and also lower prices for all consumers in the economy. That´s one of the successes of the first stage of the development.

We know this vicious circle begins pushing economy to the middle income - fallen morbidity. And then urbanization really comes into play. As I said earlier, the matrix of success for the traditional food security policies, really are: sufficient low-price calories and proteins, and macro nutrients are enough for most of the population, that mainly we say calories. And those working in factories and construction sites are healthy and strong and those left behind on the farm also are healthy and strong because this stage they are producing lots of cheap calories and then vegetables and proteins and food security in this stage really characterizes important part of the development strategy, when countries are just beginning their development push.

When they are poor, people need sufficient macro nutrients. I still remember when I was a Middle school/High school kid, I consumed two big bowls of rice, but now I consume less than a half of a small bowl of rice – that´s from my own kind of experience you could see the shift of diet pattern also. At that stage, macro nutrient

sufficiency is a character. And then China´s experience, since the 80´s is really a classic example of such kind of shift, moving from a food insecurity to a food security state. This one I´ve showed several times, China from the late 80´s basically had nearly 10% of GDP growth annually. This year we are down to 7.8% or something like that, but it´s still high enough. And agricultural growth remained high, for this year, about 4% or something like that, but the key fact is agriculture annual growth is four times the population growth. That really ensured food security. And lots of people moving into cities and into the off-farm sector that is also partly raising income and moving people away from farms and countryside.

We had sufficient calories like protein, when we look at the FAO statistics, we find that China is more or less like other countries in comparison in terms of their calorie intake.

The food security challenge in the middle-income world from the economy context is really a problem and the reasons that and the policies options, are what I am going to talk about mainly later in the next part. In the economy context, economic setting for this is important in order to understand why my argument comes later on, because this really can explain how malnutrition, other issues and all those can co-exist with rising incomes – we also talked about on the way here. This is really the stage that the rapid growing the country and then it kind of make development in the process of transforming from poor to rich but in fact it happens in two phases now, the second phase from, we are trying to move from middle income to rich.
And then this one is difficult. Who we are talking about here? Countries with income per capita level between 5 thousand to 12 thousand US dollars per capita or less, and these are among those countries who by the World Bank characterize as postulants for higher income states, including China. And there are lots of other similar characteristics, apart from income level. In this phase, especially for rapid growing countries, economic dynamics of a country is in different forms than phase one. Remember we had low wages but this stage we have wages are rising and also rapidly and permanent urbanization like what happened in China and in other middle-income countries, and low manufacturing, subsistence agriculture are vastly disappearing. Then industrialization lead to high valued innovation-based industries and service sectors. Remember, we are not producing strong laborers for farming, but we need new knowledge, skills set for those individuals who want to take advantage here. And there is high premium on education health. This is where we are coming from, it needs to have skills in math and science and language in order to get a job in a higher wage kind of state or industry or the economy.

At this point of course takes place in an environment that is not that they´re fully developed, fully developed the countries where, we were talking about at dinner time yesterday we were talking about market functions. And this stage in some countries, especially in the fast-developing countries we are still underdeveloped in the kind of making social institutions, imperfect markets for credit and less than perfect health insurance, and food security and welfare systems. All those are in place of completion or improving. These are the typical low you know, permeable safety net that everybody wants to have there, so those are the characteristics.

And then of course at this stage there is a higher level of inequality measured by Gini coefficients almost ranking from 40 or 41 above and China is about 50. Although the national statistics says a much smaller number than that, but our calculation, researchers' calculations are more than 50 of this.

The implications for this high inequality are up, although average per capita income rise and absolute gains, poverty is disappearing, but there are many near poor. The numbers, China has 150 million people live with less than 2 dollars a day. But there are more than 300 million people with less than 3 dollars a day so there are lots of near poor. Of course, China has a lot of millionaires in the world, also.

And the food security in this stage is not macro nutrient deficiency but lots, as I have already shown that others, but lots of micro nutrients deficiency. We call it hidden hunger – which are iron, zinc, and vitamin B and more of those micro nutrient deficiencies.

What is the evidence of this micro nutrient deficiency in the middle-income countries? I wanted to give you a couple of comparisons in the whole world and in the case of China, so this is really the statistics about the whole world. The percentage of iron deficient anemia in the world but in the countries that are put into comparison, look at China we have pre-school at 20%, pregnant women at 29%, and reproductive age women at 20%. More or less like what happened in Thailand - had 25%. Brazil – Preschool kids have 55%. Those are the statistics that were drawn from the World Bank and the FAOSTAT.

Obviously, we are among those, like micro nutrient deficient countries. In our own study we tested about more than 60 thousand students across China. We found iron deficiency anemia is a huge problem. We also tested the infants, from 6 months to like 20 months, or somehow, we tested 2000. What we found, like that among 2000 babies, nearly half of them are iron deficient anemia. And then, this is really anemia rate nearly 50%, but you know we only have less than five percent who were stunted or wasted. When you measured by stunting or wasting, China we do not have problem.

And then the funny thing is that when you look up their parents, their mothers, it´s not really the money issue because their parents were not that micro nutrient deficient or iron deficient. They get enough calories but not enough nutrients or micro nutrients. This is really why we did the test, and we know that, about 40% of them would fail their baby infant IQ test because of subnormal cognition or subnormal motor skills. There are the numbers we show that, these babies are 25%, more than 20% of cognitive delay and more than 30% of motor delay. If we add it together, it´s about 40% of those in the sample who were significantly delayed in either these two indicators. And that we know is this is going to have permanent impact in their lifetime, because nutritionist has told us, that all of those – if you didn´t get corrected when they´re infant, it will have a lifetime impact on their IQ, mental health, height and weight, and in general health kind of performance. That´s what we are more worried about.

What does it mean? The harshest terms are that we have 20% of future labor forces are not ready to take up the job they are offered, even if there is availability. They are basically physically and mentally handicapped. We use quotes and quotes and handicapped, because of those problems.

And about the childhood anemia, or the school-aged children anemia, as I said, we tested more than 60,000 of them, so anemia rate was - 30% - 33%. And that really implies, because we conducted these tests in poverty counties, if we extracted and extrapolate into national level, we nearly have a 30 million school aged children are suspected of having anemia. That is another kind of issue.

We also know anemia at the school age also impacts their school performances, and the study by many have already confirmed that. And even from our own study. In summary of these cases, in the longer run, the implications for the economy of the societies, is that hundreds of millions of children are cognitively impaired and they are not competitive in school systems. And they are likely to drop out more than others.

When the lower wage job disappears, only the high wage jobs are left, and the employers would not hire those people who are not really prepared for it. The polarization of the labor market, half of them in high wage sectors and half of them in informal sector. It´s going to has a huge implication. The society has to spend more and more on police and crime control and security. Large part of the labor force is unproductive. That is the vicious circle and stagnation that we don´t want to have. When the economy grows fast in the rich and the middle-income level. In explaining the causes of the new food security challenges, I want to let you know that the real question on what is going on is, that the countries are growing faster, and wages are raising and there is a lot of poor people but not extreme poverty. Why don´t the families invest in their babies, children, mothers to be? That´s where I come up later on, about knowledge aspects and asymmetric information probably. It is not hard science, but they need institutions in place to address those issues.

There are two reasons that I wanted to summarize here. One is the price of the food. The victims of their own success in phase one, is that investment in agriculture and open-door policy are behind wealth, contributing to alleviate the poverty population and demand the price of food low. The cheap calories raise their demands for staples by those in the lower end of the income distribution, even though they could afford more. And many reasons for not spending more on diverse diet, that's, one reason is that real cost of meat and fruit and vegetables are not only relatively expensive but also they´re absolutely expensive in real terms, because you need refrigerators, and you need markets close by, and also you need time for markets not close by that might be fast transferring so that the transportation is more expensive to prepare. When we did a study on adding kind more diet for school children, like meats or fresh vegetables and the school principal said "look, providing us money to buy meat is not sufficient. We looked at the markets and the only ones are once a week, so I need storage, I need refrigerators to put those foods into storage".

And then some local schools also started the eggs program. They said "the government had good intentions providing eggs for all the kids". Given the backside of it – eggs don´t have iron, but at least it´s still good protein. What the local principal said was "I have to look for all the houses, for eggs that are needed for my kids, in order to provide one egg a day".

Basically, there wasn´t a market there, so those institutions really put much higher prices on those, for providing a protein of diverse food. And there are also many competing uses for extra income. We always say, because in China in recent decades we have initiated a lot of welfare programs, basically by transferring the money to households. And on per capita basis, probably we could have 5 – 6 or 700 yuan per capita or, per 10,000 yuan per household, or something like that. But why can´t they buy meat for the children? But there are lots of competing uses for that. Because of the imperfect credit market and then insurance system, we have to save for marriage safety, house safety, saving for retirement, so for catastrophic illness because of the imperfect health insurance market. And also, all those are really competing so I will tell you later on why nutrients are, you know children´s nutrients are not really in the radar screen or school of most households, because obviously that is not visible, because if you are slim and short you know there is something, but you don´t see, so I´ll show you later.

And then the absence of knowledge, this is where it shows, because it´s a hidden hunger, because you don´t see that, because you are micro-nutrient deficient. Because there are no outside symptoms so that´s why. The slow and imperfect correlation between nutrition intervention and anemia status and also behavior and performance and physical statues, there is a lack of knowledge to show it. With high rate of migration caregiver is being done by grandma and when you ask, do you need to give babies additional food, solid food or somehow when they are six months, I never ate meat when I was a baby, when my son was a baby I never fed them with meat but they grow fine, but they forget that, we say that time inconsistency between demand for skill and needs for investment in skills are current health and cognitive skills are fine for now not sufficient for 20 years from now because when the grandma feed their babies, they´re producing farmers, they are working in the fields if they are strong it´s good enough. they have 90 point, IQ of 90 was good enough, but now IQ 90, you could not compete in the competitive system – you need about 100 or 120 so that is what they don´t realize because it's an inconsistent knowledge there. And lack of a former nutrition education training is part of it. Sometimes this is not a money issue it is really the knowledge issue.

Our empirical evidence shows that the most educated person in rural communities in the poor countries in China are school principals. But only one out of 20 even know what it means by anemia – what? Anemia? I heard – you are not having enough blood so that is what they say. So oh, you have a pale face or you are really slim or somehow – so those are the knowledge they have about anemia. And the principal believes that only 3% of their kids were really, you know, anemic, but we found out that more than 35 – and only two out of 100 caregivers have had any form of education training about nutrition. It´s funny when we ask those, our interviewed villagers, kind of caregivers – do you know when you raise pigs you need to add micronutrients or whether you need to add micro nutrients – Yes of course; Do you know when you feed babies you also need? No, we don´t need. They know, they have knowledge of raising pigs, more than the knowledge of raising the babies. When we ask 100% of them say, yes, we need to add micronutrients to their feed to the pigs but very few say babies need micronutrients after 6 months or somehow. This is a lack of knowledge which really is something we can fix.

The policy responses we are talking about this, their social return is, to good nutrition in individual nutrition, and individuals leads to individuals return to good nutrition – but it is hard for individuals who are poor to invest in something which they don´t even see good you know seen these days and that has a return that is 10 to 20 years away, or 20 years from now on – because really, they are not aware of this and they don´t think, they think about tomorrow or next year but not in 20 years from now, and they probably think their children can step out and go to contraction work, but they don´t think about 20 years' time, there is no construction site for them to work on so that's the thing. And therefore, there appears to be a state in trying to address micronutrient deficiency based on food insecurity. We hear "hey babies are micro, can´t parents buy the food for them?" – yes, they have the money, but they might not have the knowledge. And where to seek kind of knowledge training. When we ask the caregiver where they got micronutrients supplement information, they said from formula powdered milk sellers and from my neighbors or peers, so they never got formal training and that's really, we are working with the government trying to get that information through the system because it is not really a research kind of project. You need to have a protocol ready and then – I know one of my friends

who is from working in CDC, he gave birth to a baby in the US, he said as soon as that baby was born she got individualized training, I said when, she said in one or two weeks or when they have to vaccine or when they have to feed something. In China, in theory we should have those things there but there is no system that is working well in this case. That is one of the policy implications. Of course, one of the possible interventions that- education in schools, because the children need to start to know what the problems are. Training in villages through public health systems in China we have very good system where Health system, we thought kind of at least they can transfer the information from top to the bottom. We just need to give them packages – what to train – you know, how we get this knowledge to them in a simple way. A lot of those caregivers don´t have education more than three or four years of time, so that's really a fundamental kind of challenge like urban area, when my colleagues say – I got information from the internet somehow, I say hey how many rural farmers can surf the internet? Or have the access even, so those are the problem. Of course, we are also talking about technology. We need agriculture diversification – this is really against the trend – it´s commercialization, specialization, that´s really, it´s difficult to reverse. That is one of the challenges.

Of course, fortification is one of the things that commercial kind of perfect market are thinking, but in China lots of us are really semi-subsistence, especially in the poor areas. The food itself is subsistent in terms of producing, so I have, I don´t know the time, how much time I have but I have a story when we got, ok, when we got the micro, we found the school aged children anemic and then the CDC people says "Oh we are developing 45 flour, wheat flour so the Northern people eat noodles and bread, we should suggest them to buy", we look at the market and none of those manufacturers are producing 45 flour, why?, because there is no demand. Or the farmers are producing their own wheat and milling their own flour they don´t go to market so the 45 flour factory mainly bankrupted after one year because it had good intention, but there was no demand. When you look at, when you have this technical kind of suggestions or solutions you also have to look at the markets and institutions and consumer behaviors whether those are ideal, and some others say they need 45 soy sauce, I think I said this before in some other form – yeah they said, 45 soy sauce but we need to drink two bottles of soy sauce in order to get enough iron a day for those anemic kids you know that´s basic (thank you – I have 10 minutes so) . This is really something, a challenge. But of course, we say the role of state, really directed micro, you know multi-mineral nutrient supplement program is needed. China is starting this program for infant and babies, but now we are testing how good those can be delivered to the individual households like those, you know, kind of micronutrient powders, sprinklers you can put into any kind of food that babies are eating. So, we are trying to initiate that, but the challenge is, lots of people are mobile, like migrant, the mothers are moving away if it was really resident based, it´s difficult to do, you have to have individual id in order to track where they are which is not really that easy these days. And of course we know that there are some, for China we have, the Chinese government they have free maternal and child health benefit programs in the prenatal and after natal check-ups and those but we know in those poor areas very few are taking up those free public services because the access itself has a cost so we are introducing some conditional cash transfer (CCT) interventions in which if you go to receive the free services, we give them a subsidy because that way it could incentivize them to come to use more. What I wanted to say here is even government start to take action, still you need enforcing programs to come up with. It´s not saying that – I have a free program, everybody can use, but you need to understand that utilization access itself has a cost especially for remote people. That one, we should not end up with providing, making the service available but we have to enforce its utilization by different kinds of interventions beyond these programs already here. The challenges of those interventions, of education training, you have to teach old dogs the trick, because so that avoids, they say the parents the grandparents – I raised up the children the way I did it and they were all fine, they´re healthy somehow so, and encourage the, or actually avoid, they say in the previous slide, the challenges of those, so skip that. And supplementation is expensive of course, difficult one is CCT – conditional cash transfer in some areas, we also we tried those CCTs in remote mountainous or minority areas, getting access itself, getting the information passed on itself, is very difficult. Now we are working with the minister of health in China, they used to have a population control and a population planning and control division, and now the birth rate has reduced so they said ok, we need to shift our function from controlling the people to improve the quality of the people. They are working with us to trying to improve the quality of the population, that's we are talking about China case.

Of course, challenge of meeting new food security for policy makers have to be thinking ahead so when we talk about, we are going to have a challenge in the future, we are not going to have a quality labor forces – if you don´t think ahead – they say, no everybody is employed – we even have labor shortage now so why should we worry. Kids are you know, when the wages were low, and everybody get a job when wage increasing at

this beginning stage, everybody can still get a job, but when the wage is high enough nobody would hire a person who didn´t even complete the middle school education because of no competitiveness. We are really thinking about education is for the people – 20 years from now, not for the labor forces tomorrow – so this is really one of the challenges.

And it´s the same way with addressing in the micronutrient deficiency because you need to invest now in the babies/infant and you see the results in 20 years' time or 30 or 40/50 years' time from now – because they get a better job in the future, they have a higher income – the negative vicious circle you know, they are basically non-competitive, don´t have a job and have a poor health, so you have to think about in 20 years or 30 years' time from now the consequences of addressing or not addressing these issues. Individuals, especially of poor households, they don´t have that mind at this moment, so it has to be the society and the government to push that forward.

I think all of those are really trying to justify why this is a challenge, because this is maybe the issue in the rapid growing stage and also the type of growth happens in a globalized and high tech world and if movement from middle income into high income lasts several generations and that is going to be a challenge as well, so learning about nutrition can actually be slow, and the wage can also raise more slowly, so all of those we see as challenges. Is this a new challenge, I think definitely this is a new challenge? The challenges we were not aware, the challenges we are probably not patient enough to wait to see the results. All of those would pose a challenge to us. Not only the scientists, I think the, I said in some venue, sometimes technologies are ready, but the implementation of those technologies need more than just technology substance itself, but need institution and need policy and the market as well.

It is irony that combating this food insecurity is difficult, so you need a policy prescription of course those are easy to say, but difficult to achieve. I want to stop here, I have a few more slides but I just want to stop here. I don´t want to run over time so thank you very much.

Feeding the World in 2050

Alan Bojanic (Food and Agriculture Organization of the United Nations)
Conference

I will present the Brazilian policies on food security, and how Brazil has managed to there, eradicate hunger (leave the map of hunger). Now, Brazil has less than 5%, of its population living in food insecurity and for FAO standards below 5% means that it is no longer a structural problem of the Brazilian state.

I will provide an overview of global food intake based on the annual report on the State of Food Insecurity, which is mainly based on calories intake. I will present the summary of the Global hunger situation. Then, I will talk about Latin America, how also Latin America food situation has evolved in the last 10 years, and then I will concentrate on the case of Brazil answering the question on how Brazil has emerged out of the map of hunger. Considering that this is the year of family farming, I will give a perspective on family farming and the issues that need to be addressed – related to food security.

Important to mention, what we do in FAO, is within the overall UN Development agenda. The agenda that was the millennium goals, for the year 2015 – as they were set on the year 2000. That meant that under objective one, we should have at least the proportion of people in the world living in hunger, and progress achieved by many countries. Several countries have reduced hunger by half, but still many other countries have not. Middle income countries, particularly, have achieved that goal. There were two types of goals: One is the Millennium Development Agenda, and the other is the agenda of the World Food Summit (WFS 1996).

WFS Summit had tougher goals, because they were not talking of proportions, but were talking about absolute numbers, so it is certainly a tougher and Brazil has achieved both, the Millennium Development Agenda and the World Food Summit Agenda.

Nowadays we have new goals. In September 2014, the UN assembly launched new development goals which are to my understanding a bit more complex than the former 10. The so-called Sustainable Development Goals (SDG) they have many more goals (17). The first of them, deals with eradicating poverty everywhere and in

each place of the world. It´s a very ambitious new goal of the new Development Agenda. And of course, we are not just talking of Development Objectives, we are talking of Sustainable Development objectives. Therefore, SDG means Sustainable Development Goals.

The second objective of the SDG is to eradicate hunger and to achieve food security and to improve nutrition and to promote sustainable agriculture. It is clear that, within this new agenda for the year 2030, the first two ones have very much to do with what we are doing here these days.

For FAO the SDG has at least two implications: first that we should concentrate on eradicating hunger by year 2030, considering that still, we have 805 million people undernourished and thus we need to define how we will do this in the future. A future that will have a larger population, we will have at least a billion people more than what we have today by year 2050; and that means that we should ensure that those newcomers won´t be starving.

In 1990 we had more than a billion hungry people, the good news is that we have gone down to 805 which means about 200 million less. But still, and that is the bad news, is a large number. We have decreasing trend. For Latin America, we had in year 1990, about 68 million and it has gone down to almost half of that. Now we have 37 million. It is a region in the world, the hemisphere that has done the most progress overall. Asia also, from 742 million it has gone down to 525 – again almost 200 million people less than what we had 20 years ago. But the bad news is Africa, where insecurity is increasing. Thus, Africa is the continent where there is really an increasing trend in terms of hungry people.

We have 805 million people that go hungry, which means that are eating less calories than are needed to have a healthy life (calories) that represents in one in every 9 people worldwide and, 1 in every 4 – for Africa, and for some countries even much more.

We should note that we had less than a billion people in the world in year 1750. And we expect to have more than 9 billion people by the year 2050. Most of that population will be in the developing world, so we will have like an extra two billion people on earth – which need to be fed. We are very optimistic that that can be done. We certainly believe it – but that is not an easy task – not an easy job – and we need a lot of science and efforts for that.

We will have 34% more people than what we have now in year 2050, and most of that would be urban, and most of them would have a larger income than what we have today. Thus, demand for food would be certainly higher, because we are also changing patterns of consumption – we are eating more meat, we are eating more vegetables, more fruits, and that's an increasing trend which in many cases have environmental implications.

We need to increase food production substantially to feed this amount of people, we need to increase in about 70% more than what we have now, and of course improve distribution, which is certainly the issue. And we need at least to produce 2.5 billion tons of basic grains – maize, rice, wheat. And about 200 million tons of meat. Meat is also a big issue in terms of future demands. And particularly fish meat.

We have to think very carefully on how we do this in terms of the environmental impact. because currently, according to the international panel on climate change – Agriculture and related activities means about 20% of all anthropogenic green house emissions. And the idea is – how can we lower the contribution of agriculture in terms of greenhouse emissions. Thus, the great challenge is: How do we develop agriculture with less carbon emissions, and of course, with less impact on soils, water and other natural resources.

For Latin America, in food security issues, we have also good news. In 1990, we had several countries with more than 20% of their population in a situation of being undernourished. Most these countries were, above 35%. Brazil had like 10-12% in such year. This situation has changed nowadays, with only Haiti, Haiti above 35%. Most countries have come really down significant levels.

Brazil now is under 5% and 8 countries in Latin America are under than 5% of the population with food insecurity. It is a continent that has made good of progress in terms of reducing hunger.

What is the explanation? How come Latin American countries have achieved this? First of all, there has been a strong political commitment. Most governments have put food security on the top of their agendas and have put financial resources into that issue. Budgets, they have increased to eradicating hunger. Most actors have also been involved, not just government, but also civil societies have been very active in Latin America, in terms of the food security agenda. Parliaments have been very active; most of the parliaments do have committees on food security and have created networks – there is a Latin American network on food security, where they exchange legislative experiences, and knowledge. The private sector has been involved and in general different and key actors have been part of the implementation of this agenda.

The economic situation of Latin America in the last 10 years has been quite good in terms of economic growth and also in terms of social policies – with social policies focusing on the poorest and on social protection issues.

Brazil – Brazil had about 14% of the population in hunger 15 years ago. Now less than 5% - it´s about 3% in fact. That is big change. The Brazilian food security monitoring system, have a set of indicators – The Brazilian system has six indicators, one related to the production of food – agricultural production; that is – availability of food; income; and spending on food; access to adequate food which means food of good quality, not just let's say – "junk food"; health indicators - access to health services; and of course, education.

For each one of those issues we have used indicators to see how they have evolved and always trying to explain why. Why it has happened? How come Brazil has, in each one of the different dimensions of food security, done well. But not in all, the evolution of the Brazilian governance on food security has been remarkable. The commitment on food security is not really new, it comes from the times of Josué de Castro who was also president of FAO in the 50´s, but he was very much committed to put very high on the agenda food security issues in Brazil in the 50´s. In the 60´s he wrote a lot about the geopolitics of hunger, also Betinho (Herbert José de Sousa 1935-1997) made a remarkable contribution in this regard.

Brazil has built an institutional framework to deal with hunger. One of the mechanisms is the National Council on Food Security - CONSEA, which is an interesting council. It is represented by, members of each one of the Brazilian states - the 26 plus the Federal District; it is mainly handled by the civil society, but is very close to the executive power – their premises are within the Presidential palace in Brasília. They are also well funded and it´s an organization mainly for policy advise – but it is also interesting because they bring all the issues of the food security agenda in Brazil to the very top because Ministers do participate in that, as well as the different actors.

Around 2002 the Brazilian State launched an initiative which is the Zero Hunger initiative to eradicate hunger in Brazil. It has been a successful strategy. Nowadays it involves more than 19 Ministries committed to that. There is an organic law on food security; you have the National system; there is the National policy that was launched in 2010; the budgets have increased tremendously for each one of the different items – there is a national plan and there is a program which is called "Bolsa Familia", which is a way of subsidizing the poorest families in Brazil to have access to food.

In terms of the dimension of food production, Brazil has done remarkably because they have increased the production in about 60% in only 10 years – which is really a lot. Most of it is soybeans, a lot of it is maize – but also meat, it is also other products. The productions of Brazil have increased tremendously in the last 10 years due to increase in the agribusiness type of agriculture, and also family that farming agriculture.

The other dimension of food security which has to do with access to food – means that Brazil has done quite well in terms of reducing inequality. Around year 2000 it was 0.6 of the Gini coefficient, the index – it has gone down to less than 0,5, so it has improved this indicator – it is still quite high – I mean 0,5 is still high but it is a going down. Trend with improving access to food. The prevalence of stunting has gone down, and it is very nice to note that it has gone down from 9.2 to 3.7 – which this is about the weight – the expected weight for small children with less than 5 years. And the overall behavior of Brazil is also really good in terms of that indicator.

In terms of access to health also has done well. Particularly Infant mortality has gone down from 26 to 15. 1000 born between that period. On the other hand, and that are the bad news, overweight has increased tremendously in the country over the same period more than 50% of Brazilian are overweight. Overweight is

becoming one of the key issues to be addressed by the Brazilian society. This has also been increasing rather than decreasing trend.

Investments in social policies are part for the explanation of the Brazilian success – policies on minimum wage has been key to fight hunger – it has grown near 70% in the same period. Has increased the amount of public spending on food related issues, social policies, this is the "Bolsa Familia" that I mentioned, which has gone up threefold in the amount of money invested in such a large program – which is a program that reaches at least 13 million people in Brazil.

Food nutrition at schools (PND) is also a program that reaches about 43 million kids in the different states of Brazil. The family farming sort of support – the different programs, there are some of the programs that have been developed and the National Rural Development Plan which is also one of the key issues of Brazilian Agricultural Policy.

To sum up the case of Brazil. First of all, we must say that has been possible because there was political commitment – strong political commitment; a food system has been developed, the participation of the different actors; the perspective to make food security a right of citizens which is in the Constitution, in different laws, bylaws; is very much incorporated in the philosophy of how the state operates. This right to food has been really key, and it´s something that Brazil is exporting to other countries in terms of legislation and regulatory framework, on how the States should commit budgets to food security.

A participatory approach, with articulated policies. The Health policy, the Food policy, the Agricultural policy, even the Infrastructure policy is very much articulated when it comes to food. It is a remarkable approach, how Brazil has managed to articulate different policies. The monitoring of food security, on its different dimensions. Brazil is a key actor that is promoting, I would say it is not by random that the Director-General of FAO, is a Brazilian, because they are active in these international forums.

Considering that 2014 is the international year of family farming, it is a good opportunity to enlarge the visibility of this sector, how it contributes to food security, and how it gets visible by the urban consumers who many times do not think where food comes from; particularly when it comes to family farming. Just to say that there are more than 500 million family farming units in the world. About 17 million of them are in Latin America, and about 5 million are in Brazil. About 98% of all agricultural units in the world are being handled by family farming producers. And at least around 50% of total food production in the world comes from family farming. It is really a key actor in terms of food security.

For Latin America, there are 17 million units, about sixty million people involved in that production system; 80% of all units. And of course, in many products like maize, cassava, rice, they represent more than 70% of all production comes from family farming.

However, in many cases there is a yield gap. In the North of India, China, Europe, the corn belt in the United States productivity is high, but in other regions like Africa, the yields are very low – and some areas also of Latin America where the yields are quite low. And that is one of the biggest challenges, how can we improve productivity to produce food by family farming in the future without compromising environmental matters.

We need an agriculture that can adapt to the new technological challenges; we need to aggregate more value to family farming products; we need to deal with the issue of an increasing urbanization because a lot of people are leaving the family farming to go to the cities, like in the south of Brazil, most of the producers are over 60/70 years old, and the young people don´t want to stay at the farms anymore and this is certainly a key issue to be addressed; the changes in the consumption patterns for the future will certainly have a different diet than what we will have now, in 20 years' time; and family farming also needs to adapt to these new consumption patterns to new products that are being developed. We need to have a more adaptive sort of production coming from family farming.

We certainly need innovation for larger productivity, we need more sustainable practices at a massive scale family farming.

The big issue of bio energies, they need to introduce technologies that use less carbon emissions; the water use also; biodiversity conservation; To summarize, we need to produce much more in family farming, with less inputs. We need to de-carbonize family farming. A big challenge for the world, not just for Brazil – an overall challenge.

The food purchases from family farming is also successful program in Brazil. Brazil has a scheme by which at least 30% of what is being bought by the State to supply schools, to supply public organizations, public services, should come from family farming. And most of the states are really accomplishing that because it generates a stable market, it generates stable prices for family farming products, and it creates good synergies within the communities. It is a very interesting scheme that now is being enlarged to countries in Latin America and it is also strengthening family farming overall, because now they have really stable income to rely upon and also it helps their marketing, they are less dependent on intermediaries and so on.

Micro-finances schemes; access to land; intensification of production; and also, how to make more efficient the food chains, the value change with services for family farming, are also on the agenda.

To conclude, we believe, in FAO, that the world can achieve the big challenges of feeding the world of the future; eradicating hunger – but of course we need to do many things. The challenge is a daunting challenge, because we need to have a more environmental friendly production practices, we need to improve the mechanism of distribution, lots of social policies, that´s implications for fiscal policies, where are we going to get the money to invest more in family farming, how can we improve the access to food, which is really the central matter – so that everybody could have the money to purchase the food that they need. The challenge there, we need good science for that, we need technology, we need to think about how we are going to do it and that has to do with social sciences, that has to do with agricultural sciences, with economic sciences. Thus, in general terms the challenges are that we need political mobilization, political commitment, and political will to build the institutions that are necessary to make this happen.

Eighty percent of the production for the future should come from increased productivity, not just increased area, there is very little area left in the world to be added to current production, so productivity is a key issue. Increase in yields and of course change in consumption patterns is essential. In all these matters science has a key role to play.

Crop Genetic Improvement Technologies: Indispensable Tools to Tackle the Challenge of Feeding the World

Joachim Schiemann (Institute for Biosafety in Plant Biotechnology at Julius Kuehn Institute)
Conference

At first, I would like to thank you for the invitation to take part in this very important IAP Conference.

We all know the agricultural and societal challenges we are faced with. Just to repeat a few of them which already have been raised this morning, especially food security. Concerning population growth, we learned from the FAO talk that we have to provide much more biomass of a very high quality during the next 20 to 30 years. Concerning changing the consumption patterns, we learned from the Chinese talk that it is recommended to eat more meat in China. Contrary, in Europe we are trying to reduce the consumption of meat, but of course, it is recommended to provide a certain level of meat for a balanced nutrition. Then we all are aware of the challenges climate change and social and economic instability. We also discussed the problem to find a sustainable balance of supply and demand. We also learned already that we have to take care not to further losing biodiversity, and that we have to reduce the footprint of agriculture on our Earth. Another main problem is that agricultural land is degraded by urbanization and other human activities. We also learned that we will have to produce 60% more over the next 40 years on the same land area or even on a reduced land area. And we will be faced with the problem of competition between "plate and tank", the competition between food and feed production on one side and production for bio economy, energy, basic substances for chemical industries, livestock feed etc on the other side.

Therefore, my clear message is that to tackle these challenges we need all the crop genetic improvement technologies which have been developed during the last, let´s say, 10 thousand years, including genetic engineering and the recently developed New Plant Breeding Technologies.

I was very much impressed by the developments here in Brazil, and I think one of the key measures taken is that the Brazilian government strongly commits plant research, life sciences, also developing a science-based regulatory framework to try to combine all the different breeding tools which are available. We need crops with new traits, like higher yield, pest resistance, draught tolerance, nutrient use efficiency, improved nutritional value (we just learned from the Chinese talk, that to produce plants with a higher nutritional value will be very important). And plant breeders should be able to explore the interesting and diverse toolbox being developed recently.

What are these crop genetic improvement technologies mentioned above? What does the breeding technologies portfolio include? Starting with conventional breeding, crossing of superior plants obtained by selection breeding has been for a long time the only possible method to improve cultured plants. Such traditional breeding techniques have been complemented since the last century by conventional mutagenesis, translocation breeding and intergeneric crosses leading to a more sophisticated exploitation of the existing natural genetic variation by plant breeders.

With the upcoming of genetic engineering in the 1980s, plant breeding made a step from mostly cisgenic approaches towards transgenic plants in which genes from non-crossable organisms (e.g. bacterial Bt-toxin) are introduced by different transformation techniques. These transgenic plants are produced by undirected approaches delivering the transgene (or cisgene) in a not further specified location of the plant genome. From the beginning, the potential risks of transgenic techniques were analysed and a complex GMO regulatory system was put in place which is based on the technique rather than the product. In transgenic plants of the first-generation input traits like herbicide tolerance and insect resistance have been modified. Currently these traits are present in over 180 mill hectares cultivated crop p.a. providing benefits mainly for seed companies and farmers. In second generation transgenic plants mainly output traits like starch composition or content of health-promoting substances have been introduced. Thus, the second-generation transgenic plants focus more on consumers' interests worldwide. Furthermore, transgenic plants are increasingly established as production platform for pharmaceuticals or other valuable substances.

Since then the development of breeding techniques progressed rapidly resulting in much more sophisticated methods to create plants containing new traits. These techniques are summarized as New Plant Breeding Techniques and especially the genome editing and modification techniques including oligo-directed mutagenesis (ODM) and site directed nucleases (SDN) are tools for sequence-specific changes in the plant genome. Thus precision-based mutation approaches can now be used which, unlike chemical or radiation mutagenesis, do not create hundreds of additional mutations throughout a genome.

These breeding techniques describe above are complementary, not mutually exclusive and are essential tools to meet the challenges of agriculture.

Which are these new tools (1, 2, 3) in our toolbox, the so-called New Plant Breeding Technologies (NPBTs)?

<u>Zinc finger nuclease (ZFN) technology</u>
The term zinc finger nuclease is used in the original reports by Lusser et al. (1) and the New Techniques Working Group (2), but here and elsewhere is replaced by the term site-directed nuclease (SDN). Meganucleases and transcription activator-like effector nucleases (TALENs) possess a very similar mode of action to ZFNs, and all of these together may be covered by the term SDN. SDNs are DNA-binding and restriction proteins that are designed to recognize a specific DNA sequence. They either consist of a single protein chain that recognizes, binds and cuts a specific DNA sequence (meganucleases), or two proteins artificially connected by a peptide linker (ZFNs and TALENs). Over the last 2 years, details of the CRISPR/Cas9 nuclease (clustered regularly interspaced short palindromic repeats), a new kind of SDN, have emerged. In this system, the Cas9 nuclease is guided to a genomic sequence by a specific guide RNA. In general, SDNs may be used for targeted genome mutation, including editing, insertion, deletion or replacement of genes, and stacking of molecular traits.

Oligonucleotide-directed mutagenesis

The basis of oligonucleotide-directed mutagenesis (ODM) is a modified DNA or DNA/RNA oligonucleotide of 20-100 nucleotides that is delivered into the cell by suitable methods. The sequence of the modified oligonucleotide is homologous to a genomic sequence, but differs in one or a few nucleotides. Therefore, after binding of the homologous genomic sequence, a mismatch pairing is created that is corrected by the repair system of the host cell, leading to specific mutations if the sequence of the oligonucleotide is used as the template for synthesis of the new DNA during the repair process. ODM may be used for targeted genome editing, e.g. to induce herbicide resistance by point mutation. Interestingly enough, in the end product you cannot detect with any kind of technology whether this modification has been induced by oligonucleotide-directed mutagenesis or just by conventional mutagenesis. So, the question is: should we regulate ODM as GM technology or not?

Cisgenesis and intragenesis

Cisgenesis/intragenesis involve transfer of an intact gene or a DNA fragment between organisms of the same species or from a cross-compatible species. In the case of cisgenesis, the transferred gene is unchanged, whereas, for intragenesis, parts of a gene (e.g. regulatory elements) may be transferred. Cisgenesis may lead to a new organism that is indistinguishable from a conventional cross. Intragenesis always leads to an organism that is not obtainable by conventional crosses.

RNA-dependent DNA methylation

The RNA-dependent DNA methylation (RdDM) method enables modified gene expression by transcriptional gene silencing or promoter methylation without changing the genomic sequence. The methylation patterns are induced by double-stranded RNAs that are processed by various host enzymes of the RdDM machinery. The epigenetic changes may be inherited and stable for at least a few generations. RdDM may be utilized to modify the expression of one or more genes.

Grafting on GM rootstock

Grafting itself is a classical breeding method in which two plants with different phenotypes are combined by physical attachment. When the lower part, the rootstock, is taken from a transgenic plant and the upper part, the scion, is from a conventional plant, the resulting leaves, stems, seeds and fruits do not carry transgenic DNA.

Reverse breeding

Reverse breeding is a technique that relies on suppression of meiotic recombination during propagation of an elite hybrid plant. The meiotic recombination is suppressed by silencing or knockout of genes that are essential for meiotic crossover but leave the chromosomes intact. Therefore, the allelic chromosomes are not paired during meiosis and are distributed by random segregation only. Viable microspores containing in some cases by chance a complete haploid chromosomal set are then converted to a double haploid state. The advantage of reverse breeding is that elite hybrid plants with unknown parents may be used directly to reconstruct the homozygous parental plants de novo, which is essential to maintain the hybrid line.

Agro-infiltration

Agro-infiltration means that a plant tissue is infiltrated with an Agrobacterium suspension. The bacteria contain the genes to be expressed in the plant. Therefore, the desired genes are expressed locally and only transiently in the plant, producing new proteins at high levels.

Synthetic genomics

One of the main goals of synthetic genomics is the design of artificial biological systems to study the prerequisites of life and to create new production platforms.

The European Plant Science Organization is trying to strengthen the voice of European plant scientists. It has recently published a Statement (4) requesting the European Commission to draft and discuss science-based regulations for the New Plant Breeding Technologies. EPSO welcomes the outcome of the majority opinion of the Member States expert working group (the "New Techniques Working Group") report (2) and asks the European Commission as a matter of urgency to provide a guideline document that follows these recommendations to provide legal certainty for science and industry concerning the application and exploration of NPBTs. Since an increasingly number of new breeding techniques will be developed, a more detailed and

comprehensive discussion on a new approach for the regulation of new plants is required. This new approach might be based on the new characteristics of a product/trait and should take the following into account:

a. A clear and reliable definition, based on scientific evidence, of what constitutes a novel plant trait, and thus needs to be assessed by an appropriate body (legal certainty);
b. The need to avoid overregulation whereby an unwarranted number of processes and products will have to undergo expensive and lengthy authorization procedures (disadvantage for SMEs and scientists);
c. The need to uncouple the question of environmental risk and safety assessment from the question of labeling (consumer acceptance).

I have been asked recently by the National Agricultural Biotechnology Council of the USA to provide a talk about the EU perspectives on new plant breeding techniques in the frame of a very interesting workshop on new DNA editing approaches, methods, applications and policies for agriculture. I must say it was not easy to provide the European position because we do not have a position in Europe – so I was asking different questions: Does the European Union have a position on new plant breeding techniques? The answer was No. Does the European Commission have a position on new plant breeding techniques? No. When will the European Commission touch the hot potato? You might know that we have a new European Commission just starting to work as of the beginning of November 2014, and I think for them it is very difficult to define a position – especially under very hard pressure of different NGOs requesting a regulation of NPBTs similar to GM technology.

But the European Scientific Community has a clear position, and this position has been published in several reports and been discussed in several workshops – some of them are listed here (5, 6, 7). In this talk I will focus on the important report of the European Academies Science Advisory Council, published in 2013, I had the honor to take part in drafting.

The EASAC Report "Planting the future: opportunities and challenges for using crop genetic improvement technologies for sustainable agriculture" (8) has been endorsed by several European scientific organizations. For me the most important voice was the voice of Anne Glover – the former Chief Scientific Adviser to the President of the European Commission. She emphasized that this report is an authoritative, joint statement of the national science academies in the EU Member States and that the conclusions of the report are based on the best possible evidence. "There is no evidence that GM technologies are any riskier than conventional breeding technologies and this has been confirmed by thousands of research projects." "Finally, we shouldn't forget that there are also other promising novel plant breeding technologies, post-GM, and we shouldn't make the mistake of regulating them to death as we have done with GM." (9)

The aims of the EASAC Report were, amongst others, (i) to explore the implications for EU policy-making of alternative strategic choices in utilizing crop genetic improvement technologies for sustainable innovation of agriculture, (ii) to compare what is happening in other economies who have adopted GM crops more actively, (iii) to collaborate with African experts on agricultural biotechnology to evaluate how previously EU policy debates have affected African countries, and (iv) to examine multiple EU issues for regulatory reform, including science base, public engagement, intellectual property, new environmental challenges, other applications in the bioeconomy.

We have been looking into several case studies from comparator countries, like (i) Impact of GM herbicide-tolerant soybean in Argentina, (ii) Socio-economic impact of Bt cotton in India, (iii) History of developments in Bt cotton in Australia, (iv) Trends in GM research in Brazil, and (v) Regulatory system for plants with novel traits in Canada. We were impressed by the fact that Brazil is exploring the new breeding technologies and is also developing several own new traits and products, not depending on multinationals, but strongly investing into own research and development.

Based on the case studies we defined emerging cross-cutting issues, like (i) Export of agricultural commodities is increasingly part of economy of competitor countries – one consequence is stimulus to basic science and innovation, (ii) Vital to distinguish between any specific effect of a technology and consequences of other changes in agronomic practice and social developments, (iii) Increasing volume of evidence to document benefits of GM crops – GM technology itself has no greater adverse impact than any other technology used in plant breeding, and (iv) Streamlined, transparent, effective regulatory frameworks can be devised that encourage investment and innovation – they must focus on product/trait rather than on technology.

Our collaboration with African experts on agricultural biotechnology involved academies from 13 African countries, two workshops together with the African Academies of Science, and case-studies from Ghana, Uganda, Tanzania and Kenya. The most important observations were: (i) Evidence shows that EU actions historically constrained use of crop genetic improvement technologies in African countries, creating difficulties for farmers, scientists, and policy-makers, (ii) Recently, increasing activity in Africa to characterize and cultivate GM crops to address local needs, (iii) Significant opportunities for information-sharing and R&D partnership between EU and Africa to strengthen local systems, and (iv) Continuing role for science academies to work together to identify science and technology priorities, strengthen centers of excellence, contribute advice to support policy-making and public debate. For me it was highly interesting to see that in several African countries, for example in South Africa where the recent International Symposium on the Biosafety of GMO (ISBGMO-13) took place, own new breeding tools and own plant traits are developed, and there is also a high level of capacity building.

The strategic priorities defined in the EASAC Report were focused on the European Union but might also be important for other parts of the world. These were: (i) The potential of crop genetic improvement technologies is very significant, (ii) It is urgent for the EU to capture these benefits, (iii) This requires better policy coherence to exploit the research and technologies that the EU was instrumental in generating: in common with other sectors, the aim should be to regulate the trait and/or the product but not the technology in agriculture, (iv) We have collective responsibility to provide and utilize scientific solutions to improve agricultural productivity globally and reduce the adverse impact of agriculture on the environment, and (v) All available approaches – traditional and novel – must be deployed.

I will close my talk by citing Ann Glover (10) again: "... now in 2013 with more research into GM technology than almost any other area of food research, there is no evidence to suggest that the GM technology per se poses any unique risk compared to any other plant breeding technology." "To be provocative – can we meet the demand for food to feed 9 billion citizens by 2050 without using every tool in the tool box? Is it ethical to reject technology without evidence but on the grounds of preference when 1 billion global citizens every single day are starving?" "Our obligations as citizens are to look at the evidence presented and have the courage to reposition our views as that evidence accumulates." Very distinct words by Anne Glover, unfortunately I have to say – former – Chief Scientific Adviser to the President of the European Commission. The new President just discarded the position despite strong interventions by EASAC, EPSO, and other European science organizations.

I want to thank you very much for your attention, and I am doing this with a photo my daughter took about 15 years ago at the remainders of the Berlin Wall. You might know that just on the 9th of November we have been celebrating the 25th anniversary of the destruction of the Berlin Wall. The picture shows a sentence by the German writer Erich Fried: "Wer will // dass die Welt // so bleibt // wie sie ist // der will nicht // dass sie bleibt" which might be translated into "Those who want the world to continue as it is – do not want the world to continue".

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The Crucial Role of Science, Technology and Innovation in Alleviating Poverty

Amr Farouk Abdelkhalik (Academy of Scientific Research and Technology, Egypt)
Article

More than one third of the world's population lacks the resources and information to meet basic human needs such as adequate food, clean drinking water, sanitation, good health provision, shelter and education.

Science, technology and innovation can play a crucial role in alleviating poverty. They have led to a wide array of developments, from boosting agricultural productivity to providing the means to generate energy cheaply. Technology can result from the application of science to add value, simplification, diversification, and productivity to a management process or product. However, technology's value wanes unless it can be transferred to a user who can apply the technology to create a tangible benefit. Arising from this assertion, the vitality of public good science funding is critically dependent on technology transfer.

As the Academy of Scientific Research and Technology is the main coordinating body for scientific research in Egypt and a national authority that provides a public service by ensuring independent, unbiased assessments of the sciences. And as ASRT is totally aware that Technology transfer appears to be a simple communication process, however, in-depth analysis reveals a predictable learning pattern whereby, comprehension of the technology is first achieved, and then comes the interpretation of how the technology can be used to solve a problem. And as ASRT is aware that poverty eradication is one of the main issues that is taken into consideration worldwide, that's why ASRT was keen to include within its call for national initiatives various range of projects designed to benefit people in the poorest parts of the Egypt, particularly those living in rural areas. As Egypt is known as one of the oldest agricultural civilizations, the Egyptian economy has relied heavily on the agricultural sector for food, feed, fibre and other products.

SESSION 2 - Science for Water Security: Enhancing Global Access to Water

Chair: **Marcello A. Barcinski** (Brazilian Academy of Sciences and National Academy of Medicine, Brazil)

Every Drop Counts - Count Every Drop

Bai Mass Taal (African Ministers' Council on Water)
Conference

I thank Jacob Palis, President of the Brazilian Academy of Sciences and Chair, Global Network of Science Academies (IAP) Science for Poverty Eradication Committee for your kind invitation to this International Conference on "Science for Poverty Eradication and Sustainable Development: a Call for Action." I am especially delighted to be asked to speak on "Science for Water Security: Enhancing Global Access to Water".

The theme of this conference "Science for Poverty Eradication and Sustainable Development: a Call for Action" indicates an unwavering commitment of the Global Network of Science Academies to its core mission which I understand is the development of strategies to engage Science Academies in the global effort to eradicate poverty and transform economies through sustainable development. That you have asked me to speak on "Science for Water Security: Enhancing Global Access to Water" underlines your understanding that water stands at the center of nearly every global challenge: climate change, health, nutrition, environment, transportation, and even political conflicts. Permit me to quote some of the introductory highlights of the 2008 World Economic Forum report on water security. I quote: "Water security (whether it be the challenge of too little water over long periods of time, or too much water all at once) is one of the most tangible and fastest-growing social, political and economic challenges faced today. It is also a fast-unfolding environmental crisis. In every sector, the demand for water is expected to increase and analysis suggests that the world will face a 40% global shortfall between forecast demand and available supply by 2030." The Report goes on to say: "This outlook bears potential for crisis and conflict since water lies at the heart of everything that is important for human life: food, sanitation, energy, production of goods, transport and the biosphere; as such water ensures not only mere survival of humans, but also social well-being and economic growth. In addition, water is a renewable yet not inexhaustible resource – it cannot withstand constant over-extraction and being depleted faster than being renewed. What is more, water cannot be substituted."

Science on the other hand has completely revolutionized the way we live, defining the future, greatly amplifying humanity's progress and material comfort, untangling the webs of human challenges, increasing human security, steering us away from health risks toward healthier communities, and improving overall quality of life. Hence in this age the role of science in sustainable development becomes indispensable.

The role of science in sustaining water security therefore cannot be disputed especially when we consider the challenges that we face in efficient management of water resources for socio-economic growth. The World Health Organization has observed: 'If humankind would manage its water resources properly, ensure everyone has reliable access to safe drinking water and basic sanitation, and make basic hygiene practices the norm, we could save around 1.8 million lives yearly – mainly the lives of young children'.

Let us also consider the interlinking and interdependency nexus between water, energy, and food. Research has shown that growth in population, growth, expansion in our cities and the accompanying accelerated economic activity will surely outstrip the demand for energy and food and create unsustainable pressure on our water and land resources. It is anticipated that if we continue in a business as usual scenario, humanity's demand for water could outstrip supply by as much as 40 per cent. This would place water, energy and food security at risk, increase public health costs, constrain economic development, lead to social and geopolitical tensions and cause lasting environmental damage. If we are serious concerning alleviating poverty and creating a climate resilient and robust green economy, it is crucial then that we think of water, food and energy security in an integrated manner.

To respond to the emerging needs and those of an expected growth rate of more than two billion more people likely to be born in the coming decades, we need better, more efficient and more productive use of the scarce water resources available. Both rain-fed and irrigated agriculture need to be intensified. We need more efficiency in irrigation and improved coordination between land and water resource management. We need to think water for food production in terms of not just quantity but quality. How can we effectively reuse waste water and still maintain required nutrient levels necessary for improved agriculture? How can we engage rain harvesting more efficiently to catch and store more water for irrigation purposes? We have to acknowledge the enormous potential in promoting green energy especially hydropower rather than fossil fuels, which makes sense in an era of climate change and which offers Africa the least-cost energy supply with zero carbon emissions.

So what can Science do for Water Security in order to enhance global access to water? Water must not become the limiting factor for food, energy and water security (Africa Water Vision 2025). Nexus thinking needs to be based on science-based evidence of the gains to be made. So, added focus is needed on research and development, innovation, green technologies including decision support systems and sharing of data and information, along with dissemination of results through a stronger science-policy dialogue. Policies then must emerge that are scientifically sound, economically viable and socially acceptable.

There is also need to put science into action, by promoting the process of transformation, building competences and experience into answering local and regional needs for tools; tools to adapt Integrated Water Resources Management (IWRM) in meeting today's global water challenges. Implementation of IWRM requires sound enabling technologies and enhanced hydrological and meteorological information systems that are crucial to directed interventions.

It is also essential to build knowledge platforms where stakeholders, researchers, local institutions, policy makers, and education entities can exchange and share the information, communicate each other, and develop new ideas that would support policy making and decision taking.

The communication between scientists, policy makers and stakeholders is an important step toward development of community understanding and ownership of water risk. Scientists have a responsibility to educate the community they serve regarding the water risks that these communities face and possible actions they can take to reduce those risks.

Efforts should be made to improve and update water education at all levels. In this context, water education should include a multidisciplinary and interdisciplinary approach aimed to advance scientific knowledge through the training of scientists, as well as to strengthen and enhance the water sector through the formation of water

professionals and decision makers. Education, knowledge and capacity development at all societal, scientific and institutional levels are keys for efficient and sustainable IWRM and resource development.

The challenges of shared waters persist, and transboundary collaboration call for scientific evidence on which to base the development of strategies and plans. Although there is a growing literature in the field of shared waters and conflict resolution, many water professionals still lack the necessary tools to enhance effective transboundary water management. This requires efficient data gathering, analysis and Information sharing. A common component of most information systems supporting transboundary river basin management is data gathered from monitoring systems designed to collect information regularly about specific parameters, at certain locations and frequencies. Similarly, implementation of plans and their impacts, positive or negative, need to be monitored, which requires data and information about the shared river or aquifer system.

There is a clear need in Africa to increase funding to build scientific, human and institutional capacities to effectively develop and utilize water resources. Investment in the water sector should come from both government and private sector, and this should be done based on the real value of water including its environmental, social, operational and construction components.

Distinguished Scientists, your network - the Global Network of Science Academies is a Network for promotion Excellence. Organizations such as yours which propel knowledge sharing and skills acquisition remain the bastion of hope for a better tomorrow with smarter solutions for the world's myriad of challenges. Permit me to say that it takes vision to lead, it takes a sense of mission to seek to achieve excellence, and there is no higher virtue than to commit to seeking and achieving excellence.

Aspiring for and maintaining excellence is a vision borne out of an underlying desire to achieve the best that ever could be, it satisfies the curiosity and rigorous exercise of the intellect. It thrives where ordinary mortals fear to tread. It shows absolute disdain for lethargy borne of fear of failure; it resists the lure to lie comfortably in the bed of failure. It seeks to display the fountain of knowledge as the key to unlocking the solution to life's myriad of challenges such as that confront us when we discuss science, water and sustainable development.

Let us therefore not be discouraged by the inadequacies of our time and rather think of tomorrow that will be better than today. I challenge all members of this network to inspire all budding scientists to think outside the box to bring forth new innovations for enhancing greater efficiency in water resources management. Can we develop new technology to do toilet without water or which uses less water, what better ways can we improve irrigation and food production; water storage and rain harvesting? How can science and technology continue to drive energy efficiency and climate change mitigation?

I ask you to rise to the challenge of experiment and creativity, which today's circumstances demand. I believe that we can do it if we set our minds to it.

I thank you for listening.

Water and Poverty: How the UNESCO-IHP Programme contributes towards understanding the link

Blanca Jimenez Cisneros (International Hydrological Programme of UNESCO)
Article

If the misery of our poor be caused not by the laws of nature but by our institutions, great is our sin, Charles Darwin (1809-1882)

1. Introduction

Even though there is not a universally accepted definition for poverty (W, 2002, WRI, 2005), everybody knows that at the global level there are more poor people than rich people. Simply, the bottom half of the global population owns less than 1% of the total wealth while the richest decile holds 87% of the world's wealth (Credit Suisse, 2014). Most of the poor lack (proper) water services, but moreover they also lack water resources to support their economic development. Furthermore, the poor live in areas prone to droughts and floods. It is

well known that all these conditions increase inequity and the vulnerability of marginalized groups (Torras and Boyce, 1998). Water is indispensable for human and economic development, as well as for achieving sustainability. However, the acknowledgement of universal access to water since 2006 by the United Nations only relates to the provision of water services and does not take into consideration other aspects of water itself. Under this framework, this paper explores the causes and links of water to poverty and to sustainability beyond the merely supply of water and sets simple recommendations to overcome challenges.

2. Background

Water problems as a result of local physical, economic and management constraints

In many regions, people lack water simply because they are placed in areas where the resource is scarce (Fig. 1 A). For developing countries, most of which find themselves located in such type of regions, this is a concern, since in addition to having physical water scarcity[1] they also experience economic scarcity (Fig.1B).

3. Scarcity of water resources and disasters as a cause of poverty

The lack of access to water resources and the exposure to water related disasters are causes of poverty

Most of the time, in literature, the only link made between water and poverty relates to the water supply. However, the lack of access to water as a resource and/or being exposed to water related disaster are also sources of poverty. Moreover, water is linked to poverty through many different pathways, that may act in parallel or in series following complex pathways (Fig. 3) and with consequences that do not always add linearly.

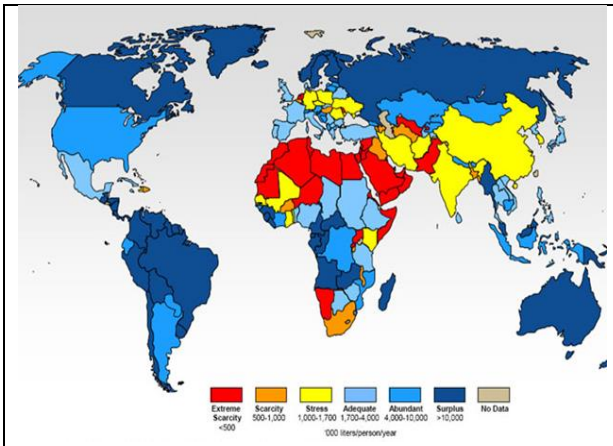

Fig. 1A: Per capita global water availability estimated for 2025, from GEF, 2005.

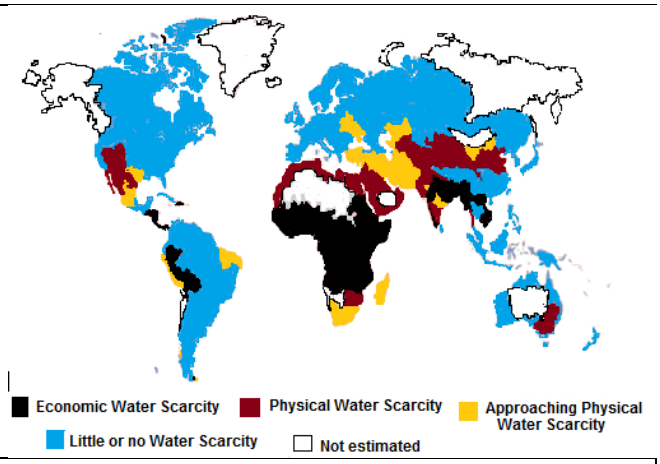

Fig. 1B: Physical and Economic scarcity, with information from IMWI, 2007.

[1] **Physical water scarcity**: Water resources development is approaching or has exceeded sustainable limits. More than 75% of the rivers are withdrawn for agricultural, industrial or domestic purposes (accounting for recycling of return flows). The definition relating water availability to water demand implies that dry areas are not necessarily water scarce.
Economic water scarcity: Human, institutional and financial capital limits access to water even though water in nature is locally available to meet human demand. Water resources are abundant relative to water use, with less than 25% of water from rivers withdrawn for human purposes but malnutrition exists.

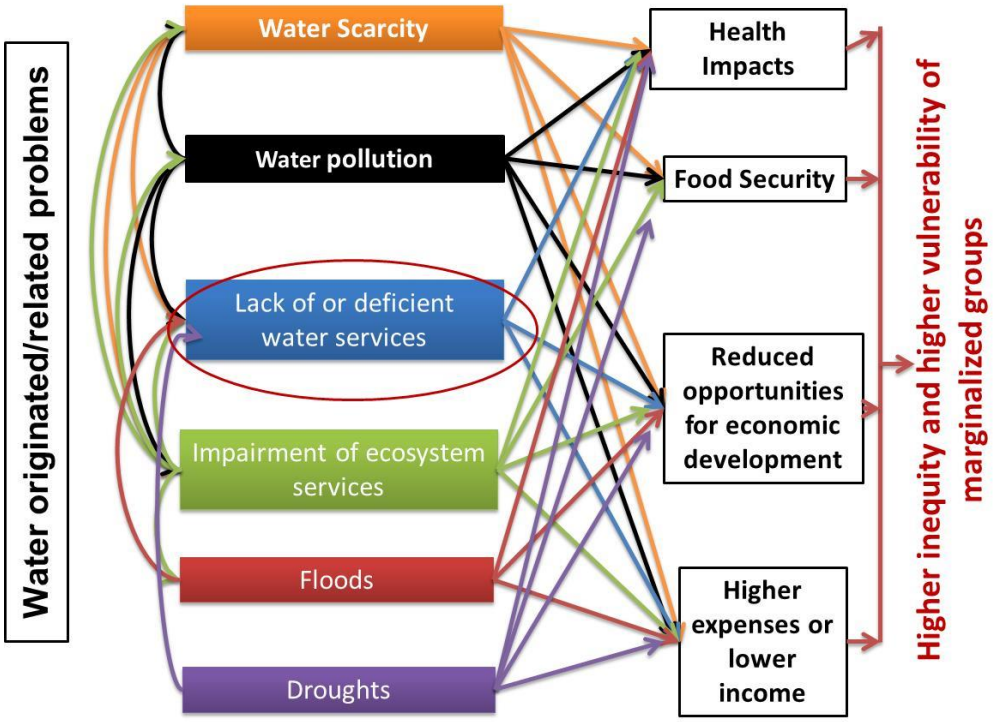

Fig. 3: Water and impacts on poverty.

Water has impacts on economy

The only realistic mean to lift the poor out of extreme poverty is economic development. However, in order to perform economic activities, water is needed. Overexploitation and pollution of water decrease the water patrimony and with it the opportunity for development. For the poor this can have significant impacts, as frequently the only capital they possess is the natural environment. The improper management of water has high costs on the economy. For instance, in Peru it costs 4% of the GDP (Gross Domestic Product) due to problems associated to water related diseases (1.06%), overfishing (0.36%), soil degradation, soil erosion and salinization (0.35%), deforestation (0.26%) and solid wastes mismanagement (0.05%), UNDP (2006). Water overexploitation and its pollution not only reduce the availability of the resource, but they also increase the competition for it.

As any other user, the poor compete for water; however, they compete under tougher and more unfair conditions

Water consumption increases with population growth, but it increases twice as fast (WWC, 2015). Water is needed not only for human consumption but for all municipal uses, to produce food, to support economic development, to generate power and to protect and sustain the environment. Hence, when water is scarce the competition for the resource is tougher. For the industrial use, for example, in just 30 years the consumption of water more than doubled and it is estimated to increase by 400% between 2000 and 2050 (OECD, 2012). Furthermore, to restore the environment, more water should be allocated in the future. During the XX century alone, 50% of the wetlands disappeared because of problems associated to the resource (Millennium Ecosystem Assessment, 2005). The poor have fewer opportunities and are less skilled to fight for their rights to water not only because of their decreased level of education and information social and economic barriers. The competition can be extreme, placing their opportunities for livelihoods at risk. For instance, irrigation which is the easiest way for farmers to increase their incomes, is accessible to the rich only, endangering the availability of water for the poor even with regards to water for human use. Irrigation enables sowing between 3 to 5 crops per year instead of the 1-2 that can be sown in rain-fed irrigation fields. Furthermore, thanks to irrigation, it is possible to grow crops with higher market value and increase yields per area of cultivation. However, irrigation considerably increases the demand for water at a local level. While only 20-50L of water per person per day are needed for human use, to produce food, 3500 L/person per day are needed. Poor farmers compete with rich farmers for water to be used for irrigation or for human consumption, in addition to competing over access to infrastructure. Frequently, the population with low income is placed far away from water resources and/or

primary irrigation networks. Their access to credits to invest in the required infrastructure is limited and they lack means to ensure the return of the investment to banks.

Water related disasters particularly affect the poor, both in terms of number of people injured as well as with regards to the percentage of personal income lost

Deprived population are often located in densely populated urban areas – slums, shanty towns – or in rural areas in isolated regions placed in lowlands, zones exposed to landslides and/or in semiarid and arid regions. Thus, they suffer from floods, droughts or both. Occasionally, during a same year, they are repeatedly affected by water related disasters, losing all their possessions each time, if not their lives. Since the mid-20th century, socio-economic losses due to floods have been growing due to greater exposure and vulnerability (Jiménez et al. 2014), representing over 95% of the total reported deaths in developing countries. From this total of 95%, 75% come from southern, southeastern and eastern Asia (Handmer et al., 2012). Although floods are believed to have higher impacts than droughts, because of the publicity they receive from the media, damages from droughts are much higher (on a ratio of 10 to 1 as can be seen for example, in Mexico Jimenez and Tundisi, 2012) however they are poorly documented. This is an issue of concern since the population growth in arid and semiarid areas is faster than that experienced in other geographical regions (Millennium Ecosystem Assessment, 2005).

4. Water services and their link to inequity

Lack of proper water services affect health and human development, with major impacts on the poor, women, children, and the elderly.

Low income people placed dispersedly in isolated regions or in difficult topographic conditions receive water services with less priority. Basically, for governments, following cost/efficient criteria, it is more convenient to provide services to population placed in more suitable areas. This partly explains why, despite the efforts to achieve the millennium developments goals, 748 million people still lack access to clean water and 2.5 billion (40% of the world's population) still lack improved sanitation services (WHO-UNICEF (2015). As a result, the 80% of fecal-oral transmitted diseases are attributed to inadequate sanitation, lack of hygiene and safe supply of water, killing over 1.5 million children each year as a result of diarrhea. The lack of sanitation spreads many other diseases, pollutes water, land and agricultural food and denies basic dignity to the poor. Lack of proper sanitation has particular impact on women, as girls are pulled out of schools when there are no adequate sanitation premises or are at risk of rape when traveling to isolated areas to defecate. This is an additional barrier to their education. The lack of proper water services is a common characteristic for the poor even in emerging countries (WHO and UNICEF, 2015), where the economic growth seems not to be reflected on the coverage of services. The resulting costs of the lack of water services is high, as their impacts represent around 2 to up to 7% of the Gross Domestic Product (GDP) in poor countries (WSP cited in UN 2015).

The poor have to invest more money and more time in order to have access to water

In order for the Human Right to Water to become a reality, the poor not only pay more for the service than higher social classes but also have to invest time. In some cities, it has been documented that those with no access to water pay prices going from five to up to a hundred times the price of the regular water tariffs (WB, 2002). The higher costs can be measured not only in economic terms but also with regards to the time consumed to get the water. The poor wait long hours in lines to obtain water from water tanks or walk long distances to fetch it. When the distance is more than 5 km, the amount of water used per person is drastically reduced. From the minimum recommended of 50 L/d per person, it decreases to 15 L/d per person (WB, 2002), compromising activities that are vital for maintaining adequate hygiene and a clean environment at home. In addition, the fetched water frequently still needs to be cleaned. Boiling is the most common applied method, but it results in additional costs for the urban population or is a source for deforestation in rural areas where fired wood is used in the process. The time invested (mostly by women) to accomplish both, fetching and treating water, is time that it is not used on activities to promote social mobility, such as education or economic activities.

The decision-making processes are not adapted to particularly serve the poor

Slums or poor villages are placed on hills, ravines, on soils which are inadequate for buildings and/or far from areas where public services are already provided. This is why their land is cheap. However, for water utilities these are areas that demand high investments for installing infrastructure and for operating hydraulic infrastructure. As any other enterprise, water companies function using economic efficient criteria, in which the

selection of areas to provide the service is made on the best cost/service ratio. Thus, in practice, the poor are serviced last. This situation, although less documented, is even worse in rural areas where the dispersion of the population further increases the costs.

Most of the current water supply technology is not adapted for the poor
So far, the provision of water services is conceived to be operated in a centralized manner and with relatively high specialized maintenance. There is need to develop technology suitable to the conditions in which the poor live, that is to say, there is need to develop technology at a reasonable cost, that can be easily operated, requiring low maintenance and with high resilience to several contingencies (such as lack of power, floods, wars, insecurity, etc.).

5. What can be done to reduce inequity in the management of water

Government is responsible for providing both access to water to support human and economic development, and water services for all (including the poor)
Governments have the goal to ensure access of enough water to all users - present and future-, avoiding overexploitation or impairment of the quality of the resource. In parallel, the governments also need to protect the population from the impacts of floods and droughts. This way Water Security would be achieved. And the management of water would contribute to achieve food, energy, biodiversity and human securities. To reduce urban and rural inequity, this objective has to be implemented through programs that specifically target to serve the poor and marginalized groups.

The government's goal to manage water and a sustainable way, provide water services for all and protect the entire population from water related disasters can be achieved directly or indirectly to implement the program effectively there is need to develop proper laws and regulations, and build institutional and human capacity. This is not an easy task as poverty reduction needs to be tackled jointly by both public and private sectors. Alongside this, the development of monitoring programs using indicators to measure the effects on the poor and marginalized groups are also required.

Social and natural sciences can contribute to the process by assisting in the mapping of poverty related to water problems, designing solutions and monitoring their results
To support governments and society, the academia can contribute by assessing the current situation and needs, understanding the causes of the problems and developing feasible solutions to improve the situation of the poor. Of particular interest to policy makers is the mapping of poverty, the identification of priority areas to act upon (spatially and thematically), and the provision of independent monitoring and verification of the achievement of the targeted results.

To cut the link between water and poverty, there is need to act at the global, regional and local level
Unfortunately, poverty is a global challenge and it is indispensable to provide international support to promote solutions at the global, regional and local levels. In this context international and intergovernmental programs can play an important role by providing policy advice, facilitating knowledge and technology exchange and promoting human resources and institutional capacity building. One of such programs is the International Hydrological Programme, or IHP, of UNESCO (Table 1). The Programme, created in 1975, uses a multi- and transdisciplinary approach to improve the governance of water. The Programme is at its Eighth Phase (2014-2021). It has the goals to contribute to achieve Water Security and to assist in the implementation of the international post-2015 agenda.

6. Conclusions

Water and poverty are linked, as the lack of water resources and the impacts of water related disasters can be a source for poverty, and lack of water services negatively impact the poor. The pathways for these links are many and act in a complex way. Moreover, water affects not only the economy of the poor, but it also affects the economy of a country, with costs that can reach, in some cases, up to 7% of the GDP.

To have access to water, the poor have to compete with other users under conditions that are frequently unfair, as in addition to the impacts of the hydraulic problems they face, they are vulnerable because of many other reasons, and this limits their capacity to defend their rights to water or to achieve social mobility. Furthermore,

the poor invest more money and time than higher social classes in order to have access to water services. In addition, water problems have negative impacts on gender inequality, children and the elderly, a situation which worsens if, additionally, they are poor.

The decision-making processes based on cost efficient criteria and the available hydraulic technology, in general, is not adapted to reduce inequity with regards to the access to the resource, the provision of water services or the protection to water related disasters for the poor. To reduce inequity and cut the links between water and poverty it is necessary for governments to explicitly acknowledge these problems and set specific goals to address them under a proper institutional framework using monitoring programs designed to measure the progress achieved.

Poverty is a global challenge, thus international and intergovernmental programs working in a trans disciplinarily way with all stakeholders, such as the IHP, are needed to promote solutions at the global, regional and local levels.

Table 1: Focal areas of IHP-VIII2 Water Security — Responses to Local, Regional and Global Challenges.

Theme 1: Water-related Disasters and Hydrological Changes 1.1 Risk management as adaptation to global changes 1.2 Understanding coupled human and natural processes 1.3 Benefiting from global and local Earth observation systems 1.4 Addressing uncertainty and improving its communication 1.5 Improve scientific basis for hydrology and water sciences for preparation and response to extreme hydrological events	**Theme 2: Groundwater in a Changing Environment** 2.1 Enhancing sustainable groundwater resources management 2.2 Addressing strategies for management of aquifer recharge 2.3 Adapting to the impacts of climate change on aquifer systems 2.4 Promoting groundwater quality protection 2.5 Promoting management of transboundary aquifers
Theme 3: Addressing Water Scarcity and Quality 3.1 Improving governance, planning, management, allocation, and efficient use of water resources 3.2 Addressing present water scarcity and developing foresight to prevent undesirable trends 3.3 Tools for stakeholders involvement and awareness, and conflict resolution 3.4 Addressing water quality and pollution issues within an IWRM framework (improving legal, policy, institutional and human capacity) 3.5 Innovative tools for safety of water supplies and controlling pollution	**Theme 4: Water and Human Settlements of the Future** 4.1 Game changing approaches and technologies 4.2 System wide changes for integrated management approaches 4.3 Institution and leadership for beneficiation and integration 4.4 Opportunities in emerging cities in developing countries 4.5 Integrated development in rural human settlement
Theme 5: Ecohydrology, Engineering Harmony for a Sustainable World 5.1 Hydrological dimension of a catchment (identification of potential threats and opportunities for a sustainable development) 5.2 Shaping of the catchment ecological structure for ecosystem potential enhancement — biological productivity and biodiversity. 5.3 Ecohydrology system solution and ecological engineering for the enhancement of water and ecosystem resilience and ecosystem services 5.4 Urban ecohydrology – storm water purification and retention in the city landscape, potential for improvement of health and quality of life. 5.5 Ecohydrological regulation for sustaining and restoring continental to coastal connectivity and ecosystem functioning.	**Theme 6: Water education, Key for Water Security** 6.1 Enhancing tertiary water education and professional capabilities in the water sector 6.2 Addressing vocational education and training of water technicians 6.3 Water education for children and youth 6.4 Promoting awareness of water issues through informal water education 6.5 Education for transboundary water cooperation and governance

[2] Cf. http://www.unesco.org/new/en/natural-sciences/environment/water/ihp-viii-water-security/

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Science, Poverty and Sustainable Water Management: why they will never coalesce unless we re-think "science in society"

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Article

Three of the words in the title of our theme – "poverty", "sustainability", and "water" – are what are called "wicked problems", i.e. problems that we often cannot get everyone to agree on what even the definition is. The fifth – "management" – is about finding solutions; but how can that be done when we cannot even agree on what the problem is in the first place? The first word in the title of the conference – "science" – is a certain approach to problem solving that, if we follow Karl Popper's reasoning, is best done in an "open society' where the future is always uncertain, our certitudes can only be tentative until falsified, and thus our attempts at problem solving can best be piecemeal and humble (Popper, 1999). The complex problems within each one of these words have not coalesced into a single solution in the past, that being part of the problem, and getting to do so is the challenge before us which is not going to be simple. Towards that end, this essay will try to

deconstruct the scientific problems of complexity and interdisciplinarity within the context of failed development of the past half century using the sectoral backdrop of water to explore how science should tackle poverty.

Complexity, Interdisciplinarity and Vantage Point

Much of science in recent decades has been dominated by reductionist and specialized silo thinking of ever narrowing disciplines. Great achievements have been made in highly specialized branches of scientific knowledge and they have opened up many technological possibilities. In their wake, however, has come the conundrum of complexity. Problems that need solving – wicked problems such as climate change, poverty, water, energy or even development – seem to be the focal points where many disciplines intersect. A single discipline finds itself unable to solve such a wicked problem without the aid of other disciplines. Energy crisis cannot be tackled without economics; water conflicts cannot be understood without the social sciences; and solutions to poverty or development cannot be even attempted without understanding the underlying political economy, their history or their legal regimes.

Attempts to solve complex problems have been tried by "multi-disciplinarity", i.e. a task force or a government commission is often set up with experts from different fields to look at the problem from different disciplinary angles and to suggest solutions. However, it quickly becomes obvious that in such teams different experts apply the tools that their fields of expertise give them only to the slice of the problem amenable to the use of those tools with very little cooperation between disciplines. It is assumed then that some mythical "policy maker" is able to all the disciplinary analysis together and synthesize these concerns into a coherent message for appropriate policy action. Unfortunately, an average politician or an average departmental manager is often unqualified to do so or unwilling to take such a risk.

The task of addressing the problems faced by a discipline (say an electrical engineering problem of energy supply or demand management) with the help of another discipline (economics, law or even the sociology of consumer behavior) has been given the broad name of "interdisciplinarity" (Gyawali, 2003). Within it, several types or stages too have been identified (Thoren, 2015), such as "cross-disciplinarity" (where 'problem feeding' occurs from one discipline to several others without much feed-back); "pluri-disciplinarity" (where a phenomenon may have several causes that will require contribution from several feeding theories); as well as "trans-disciplinarity" (where coordination is sought from several higher level concepts from different disciplines). What is important is whether the disciplinary knowledge fields and their theories are organized in think tanks where no single discipline or theory enjoys any hegemony AND whether there are efforts between them at common problem solving. Universities and their teaching departments are often not organized in such a manner and function best as silos of reductionist excellence.

In such a framing, defining the overarching problem that different branches of knowledge can contribute to solving becomes paramount. Here then is the problem of scale, wherein I argue that there are two types of sciences: Eagle´s Eye science and Toad´s Eye science. The former has perspective and the latter has depth. Happy would be a scenario where both existed and complemented each other; however, in Southern developing countries there is not enough Toad´s Eye science. Turn to any statistical yearbook from any major multinational development agency and much of what you see in terms of the data will be from an Eagle´s Eyes perspective. They often completely miss many of the things that are happening on the ground, especially in the informal economy of the poor, and that is where well-meaning development policies seem to go completely wrong. Let us illustrate this with some cases.

Some Examples

The first example of a disjuncture I wish to place before you is this one of a lady of Lahore selling strawberries on her semi-traditional donkey cart (semi-because the pneumatic tires are a modern syncretic innovation), using a mobile phone to connect to her customers against a background of mobile towers and high voltage transmission lines as well as medieval Mughal ruins is a study of transitions (DST, 2008). This depicts several transitions –between ages,

between spaces, and between technologies. The product that she is selling (strawberries) is very exotic and not traditional, demanded by the rich elites probably for their ice-cream. However, the lady obviously has gotten out of poverty, with some of with the help of several changes – in cropping patterns, in technologies, and in marketing skills. And the origins of this success are not from international development agencies or even the national government but from innovations in the informal sector.

Where the problem is and where successful solutions can be found is not linear, and it does not lie in comfortable textbook knowledge either, which must have gotten us into the mess in the first place. If you look at the problems in the electricity sector in my country (Nepal) right now, the foremost seat is occupied by the 15 hours of power cuts a day that the integration Nepali national grid is suffering from. The demand is much higher than the supply, 1200 Mega Watts (MW) being the former and 400-700 MW being the supply depending upon whether it is the dry winter months or the rainy season for the hydropower-based system. The standard definition of the problem is: Nepal is a poor country and needs foreign aid to build the power stations. Official statistics will tell you we have only 700 MW of installed capacity in the national grid However, recent surveys by non-government sources show that private housing, shopping complexes, hotels etc., have added 700 MW of diesel as well as some 46 MW of solar (equivalent to the national grid capacity) that is invisible. So what goes out of the window is official development logic because people seem to have enough money to invest in the equivalent of the national grid while paying five to ten times the official rate for power! Whence this blindness?

This picture demonstrates the contradiction in the levels of science we do: you think you are seeing a truck as you might if you are a drone operator deep into Eagle Eye science. However, it is not really a truck: it is an irrigation pump rejigged up as a truck locally called a jugad ("make-do") in the parts of Gujarat and Rajasthan where this one was located (see DST, 2008). It does not have a license plate and often is driven by people who do not have driver's license either. The story behind it comes from the Eagle Eye policy of India's rural development bank that gives soft, subsidized loans to farmers only is, the Indian Rural Development Bank – NABARD or whatever it´s called, gives loans, very cheap loans to farmers to buy three horsepower (HP) pumps – because the engineers and the economists decided that it takes that much to pump the required water. However, Toad's Eye calculation of farmers is that, if you buy a three HP pump you can only use it only for 2000 hours a year for irrigation and have it stored in a shed for the rest of the year. But if you buy a 10 HP pump, you can use it for 2000 hours of pumping and maybe another 4000 hours as a transportation device, a jugad. It transports goods and pays your loan off in maybe two instead of seven years. Farmers turn out to be smarter than the engineers and the economists that development banks hire. Toad's Eye science triumphs over Eagle's Eye!

Another example, this time from central Nepal along the Tinau river, shows how technology choice is a function of the social solidarity at work (Gyawali, 2004). Farmers have used brushwood dams to divert river water to their irrigation fields in the dry season for centuries. They use the community's volunteer labor for the task which can take several days and benefits all the water users of the irrigation locality. During the monsoon season, the floods wash away this brushwood dam as it is designed to do, which is quite advantageous because the issue then is not more water but less and how to quickly drain away the flood flows.

However, with the onslaught of modernity, volunteer labor is hard to come by due to the lure of the market where it fetches a price; and the system managers want small help with their task – a backhoe maybe, or plastic sheets etc. They come to the government irrigation departments where engineers are trained in modern cement technology and the concrete dam they know how to design and build. (No engineering institute or university I know of teaches brushwood dam design, nor do most of them have much to do with traditional technology, which they see as primitive and beyond their dignity to have anything to do with. This anomaly happens despite the fact that maybe as high as some 80% of Nepal's hill irrigation is still dependent on such brushwood dams even today!) Unfortunately, as seen in the second picture of the Hattisunde barrage built in the lower reaches of the Tinau failed to function in the immediate year after it was commissioned since the river shifted its course after a flood that year.

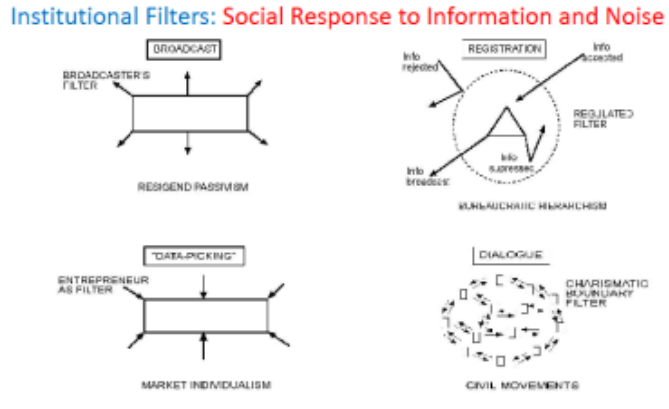
Unfortunately this "comedy" was followed by a genuine tragedy: in the lower reaches of the Tinau, in the Marchawar region next to the Indian border that was supposed to be a beneficiary of this modern, agency-managed technology, the failure of this new technology that was supposed to replace their primitive brushwood dam system meant a collapse of social order with widespread banditism as people resorted to any means to survive. The situation was reversed only two decades later with the third picture in the montage: the humble diesel irrigation pump introduced by the market – for a price. Thus, you see three different technology choices – community's brushwood dam, irrigation agency's cement barrage, and the market's groundwater pump – made by three different social styles of organizing, e.g. community's egalitarianism, bureaucratic hierarchism, and market individualism.

This next example is that of the infamous breach in August 2008 of the left bank of the Kosi embankment. It displaced some sixty-five thousand people in Nepal and some three and a half million in downstream Indian state of Bihar. Given that the Indo-Gangetic plains are very fertile, these disaster victims were pretty prosperous people who grew vegetables and sold at the market; but now their fields are under six feet of sand brought by the flood from the breach. The government of India was quick to repair it and restore the status quo ante; however, questions of why the breach occurred have been swept under the carpet.

Some were quick to blame climate change while the local politicians were pointing fingers at each other across the transboundary divide for this flood. However, how can one call this calamity a flood (even though in the pictures it sure looks like one) when the river was flowing only at 60% of average flow for that time of the year? So what happened? It seems such breaches have happened some eight times in the past in Bihar over the last half century of the building of the embankment, but they were mostly not reported. This time it happened in Nepal and could not be ignored. Site visit and interviews indicated that the cause was massive corruption during the building of the embankments. Clay core was never put in place nor compacted properly when it was; and just piling up of surrounding sand was routine. This meant that the embankment would inevitably breach, as it did in 2008 and some eight times previously. The larger question of science that this event and the official whitewashing of the disaster brings forth is that solutions to the problems of floods in such a hydro-geo-climatic ecology of the Kosi may not lie in civil engineering of embankments that provide the false promise of "permanent" security and control over floods. Instead, the solution might lie in geography of flood zone demarcation between settlements and agriculture land as well as in architecture of houses built on stilts.

Each of the cases above serves to highlight the complex and interdisciplinary nature of everyday problems that need solving, the need for a science that transcends reductionism and is able to both feed problems and be fed theories from other disciplines, and the ability of scientists to work with policy makers to link all these efforts with poverty. Indeed, it now needs to be made explicit: each of the cases highlight the link to poverty or how people got out of it; they also serve to highlight the inchoate nature of the task of defining what the problem itself is.

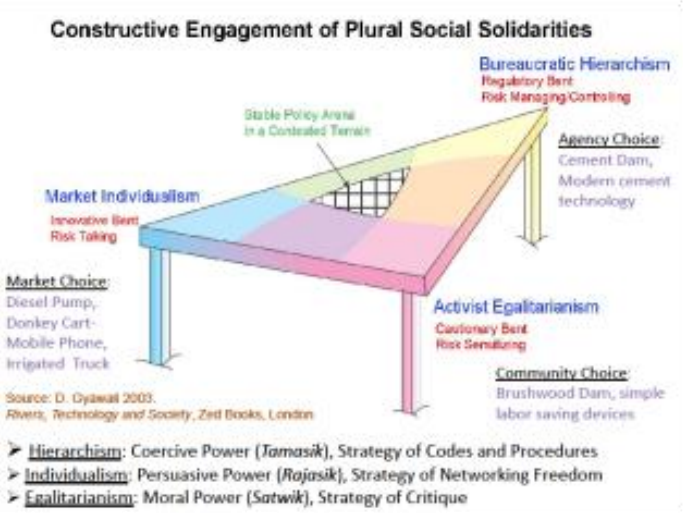
Using Cultural Theory



Gyawali, D., I.A. Allan *et al.*, 2006. *EU-INCO water research from FP4 to FP6 (1994-2006) – a critical review*. Luxembourg, Office for Official Publications of the European Communities.
EU website http://europa.eu.int/comm/research/water-initiative

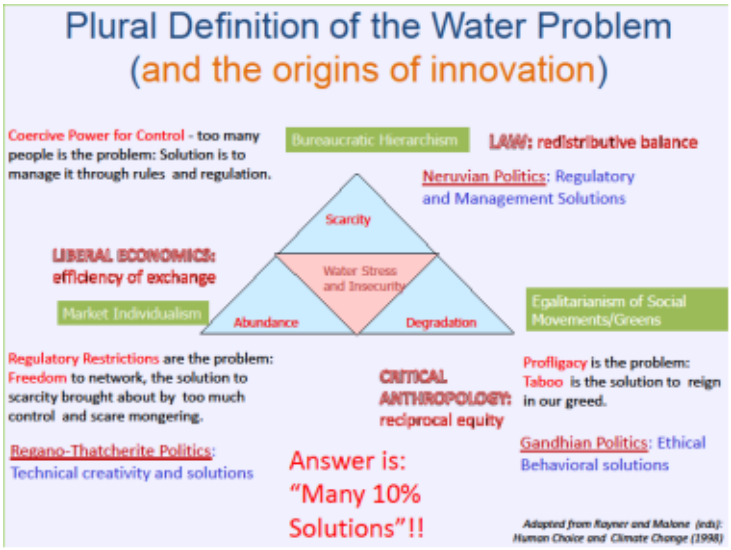
Now the big question is – where does this institutional blindness come from? The diagram at the left describes the four types of data filters that are inherent to each different type of social organizing. At the South-West corner lies the world of market individualism, unbounded and unstructured by pre-defined obligations, where the proclivity is towards risk taking for profits (substantive rationality).

The entrepreneurial businessman, contractor or consultant is the filter that decides whether the information is profitable or not, i.e. whether it is worthwhile 'data' or 'noise' that can be ignored. If it helps make a profit, it is valuable and worth pursuing; if it does not it should be ignored or even suppressed if has the potential to harm profit making possibilities, i.e. pesky environmental or social data to a dam building agency or company. At the South-East is the world of activist egalitarianism with strong bonding for a common cause but without much organizing structure, i.e. all are equal, comrades! The proclivity here is risk amplification/sensitization with critical rationality because it helps the "cause" and keeps the flock together. Very often, what was filtered out as useless "noise" by market players or governments can be the very grist to their mill for campaigns. At the North-East is the world of bureaucratic hierarchism functioning according to procedural rationality to manage risk and keep things under control. It is both bounded and with structure; as a result of which only data that is officially sanctioned is recognized as data while that which is not is filtered out as noise. In this world, more important than "what data" is "who has the right to receive and give out data". These three are known as active social solidarities that both cognize and strategize. In contrast, at the North-West corner is the world of conscripted fatalism which is passive but capable of reaction (i.e. frustrated voters or boycotting consumers): they are cognized and strategized upon by the other three.



These four organizational proclivities come from two discriminators in an integrative and relatively new social science called Theory of Plural Rationalities (or more popularly Cultural Theory: see Thompson et al, 1990 as well as Thompson and Verweij, 2006): on the X-axis group cohesion or lack thereof where competition is fettered or unfettered; on the Y-axis is the presence or absence of pre-ascribed order that make transactions symmetrical or asymmetrical. These two discriminators not only generate the four styles of organizing but also the worldviews therein as well as the manner in which they define a problem. Furthermore, they also deploy different types of power ("the will behind policy"): hierarchism uses coercive power of the state given by its laws; market individualism uses persuasive power of blandishments often powered by advertising; Civic egalitarianism uses the power of moral persuasion (the moral high ground) as well as 'naming and shaming'. Where they differ in the science that they do – and equally important, where they differ in the science done by others – is in the very values underlying the framing of the question.

Taking the example of water, is the problem on of abundance, scarcity or depletion? Market individualism believes in resource abundance (private goods available to those who can pay the price), that Nature is an unending cornucopia where the only limiting factor is our ingenuity that can be unleased if the price is right



and regulations minimal. Activist egalitarianism argues against resource depletion/degradation and the need to uphold common pool goods available to all. Nature is fragile but has enough for our needs although not enough for our greed (Mahatma Gandhi's famous statement). It appeals to the moral high ground as a source of power. Bureaucratic hierarchism, on the other hand, tries to balance the above two by arguing for resource scarcity to be managed as public goods distributed according to rank and need. For the poor fatalist all this is of course club goods from which they are excluded or have no voice in. In trying to understand the social response to ground water overdraft, we see all these four proclivities at play, each defining the problem in its own way and trying to find solutions that fit its own worldview as opposed to that of others.

Coalescing of Science, Poverty and Development

What we have seen from the above examples is that scale and perspective matter in defining the problem of poverty, hence in doing the kind of science one does. A manager of international institutions dealing with resources would perforce need to take a wider (one might say global) view of the problem: a rural household or village headman would have little use of such broad perspective but would need to define the problem with a view to potential for solution closer to home – and definitely more realistic for him or her. An example is the Millennium Development Goals in Nepal right now. By all measures Nepal has "over-fulfilled" the targets, with much better performance in girl child school enrollment, in maternal health, nutrition etc. The only problem is that little of it can be causally traced to either Nepal government policy (the country has been on an interregnum limbo since 2005) or donor efforts either (although there is much 'bending over backwards' to paint aid agency programs as if they did).

The real reasons seem to lie in the Maoist insurrection that shut down factories and pushed every village mother to send her son or daughter away fearing possible recruitment by the rebels or being then shot at by the Nepal Army. The Maoist insurrection began in 1996 and by 1995 Nepal government had reduced dramatically the transaction costs for making a Nepali passport to a villager far away from the capital city through the simple act of having it issued in the districts themselves. The result today is that almost every rural household has one if not two members of the family working in the Gulf, Malaysia or Korea and sending remittances home that is several times what they would earn if they could find a job in Nepal. It then meant their buying better health care, better nutrition etc. Remittances account for almost 30% of the GDP in 2014 and the success in meeting MDG targets, even though the phenomenon remained under the radar until a few years recently. This point too highlights the arguments made above regarding the importance of Toad's Eye science.

While there is a tendency to talk about poverty in Eagle Eye terms of $1/day and so on, it must also be realized that that is a science that is useful only to global managers. No poor farmer sees his or her poverty in such terms because poverty, especially that of the involuntary type, is relative (voluntary poverty of monks, fakirs and yogis need not concern us here); and it is also structurally created and maintained. There are too many institutions and people who are benefitting from poverty, who would like to keep things that way; and this political economy must not be forgotten as we do our science for poverty alleviation. Another factor is the informal economy in many countries of the Global South where it can account for almost 80% of the overall economy. Indeed, much of the remittance economy is still conducted within the informal realm with households deciding on their own where and how to spend them, official taxation system hardly reaching them or influencing their decisions.

One social science conceptual jujitsu in understanding the phenomenon of the informal economy is through the idea of desakota (DST, 2008). As we said earlier in talking of scientific data, the important question becomes: whose data? Generated for what purpose? Desakota is a Bahasa Indonesia term originally from Sanskrit which

basically means neither urban nor rural – or maybe both. If we take that remittance-dependent Nepali rural household perhaps three days walking from the nearest road head, Eagle Eye science would unhesitatingly call it a rural one from the perspective of physical geography alone. Toad's Eye science, however, would look at its income basket and, on discovering that only maybe 40% of the income is coming from surrounding rural sources and 60% from Dubai, Kuala Lumpur, Tokyo, or even London. Trying to explain the behavior of that household with rural concepts would be plainly wrong as 60% of their aspirations are commensurately urban. Thus, the whole classification system between "rural development" and "urban planning" essentially becomes meaningless as does the standard concepts of poverty defined in only economic terms. Because desakota regions are also places where both the reach of urban formal municipal rules as well as informal traditional rural customs get progressively weaker, they are places where technological innovations can be incubated and what technology choice means for these households be redefined as the example of the jugad above showed.

Once can thus conclude tentatively that science for poverty alleviation will have to mean Popperian humility in the search for data and prescription of solutions; acceptance of clumsy, non-linear processes that dominate (Verweij and Thompson, 2006); and sustainability seen in inter- or trans-disciplinary approaches defined less from the perspectives of nation-states and more from that of families and households that have shown themselves to be sustainable over generations, indeed centuries. The political economist Karl Polanyi probably had the last word on the subject when he said markets and competition have been historically less "natural" to human societies than cooperation and cooperative bonding (Polanyi, 1957). The science of poverty alleviation too might have to follow that line of thinking if it is too making a new dent on this old problem.

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Science for Water Security: Enhancing Global Access to Water - Focus Latin America

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Article

1. Introduction

Water is one of the key natural resources which stands at the base of economic and social development; management and protection of water resources is therefore an essential requirement to assure and strengthen sustainable development and eradicate poverty.

Our goal here in the IAP conference in Manaus, Brazil, is to stimulate Science Academies to contribute to the design of the Post 2015 Development Agenda, and the subsequent implementation of the Sustainable Development Goals.

This presentation will focus on Latin America, pointing out the actual situation of water resources in many developing countries: drinking water coverage, basic sanitation services, contamination of water resources

which affects its quality for different uses, the consequences in health of the population and the effects of climate change on water in both urban and rural areas. Based on this, suggestions will be presented on: "How can Academies of Science contribute to Improving Water Security which enhances the quality of life of poverty-stricken populations?".

2. Presentation

The sixth point of the Sustainable Development Goals (United Nations Department of Economic and Social Affairs, 2014) to be reached by 2030 is to "Ensure availability and sustainable use of water and sanitation for all" and includes such factors as universal and equitable access, adequate and equitable sanitation, improvement of water quality, increase in water-use efficiency which seeks the reduction of people living under water scarcity, implementation of integrated water resources management, the protection and restoration of water ecosystems, the expansion of international cooperation and capacity building to developing countries to improve water and sanitation and strengthen the participation of local communities for improving management. Some of these goals will be portrayed here in the context of Latin America. And we, as scientists along with the Academies of Science are working toward not only describing the problems found globally and regionally but also in developing solutions and proposals on a technical, social and political basis while seeking water equity in all countries.

Coverage of Access to Water in Latin America and the Caribbean

Since 2007 the world urban population is greater than the rural (United Nations, 2014). It is important to note that Latin America has a high urbanization rate with 72% of its population living in cities (Blanca Jiménez and Joan Rose, 2009).

Latin America and the Caribbean have reached a high coverage for access to improved drinking water sources of 92%; the global coverage of access to water is 87% and for developing countries, 84% (World Health Organization and UNICEF, 2014). But the rural areas of Latin America have not been able to reach this degree of coverage and there is a somewhat greater Urban/Rural disparity in Latin America of 97% to 73%, as globally seen the coverage disparity is 96% to 78%.

Coverage of Sanitation in Latin America and the Caribbean and other problems in Rural Areas

There is an even greater problem in sanitation for the rural population in Latin American countries where only 49% has access to sanitation services. 7 out of 10 people are without sanitation in rural communities. This of course impacts health, and in turn earnings and maintains people in poverty. According to the WHO, the best water system to achieve health improvements for the population is Piped Drinking Water on the Premises where urban regions report 90% but rural areas only 48% coverage (World Health Organization and UNICEF, 2014).

The problem of open-air defecation still exists in Latin America where some countries still have more than 20%, for example, in Central America, Honduras with 28% and Nicaragua with 27%. In South America, 5 countries still register more than 20%: Colombia (20%), Surinam (21%), Peru (35%), Brazil (40%) and Bolivia (54%). And, of course, the situation in the Caribbean where only Haiti has an extremely high rate of open-air defecation in 51% (Vammen, 2014).

Rural areas have prominent problems of contamination of water resources due to agricultural practices with pesticide use, nitrate contamination of ground water, bad sanitary state of water resources especially from bacterial contamination due to the open defecation and lack of control of animal fecal contamination. The changing soil use, deforestation, increases in agriculture and dominance of pasture lands in watersheds also have led to an acceleration of eutrophication in surface waters (Vammen, 2014).

Urban Water

For 2014, North America has been characterized at 83% urbanization, Latin America and the Caribbean at 80% followed by Europe in 73%. Africa and Asia remain at 40 and 48% (United Nations, 2014). Developed countries have large and stabilized urban populations whereas in developing countries urbanization is steadily growing (United Nations, 2013). This phenomenon has been observed globally and applies across the Americas.

The high rate of concentration of populations in cities and mega urban areas means intensification and competition for the use of water resources for human needs into a smaller space and vice versa the availability

of water presented from the characteristics of the hydrological system in and around cities plays a key role in their potential for urban development and growth as a source of consumption for the population but also in the disposal of wastes. This allows greater efficiency in water use, but it also imposes special demands associated with water transport, water quality maintenance and the management of excess water from storm events, among other challenges. If the human needs for healthful domestic living conditions are to be met and if economic development is to prosper, more efficient methods for the management of the urban water resources are essential (IANAS and UNESCO, 2015).

The Interamerican Network of Academies of Sciences and the United Nations Education, Scientific and Cultural Organization have just recently (March 2015) published the book, Urban Water Challenges in the Americas, A Perspective from the Academies of Science. 20 countries participated with contributions on urban water and most of the problems which will be presented here are highlighting some of the conclusions presented in this book.

Environmental Impact of Urbanization

Urbanization related to the concentration of population in cities requires the adaptation of water and waste systems and needs special management. Most of these processes have not been accompanied by adequate planning. Therefore, environmental impacts result in adverse effects on water resources: To mention some of these observed in the Americas: 1) Inappropriate land use and deforestation in the watershed and surrounding areas of urban centers leading to erosion which then brings heavy sedimentation into the cities and contaminates sources of water; 2) Uncontrolled discharges of domestic and industrial wastewaters into surface waterbodies and coastal areas; 3) Deficiencies in hygienic habits of the population and inappropriate management of solid wastes deposited into sources of water or city drainage systems; 4) Contamination of ground and surface water from different sources: mining, hydrocarbon spills from industry and contamination from storage of fuel tanks at service stations as well as pesticide runoff from agricultural activities from the surrounding watershed; 5) Impairment of recharge to urban aquifers due to reduction of green cover (forests, wetlands, riparian forests) and impermeable infrastructure associated with urbanization and more.

Access to water in urban areas

The coverage of water supply services in the great majority of urban areas of the Americas is over 95%. Latin America and the Caribbean have the highest drinking water coverage of the developing world (World Health Organization and UNICEF, 2014). The problems have to due mainly with the continuity of services and ruptures in the distribution systems. The deficiencies in the continuity of access to water for the population causes health problems as domestic water must be stored in containers which can then convert into media for vectors for water transmitted diseases such as mosquitos. Some cities such as Managua, Nicaragua have had to develop urban zoning for different time ranges for access to water from 24 down to 1 or 2 hours a day. The loss of treated potable water due to ruptures has been observed in both developing and developed countries of the Americas due to a lack of renovation of distribution systems. (IANAS and UNESCO, 2015).

All cities of South America, Central America and the Caribbean Islands are affected by the informal growth of peri urban areas which have little or no water coverage or sanitation. These peri urban areas usually arise from migration from rural areas. These are areas with the highest rate of water borne diseases and contamination due to consumption from irregular water sources. Here also exists a very high rate of illegal connections to the distribution system (Blanca Jiménez and Joan Rose, 2009) (IANAS and UNESCO, 2015).

It is also very important to mention that lower income groups have higher income percentage for the access to water. In Latin America, the income share spent by the poorest quintile is more or less twice the income share for the richest quintile. And the use of informal non-piped services such as water vendors and tanker trucks are used more by lower income groups at higher cost for unit. Globally, the higher income group is twice as likely to use improved water services and four times more likely to use sanitation services as the lowest income group (IANAS, 2013).

There are special difficulties in most countries in securing the delivery of good quality water. Most monitoring systems are not complete for the whole country and usually do not include rural areas. Also, the systems usually don't include all contaminants especially metals and organic pollutants. There are many new emergent contaminants where most water quality laboratories still do not have sufficient capacity to determine even in

North America. Sanitary evaluations of quality usually only include bacterial contamination and have yet to develop the capacity for enteric virus presence. Also, many countries report non-sufficient water quality according to legal standards without follow-up measures (IANAS and UNESCO, 2015).

Treatment of wastewater in urban areas

Treatment of waste water in urban areas in Latin America is still a serious problem and most of the countries are not on track to reach the Millennium Development Goals for sanitation (World Health Organization and UNICEF, 2014). In South America, the coverage of sewage systems in cities is around 80% for improved sanitation and it is important to stress that in most countries a high percentage of the waste waters is discharged into surface waters or the ocean without treatment (IANAS and UNESCO, 2015). It is also a fact that 15% of all waste waters do not receive any primary treatment. It has been observed that improved sanitation does not mean that contamination does not occur to water sources. In Central America the coverage of improved sanitation is between 63 and 95% according to the WHO and UNICEF report on Drinking Water and Sanitation (2014) but there are many examples of domestic treatment systems such as Oxidations Lagoons which are discharged into surface waterbodies which then undergo strong eutrophication meaning that these lakes or rivers which formerly could have been used as a source for water to undergo treatment for potable water now have lost this potential use. Also, cases for example in the Dominican Republic with the use of vertical septic tanks and in Central America with the massive use of septic tanks in new urbanizations in which both cases have been observed to contaminant groundwater used for human consumption.

There are many positive examples of efforts to improve the coverage of sanitation. To name a few in Central America, the city of Managua installed a modern treatment plant in 2009 which has greatly improved the environmental sanitation situation of the city. Chile has seen a rapid increase and has reached 100% coverage of the country's sanitation system; this has been possible due to the economic stability, the introduction of a process of restructuration of institutional responsibilities and significant investments (IANAS and UNESCO, 2015).

Water and Health

Where water supply and sanitation reach only part of the population or are completely absent, the environment is favorable to the development and spread of waterborne diseases. For example, there exists a clear reciprocal relationship between mortality in children under 5 years of age and coverage of sanitation, where for example Haiti with the lowest sanitation coverage has the highest mortality rate (Otterstetter H., Galvão, L., Witt, V., Toft P., Caporali S., Pinto, P.C., Soares, L., and Cuneo C., 2004). Outbreaks of Dengue in cities have been frequently observed in part out of necessity to store water domestically due to the failure of continuity of access to water and also the appearance of different serotypes of the virus (IANAS and UNESCO, 2015).

Water and Climate Change

In 20 years, the demand for water will have increased by 40% due to climate change and the rural areas especially in semi-arid and arid zones will receive a more severe impact where there is already a low coverage of water access and irrigated agriculture dominates. So, this will mean even more pressure to assure economic growth in rural areas (Vammen, 2014).

Equity in water distribution in rural and urban areas

There have been some efforts to give priority in policies and management for water and sanitation to the least served. In 2003, the World Health Organization and the United Nations' High Commissioner for Human Rights authorized a document on "The Right to Water". Among others the document mentions that governments should include facilitating improved and sustainable access to water, particularly in rural and deprived urban areas. "But as a whole, the water resource community has ignored water equity and not developed ways to serve distributional and procedural fairness" (Ingram, 2014).

3. How can Academies of Science contribute to improving water security and in turn contribute to the eradication of poverty and sustainable development?

Some suggestions in different focal areas and for different groups of the population.

- Water Access and Sanitation for Rural and Urban areas require different technical, institutional and social solutions.

- Better coverage of large to middle scale sewage systems in cities and special solutions for peri urban areas such as sanitation systems per condominium units or per neighborhoods or other collective organizational units.

- Sanitation in Rural Areas deserves special Remedies.
  - Most rural settlements don't need centralized sewage systems. Dry toilets, urine-diversion toilets, vacuum toilets, on-site composting, or anaerobic digestion are all potential means to keep places clean and hygienic.
  - Remedies are needed that are widely adapted to the specific area that better fit the physical and human systems therefore assuring widespread use.

- Education – Increase in Development of Postgraduate Programs in Water Sciences for Water Managers, Governmental Authorities and Professors. (Example: Regional Central American Master's Program in Sciences of Water in Nicaragua)

- Capacity Strengthening on water related problems
  - Universities, governmental institutions or NGO's need to provide technical assistance and capacity strengthening on different levels from general hygiene education of the population up to the technical and institutional management of the water and sanitation systems.
  - Capacity building for local government authorities in order to coordinate activities and negotiations as well as developing monitoring and regulation for decentralized systems.

- Increased Development of Research Centers specifically devoted to Water Research in Multidisciplinary Aspects of Hydric Resources on a national and regional level.

- Strengthening of Governmental Water Management Institutions

In most countries there are existing Water Authorities and specific legislation for water management and supervision. It is now important to reinforce their capacity to be more effective in the management of water resources and to acquire the capacity to enforce the existing legislation while assuring equity in water distribution.

- Improvement of Policies for Water Management based on Science.

- Better governance through better regulation and equity in service delivery.
  - Accountability of public officials through systems of revision.
  - Reinforce user participation at all levels so that regulators and service providers respond to interests and needs of users.
  - Improvement of local governance can prevent clientelism from affecting equity.

Some countries (South Africa) have special legislative framework for water supply and sanitation transferred from national to local governments.

- Strengthening of Water Management with stronger Nexus to other areas.
  - Nexus to communities where the problems are found.
  - Promote Water Management and research of Water Resources related to impacts of Climate Change.
  - Nexus of Water to Food Security: There are many conflicts of use for water between agriculture and domestic use especially in rural areas. "Agriculture accounts for approximately 3,100 billion m3 or 71 % of global water withdrawals today and without efficiency gains will increase to 4,500 billion m3 by 2030" (Water Resources Group, 2009). It is urgent to increase Reuse of Water in Rural Areas for Agriculture and research and implementation is needed in the following components:
    - Design of components for treatment systems with effluent use in agriculture.
    - Irrigated agriculture could receive and use different qualities of water. Farmers could be inserted into the end point of the sanitation system which economizes nutrient use.

- It is hard to accomplish both hygiene and food safety along with the reuse of excreta. Special monitoring capacities and mechanisms for handling excreta are needed.
- Protection of water quality must be guaranteed which means controlling runoff to local water resources. (Vammen, 2014).

- Nexus to Health:
  - Special surveillance of water transmitted diseases in periurban areas of cities, acute diarrhea disease and those caused by vectors such as mosquitos, Malaria and Dengue and recently Chikungunya.
  - Health problems due to heavy metals in water from agriculture, industry and natural sources. Arsenic, Mercury and others.
  - Increase research on Chronic Renal Disease related to common consumption media (water) related to content of pesticides, heavy metals or general water quality.
  - Increase installation of sanitation and public health surveillance systems to keep water transmitted diseases under control.
- Nexus to Energy:
  - Use of water for energy is becoming a global challenge as the world economy grows at a faster pace; the demand for water will increase and will accelerate more rapidly than population growth.
  - Water and energy have crucial impact on poverty alleviation as water and energy can be binding constraints on economic growth and also increasing efficiency is the ultimate hope for widespread poverty reduction (UNESCO and UN Water, 2014).
  - Renewable energy forms such as hydroelectricity, wind, geothermal and solar require little water for the raw material production. Even better is that wind and solar use almost no water in the production stage of power except for washing activities.
- Water and Equity:
  - Water is the quintessential equity issue because it is a public as well as an economic good.
  - It is important for the water resource community to develop ways to serve distributional and procedural fairness (Ingram, 2014).

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SESSION 3 - Science for Health: Ensuring Universal Access to Health

Chair: **Eduardo Moacyr Krieger** (Brazilian Academy of Sciences and National Academy of Medicine, Brazil)

Role of the InterAcademy Medical Panel

Lai-Meng Looi (InterAcademy Medical Panel)
Conference

Science is most meaningful when it benefits people. The doubling of human life span from 30-40 years to more than 70 years in the 20th Century suggests significant advancements in healthcare (1). Much of these can be attributed to Science. The infusion of scientific knowledge into medical education has led to an evidence-based and rational approach in medical practice resulting in more effective healthcare. Scientific innovations have also been addressing many problems in Society that impact on health: delivery of piped water, electricity, food; improved habitats and transportation; IT for more effective communications; advances in surgery, medicines, vaccines and diagnostics, to name a few. Also, the adoption of professionalism, training for competence, accreditation, standards, ethics and accountability have impacted positively on medical practice.

The 21st Century: the world is far from well

In spite of the tremendous advances made in the past century, we have entered the 21st Century realizing that the world is far from well. Many communities, especially in poor and developing countries, do not benefit from the advances of the 20th Century. When we consider the global distribution of burden of disease, the disparities become more obvious. Africa, for example, has a disability-adjusted life years (DALY)/100,000 population of >30,000 whereas in Canada and Australia, it is <15,000 (1). There are also inequalities in distribution of health workforce across the globe. Of the WHO regions, Africa, East Mediterranean and South-East Asia carry a burden of disease that is way higher than their share of the global workforce. Africa has close to 25% of the world burden of disease but less than 5% of the global workforce. In contrast, both Europe and America each has only about 10% of the global burden of disease but more than 25% and 35% of the global workforce respectively (2).

There is also a 10/90 gap that further compounds this disparity: only 10% of global spending on health research is devoted to diseases or conditions that account for 90% of the global disease burden. Furthermore, lower- and middle-income countries (LMICs) lag behind the high-income countries in their research capacity, hampering their ability to find solutions for their own health problems. National commitment to R&D varies. The Gross Domestic Expenditure of R&D is 2-4% of the GDP for most advanced countries. This figure is <0.5% in most LMICs (3). Malaysia, a country in transition, only just managed 1% recently. While there is a smaller pool of quality researchers in LMICs, and there is, in addition, a brain-drain of their expertise to the high-income countries.

When we examine life expectancy data by income group countries, high income countries enjoy a much better life expectancy (78-82 years), whether they be male or female, compared to low income countries (60-63 years) (4). We live in an unequal world. There is gross disparity in burden of disease, standards and availability of healthcare, and research capacity in various communities of the world. All these will impact negatively on the achievement of Universal Health Coverage.

1. Universal Health Coverage

Universal Health Coverage (UHC) is one of the targets of the proposed post-2015 sustainable development goals. WHO has defined UHC as ensuring that all people have access to needed promotive, preventive, curative and rehabilitative health services, of sufficient quality to be effective, while also ensuring that people do not suffer financial hardship when paying for these services. So, basically, there are two components to UHC: (1) access to needed healthcare for the whole population and (2) financial risk protection.

Universal Access to Healthcare

This morning's forum is devoted to the first component of UHC i.e. universal access to healthcare. There are many facets to this, but the fundamental concepts evolve around three aspects:

(1) Firstly, the healthcare provided has to be relevant and sufficient for the needs of the people. This implies availability (in quantity and quality) of human expertise and technical resources. In practical terms - enough

hospitals and clinics, enough doctors and healthcare professionals, and a wide enough range of services to cater for the kinds of problems that people in that society or country encounter. Services include not only curative (e.g. medical and surgical), rehabilitative and diagnostic services, but also preventive (e.g. vaccinations and check-ups) and promotive services (e.g. education and activities to encourage healthy lifestyles). There is general agreement that health outcomes are better when these services are built on a primary healthcare delivery system rather than a tertiary system.

Determination of the healthcare package that it is an entitlement of all is a major challenge. The package would surely vary between countries, raising the question of whether there should be a global package that all countries should strive for. In addition, there has to be a plan for rare and high-cost illnesses, especially when these need more than the usual expertise and resources, and will likely lead to catastrophic expenditure for individuals if there is no buffer.

(2) Secondly, healthcare resources would be futile if the people cannot reach the facilities. Because health services have to be supported by suitable and adequate social infrastructure e.g. roads, transport, communication, community support, etc., UHC planning require input, dialogue and coordination with town planners, social scientists and civil society.

(3) Thirdly, there has to be commitment to social justice. There should be no discrimination in access to health services on the basis of monetary income, gender, age, ethnicity, religion, social status, etc.

Financial Risk Protection

Many communities finance their health services through general taxation, with or without mandatory insurance. Most experts in this field suggest that a publicly funded healthcare service is fairer and more all-encompassing. The aim of risk protection should be to minimize out-of-pocket spending on healthcare, which can lead to catastrophic household health cost, especially when faced with a high-cost illness.

2. Role of the InterAcademy Medical Panel: Addressing the challenges to Universal Health Coverage

The InterAcademy Medical Panel (IAMP) is a global network of (currently 73) national medical academies and science academies with medical sectors, committed to improving health worldwide through building scientific capacity as well as providing evidence-based advice to governments. Because scientists wear many hats, national academies of medicine and science can influence policy-makers through many avenues. Most countries have yet to achieve UHC. Furthermore, there are many unique challenges to UHC in the 21st Century, some of which IAMP has sought to address, directly or indirectly.

Social Determinants of Health

The Commission on Social Determinants of Health (2005-2008) set up by the World Health Organization (WHO) (5) and chaired by Sir Michael Marmot showed that "in all countries, at all levels of income, health and illness follow a social grading: the lower the socioeconomic position, the worse the health". This is significantly affected by the economic and the political system of the country. WHO summarized: "Science shows that social factors account for the bulk of global burden of disease and of health inequalities between and within countries".

The Commission's three principles for action are (1) improve the conditions of daily life (the circumstances in which people are born, grow, live, work and age), (2) tackle the inequitable distribution of power, money and resources (the structural drivers of conditions of daily life) – globally, nationally and locally, and (3) measure the problem – evaluate the action, expand the knowledge base, develop a trained workforce and raise public awareness.

The World Health Assembly resolution of May 2009 urged all member states to tackle health inequities through action on the social determinants of health. There is a growing need for sharing knowledge between and within countries about these determinants and what can be done to inequities. Research and monitoring are important - no data means no recognition of the problem.

The IAMP at its General Assembly in Kuala Lumpur, Malaysia (2010) highlighted the importance of recognizing the Social Determinants of Health in national health agendas. In partnership with the Institute of Health Equity,

University College London, headed by Sir Michael Marmot, IAMP has solicited member academies interested in exploring the process of engaging governments in analyzing the conditions leading to health inequities in their countries and working with partners to address them. Twenty-five national academies participated, bringing together more than 35 participants at a workshop on 'Promoting action on the social determinants of health', in Trieste, Italy, in July 2014. Efforts to ensure that each country had two representatives – one from academia and one from government – were designed to have maximum impact beyond the duration of the workshop and to develop in-country links that will lead to positive action at the national level.

Climate change and One Health

Climate change affects the social and environmental determinants of health. In high-income communities such as London (UK), mitigation of green house gas emissions can reduce heart disease and stroke by 10-20% and breast cancer by 12-13%. Similarly, in a low-income community such as Delhi (India), a 11-25% cut in the burden of heart disease and stroke, and a 6-17% reduction in diabetes can be achieved (6). Climate change also leads to environmental disasters (e.g. tsunamis and floods) and disease outbreaks, resulting in catastrophic loss of lives and demands on health services. Climate change stresses the delicate balance between the natural environment, wildlife, the farming industry and human habitats, resulting in emergence of zoonotic diseases that threaten lives and economies. In Malaysia, a lesson on "One Health" was learned from the novel Nipah virus outbreak that rapidly claimed more than 100 lives and devastated the pig-farming industry in 1998-1999 (7).

As a global voice, IAMP has issued carefully researched statements advocating for action on issues of global concerns. In November 2010, IAMP academies endorsed a statement on the "Health Co-benefits of Climate Change Mitigation," pointing out the scientific basis for various mitigation actions. The statement was also presented at the UNFCCC in Cancun, Mexico in 2010. Recognizing the need for a holistic view of world health, IAMP endorsed the "Bucharest Declaration on the One Health Concept", and the One Health Initiative in 2014, and will look to developing integrated solutions to the challenges affecting the health of people, animals and our environment.

Changing health systems and globalization: the need for educational reform and leadership

The healthcare practices of this century are very different from the previous one. The explosion of new medical technology and knowledge has led to new demands and concomitant rising costs. Treatment options are often super-specialized, and in the realm of targeted therapy and personalized medicine – all extremely expensive. Teamwork is the norm. It is unlikely that any one patient would be treated by just one doctor. He would have a team of healthcare professionals looking after him: physicians, surgeons, oncologists, radiologists, pathologists, nurses, rehabilitation experts, physiotherapists, each complementing one another. There is a lot more coordination required and more demands on the health financing system.

We are also in "an era in which commerce, travel, ecologic change and population shifts are intertwined on a truly global scale" (quote: US CDC). Disease outbreaks spread at an unprecedented pace. What happens in one corner of the world can rapidly affect the whole world. Also, societies in most countries are rapidly evolving towards a cosmopolitan composition. All these impact on the education and training of healthcare professionals, particularly with regards capacity to cope with changing health systems, and preparedness to deal with diseases that are not endemic in their own communities.

The above challenges are even more pressing in the LMICs where the disease burden is greatest and socio-economic changes the most rapid. The weak research capacity of such countries is one of the most important rate limiting factors to achieving solutions to their health and development priorities.

IAMP has mounted a number of initiatives which directly or indirectly address these challenges: (1) educational reform, (2) leadership development and (3) research capacity strengthening.

(1) Transforming education for an interdependent world: An independent commission of 20 academic leaders from around the world launched a report in the Lancet in November 2010 - "Health professionals for a new century: transforming education to strengthen health systems in an interdependent world" - which calls for major reform in the training of doctors and other healthcare professionals to better equip them for the healthcare challenges of the 21st century (1). IAMP, in partnership with China Medical Board and the US Institute of Medicine, has contributed to the second phase of the Commission's work – dissemination of findings

and advocating for professional education reform specifically in LMICs. IAMP has also encouraged specific member academies to take responsibility individually or in partnership with other regional academies to host events with the specific purpose of promoting clear understanding of the Report's recommendations and identifying champions to lead on implementation in their countries or the regions. The response has been encouraging and has generated follow-up events.

(2) The IAMP Young Physician Leaders (YPL) Programme: IAMP's signature Young Physician Leaders (YPL) Programme was created to "tackle a void in medical education – leadership.8 Launched in 2011 in partnership with the World Health Summit (WHS) in Berlin, it aims to foster a new generation of leaders in global health for the 21st Century, to develop a critical mass of young physician leaders in a learning and action network worldwide, and to challenge member academies to support young physicians in their countries and to strengthen their leadership skills. The inaugural Programme was held at the Berlin Brandenburg Academy of Sciences and Humanities (BBAW) in October 2011. Subsequent sessions were held in conjunction with the 2012, 2013 and 2014 WHS. A regional event was organized at the Regional WHS in Singapore in 2013. To date, IAMP has trained 88 YPL, all top young professionals under the age of 40 years, nominated by their national academies. The potential of the YPL alumni network to bring about change locally, regionally and globally is tremendous.

Research capacity strengthening: IAMP issued a "Call for Action to Strengthen Health Research Capacity in Low- and Middle-Income Countries" in May 2013, on the occasion of the World Health Assembly discussions on Research and Development. Support for the Statement has also been expressed by the Global Young Academy (GYA) and the Council on Health Research for Development (COHRED).

<u>Emerging threats: Antimicrobial resistance</u>

A recent report by the UK Chief Medical Officer concluded that "antimicrobial resistance poses a catastrophic threat" to human health today. If no global effort is taken on policies on antibiotic usage in medicine, industry and agriculture, we may well be entering a "pre-antibiotic era" where we will be facing "superbugs" without any effective antibiotics to use. This crisis is exacerbated by a relative lack of innovation in generating new antibiotics. IAMP and IAP (the global network of Science Academies) jointly issued a statement "Antimicrobial Resistance: A call for action" in November 2013, urging for recognition of antimicrobial resistance as a global threat, and requiring collaboration worldwide to generate the resources for antibiotic innovation and to ensure optimal treatment for all.

<u>Urban Health</u>

Since 2007, half of the world's population has been urban, and by 2030, it is projected that 60% will be urban. Urban societies and mega-cities have unique health problems, such as isolation of disabled and elderly people who are unable to cope with the complex environment, mental health, adolescent problems, rising crime and violence. Urbanization is also an underlying driver to non-communicable diseases (NCD) such as heart disease, diabetes and cancer. Notably, the biggest increase in premature deaths (before 60 years of age) is related to urbanization, and NCD is projected to assume the highest prevalence in the LMICs, where the majority of the world population resides and where urbanization is most rapid.

Following the Political Declaration of the High-level Meeting of the United Nations General Assembly on the Prevention and Control of Non-Communicable Diseases (New York, September 2011), IAMP has initiated and participated in several conferences, workshops and forum on emerging health issues such as NCD, Adolescent Health and Mental health (e.g. Regional Workshop on NCD hosted by the Brazilian Academy of Sciences 2012; Conference on NCD, Academy of Sciences of South Africa, 2013; International Conference on Child and Adolescent Mental Health, The Royal Swedish Academy of Sciences, 2013; Symposium on Urban Health and Wellbeing at the Regional Meeting of the International Council for Science (ICSU), Kuala Lumpur, Malaysia, 2013; International Conference on Urban Dynamics and Health, Paris, France, 2013). IAMP is currently working in collaboration with ICSU to address Urban health issues.

<u>The ageing population and sustainable health</u>

Elderly people have higher healthcare utilization. The rising proportion of the aged in most countries will affect UHC in terms of the services required and the finances to support them. Preventive and promotive action to sustain good health well into "old age" is crucial in the health agenda. Some actions such as taxes to discourage smoking and prevention of smoking in public places would require legislative backing. Promotion of healthy

physical activity require interaction with town planners, engineers, and many other sectors of society. Promotion of healthy eating habits require social designs for easier access to fresh fruits and vegetables, and campaigns to cut down the use of trans fat and sugary drinks.

3. Global collaboration

The last twenty years have seen tremendous change in the landscape of global collaboration. The millennium development goals, the Global Fund and GAVI alliance are examples where global collaboration has made a difference. Now close on the post-2015 sustainable development goals, it is imperative for scientists, through the many hats they wear, to impress on governments that "you cannot tackle hunger, disease, and poverty unless you can also provide people with a healthy ecosystem in which their economies can grow" (quote: Gro Brundtland). The Lancet commission report of December 2013 (9) pointed out that "between 2000 and 2011, about 24% of the growth in full income from low-income and middle-income countries resulted from health improvements". This is a powerful selling point for governments to prioritize investment in health.

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How can science contribute to universal health coverage?

Garry Aslanyan (World Health Organization)
Conference

I am not who you thought I would be, because I think the invitation originally went to the Director General of WHO, and obviously she was not available and then we played a little bit of communication back and forth, and here I am.

Just from the start, I want to tell you that I work for TDR, which is a special program within WHO, but because the focus of today was to look at universal health coverage and how science and research can contribute to that. I am going to do a little bit of that, and then more on the program I work in.

I don´t have the benefit of the discussions of yesterday, so I may say things that you have talked about and/or have set a mood here – so forgive me for that.

So why research for universal health coverage? If we look at WHO, as an organization, its a member state organization that came along in 1948 –one of the institutions that was established after the several wars in the 20th century – research appears in its constitution. In chapter 2, it says promote and conduct research in the field of health. But the organization itself is not a research funding agency or research organization per se.

It is important to note that WHO it is not a funding agency but that it also has an interaction with National governments - so it plays a role when it comes to promoting research. In a few years back, we will look at what WHO itself did in research, and today about 35 departments throughout the organization do research activities – But that is not evenly distributed. You could see that communicable diseases, maternal, peri-natal and nutritional diseases are heavily funding, and research is heavily skewed there, and of course some other areas are less. My own department TDR has a specific focus on research, but that is not true for other parts.

Hold this thought in terms of the distribution of where health research is focused on because we are going to come back in light of the universal health coverage issue that we´re discussing here.

In the last, I don´t know, 35 years, obviously the money and funding that is going to research and science that is focusing on health issues has been on the rise. There is no question that the most recent numbers up to 2009, and in fact we will probably have even more than that, the number of billions of dollars that have been put into research has been obviously increasing.

It´s, as I said, in 1948, the organization said it will focus on research, but it took WHO up until 1986 - or not 86, 1990, to have a special commission, just similar to that that Lai-Meng mentioned on social determinants. In 1990 there was a commission on health and research. And some would say, sure that was important to do and maybe that played a role, some of these things are difficult to linearly sort of link, and say that because of that commission in 1990, the numbers in investments went up. But more interestingly is to look that in 1990, at a time when that commission looked at health research, only 5% was for or in low- and middle-income countries.

Over the years, you would see that there were several attempts, committees, or global forums for health research that looked at the investments in health research, and most recently G-finder, which is a report that does assessment of investments in health research, you will see that that changed – it is not 5%. We have about, still a huge amount comes from public – about 66% comes from public and it focuses on about again 31 neglected diseases, but there is a huge increase in philanthropic, so you don´t see that number there at the end that says philanthropic, but that is about 30% from the previous times. And we all know that it´s true in many countries, and of course, Gates foundation has changed that number tremendously.

So, some challenges still remain in terms of how health research is funded. There are large gaps in data, sometimes we don´t know how much countries spend on research, public moneys from governments. There isn´t really one standardized way to look at how research is defined. Everyone does it their own way, in their own language and in their own definition. Which is fine, but it´s hard to come up with global pictures. And again OECD counties have more information than the others, and there isn´t really a lot of transparency on the private sector which really doesn´t need to report because most of the time they report to a living donor or a dead guy who left the money, so to say – and they don´t have to report, but because they play such a big number and role, that becomes extremely important.

I told you earlier to hold your thought; I think that´s transition slide, to tell you that what is going on in health is really a bit of a mess because everyone has various projects and initiatives so add to the complexity here, of trying to understand who funds what for research and prioritize – add this picture that really is only a fragment of actually what else is going on.

Health has received good attention, so there is nothing wrong with that. But at the same time, it suffers from a complexity of initiatives and overlapping priorities etc.

In 2009, the WHO came up with a strategy, and the purpose of that was both internal and external. And as I said, because it plays a role in advising the Ministries of Health in countries, or has a bit more of a sway with policy makers – a little bit I guess, more than maybe the private philanthropic sector, this report, or the strategy was important because it gives at least a little bit of guidance how one should go about on a national level of doing funding or health research or prioritizing.

And I won´t go into exact details but it basically gives some principles. One tool that is important to look at is how we prioritize research. You´ve seen through Lai Meng´s presentation that things are changing, and the health picture is changing, and the needs are changing, priorities are changing, but how to move from what we fund today into what we will need to fund tomorrow? One of the things that that strategy gave, was the sort of the priority setting checklist that helps to prioritize – or move from one area to another. I mean, you probably come from institutions that have their own challenges of switching from one agenda to another. And it´s not that easy, especially if moneys have been invested in certain areas – it is hard to overnight switch it to something else.

Remember I showed you the skewed distribution of funding at WHO when it comes to needs? The same happens in countries, and I picked Brazil, the data source indicated below, so don´t blame me, I didn´t come up with this, but if you look at Brazil, same thing is happening in terms of communicable disease there, then non-communicable disease, less, and health systems – something that we need to talk about let´s say in light of universal coverage, or how to achieve universal coverage, while research still remains a smaller proportion of any health budget.

Now this is in 2004 – 09, published in 2011 – it may not be the same. And this is not to point a finger but just to say that some of these things are changing, just not as fast, in terms of helping with the universal health coverage, sort of goal.

Some of you may have heard that another process that is going on amongst the member state of WHO over the last ten years, among your own governments and your representatives at the World Health Assembly, is what is a goal to come up with coordinated mechanisms at a global level. There was a report of a consultancy expert group on research and development that really looked at different ways and as a result the assembly, a couple of years ago, the World Health Assembly, basically the Ministries of Health and the Member States of all countries have agreed to these four things basically: to come up with an observatory, based at WHO that will look at the research and development; what is going on, who is funding what, at a global level. Not an easy thing, not either cheap and/or doable considering the issues around how you classify research, and who reports and where you get the data.

Coordination, all that picture I showed you, try to come up with mechanisms that will help all this funding mechanisms to come together and prioritize together and fund things in a more coordinated manner. Of course, financing is key with various ways to do, everything from a universal tax on all countries to voluntary funds and that still continues to go on and some demonstration projects. And I won´t go more into this, but just to say that at the global level, the Ministries of Health and Ministers of Health, your own ministers go to these meetings and discuss this. So, I don´t know how much you know, or have an influence or are asked to provide guidance on this, but just to say things are happening there – although slowly.

Universal Health Coverage: Each year, WHO comes up with a report for the day of the World Health Day. In 2013, the World Health Report focused on research for universal health coverage. So, if the title of the session is research of science for Universal Health Coverage, this fits in. What was very unorthodox about this report is that it looked at case studies to illustrate the role and need of health research for universal health coverage, and they included things like observational studies; something that before it was really not that easy to do; it was not seen as pure science. Or they included some sort of more non-traditional examples of how operational implementation research can help. So, I won´t go into the detail but just to say that this could be a good tool for us to promote and I will give you some examples here. You maybe have heard many times this quote from Dr. Chan, in 2012, when she took on this challenge of universal health coverage and promoting with the member states and the countries that you show the map, you saw the map that it´s not entirely there and not even close – that public health and universal health coverage for public health are one of the most powerful things we can do. So that continues and what is the role of research? The role of research in questions like the understanding of the gap in financial risk protection. If you look at the map here, you will see that in many countries out of pocket expenditures are quite high, but these things are not understood, and well researched. If we look at why we still need to do research in universal health coverage, you will see that only half of the people with HIV who are eligible for treatment, are actually receiving it. So, we don´t know why the rest do not get it. And it is not because we need research on the HIV drugs, but we need research on how to get these things to them. Same with TB, same issues, about fewer than 7% of TB cases were detected and reported and were still true in 2010 and 2012 so those things are not changing, they need research to be overcome.

Another issue here, comparing Philippines and Ukraine, of how the incidence of catastrophic health expenditures, those that are really the hazard of non-universal health systems. A lot of the issues around that are still not well understood, and you will see in comparison, for example the – how the out-pocket payments impact poverty. Some of these issues are not researched and they are not completely in health area.

Equity: We can talk about universal health coverage and on paper you could have universal health coverage, that does not mean that everybody gets it. Let´s say maternal child health services in places where there is an attempt to have it universal, and still those who have more money or wealthy quintiles of populations are those

who are receiving it; so we think, and it´s a complex slide, but the point here is that, within certain populations, again there is a lot of inequality and inequity, and we need to do more research to address that.

OECD countries are not any better, and here the issue is not quantity but quality. You will see from Denmark to Slovenia or Belgium in terms of the fatality rates following ischemic stroke after admission to hospital, you will see that the rates are quite different – so you may have the service, but the outcomes are different. So, a lot more needs to be done. Although we know the treatment and it should be the same but the outcomes in quality are not the same.

I have three more case studies and then I will switch to another topic. And again, the idea here is to show, and this is from the report, that we have powerful examples how doing research in universal health coverage is the only answer to actually getting there, because throwing more money or more funding at the problem is not going to solve it.

And one example is on antiretroviral therapy and how after in nine countries where this was done, basically the message here is that 96% reduction in transmission of HIV was achieved in these countries because of the implementation research done with these people. Similarly, the obstetrics care in reducing maternal mortality, and there is an example from Burundi how that number went down tremendously just because they´ve had good understanding of what is going on and what the issues are.

Maybe something closer, in this region as well, although this is a global meeting – conditional cash transfers and the examples in Brazil, Colombia, Honduras, Malawi, and Mexico and Nicaragua – how this research has helped to introduce this cash transfers and how research in this area helped to increase demand for health services.

So key messages from that report and I´ll switch to another topic – and I still seem to have 10 minutes. Again – Universal health coverage cannot be achieved without evidence from research, sounds that we all know this, sounds motherhood and apple pie, but it´s not all this easy to keep up on making sure that it is part of every health program. Research can address very wide range of questions including coverage or other issues that are not perceived as pure science in a way. Again, maybe I am speaking to a part of this audience that may throw rotten tomatoes at me; and the other point of the report is that all nations, it is not an issue of only countries who are able to fund research, even from the case that is an example that you had – all nations, low or middle or high income countries – all need to invest in research for universal health coverage – that is if they want to achieve this result.

From the experience of the country I come from, Canada has universal health coverage, but it also throws a lot of money at it. It is not because it is that easy to do. So, we can always be smarter in how to use this.

Now I am going to move to the next part which is more, just a little bit, two examples of how capacity strengthening can help. And I almost would not be able to come here if I didn´t speak of the program that I work in, so I had to take time from work for two days, I cannot afford not to do that, but I think it is very relevant.

TDR has basically been around for 40 years. This year we are celebrating 40 years of the program. We focus on tropical diseases, but infectious diseases now that is what we call. How many of you have heard of TDR? ok, so three out of 40, ok. Four, ok. But again, in the recent years, and this is also an example how priorities have changed, and it took TDR about 10 years and two crises to switch from funding drug trials to focusing on implementation and operational research. And this is my own experience of my own program, so I am not shying away from saying that even within a program that is funded by a lot of developing assistance money etc., it took about ten years to switch from funding traditional sort of research in product, to focus on implementation research for universal health coverage.

So why focus on implementation research, or operational research? And again, these are sort of ways to show how sort of the need goes from using the interventions or technologies that we also have, already have, and some of them may not be effective when used within the routine system or real-life system setting. So, here is also where the capacity strengthening part comes in, and part of our program is, a major part of it is now to invest in capacity strengthening for operational and implementation research.

With two examples, one is SORT IT the structured operational research and training initiative, and we also have produced an implementation research tool kit. And, basically, helping the health system, health workers, or those interested in the health system to switch from either doing research if they are not doing research in operational and implementation research area of the program they work in; or if they´ve been trained in more basic science, to basically acquire some knowledge in terms of how to do operational research. So, it is more products oriented. They have to provide a research paper at the end; and that training only has about three modules and it takes about a year. You don´t have to leave your job for that.

So, what basically happens is, implementers, those who work in the health system, they get together, about 12 participants in total per course, and again, it´s three modules that are done at different times, and at the end of the day they bring research data, they do data analysis, at the end they have a publication.

I won´t go into more detail. The other example is implementation research tool kit. While it is easy to say, sometimes it is not easy to be understood what we mean by implementation research. But implementation research for universal health coverage in our case for diseases of poverty, infectious diseases of poverty, but this could be used for any sort of health issue. This tool kit basically gives a workbook, a facilitator´s guide and a PowerPoint slide set, and that also is purpose to if you are trained in social sciences or if you are trained in health system research or any other basic or molecular biology or whatever, it doesn´t really matter, if you work in the health system, you can do implementation research, because you are equipped already with research and scientific skills. And, basically, this tool kit is bringing these multidisciplinary implementers, health administrators, researchers, policy makers to bringing them together and working over this tool kit, so they can look at the issues that they work with, in the system, that they know of, because they work in that system.

And there are various steps, you will see in terms of when you have to contextualize your challenge in the health system, what is the problem? We have something, but we can´t resolve. How to develop a proposal. A plan to conduct research in this area. Who to engage. And that is important because one kind of set of skills is not going to do this in one system these days, because of the nature of the health problems. Analyze, present, and most importantly, disseminate. And this, step five, usually, well at least what we've seen, is an absent part of about 80% of research that is done. Because just publishing it in a journal, does the trick, but it doesn't, depending on what the goal is. When it comes to health system change, this step number 5 is extremely important.

So again, that tool kit is available on our web site, if anybody is interested and I can answer more questions. But, basically, it has sort of discussions, lectures, analysis of cases, data etc. And the target audience, as I said is very, very different. You have anything from health providers to decision makers to researchers, financial and administrative people, media and ethics committee, committees in countries or institutions. So, in each part, kind of speaks to different parts to it. As I said it´s available on the web site. If you go somewhere, even if you write "a tool kit in TDR" it will come up, I´m pretty sure.

Thank you for your attention!

Health in the Post-2015 Development Agenda: National and global challenges

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Article

1. Introduction

In 2012, at the Rio+20 — the UN Conference on Sustainable Development — science was very prominent. One reason was the emergence of a new, interdisciplinary, unified science of sustainability in the 2000s. In 2010, the effort included approximately 37,000 authors in 174 countries (United Nations, 2014). That alone would have been enough reason for the "Science for Poverty Eradication and Sustainable Development" Conference, organized by the InterAcademy Partnership (IAP). The social accountability of Academies throughout the world toward sustainable, universal, equitable, high-quality social and economic development certainly added to it.

The almost bicentennial Brazilian National Academy of Medicine, founded in 1829, is dedicated to the integral development of medical sciences, and, because of its technical and political capacities, participates in the debate of important national issues. I would like to thank my peers for appointing me to represent the Institution in this milestone event.

Since the creation of the United Nations in 1945, people throughout the world have aspired to advance great and key global issues, such as peace and security, freedom, development, and the environment. The concept of "sustainable development" brought together the ideas of "social and economic development" and "environment." Now, strong interdependencies are recognized between the economic, social and environmental dimensions of sustainable development.

Currently, natural and social scientists have been highlighting a series of sustainable development issues and recommend integrated policy action and commensurate means of implementation, in areas that include technology, finance, capacity building and trade. Since the beginning of the process, human health has been recognized as a vital dimension of sustainable development.

In this paper, I will discuss aspects of the most important ongoing initiative of the United Nations — an action of global consequences, the Post-2015 Development Agenda, which will take the place of the Millennium Development Agenda (2000-2015) —, as well as the presence of health in the Agenda, as one of the 17 Sustainable Development Goals (SDGs).

In the first part, I will introduce some figures about the general global socio-economic context within which the health of populations and health systems evolve. This is necessary because both dimensions of health are fully dependent on the social determinants of health, as confirmed in recent key documents of the World Health Organization (WHO) (WHO, 2009; WHO 2011) and discussed in many papers and books (Marmot, 2004; Buss & Pellegrini, 2007; Pellegrini & Buss, 2011; The King's Fund, 2014).

In the second part, I will discuss main aspects of the development of the Pos-2015 Agenda and the presence of health in it. Finally, I will ask for the contribution of scientists and Academies to support the implementation of the Agenda both globally and within countries.

2. The global economic and social situation: some figures

While adopting the Millennium Declaration in 2000 (UN, 2000), world leaders pledged to create a more equitable world. Indeed, addressing inequalities is not only a moral imperative, but also necessary to unleash the human and productive potential of the population of each country and to take development towards a socially-sustainable path. Moreover, inequality not only matters to people living in poverty, but also to the overall well-being of society.

Income inequality has increased in many countries over the last few decades. The wealthiest individuals and families have become wealthier, while the relative situation of people living in poverty improved little. Thomas Piketty (2014), in his already classic book on capitalism in the 21st Century, affirms that, never before has wealth been so concentrated. His central statement is that inequality is not an accident, but rather a feature of capitalism that can be reversed only through State interventions. Moreover, he also writes that, unless capitalism is reformed, democracy will be threatened. Finally, he mentions that an ever-rising concentration of wealth is not self-correcting and that, to address the problem, redistribution through progressive global tax on wealth is recommended.

Disparities in education, health and other dimensions of human development still remain large despite some progress in reducing these gaps. Various social groups, especially the urban poor, rural populations, indigenous peoples and people with disabilities suffer disproportionately from income poverty and inadequate access to quality services. Plus, generally, disparities between these groups and the rest of the population have increased over time (UN/DESA, 2014).

The persistence of large inequalities in health and education within and across social groups and regions within countries is indeed a matter of ethic and global solidarity. The world as a whole has conditions to face these unfair problems, and it depends only on political decisions of Western powers and the United Nations.

Consider, for example, life expectancy at birth, a widely-used indicator of human well-being (Figure 1). Disparities in length of life reflect inequalities in health risks and in the access to health services; life expectancy is also a marker of a country's economic and political situation, including its level of stability and human security.

The absolute gap in life expectancy at birth between more- and less-developed regions shrank from 23 years in 1950-1955 to 13 in 1980-1985, and further, to under 10 in 2005-2010. However, life expectancy has improved more slowly in least developed countries, particularly during the "lost decades" (the 1980s and 1990s), in which incomes and public expenditures declined. Since the year 2000, however, stronger economic growth has gone hand-in-hand with faster progress in health, but the recovery has not been sufficient to significantly reduce the gap with other developing countries.

Disparities in life expectancy have also declined across most geographical regions, with the notable exception of sub-Saharan Africa. Life expectancy at birth was about 14 years below the world average in 1980-1985 and over 16 in 1995-2000.

As we can see below, average life expectancy in sub-Saharan Africa is still 16 years below that of most countries in Asia. Most of the relative lack of improvement in sub-Saharan Africa can be traced to the ravages of the HIV/Aids epidemic that swept through much of the continent. Additional factors, including civil wars and other violent conflicts, also contributed, both directly or via their impact on nutrition (by disrupting food supplies) and on the provision of health services and basic infrastructure.

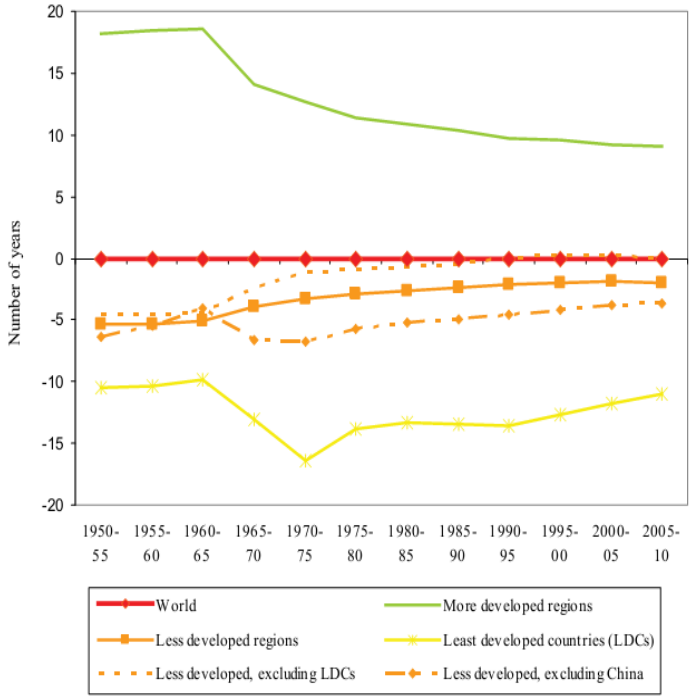

Fig. 1: Trends in the gap in life expectancy at birth between each major area and the world average, 1950 – 2010 (both sexes). Source: United Nations, Department of Economic and Social Affairs, Population Division (2013) World Population Prospects: The 2012 Revision, CD-ROM Edition, published in DESA (2014). Inequality matters (ref).

One of the most important determinants of life expectancy, especially in countries with high mortality rates, is the health of infants and young children.

Figure 2 shows that, while East and Southeast Asia have experienced significant declines in child mortality, the rate for sub-Saharan Africa has barely fallen. In recent years, the decline in child mortality has slowed in South Asia, such that regional gaps in child mortality have remained significant.

Increasingly, child mortality is concentrated in the poorest regions of the world, with sub-Saharan Africa (47%) and South Asia (37%) accounting for more than two thirds of all child deaths. Child mortality, particularly

neonatal mortality (death in the first month of life), strongly correlates with the health and nutritional status of the mother, as well as with the access to both basic and emergency health services; in other words, child mortality is definitively linked to poverty.

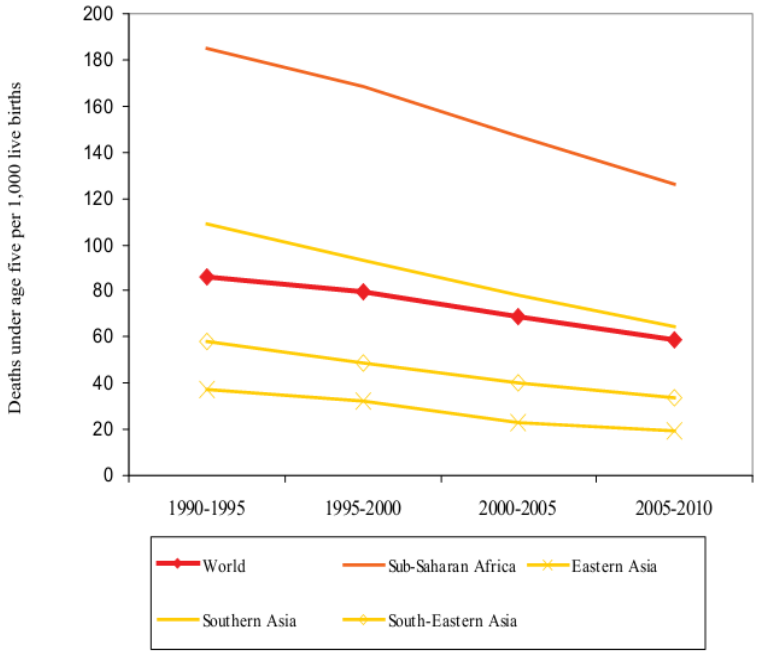

Fig. 2: Child mortality by region for both sexes, 1990-2010. Source: United Nations, Department of Economic and Social Affairs, Population Division (2013) World Population Prospects: The 2012 Revision, CD-ROM Edition, published in DESA (2014). Inequality matters.

A significant part of the modest progress achieved is due to the global efforts of the Millennium Development Goals (UN, 2014), the reason for the political decision of the UN Member States to define a new global commitment at the United Nations through its Pos-2015 Development Agenda and the Sustainable Development Goals (SDGs).

However, it should be mentioned that the Millennium Development Goals failed for having ignored the fight against the structural causes of the modes of production and consumption and the unequal distribution of power, which are the true promoters of inequality and hinder true development. Proposals for the Development Agenda should move beyond reductionisms and advance conceptually and methodologically to address socio-environmental determinants of health through intersectoral actions, including social participation, in all government spheres (Buss et al, 2012).

The importance of the global roots of health inequality — determinants that were minutely discussed by a Commission sponsored by the prestigious medical journal The Lancet and the University of Oslo, which the author was a part of — should also be considered (Ottersen et al, 2014). Among other results, the harmful influence of not only austerity and State-reducing measures suggested by international agencies like the International Monetary Fund (IMF), but also the actions of certain transnational companies — especially those in the tobacco and pharmaceutical industries — was made clear.

3. The UN post-2015 Development Agenda

It is in this context of such blatant inequalities between and within countries and of a great influence of transnational companies that the work of the Millennium Summit and the Millennium Development Goals is ending and the discussions for the establishment of post-2015 commitments are being carried out. Despite all criticism toward the United Nations (which is celebrating 70 years of existence in 2015), it should be recognized that the UN is the only intergovernmental institution with legitimacy (granted by the union of 193-member states) to propose global commitments like the Post-2015 Development Agenda and its SDGs.

The idea for the development of the above-mentioned Agenda emerged at the United Nations Conference on Sustainable Development, the Rio+20 Conference, organized in Rio de Janeiro, on June 2012. The outcome document, The Future We Want (UN, 2012), was signed by Heads of State and Government or representatives from all Member States of the United Nations and establishes — in its 53 pages and 283 paragraphs — the fundamental guidelines for the contents of the global agreement that will be signed at the United Nations General Assembly, in September 2015, at the headquarters of the UN, in New York.

After a process of consultation to interested parties — including government, the civil society and the private sector —, the Open Working Group (OWG) — an intergovernmental group formed by diplomats of all member States of the UN — prepared an Outcome Document (OWG, 2014), which will be introduced to discussion and approval at the UNGA of 2015, including proposals for an Agenda, for SDGs and its main targets. The process, in course since 2012, has been widely discussed in Buss et al (2014) a Kickbusch and Buss (2014).

The Agenda should be universal, transformative, inclusive and people-centered, with eradication of poverty and the achievement of sustainable development as its overarching objectives. It should also be holistic, ambitious, action-oriented, and universally applicable, while taking into account different national realities, capacities, levels of development and respecting national policies, priorities and strategies (OWG, 2014).

BOX 1 - SUGGESTED SUSTAINABLE DEVELOPMENT GOALS (SDG)

Goal 1. End poverty in all its forms everywhere

Goal 2. End hunger, achieve food security and improved nutrition, and promote sustainable agriculture

Goal 3. Ensure healthy lives and promote well-being for all at all ages

Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all

Goal 5. Achieve gender equality and empower all women and girls

Goal 6. Ensure availability and sustainable management of water and sanitation for all

Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all;

Goal 8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all

Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation

Goal 10. Reduce inequality within and among countries

Goal 11. Make cities and human settlements inclusive, safe, resilient and sustainable

Goal 12. Ensure sustainable consumption and production patterns

Goal 13. Take urgent action to combat climate change and its impacts

Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development

Goal 15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss

Goal 16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels

Goal 17. Strengthen the means of implementation and revitalize the global partnership for sustainable development

The OWG suggested 17 SDGs (Box 1), each of them containing targets (in a total of 169) and indicators. Two SDGs (16 and 17) refer to the general "means of implementation" of the SDGs. It is a complex set of goals related to many areas in the economic, social and environmental branches that make up sustainable development.

Although the SDGs may respond to sectorial visions and expectations as a whole, they lack the fundamental elements of governance and financing, which haven't yet been detailed in their preparation, that will be capable of bringing their various dimensions together and assuring coherence and synergy between them — and, therefore, the necessary effectiveness in the implementation of each and every one of them.

Indeed, what has been observed today globally and within countries is, generally-speaking, not only governance dedicated almost exclusively to leveraging productive power, but also a strong concentration of political power in entrepreneurs and promoters of economic policy, both of which are associated to generally unsustainable environmental policies and redistributive, assistentialist, compensational social policies in the fields of social development, including health. In this context, there is pressure for social and environmental deregulation, which are directly linked to elements that produce a strong negative effect over the environment and, consequently, over health, such as monocultural farming in large tracts of land, mega projects in energy generation and business centers, as well as many others, always masked as elements of a "Green Economy" (Gallo et al, 2012).

Moreover, global governance is far from restricted exclusively to the United Nations. The G8 and the G20 — groups of the most developed countries to which a few emerging economies, such as Brazil and India, have been invited recently —, international financial institutions and

multilateral development banks are also important in determining the economic and social course the world will follow. Their guidelines should be carefully evaluated for a full understanding of the path global governance for development will take in the future (Buss et al, 2012).

Generally, what has been observed is the prominence of rhetoric; the submission of the "social" agencies of the UN to its "economic" agencies; the high level of incoherence between the policies and practices of the most powerful countries, the traditional donors; and an important democratic deficit in international decisions, with the submission of environmental and health policies to economic policies. For instance, the harm of unfair international trade and intellectual property issues, supported by the WTO and WIPO, over health and agriculture, that is, over the access to essential goods for health and food, nutritional and environmental safety, is flagrant (Buss et al, 2012).

4. Health as a Sustainable Development Goal

One of the SDGs is the Health Goal ("Ensure healthy lives and promote well-being for all at all ages"), which contains nine targets (Box 2) and four means of implementation (Box 3). Three of the targets refer to the still "unfinished agenda" of the Millennium Development Health Goal: (1) to reduce the maternal mortality; (2) to end preventable deaths of newborns and under-five children; and (3) to end the epidemics of Aids, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases.

The other six are: (4) to reduce the pre-mature mortality from non-communicable diseases (NCDs) and promote mental health and wellbeing; (5) to strengthen prevention and treatment of substance abuse; (6) to halve global deaths and injuries from road traffic accidents; (7) to ensure universal access to sexual and reproductive health care services; (8) to achieve universal health coverage (UHC) and the access to health care series, medicines and vaccines; and (9) to reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination.

Four specific means of implementation are suggested (Box 3): a) to strengthen the implementation of the Framework Convention on Tobacco Control; b) to support research and development of vaccines and medicines and provide access to medicines and vaccines, in accordance with the Doha Declaration; c) to increase health financing and the recruitment, development and training and retention of the health workforce in developing countries; and d) to strengthen the capacity of all countries for early warning, risk reduction, and management of national and global health risks.

Box 2 - Proposed goal 3. Ensure healthy lives and promote well-being for all at all ages

3.1 by 2030 reduce the global maternal mortality ratio to less than 70 per 100,000 live births;

3.2 by 2030 end preventable deaths of newborns and under-five children;

3.3 by 2030 end the epidemics of AIDS, tuberculosis, malaria, and neglected tropical diseases and combat hepatitis, water-borne diseases, and other communicable diseases;

3.4 by 2030 reduce by one-third premature mortality from non-communicable diseases (NCDs) through prevention and treatment, and promote mental health and wellbeing;

3.5 strengthen prevention and treatment of substance abuse, including narcotic drug abuse and harmful use of alcohol;

3.6 by 2020 halve global deaths and injuries from road traffic accidents;

3.7 by 2030 ensure universal access to sexual and reproductive health care services, including for family planning, information and education, and the integration of reproductive health into national strategies and programs;

3.8 achieve universal health coverage (UHC), *trough universal, equity, comprehensive and quality health systems,* including financial risk protection, access to quality *necessary* ~~essential~~ -health care and *public health services,* and access to safe, effective, quality, and affordable ~~essential~~ *necessary* medicines, and vaccines *and medical and public heath technologies* for all;

3.9 by 2030 substantially reduce the number of deaths and illnesses from hazardous chemicals and air, water, and soil pollution and contamination *and protect the health of the population regarding those threats;*

3.10. *address the social determinants of health, through innovative forms of governance that include other government sectors and civil society.*

We understand that the Health Goal was very well formulated for "ensuring" healthy lives for all in all ages and uniting the ideas of "health" and "well-being." The main criticism regarding its "targets" is the fact that they refer to "diseases," not health, and that, even if fully accomplished, the SDG would still not be fulfilled. Therefore, improving the targets is suggested, as pointed out in the boxes in italic letters: targets "3.8" and "3.9"; means of implementation "b" and "d"; and adding goal "3.10".

Box 3 - Health Goal Means of Implementation

a) to strengthen the implementation of the Framework Convention on Tobacco Control in all countries as appropriate

b) to support **research and development of vaccines, medicines** *and technologies* for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential *necessary* medicines, and vaccines *and technologies,* in accordance with the **Doha Declaration** which affirms the right of developing countries to use to the full the provisions in the **TRIPS agreement** regarding flexibilities to protect public health and, in particular, provide access to medicines for all

c) to increase substantially **health financing** and the recruitment, development and training and retention of the **health workforce** in developing countries, especially in LDCs and SIDS

d) to strengthen the capacity of all countries, particularly developing countries, for early warning, risk reduction, and management of national and global health risks, *as well as, capacity for sanitary surveillance and regulation*

Therefore, it is important to detail what "universal coverage" (target 8) is, mentioning that it will only be attainable in the context of "universal, equitable, comprehensive and quality health systems," which includes the access to medications, vaccines, as well as medical and "public health" "technologies", which, in every case, are "necessary," not "essential," since the last idea refers to "minimum standards," which equals a form of "medicine for the poor".

Moreover, "means of implementation" account neither for the scope of the SDG Health, nor for the fulfillment of the proposed "targets." To really ensure healthy lives, favorable actions are necessary in all the other Goals, not just the health sector. All other development-related sectors should commit to its actions producing favorable consequences over human health, avoiding harm over it and using health impact assessments (HIA) (WHO, 2015).

In order for that to happen, consistent "governance" mechanisms for sustainable development will also be necessary, avoiding them to get fragmented and ensuring a coherent and harmonic implementation with co-accountability, all of them vital in a process this big and complex.

Because of the reasons put forth in the previous two paragraphs, we suggest the inclusion of target #10, which should also produce a consequence in the "means of implementation" of SDG Health, as well as practically in all other SDGs: 3.10. to address the social determinants of health, through innovative forms of governance that include other government sectors and civil society.

5. The role of Science Academies

With their social commitment and the commitment to improve governance, promote democracy and fulfill human rights, Academies must organize the existing knowledge toward sustainable development in all its dimensions and make it available for global (the United Nations System and other organizations) and national governances.

In order for the IAP to be effective, it will be important to deeply understand the process of preparation of the Post-2015 Development Agenda, which will peak on September 2015, at the United Nations headquarters, in New York. The prestige of the IAP may assure its participation as a stakeholder of the civil society in the debates that evidently have already started. Therefore, at the United Nations level, this means acting with the Secretary General and corresponding departments at the UN — and the United Nations General Assembly (UNGA), given its meeting on September 2015 at the UN headquarters, in New York —, as well as through the ensuing process.

'Still at the global level, the IAP should participate in the Sustainable Development Solutions Network (SDSN) (2015), launched by the UN Secretary General in 2012 "to mobilize global scientific and technological knowledge on the challenges of sustainable development, including the design and implementation of the post-2015 global sustainable development agenda."

To strengthen its global presence, the IAP must organize processes like the one carried out in Manaus and disseminate its results globally. The organization of interacademic (transdisciplinary in essence) activities (to

extract as much as possible from the "sciences of sustainability") is the ultimate recommendation stemming from the IAP event in the Amazon.

The post-2015 global pact, which will result in a agreement to the signed at the 2015 UNGA, will imply commitments that should be implemented internally by the UN member States in the years leading up to 2030. In this context, National Academies must mobilize the civil society and organize the national scientific knowledge as evidences and use their prestige to act closely with governments (at the executive branch) and the national Parliament, given the recognized and crucial role of the State in promoting development and implementing governance schemes capable of executing coordinated, harmonic intersectoral actions that are fundamental for sustainable development.

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SESSION 4 - Building Equity through Social and Economic Policies

Chair: **Alexander W. A. Kellner** (National Museum/UFRJ and Brazilian Academy of Sciences)

The Japanese Social Security system

Aya K. Abe (National Institute of Population and Social Security Research)

Conference

I am a poverty expert from Japan, my research is mostly about the Japanese Social Security systems, such as Public Pension, Public Health Insurance and Social Assistance programs in Japan. You must all be thinking: "well do you have any poor in Japan?". But we do, and I think my presentation is going to be of some interest to you because Japan is a country which developed before most of the Asian and South and Central American

and African countries – a little bit ahead and at the same time is a non-western or non-European origin country, Japan did achieve universal health insurance about 50 years ago but now it´s on the verge of a collapse. And I will show you how it happened and maybe this will be a lesson to many other countries that are following Japan.

And here I use the term social security to mean pensions for old age, disability and widowers and also the public health insurance and also long-term care insurance these are public social insurances, and social assistance. The social assistance is what people in the US call 'welfare'. It is the income support for the poor. You probably all know that social security is going to take up a bulk of the budget of the countries and it is going to happen eventually to all countries. These are just some of the figures of some developed states and the figures show that somewhere between 20-30% of GDP is going into social security systems. So even though many of these developed countries have dealt with poverty issues a long time ago, but still they are spending a lot of money on these systems. It is precisely because we are spending this much money, that is why we do not really see the absolute poverty as we see in other developing countries.

I am going to talk a little bit about the demography which I think is going to be a nice continuation from Professor Behrman´s presentation because demography plays a key role in developing and planning the social security systems. This figure shows Japan's population change from 600 AC to 2000 and projected to 2200 and you can see that we had long years of stable population, then it started to increase, then there was the Tokugawa Era which is a 300 years of peaceful time during which we had a slow increase in population, then after modernization, there was a population boom, and then here, this is where we are now and the graph is turning because we started to see a decline of the population. And the population is projected to decline very rapidly. This is the transition that we will have to face, and this is the transition that most countries will have to face pretty soon as well. The next slide shows a little bit more of a shorter term, this is the Japanese population by age group from 1880 to 2100.

1961 is when we achieved universal health insurance and universal pension. That is right here. So, you can see the population composition at that time was: this is children, and this much of the working age population, and this much elderly. And this proportion of elderly, working age, and children is probably close to what we are seeing in a lot of developing countries right now. But the population composition changed very rapidly from here on and then, now we are seeing that this much elderly; about 23% of population in Japan are elderly now. The working population is 63.8% and children, 13.1%. And it´s going to get worse for some time and then it is going to stabilize eventually.

The next slide shows the ratio of elderly among the population. You can see that in 2010 it is about 1 in 4 people, and it´s going to be 1 in 3 people very soon. And the next slide is looking at the same kind of thing, but in a little bit different way, Professor Behrman talked about the dependency ratio and here we are dividing the dependency rate into two ratios, one is child dependency, this is the ratio of number of children as opposed to number of working age people, and then we have the elderly dependency ratio. Because the number of children is decreasing, the child dependency ratio is going down quite a lot, and the number of elderlies is growing very rapidly, so that is shown in blue line. Here is what we call the population bonus, or demographic dividend as we call it. And if you look at the 1960´s right here, this is when we started our social insurance systems. So, at that time we were facing huge population bonus and it continued for about 40 years. But now we are hitting what we call the population onus, which is the opposite of population bonus.

Now let me explain the brief history of Japanese social security systems. After the WWII, the war left virtually nothing in Japan. Everything was completely destroyed, and all the wealthy families were gone and there was nothing there. So, the war, in the end left a very flat society, and everyone was poor at the time. After the war, we started to see the economic boom, and then what happened is we also had a tremendous population bonus and very low dependency ratio. So, we achieved a fairly equal society in 1970s, twenty years after the war. And this is why most of the people feel, even the non-Japanese people say that Japan is a very equal society. The numbers from the 1970s show that Japan was a very equal society. In the 1970s the Gini ratio of Japan was quite close to those of the Nordic countries. Around this time, we were coined the term "all middle-class nation", because opinion surveys took around this time all said that nearly the entire population said "I´m belonged to the middle class". And also, Japan was facing a very strong economic boom, so everyone was feeling pretty good even those who are low the economic strata.

And what about the poverty? After the war there was a lot of hunger and also the homelessness in Japan, but in the 1960's and 1970's, these poverty were seen less and less. The public assistance ratio (percent of the population who receive public assistance) started to decline sharply and it fell eventually to as low as 0.7%. We also started to build social security systems such as public pensions, and public health insurance but we didn´t quite see that it was dependent on the population bonus. As I will show you later on. And also, we did not build any safety net for the poor because the government assumed that poverty was eradicated from Japan.

Up to 1965, Japanese government collected statistics on the poor. In 1965 it stopped collecting any statistics on poverty, by declaring that "the war is over". It means that all the negative consequences of the war are finally finished. The poverty was not here anymore. So, for a long time, Japanese government and public, completely forgot that poverty might be an issue in Japan. And as living standards of all people increased, poverty was all forgotten. And Japan started to develop what is called "developmental welfare state", whose guiding principle is the best way to provide safety net to the people, was the economic development. So that the economic development was the number one priority for the nation. Our welfare state also was termed "the familiar welfare state", which is welfare state where families play a large part in providing security to people. Care for the elderly and the care for the children were expected to be provided by the families (mostly women).

And then after the 1990s, things started to change. The first sign of poverty re-emerging in Japan was homeless people on the streets of major cities Japan. And then we started to see the increase in the relative poverty rate, as you see in the next slide. Mind you, these statistics first came from the Academia, not form the government. Researchers like me, and a few others started to calculate poverty rates in Japan. And actually, we had the first change in government in 2009. Only then, the new government published the relative poverty rate as an official statistic. So, there had been nearly 50 years, since the Japanese government last published poverty figures in 1960's, that the government acknowledged that there was poverty in japan.

This is the relative poverty rate of Japan from 1985. The blue line shows the poverty rate of the society as a whole, and the red one is the child poverty rate. And as you can see, it has been going up quite steadily since 1980s, and now the poverty rate for Japan is at 16.1% for the whole and 16.3% for the children. The next slide shows, I am sure many of you are very familiar with the relative poverty rate, but just in case, this is the OECD definition of poverty rate – for the developed countries. The graph shows the income distribution, and this is the percent of the population and this is the income – and this is the median of income and then this is the 50% of median which is defined to be the poverty line. And this shadowed area, people belonging to this part is considered to be poor. So, it´s a very standard way of calculating poverty rate from income data.

The next slide shows the poverty rate by age and by sex. And this was actually quite surprising to me, because we used to have poverty rate like this, 'J' shape where the elderly had higher poverty rate and the young were fairly low in poverty rate; but here for the first time, especially for men, the poverty rate for the young people surpassed the poverty rate of the elder people. Which is still not the case for women and that´s because the pension system for women is still not very good.

And here you can see what is going on in the longer term. The green one is 1995 and 2001 and 2007. And this is 2007 – the same one and 2010, and you can see that poverty rate for men is rising quite rapidly here.

But you might still think, I mean even though they are considered to be poor in a relative sense, they might not be really in so much of hardship in terms of living standards. After all, Japan is fairly rich country as a whole. So being "relatively" poor, may not be that bad. To answer to that, let me show you some data on the material deprivation. The Survey asked: Have you or your family experienced not being able to afford food or clothes that your family need, in the past year? And then 1.6% of the house hold said "often"; and 4.7 said "sometimes"; and 8.5 said "a few times". So, all together, about 15% of the families said they had experience of not being able to buy food and about 20% for clothes. Also, in the same survey we asked if the family had experience of not being able to pay utility bills and rent and about 5% of all the families have experienced not being able to pay electricity, gas or telephone bills nor house rent.

And I also wanted to bring slides with some figures on the health services, but I didn´t bring the slides so, I just tell you the numbers. About 10% of the working population said they had experience of not being able to go to a doctor even though they felt that they were sick and needed to go to a doctor. And we also asked the reasons for not being able to go to a doctor : a half of them said there was the time issue – they could not

make time to go because of work or family obligations; and a half of them was financial issues, that they cannot pay the co-payment even though the public health insurance covers 70% of the cost or that they were not covered by the public health insurance because they could not pay the insurance premiums. So even in a fairly rich country like Japan, I mean you are seeing people who cannot really get access to health care or utilities or have the stable housing.

And if we look at that relative poverty rate in international perspective – Japan is number four among the OECD countries in terms of high poverty rate. The only countries higher than Japan are the US, Turkey and Mexico. And if you look at the poverty rate of the one parent families, Japan´s poverty rate is by far the worse among the OECD countries.

So why is this happening after we had constructed social security systems half a century ago? This slide shows the rate of the population receiving the public assistance. The red line shows the percentage of population receiving the assistance. So, this is 1951, six years after the war ended. 2.4 2% of the population were in the public assistance, and the rate went down quite dramatically here. And this is 1961 where we achieved the universal health insurance and universal pension. I think, the stage that many developing countries and also the fast-growing economies is facing is this stage of the development, when the public perceive the absolute poverty going down very quickly because of rapid economic development. And then 1995 all of a sudden, the rate started to climb up again. And now we are seeing the public assistance rate at 1.7% which is almost as high as back to the 1960s. But it is still only 1.7% and that is because Japan´s public assistance system is very, very strict and we made it so. Because we made the public assistance early on during the 1960s, thinking that poverty is going to be eradicated very soon. So, we did not feel the need to make a generous public assistance system. The requirement to be eligible to receive public assistance is very high, the means test and also the asset test are very harsh, and also all the relatives have to vouch that they have no money to support you and such and such. It is very hard for any person to be eligible to receive the public assistance.

And the government is spending a lot of money is social security. The next slide shows the composition of the government outlay. For 2014 social security expenditure is 34.8% of all the national budget. The irony is that we are spending a lot of money on social security, but still, I mean, we cannot provide basic amenities for a lot of people. Why is that? That´s because we have demographic "curse". As the population ages, expenditure grows for social security for the old age pensions and also for widower pensions and also the health and long-term care for the elderly. And also, the working age population decreases so the tax-base is decreasing very rapidly. Politically, it is very hard to cut outlays in the pension and healthcare for the elderly, I mean any politician who suggested the cut in elderly pension or health care would be voted out of the seat very quickly because the age composition of the voters is skewed toward the elderly. And because of the economic situations, the working age persons were not able to burden any more taxes, and right now we had a big problem of raising the taxes – consumption tax from 8% to 10% which is low compared to a lot of the European standards I am sure. But still it is politically impossible because the working age persons are already too burdened because of economic situations. And what happens? The tab is sent to the future generations, in the form of public debt.

The next slide is the social security expenditure. This is old age pension, this is health care, and the rest are public assistance and long-term care. The expenditure has been growing quite rapidly. And this is natural increase because of the number of elderlies is growing and growing and growing. So even if we provide the same level of services, the gross expenditure would go up.

Because the government did not really think there was a poverty problem for a long time; it was doing something very unusual in terms of redistribution of income. This slide shows the child poverty rate before and after taxes and transfers. And of course, after the transfers and taxes, the poverty rate should go down, and that is happening in most of the countries here on the slide. But only in Japan and Greece, you can see that poverty rate goes up, rather than going down, after tax and transfers. And that is because the social security and tax systems did not pay much attention to poverty for a long time. The system was constructed that way so that tax an insurance premium for the poor is rather high, while transfers for the poor is rather low. And because there is no social security safety- net for the poor, the people are feeling that their standard of living is slipping lower and lower during the economic recession. They are feeling the pinch of the economic recession. This slide shows opinion survey results from 1986 to 2013 and the survey asked, "how do you rate your standard of living?" In the 1980's, a half of the population answered "I'm in the middle class, I'm doing OK". But currently,

60% of the people answer that they are having "a very hard time" or "a hard time" and that they are just making the ends meet. While people are feeling the pinch, people are not willing to share any more burdens, so they'll refuse any increase in taxes, and in social security premiums. And what happens? There is an increasing requirement of expenditure but less taxes and premiums. We have to finance it using public debt. See the next slide. The black line shows the public debt ratio. 43% of government outlay is financed by the debt, and this is pretty bad, this is very large budget deficit. And the next slide is the mounting public debt, a cumulative one, and right now every citizen in Japan has 6.15 million Yen of debt on their tab, which is about 50 thousand in US Dollars – that's a lot of debt!

Another principle that the Japan's social security system relied on was the family. In 1979 the Prime Minister Ohira said "We are going to build a welfare state – Japanese style". And what he meant was that the family plays a very strong role in providing the safety net. For example, the public pension is designed, but it´s designed so that the amount is not quite enough for the elderly person to live on his or her own – together with the incomes of his son, living in a three-generation family, that is sufficient. I mean the pension is sufficient for him to interact with others, playing golf or playing mahjong with others, but was not enough to support his living on his own.

The family plays a part even in the public assistance. Family has to come first before the public assistance, family has to vouch that there is no means that they can provide for that person. And for the care for the elderly, we have a long-term care insurance, but it is expected that care is provided at home. So, that means that if an elderly cannot live on his/her own, someone has to stay at home and Prime Minister Ohira being a man, he was thinking the spouses (wives) should be the one. There should be a man and also a housewife at home who will take care of an elderly parent at home. So that was the Japanese style welfare style.

However, the family, as we know is also changing very rapidly. This is the family structure of Japan in 1986 and in 2013. Single person household was 18.2% in 1986 but in 2013 it´s 26.5%. And now single-person household is the most popular family type. And also, the three-generation family was 15.3% in 1986 but in 2013, it is now only 6.6%. So, you can see that the family structure changed very quickly, very rapidly.

And if you look at the elderly household structure, you can see that single person household has increased from 13.1% to 25.6%. So what we are seeing is that, old people, and the red part is the couple only, meaning the elderly and his spouse or her spouse, so that half of the elderly are living in elderly only household, that means what we term – elderly caring for elderly – for example, a 68 years old wife is taking care of 72 year old husband.

So now this is my last slide, and this is what I call Japan´s dead lock. It all starts from this demographic change, population decline, high dependency ratio and aging and now we are having three crises. Fiscal crises, social crises and family crises. Fiscal crisis show that the population decline leads to less government revenue; Also aging means increase in the expenditure. And in turn, fiscal crisis means the government cannot provide enough social protection for the poor people. And that leads to social crises, increase in poverty and also confidence in the government. People feel that because the government is in such a fiscal crisis, that they cannot rely on their public pension for their own old age. So, they don´t want to pay their taxes. People are unable to pay taxes and refusing to pay social insurance taxes. And in this leads to "family crisis": there is an increase in childless people and also increase in single person households. And that is happening because young people are getting poor, so they cannot get married. The number one reason for not marrying, is the economic reasons. But now, many of men are not marrying and the main reason is that they are too poor to marry. They feel that they cannot support the family, so they do not get married. And also, there is no family member, so there is no family support when one gets to be poor. And then this in turn goes back to less families can afford a long-term care for the aging, so that means increasing pressure for the fiscal crises. And this is going around and around, and Japan is in a complete dead lock, and it cannot do anything.

I think Japan's case illustrates what not to do for the rest of the countries. Because all the countries will follow the same path as Japan in terms of demography. This slide shows the ratio of population aged 65 and over. Japan is the red one – the front runner, but all other nations are following and if we look at the regions, and this is China and Korea; Korea is following Japan very closely; and then China; and the rest of East Asia. The next slide is the dependency ratio. The tricky part is this bouncing back, and then, except for Africa which is the black line, all other regions are going to see this bouncing back pretty soon.

The lesson is that we have to make sure that when designing universal health care coverage or universal pension, that we would not hit the same kind of trap as Japan did. One, do not forget poverty as they will come back. Two, do not build social security system based on population bonus, it will not last. Three, do not assume family structure stays as it is, it will change very quickly.

And for the global strategy, what can Japan's case study tell? I think the society in which people feel that they cannot bear any more burden for themselves, would not want to spend much on international aid either. And in Japan, people don´t want to increase their taxes from 8% to 10% to finance their own social security, they will not be sympathetic to other nations' poverty.

In order for the world to be more united in combatting poverty, we have to not only look at poverty in developing countries, but also poverty in developed countries as well.

Population Quantity, Quality and Mobility

Jere R. Behrman (University of Pennsylvania)
Conference

I am talking about population, about population quantity -- the numerical side of population -- and population quality including health, education and nutrition, and population mobility related to both population quantity and quality.

1. Population Quantity, Quality and Mobility: Recent Developments and Future Projections

Population Quantity and the Demographic Transition

I start by giving a very brief description of the demographic transition because that helps give some perspectives on this topic, about where we have been and where we are likely to go and helps tie together certain dimensions of population quantity and quality.

The demographic transition is basically a change that the world has experienced to various degrees, from initial very high fertility and very high mortality and therefore low life expectancy - to situations where fertility is much lower, and mortality is much lower as well and life expectancy is much higher. These transitions result in many substantial changes in society. It is brought about in part, by the economy and affects in important ways the economy. As you can see there are lines on this diagram for various countries passing through the demographic transition: the European experience is below and to the left of the least developed country experience. But all these lines are downward sloping, which has important implications. One implication is that generally these populations are aging as we go through the demographic transition. A second implication is that in the process of the demographic transition, there typically is a substantial reduction in the dependency ratio – where the dependency ratio is the number of people too young or too old or disabled to work, relative to the size of the work force. That opens up the opportunity for what is sometimes called the "demographic bonus" that some leading researchers suggest played an important role in some of the East Asian very rapid development experiences of the past half century.

Now in the next figure here is the world population. It is amazing what has happened in recent decades to the world population. Around 1950, the world population was two and a half billion; around 2010 – over 7 billion, almost tripled – a huge increase. And here are projections from the UN population division of what will happen in future decades: using the medium projection that is referred to as most probable –an increase from roughly 7 billion plus now to 10 billion in 2100. That´s a big increase, it may be a little more or less than that. But it´s small compared with the increase that was experienced in the last half of the 20th century. The next figure gives the population growth rates that are associated with those patterns. From the first half of the 20th century they went up amazingly, to over 2% in around 1970 and then plummeted substantially and are projected to continue --depending on which projection you consider – to go down in the future.

An amazing part of this experience is that there was this huge increase in population but during the same period world medium per capita income increased by 150% and life expectancy increased by 33%. A number of major positive things happened despite the huge increase in population. The factors that demographers have tended

to emphasize as important in explaining what occurred include market and institutional responses – if something becomes scarce people and institutions substitute away from it. Likewise, innovation has been attracted where there are scarcities. But also, globalization and urbanization are thought to have integrated markets in ways that have led to greater productivity. And then on the more demographic side there has been an induced decline in fertility, probably associated strongly with increased female education and increased investments in children to improve child quality -- their education, health and nutrition, also probably very related to the expansion in female education. What happened to food and other agricultural prices over that period of time... or what happened in terms of food prices more generally over the 21st century until now and how does that relate to population changes? The world population increased and then really accelerated and the started to level off some at the end of the 20th century. There was a tremendous increase in population over the century. On the other hand, in sharp contrast, real world agricultural prices declined secularly by about 1% per year through the century. There was a lot of accommodation in terms of price responses and new technologies with the result that despite the huge population increase the secular trend in agriculture prices was downward.

Two comments are merited. First, there are lots of fluctuations in these prices. One big fluctuation occurred in the period up to about 2009/2008, when there was a lot of alarm about increasing agricultural, particularly food, prices. Since then, agricultural prices have declined back towards the secular trend. But despite this price peak, from the perspective of the past century, it was a little blip -- the secular trend has been strongly downward. Second, often it is suggested that high food prices really hurt the poor. That is true for many of the urban poor. But for most developing countries, particularly in Asia and Sub-Saharan Africa, there are larger shares of the poor in rural areas and when agricultural prices go up including food prices it generates demand for their labor and for their products. Therefore, it is not clear that if one is interested in the poor, one is interested in having low agricultural prices because those will directly negatively impact the rural poor. The effects on the urban and rural poor tend to be opposite; there is the question of which poor are going to be hit by agricultural price changes, depending on the direction of such changes.

To think about the quantity of population and the way the world varies, it is useful to distinguish among various stages in the demographic transition. There are still some high-fertility, high-population-growth regions, much of which are in Sub-Saharan Africa and much of which also has fairly low population quality. There are some areas that face a potential of a demographic bonus -- much of South Asia and Latin America. And their post-transition older population age structure in much of East Asia and most OECD counties. The basic population issues and problems differ enormously among these contexts.

<u>Population Quality – Education and Health</u>

(1) Education: If education means learning, it occurs in many venues and is not the same thing as schooling. Schooling is an important part of education, but it is not the only way that we learn. Learning occurs over the life cycle: it occurs before schooling and it occurs after schooling. However, most information we have is on formal schooling and secondly, probably related to early childhood development. Schooling enrollments have expanded very impressively in recent years and are projected to continue to expand. Schooling is very related to economic growth and economic growth is related to poverty reduction. Schooling may not be the only or the most effective way to reduce poverty, but it is certainly strongly associated with poverty reduction. A team headed by Wolfgang Lutz at IIASA in Vienna, Austria, has simulated different combinations of schooling and what they imply for economic growth. Their most schooling-intensive scenario is associated with high economic growth. This group also has undertaken forward-looking scenarios based on associations between schooling and demographic outcomes. Their so-called "fast-track" scenario with high schooling investment ends up not only with a more-schooled world population but with a smaller world population total than do their other scenarios because of the inverse associations between schooling and population growth.

Early childhood education has been receiving increasing emphasis throughout the world. A recent Lancet paper on the impacts of different types of early childhood education on cognitive skills in middle- and low-income countries finds pretty substantial impacts.

(2) Health: The population, as I have said before, is aging in the process of the demographic transition. This is well-known for the more-developed countries, but also is happening for the whole world. This red line in the figure is for the less and least developed countries, where at this point the proportion of population over 60 is on the order of magnitude of 8 or 9%, but by the middle of the 21st century is projected to be 20%, basically

the current share for the more-developed countries. So, aging is pervasive universally - just happening with different lags in different parts of the world.

Associated with aging, but not exclusively with aging, is a change in the nature of the disease burden. The figure gives estimates of the eight top causes of death in 2010 and the changes since 1990. The light blue purple diseases are non-communicable diseases – the diseases that we used to think were the diseases of development. The pink ones are infectious diseases, what we used to think of as the traditional diseases of development. With the exception of HIV/AIDS in the 1990 to 2010 period that increased greatly, the traditional diseases have reduced substantially in their relative importance and the non-communicable diseases have become much more important. This is closely related to what Lai Meng earlier was talking about regarding the distribution of resources relative to needs with the changing composition of diseases.

Population Mobility

As you probably know, recently, for the first time, half of the world lives in urban areas. Big cities have increased substantially, and projections are that this will continue in the future. The urban population, moreover, is going to be more and more concentrated in Asia and in Africa. Asia and Africa are the two least urbanized regions now. In the case of Asia, the current population is relatively very large and in the case of Africa the population growth is relatively very high. So, Asia and Africa are the major regions where future urbanization will be concentrated.

International migration – is emphasized a lot. The figure gives the stock of international migrants in 2010. One striking point is that these numbers are much smaller than the numbers associated with internal migration, which underlies a major part of the urbanization. And secondly, the more developed regions have more immigrants than the less developed regions, but not so much less – there is a lot of international migration among the less developed countries – it is not all a flow from the poorer to the richer countries.

2. Policy Implications and Benefit-Cost Ratios

Three General Points

First point -- to think about policy implications it is useful to focus on the two basic motives for policies: (1) efficiency and (2) distribution. The idea of efficiency is simply if you have given resources and given technology and merely by changing the distribution of resources among producers or among consumers, so they are better used, you can increase output or welfare through the more efficient use of resources, which would seem desirable. With regard to distribution – some people are very concerned about inequality. I think it is a value judgment in terms of what one´s concerned about, but my personal interests are much more in the subject of this conference –poverty, the people on the left hand of the distribution – rather than how spread out the distribution is in the other direction. There may be tradeoffs between efficiency and distribution, or there may be complementarities in the form of "win-win" policies that improve efficiency by improving markets for the poor and that also reduce poverty.

Second point – we should be trying to estimate benefit-cost ratios or rates of return for policies so that we can compare among policy alternatives. But this is very challenging because of the long-run and disperse impact and unintended costs and consequences of many policies. We had some discussion on this yesterday.

Third point, very much related to a point that Linxiu was making several times yesterday. The incentives in commitment schemes may be essential for making policies work.

Benefit-Cost Ratios – General Considerations

Now I am going to speak briefly of benefits relative to costs for various kinds of policies related to population quantities, qualities and mobility. I have in mind a life-cycle framework as in the figure. For example, early in life there are big risks like inadequate nutrition, infectious diseases, poor maternal health, and inadequate stimulation and learning. Various interventions might affect these risks, which in turn affect various measures of child development, which then cascade through the lifecycle, through pre-school ages, through school ages, through post-schooling ages to adulthood, through old ages. And all those may be affected by either decisions of the families or by public interventions. So, the challenges are: if we have some interventions that, for examples, improves food intake of small children, how will that cascade? What will be the benefits and, equally importantly, what will be the costs over the lifecycle?

There are several general considerations for calculating benefit-cost ratios that should be mentioned. First, as also shown in the life-cycle figure, there may be multiple impacts over the lifecycle of some intervention. For any particular impact there may be challenges in estimating what it is. Unless one had a randomized controlled trial for every possible impact, which is probably impossible logistically and ethically, one has to make inferences from observational behavioral data and that poses challenges about unobserved factors that may affect the choices that households make.

A second point, related again to these impacts and the lifecycle figure, we want to compare likes with likes. Some of these impacts will occur in three years and some of them in 40 years, say impacts upon children´s productivities when they become mature adults. Therefore, we have to adjust the impacts to the same time period. Discount rates are used for this purpose. The reason is that having a benefit sooner is better than having it later because if you obtain is sooner you can reinvest and gain more before the later benefit is realizes. With a 3% discount rate as advocated and used by the WHO, if you have a benefit of US$1000 40 years from now it´s present discounted value is about US$300. If the discount rate is higher, the present discounted value is smaller – with 6% it would be about US80 and with 10%, which is advocated in many international organizations for infrastructural projects, it would be US$22. So, what is the appropriate discount rate makes a whole lot of difference in how you think about impacts that occur sometime in the future.

A third point is that a further complication is that there may be interactions between different interventions, say interventions for improving nutrition and interventions for improving learning. They may interact either concurrently or over time. This complications assessment of any one intervention because it must be conditional on assumptions regarding other intervention.

A fourth complication, because of the multiple impacts, is that you somehow need to add together the value of different impacts – for example, an additional grade of schooling attainment with a reduction in the probability of some chronic disease. Combining across impacts becomes particularly complicated or at least controversial, if one of the impacts is averting mortality, because there is a wide range of estimates of the monetary benefits of reducing or delaying mortality.

A fifth point here for the impacts, but also below for the costs – the impacts are likely to be very context-dependent because they depend on the nature of the markets, prices, environments, other policies and resources. For example, the value of a de-worming program isn´t going to be very great if you don´t have worms in the environment. Likewise, the value of a program directed towards increasing primary school enrollments is not going to be very great where primary school enrollments already are basically universal.

Sixth, the resource costs are important as the benefits for prioritizing among interventions, though often there is much greater impact on estimating the benefits and costs are even ignored. The resource costs include both public and private resource costs, although at times the private costs are ignored and only the governmental budgetary or supplier costs are included. This practice not only is likely to lead to underestimates of the true costs, but create incentives to offload program costs to private individuals. For many programs it also has negative distributional effects because the private costs are often borne, for example, by poorer rural women who have to spend time doing something such as traveling to clinics in order to make the intervention work. Another point about costs is that there generally are also some distortion costs due to incentives created for inefficient behaviors from raising resources of public funds, estimated to be on the order of magnitude of a quarter of governmental expenditures or more, which should be integrated into the resource cost estimates.

Benefit-Cost Ratios and Other Policy Considerations for Population Quantity, Quality and Mobility

I now am going to present some benefit-cost ratios for population quantity, quality and mobility that are based on a lot of underlying work to address the general points about benefit-cost ratios previously discussed. Due to time constraints, obviously in this presentation I cannot address all of the underlying details.

(1) Population Quantity and Mobility: We estimate some really high benefit-cost ratios for some possibilities. First for achieving universal access to sexual reproductive health services by 2030 and eliminating unmet need for modern contraceptives by 2040, we estimate benefit-cost ratios over 90. Over US$90 for every dollar one spends! It sounds to me like a good deal, I would like to have an account where I could get US$90 back for every dollar I put into it.

Second, for reducing barriers to migration between low- and middle-income countries and high-income countries we estimate benefit-cost ratios about half as high as for achieving universal access to sexual reproductive health services and eliminating unmet need for modern contraceptives, but still very high. There are some costs for sure, but with the net costs to the receiving countries are much less than often suggested though adjustment policies to aid the "losers" to move to other activities well may be warranted.

Some other population quantity policies probably also have high benefit-cost ratios but are very difficult to quantify. One example is the elimination of birth-age-based eligibility criteria for retirement. The idea is that retirement age ought to be measured from the expected end of the life – not from the start of the life. The present system, based on years since birth, discriminates against poorer members of society who tend to have worse health and lower life expectancies. It moreover becomes difficult to sustain if life expectancies increase and adjustments in retirement ages lag behind. Another set of examples are various interventions that might make urbanization more effective and more efficient that that we expect to have high benefit-cost ratios, but these tend to be relatively context-specific and time constraints preclude discussing them now.

Of course, not all interventions in population quantity have high benefit-cost ratios. One example for which the benefit-cost ratio is likely to be low is maintaining or extending the current model of public pension eligibility at relatively young old ages. As discussed, such programs both discriminate against the poorer members of society and are not easily sustainable with increased life expectancies. Another example is policies aimed at increasing low fertility in high-income countries, which for the most part seem to have low benefit-cost ratios.

(2) Population Quality - Education: As noted above, I think there is growing awareness that there is great potential in terms of early life nutrition, early life stimulation, and pre-school programs. Socioeconomic gaps in cognitive skills start occurring very early in life as shown in the figure for rural and urban areas in five Latin American countries. The higher red lines are the scores on the vocabulary tests for various months from 36 to 72 for children from families in the top income/wealth quartile and the blue lines are for in children from families in the bottom quartile. Everywhere there are gaps that exist from 36 – 40 months of age (and probably when younger, we just don´t have data for younger children) and persist, and in some cases, increase into school ages.

There are some recent efforts to train community women to train mothers to stimulate better their children, which look very promising. For Colombia, for example, recent results suggest an impact of about a quarter of a standard deviation on cognitive skills tests. Some recent Inter-American Development Bank estimates of benefit-cost ratios for early life stimulation programs based on very careful trials and evaluations, suggest that home visit programs as in Colombia are on the order of magnitude of 3; preschool programs a little higher; pure daycare a little lower – all using a 3% discount rate. Of course, the benefit-cost ratios all go down with a 6% discount rates. But still at least the home visits and preschool seem to be attractive investments.

The figure gives preschool enrollment rates, which for the world increased from 33% in 1990 to 44% for 2008. But there is a lot of variations across world regions: Latin America for example is 69% and Sub-Saharan Africa is 17%. In a 2011 Lancet article we estimated, using data from 73 developing countries, the impact of moving children from the average preschool enrollment rates for the lower quintiles of the income distribution to enrollment rates like those of children in the higher quintile. We estimate a systematic relation between the gaps in preschool enrollment rates on one hand and the gaps in schooling attainment between the top and the bottom of the distribution on the other. We then translated the changes in schooling attainment into percentage changes in earnings based on average estimates from studies covering many developing countries. These estimates suggest that increasing preschool enrollments at the lower end of the distribution could have high benefit-cost ratios in the range of 6 to 17, with the variation depending on some of the assumptions that are made.

For schooling ages, there is a widespread perception that girls are disadvantaged relative to boys because their enrollment rates are lower. Indeed, there are tens of million more girls than boys who never enroll in school, which probably has a substantial equity and efficiency costs. However, once children are enrolled in school, increasingly in the developing world as in the high-income world on average girls have at least as great schooling attainment as boys despite lower enrollment rates because boys on average progress through school more slowly than girls due to greater grade repetition and dropout/re-entry. Therefore, there are reasons to direct

school policies not only towards increasing enrollments of girls but also progression rates of boys. More generally there is a need to increase what is learned in schools on average in the developing world. While enrolment and schooling attainment gaps between lower and higher-income countries have been reduced, large learning gaps persist. Some recent studies suggest that there are not likely to be many magic bullets for improving the quality of education but incentives for learning and better information might play significant roles in increasing learning

Finally, with the aging of populations, reinforced by rapidly changing markets and technologies, life-long learning is likely to be of increasing importance. Very little, however, is now known about how to increase such learning.

(3) Population Quality - Health and Nutrition: I have discussed earlier the changing health condition issues reflected in the increasing dominance of non-chronic diseases due in part to aging but also due to behavioral changes. We´ve also had some discussion in previous talks about issues related to micro nutrients, I think for certain populations that are not trivial in size there are major macro-nutrient issues as well: about 40% of children under five years of age are stunted in many countries in South Asia and Sub-Saharan Africa in particular. For individual children on average in these malnourished populations, the problem starts in the womb, with low birth weights and then typically deterioration compared to well-nourished populations until around 2 to 3 years of age, with some slight partial catchup in terms of stunting at older ages. In a series of slides, I quickly summarize the results of an INCAP randomized experiment with better (protein-dense) and less good (no proteins) nutritional supplements in 1969-1977 in Guatemala. We followed the children who were less than 7 years old at that time up into the 21st century, when they were 26-42-year-old adults. The intervention itself had important impacts, including increasing adult cognitive test scores and abilities (Raven's tests) by about a quarter of a standard deviation, male wage rates by over 40% and the birth weight of children borne by women by over 100 gms. The implications of reducing stunting or increasing height-for-age z scores at age 2 years also are multiple. For example, the estimates indicate that a one unit increase in the height-for-age z score increases schooling about one grade and moving a child from being stunted to not-stunted increases schooling by about 3.9 grades and reduces the probability of living in a household below the poverty line by about 0.33.

Ok, in my last minute, I present benefit-cost assessments of reducing stunting in heavily-burden countries under conservative assumptions about what those benefits are. We look at the cost in various societies as summarized in the slide. First notice that the costs vary a lot across societies, we then estimate benefit-cost ratios in selected high burden countries of reducing stunting, using an instrumental variable econometric procedure to try to take care of the estimation issues. The basic point again is that most of these are above 10. The Democratic Republic of Congo is 3.8. Pretty darn good, and all the rest are a lot better showing a substantially very large gains relative to costs.

3. Conclusion

Enormous changes have occurred in population quantity, quality and mobility in recent decades and are projected to continue in future decades. These changes interact and raise issues, but they also create some optimism about capacities for adaption in that median incomes, live expectancies, and schooling attainment all have increased substantially despite the largest population increase and by far the highest population growth rate the world has or is likely to experience. Nevertheless benefit-cost analyses suggest some high priority possibilities, as well as some that are not such high priority, for policies directed as population quantities, qualities and mobilities.

Economic Policies Imperatives for Inclusive Development in Africa

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Article

1. Introduction

There is stark evidence supporting the view that compared to the last two decades of the Twentieth Century, there has been growth renaissance in Africa since 2000. A look at Table 1 will show that there was growth collapse in Africa during the decades of the 1980s and 1990s. However, since the beginning of this Century, African growth has recovered approximating what it was in the first decade after independence.

Table 1: African Growth Performance, 1960-2013

	Average 1960-69	Average 1970-79	Average 1980-89	Average 1990-99	Average 2000-13
Total GDP	4.53	4.06	1.74	1.87	4.85
Per Capita GGP	2.00	1.30	-1.10	-0.85	2.12

Source: Underlying data obtained from WDI, 2014.

In addition, the current growth seems to be widespread among countries with at least 20 out of the 54 African countries registering average growth rate of over 5% between 2000 and 2013. What is more, the fast-growing countries include Ethiopia, (the fastest), Burkina Faso, Cape Verde, Malawi, Mauritania and Rwanda which are not among the celebrated resource rich African countries. See Table 2.

2. Features of Africa's Growth Renaissance

However, evidence also supports the view that the growth surge has not been stable as shown in Figure 1. In addition, Africa's growth has not been accompanied by economic diversification. With the exception of South Africa and Mauritius where the contributions of manufacturing to GDP are consistently in the double digits since 2000, outputs of other African countries are dominated by peasant agriculture and/or extractive industries. Accordingly, Africa's exports are dominated by crude agricultural and mining sector materials.

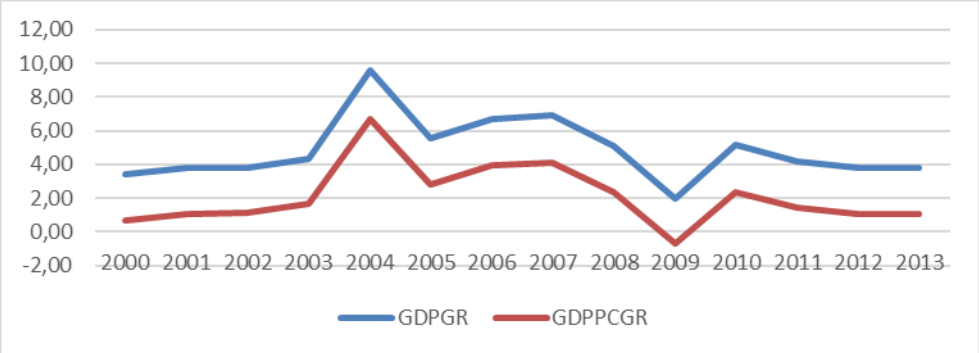

Fig. 1 Total and Per Capita GDP Growth Rates, 2000-2013.

Table 2: GDP Growth Rates Poverty headcount and Gini Index, 2000-2013

	Country	**Average GDP Growth**	**Poverty Headcount $1.25/day (Latest)**	**Poverty Headcount $2/day (Latest)**	**Gini Index (Latest)**
1	Algeria	3.13			
2	Angola*	**10.53**	43.37	67.42	50.65
3	Benin	3.91	47.33	75.32	38.62
4	Botswana	4.49	n.a.	n.a.	n.a.
5	Burkina Faso	**6.05**	44.60	72.56	39.70
6	Burundi	4.09	81.32	93.45	33.27
7	Cape Verde	**5.28**	21.02	40.85	n.a.
8	Cameroon	3.51	9.56	30.36	39.66
9	CAR	1.35	62.83	80.09	49.94
10	Chad	**8.83**	61.94	83.28	39.78
11	Comoros		46.11	64.98	64.3
12	Congo, DR.	**6.31**	87.72	95.15	44.43
13	Congo, Rep.	4.83	54.10	74.40	47.32
14	Cote d'Ivoire	2.71	23.75	46.34	44.95
15	Djibouti	4.55	18.84	41.20	39.96

16	Egypt, Arab Rep.	4.56	1.69	15.43	31.89
17	Eq. Guinea	**6.84**	n.a.	n.a.	n.a.
18	Eritrea	1.78	n.a.	n.a.	n.a.
19	Ethiopia	**11.01**	30.65	66.00	31.14
20	Gabon	3.45	4.84	19.59	41.45
21	Gambia, The	3.70	33.63	55.93	47.28
22	Ghana	**7.57**	28.59	51.84	42.76
23	Guinea	2.65	43.34	69.59	39.83
24	Guinea-Bissau	2.21	48.90	77.96	35.52
25	Kenya	4.81	43.37	67.21	47.68
26	Lesotho	4.55	43.41	62.25	52.5
27	Liberia	**9.58**	83.76	94.88	38.16
28	Libya	**7.01**	n.a.	n.a.	n.a.
29	Madagascar	2.94	81.29	92.62	46.27
30	Malawi	5.44	61.64	82.31	41.47
31	Mali	4.09	50.43	78.66	37.34
32	Mauritania	5.95	23.43	47.69	40.25
33	Mauritius	3.97	n.a.	n.a.	n.a.
34	Morocco	4.43	2.52	14.03	40.76
35	Mozambique	**7.30**	59.58	81.77	46.39
36	Namibia	**5.33**	31.91	51.10	63.9
37	Niger	4.78	43.62	75.23	39.22
38	Nigeria	**8.78**	67.98	84.49	45.88
29	Rwanda	**7.52**	63.17	82.37	n.a.
40	Sao Tome &Principe	**5.14**	28.18	54.20	50.82
41	Senegal	3.88	29.61	55.22	40.25
42	Seychelles	4.02	0.25	1.84	54.25
43	Sierra Leone	**7.98**	51.71	79.56	38.94
44	Somalia	n.a.	n.a.	n.a.	n.a.
45	South Africa	3.42	13.77	31.33	62.77
46	South Sudan	-2.36	n.a.	n.a.	45.53
47	Sudan	2.33	19.80	44.14	35.29
48	Swaziland	2.17	40.63	60.40	51.09
49	Tanzania	**6.99**	67.87	87.87	36.1
50	Togo	3.53	28.22	52.65	36.85
51	Tunisia	3.99	1.06	4.25	39.43
52	Uganda	**7.00**	38.01	64.74	44.23
53	Zambia	**6.33**	74.45	86.64	51.24
54	Zimbabwe	0.01	n.a.	n.a.	n.a.

Source: World Bank (2014) World Development Indicators, September.

Table 2 also shows that the African growth renaissance has not been accompanied by poverty reduction in overwhelming majority of the countries while inequality is quite high in very many countries. Correspondingly, Figure 2 shows that unemployment rates in Sub-Saharan Africa and North Africa are higher than in Asia; Figure

3 reveals that the proportion of vulnerable employment is highest in Africa and the proportion of working poor is higher--- in Africa than in Asia as shown in Figure 4.

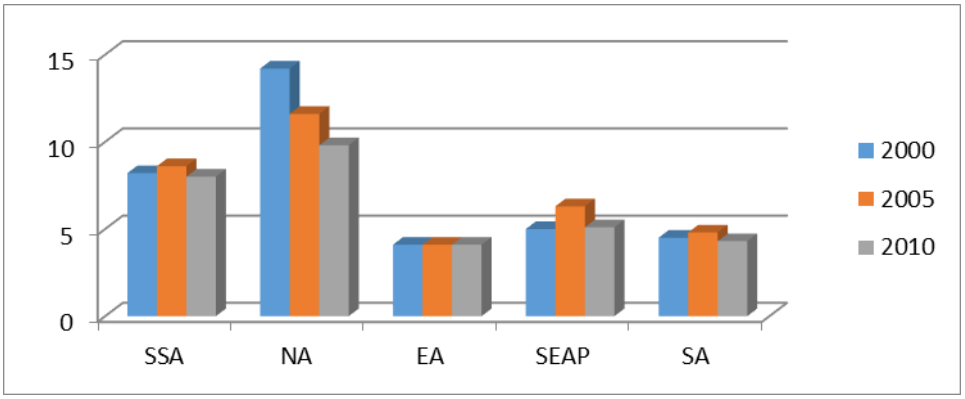

Fig. 2: Unemployment Rates, Africa and Asia, 2000-2010. Source: ILO (various years) Global Employment Trends.

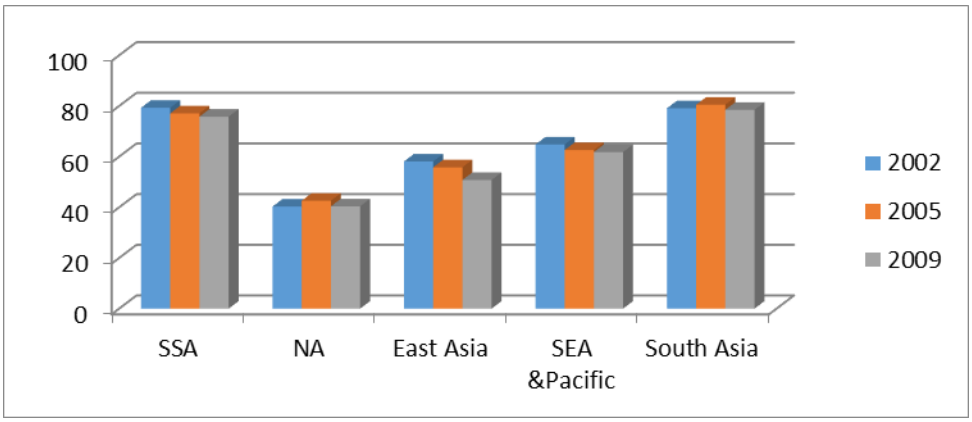

Fig. 3: Vulnerable Employment Shares, Africa & Asia, 2000-2009. Source: ILO (various years) Global Employment Trends.

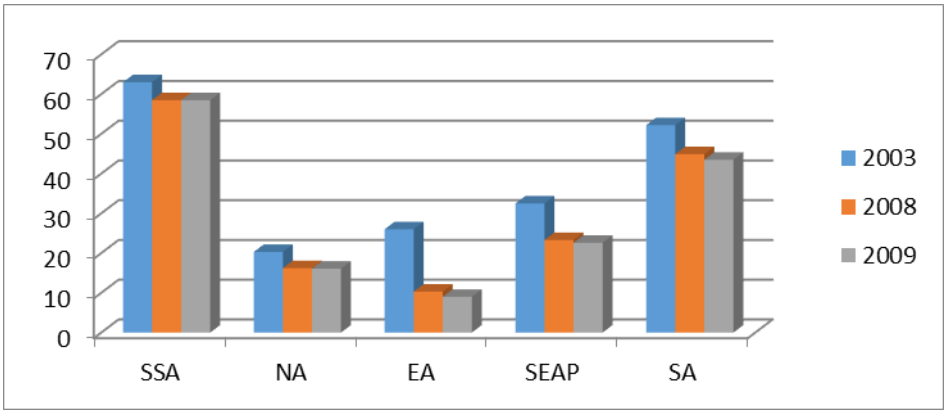

Fig. 4: Working Poor $1.25/day Share in Total, Africa & Asia, 2000-2009. Source: ILO (various years) Global Employment Trends.

The upshot of the foregoing is that although there has been growth renaissance in Africa since 2000, the growth has not been accompanied by structural transformation. The contributions of peasant agriculture, enclave mining activities and low productivity services in GDP of majority of African countries are very large making the growth susceptible to myriads of shocks. These features of African growth renaissance along with the relatively high unemployment rate, preponderance of vulnerable employment and working poor corroborates the view of analysts that Africa's growth has not been inclusive. See Ajakaiye (2014), Ajakaiye and Jerome (2014a) Ajakaiye and Jerome (2014b) for further discussion.

3. Policy Imperatives

Africa is made up of 54 countries at different stages of development. Therefore, one-size-fits-all policies should not be recommended. That said, drawing on the inspirations of Africa's Agenda 2063, the Common African Position on Post-2015 Development Agenda and the evolving orientation of the Global Sustainable Development Goals (AUC, 2014a, 2014b), it will be imperative for all African countries regardless of their level of development to correct the weaknesses of Africa's growth renaissance especially the paradox of growth with deepening poverty and high inequality. To this end, policies must be designed to pursue the basic goals of:

- Sustaining and significantly increasing the growth rates from the current single digit to double digit (like Ethiopia) over the next decade, at least;

- Diversifying the economic base by:
  - Reducing the dominance of peasant agriculture, enclave extractive activities and low productivity informal services activities and;
  - Increasing the contribution of manufacturing and modern sophisticated services to GDP from the current single digit to at least 25% within the medium to long-term while ensuring minimal damage to the environment, if any.

Pre-requisites for the pursuit of these goals should include:

- Political commitment of the leadership to maximizing welfare of the people;

- Creation and maintenance of a competent and highly motivated meritocratic bureaucracy with the ability and necessary authority to carry out all development policy activities including formulating sound development policies and programs in a participatory manner and vigorously and pragmatically implementing them;

- Strategic and pragmatic state intervention aimed at:
  - Investing in people, science and technology;
  - Investing in social, institutional and economic infrastructure and;
  - Efficiently and effectively nurturing, supporting and promoting development of world class indigenous private sector operators, organizations and institutions able and ready to partner with their foreign counterparts to their mutual benefits and complementary to national development agenda.

- A realization that the pragmatic choice is not between the state and market but between different combinations of public and private institutions by the state in delivering sustainable and equitable development to the people;

- Avoidance of capture and rent seeking behavior as well as readiness to adjust policies quickly once credible and convincing evidence shows that certain strategies and policies are no longer applicable in light of emerging circumstances;

- Every agent should subscribe to the view that the society is a corporate entity jointly owned by all and for which all must work in concert in pursuit of shared inclusive development in an environment of mutual trust, respect and sincerity of purpose.

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Building Equity through Social Sciences and Economic Policies: The Brazilian Experience

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Lycia Lima (Fundação Getulio Vargas - SP)
Ricardo Paes de Barros (Insper - SP)
Article

1. Introduction

In the beginning of the 2000s, Brazil has experienced a decade of economic and social progress, characterized by sustained economic growth and a sharp reduction in poverty alongside with a decrease in income inequality.

This paper aims to place in context these developments, focusing specifically on the evolution of poverty and inequality trends, their immediate determinants and the role of the labor market in this process. This paper also presents a few imminent challenges faced by Brazil that endanger the country´s ability to sustain the trajectory of pro-poor economic growth.

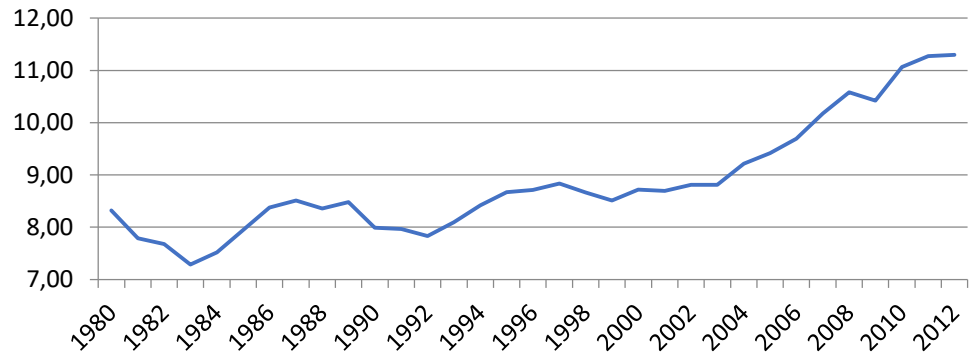
2. Economic Growth, Poverty and Inequality

2.1. The stylized facts on growth, poverty and inequality in Brazil

Stylized fact 1: Economic Growth

The path of growth of the Brazilian Economy since 1960s can be characterized by 4 distinct periods, each displaying a very clear trend in terms of economic growth. During the 1960s and 1970s, Brazil's real GDP grew at impressive rates. With the 1982 debt crisis, Brazil´s growth performance deteriorated remarkably, undergoing almost 20 years of economic stagnation. Around the year 2000, the Brazilian economy started recovering, growing steadily until around 2011. However, from 2012 onwards, the economy started slowing down again, registering very low growth rates between 2012 and 2014.

Fig. 1: Per Capita GDP (2013 US$ Thousands) - Brazil

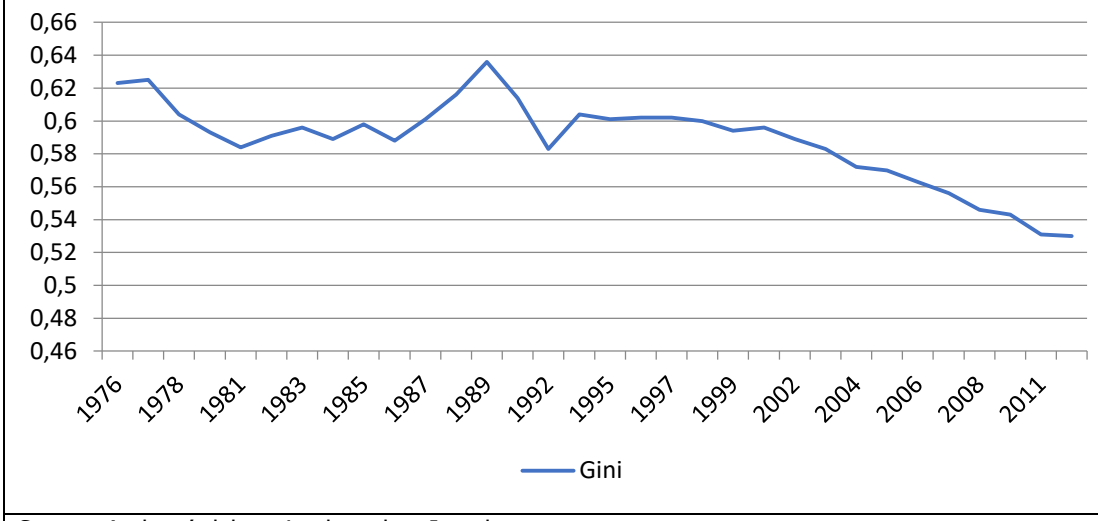


Source: Authors' elaboration based on Ipeadata.

Stylized fact 2: Income Inequality

The growth performance in Brazil from 2000 onwards was associated with a sharp reduction in income inequality, as pictured in Figure 2, which displays a historical series for the Gini coefficient in Brazil. Income inequality has experienced fluctuations between 1976 and 1993, remained relatively stable between 1993 and 2000, and declined steadily from 2000 to 2014.

Fig. 2: Evolution of Income Inequality in Brazil: Gini Coefficient

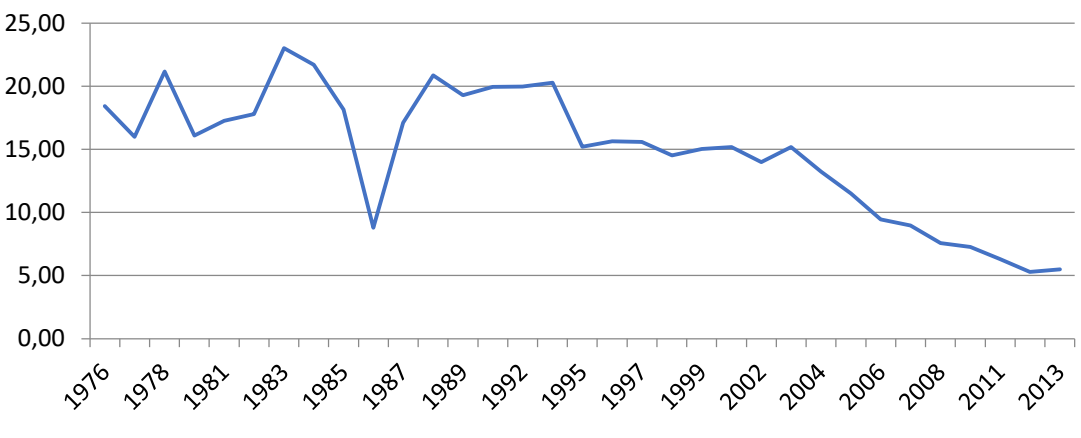


Source: Authors' elaboration based on Ipeadata.

Stylized fact 3: Poverty

Alongside with income inequality reduction, Brazil has also been very successful in reducing poverty. Poverty rates in Brazil, after a lot of volatility in the 1980s, have rapidly declined from 2000 onwards, dropping after the Real plan from around 20 percent in 1993 to around 15 percent in 2000, reaching approximately 5 percent in 2013.

Fig. 3: Absolute Poverty Headcount Ratio in Brazil

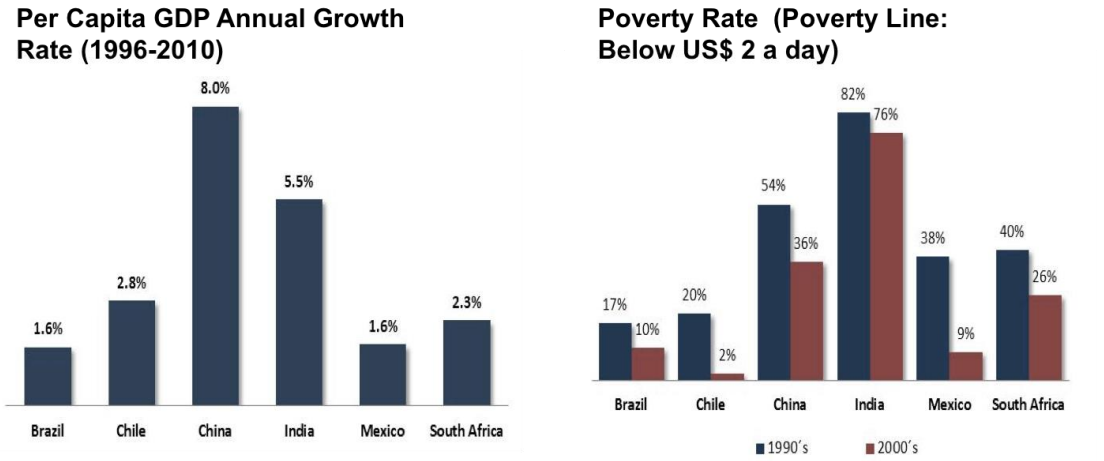


Source: Authors' elaboration based on Ipeadata.

2.2 Does Economic Growth lead to Poverty and Inequality Reduction?

Brazil has experienced sustained economic growth jointly with a reduction in poverty and inequality. The link between growth and poverty reduction is not unusual. Figure 4 illustrates that a sizeable number of developing countries, including China, India and Mexico, have recently experienced relatively sustained economic growth with part of the benefits accrued towards their lower income earners.

Fig. 4: Growth and Poverty in Selected Developing Countries



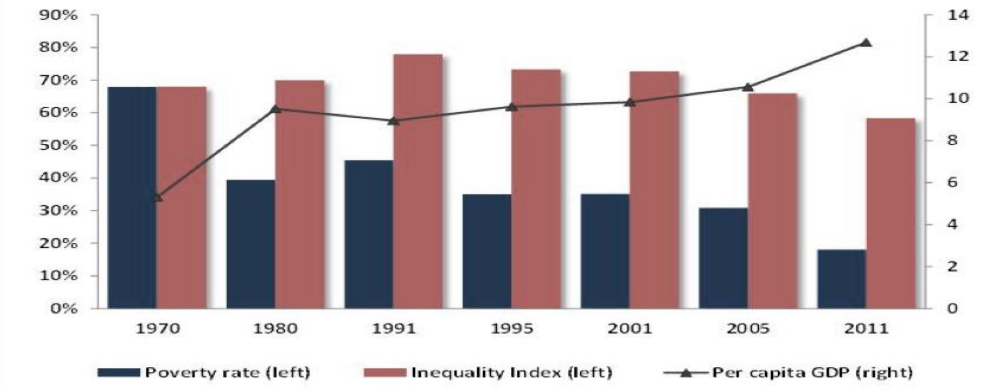
Source: Penn World Tables

Source: World Bank

Source: Authors' elaboration based on Ipeadata.

However, the link between economic growth and inequality is not so straightforward. Brazil, for instance, has experienced between the 1970s and 1980s economic growth coupled with poverty reduction and inequality increase (Figure 5). The novelty is that, in the 2000s, there are concomitant movements in Brazil of higher economic growth and faster decrease in both poverty and inequality.

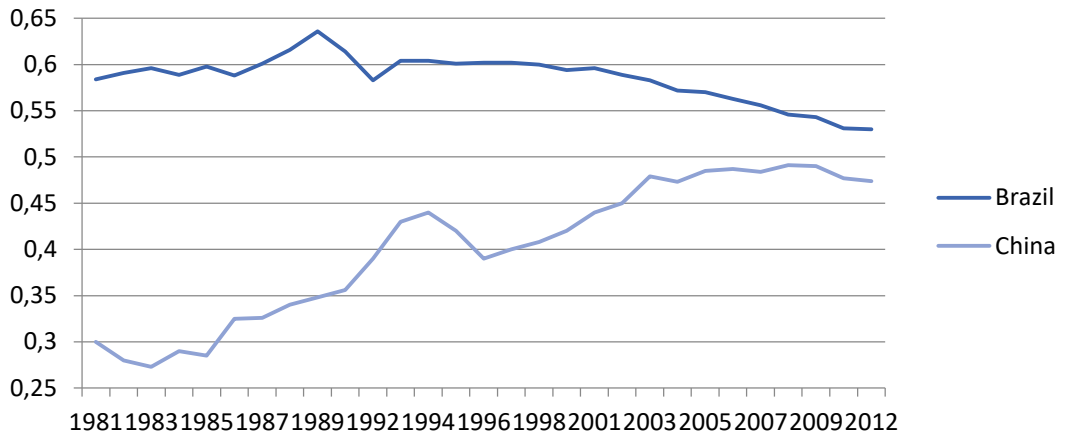
Fig. 5: Evolution of Growth, Poverty and Inequality in Brazil



Source: Authors' elaboration based on Ipeadata.

Figure 6 contrasts the evolution of the degree in inequality in Brazil and China, two countries that have experienced sustained economic growth and poverty reduction in the 2000s. Unlike in Brazil, economic growth in China has been accompanied by an increase in income inequality, similar to the previous path of Brazil in the 1970s.

Fig. 6: Evolution of the Gini Index: Brazil and China: 1981 - 2011

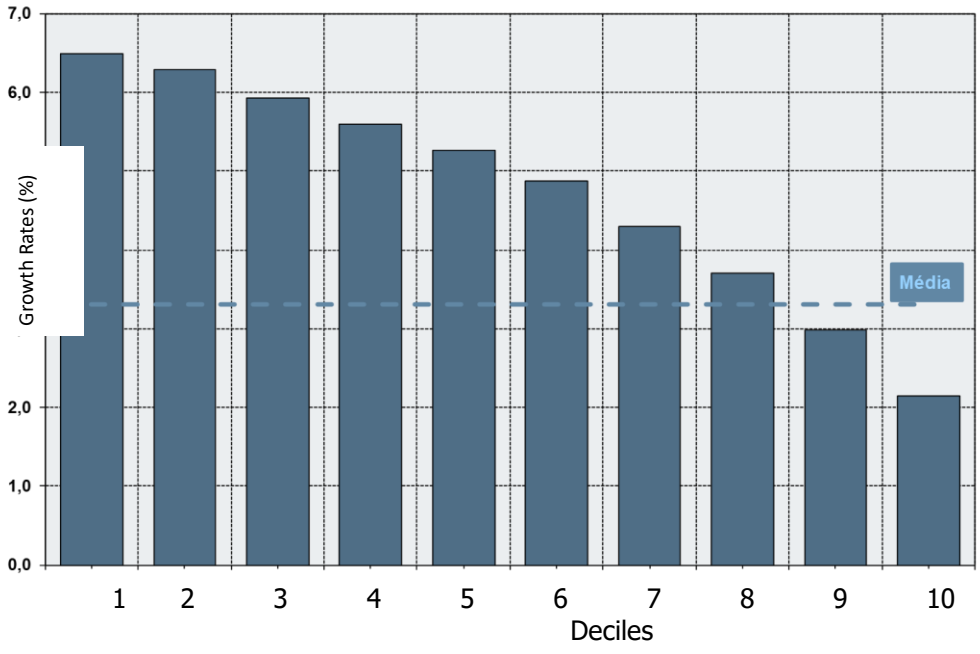


Source: Authors' elaboration based on data from Ipea, World Bank, Chinese National Bureau of Statistics.

Brazil has been successfully reducing inequality because the income of its poorest individuals (lowest deciles of income distribution) is growing at a much faster pace than the income of its richer individuals (highest deciles of income distribution), which is the recipe for promoting both poverty and inequality reduction.

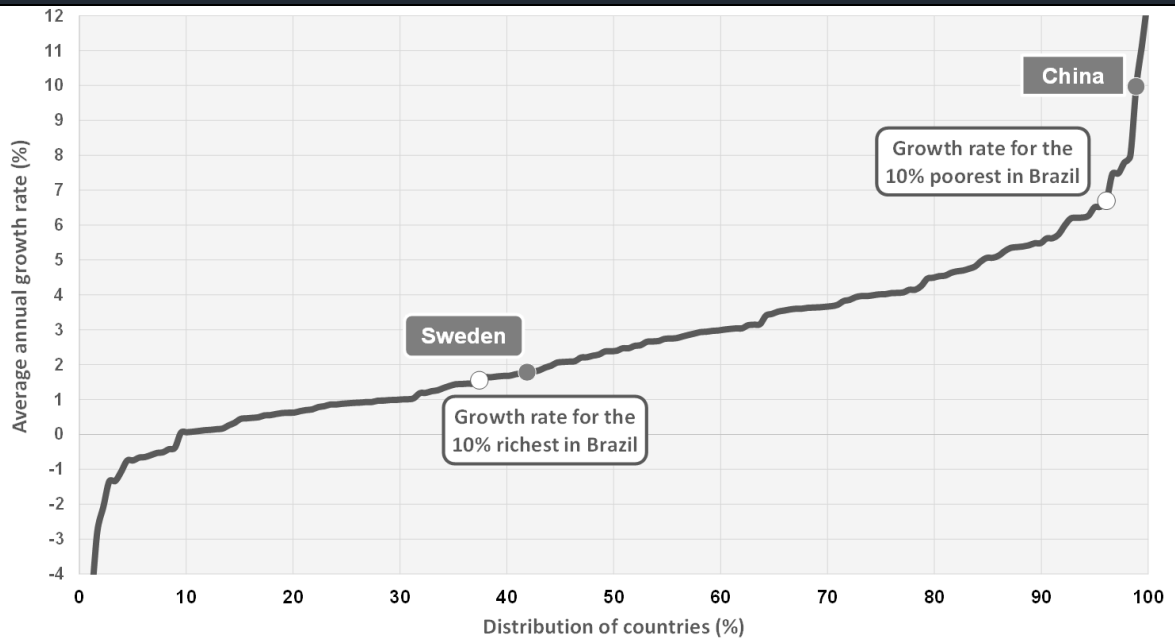
The average annual growth of income in the first decile of income distribution between 2001 and 2013 was around 6.5 percent, nearly three times higher than the average annual growth of income in the highest decile, which was around 2.2 percent (Figure 7). Nevertheless, everyone in Brazil is benefiting from economic growth, the income of the 10 percent richest individuals is growing at a pace similar to the economic growth in Sweden, while the income of the poorest ten percent in Brazil is growing at an impressive rate similar to that in China (Figure 8), resulting in a reduction of the disparities between the rich and the poor in Brazil.

Fig. 7: Annual Growth Rate by Income Deciles – Brazil 2001 to 2013



Source: Authors' elaboration based on Pnad.

Fig. 8: Average Annual Growth Rate: Sweden, China and Brazil – 2001-2011



Source: Authors' elaboration based on World Bank data.

2.3. The Rise of the Brazilian Middle Class

Because of the phenomena above presented, there is a growing concentration of the population around the middle of the income distribution, producing an increase of the Brazilian middle class. In this paper, we use the definition of middle class adopted by the Secretariat of Strategic Affairs of the Presidency of the Republic of Brazil, displayed in Figure 9.

Fig. 9: Criteria for Classification of Class by Income Levels (per capita family income)

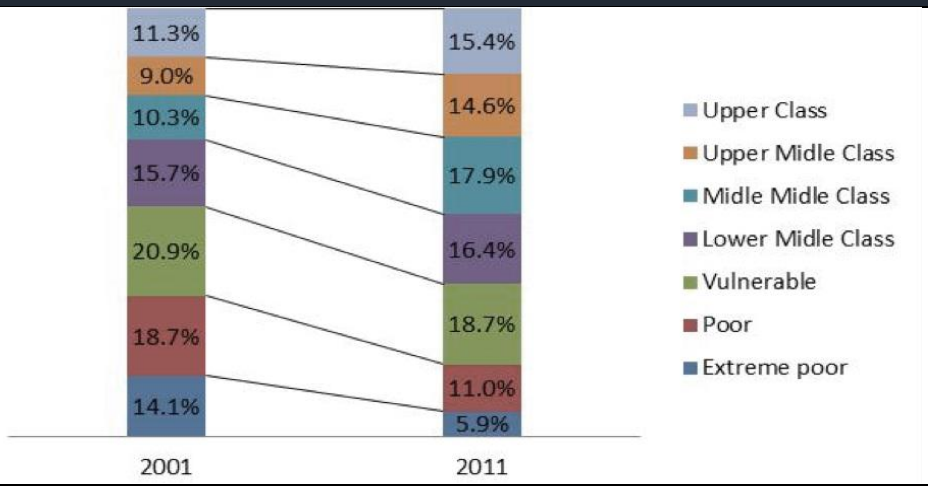
High Income	•Upper class: more than R$1,145
Middle Income	•Upper Middle Class: from R$720 to R$1,145 •Middle middle Class: from R$496 to R$720 •Lowe Middle Class: from R$327 to R$496
Low Income	•Vulnerable: from R$ 182 to R$327 •Poor: from R$ 91 to R$ 182 •Extreme Poor: up to R$ 91

Source: Secretary of Strategic Affairs of the Presidency of the Republic of Brazil
(cut offs are in monthly R$ from 2011).

Figure 10 presents the evolution of the share of Brazilian population by income class. The share of the extreme poor Brazilian population declined from 14.1 to 5.9 percent. The middle-class share has grown from 35 to 49 percent and meanwhile the low-income share fell from 54 to 36 percent. To shed light on the recent income dynamics, two decomposition exercises[3], presented in the next session, are made to understand the factors associated with this decrease in poverty.

[3] This paper will present the intuition and results of the decomposition exercises, as the technical details are beyond the scope of this paper.

Fig. 10: Share of Brazilian Population by Income Class: 2001-2011

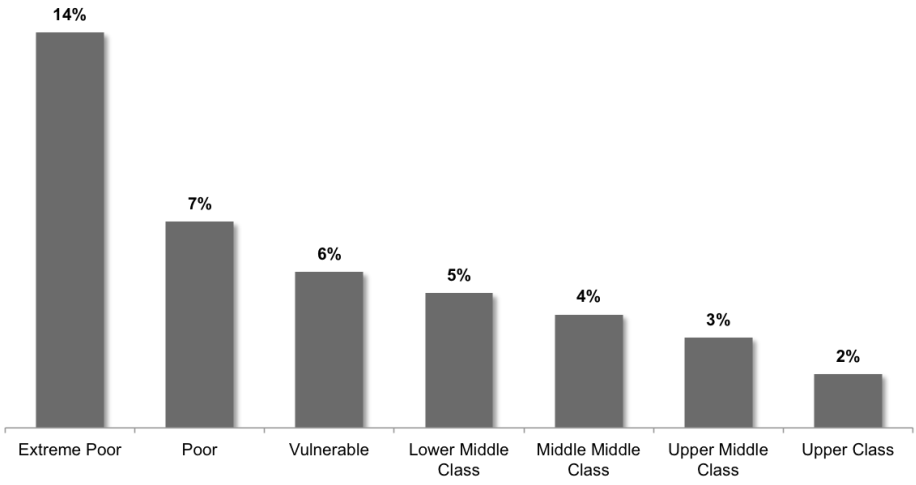


Source: Authors´ elaboration based on PNAD.

3. The Immediate Determinants of Poverty and Inequality Changes

Figure 11 displays the annual growth rate of the average per capita family income for the different categories of income class previously presented. The extreme poor families´ income has grown at around 14 percent, in contrast with 2 percent growth of the upper class´ income.

Fig. 11: Annual Growth Rate of the Average Family per capita Income



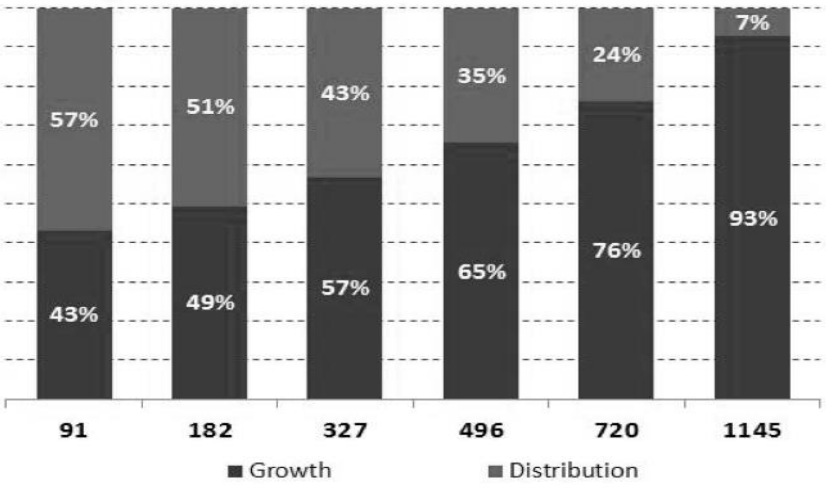
Source: Authors´ elaboration based on Pnad.

When families increase their income, they move up the income class distribution, for instance, from poor to vulnerable, or from vulnerable to lower middle income. A change in the poverty rate is a change in the population share in the lower income classes. This movement may be explained by two distinct components: i) economic growth and ii) income redistribution.

Two decomposition exercises were carried out in order to understand how much the change in the poverty rate was associated with economic growth and how much was due to the redistribution of income. Figure 12 shows the results of the first decomposition exercise. For the poor (cutoff 182), nearly half of the poverty reduction was due to the growth of the economy and the other half was due to the redistribution component. For the

extreme poor (cutoff 91), an even larger share of the reduction in poverty can be explained by the redistribution component, 57 percent, against 43 percent due to economic growth. As displayed in figure 11, the relative importance of the growth component increases as the income cut-off levels increases.

Fig. 12: Decomposition Exercise: Percentage of Poverty Reduction Explained by Growth and Distribution



Source: Authors´ elaboration.

These results have a very straightforward interpretation. If there had been only economic growth and no redistribution policies, poverty (cutoff 182) would have decreased only by half of the total observed decline. The combination of economic growth with redistribution policies was the key for the sharp reduction of poverty observed in Brazil.

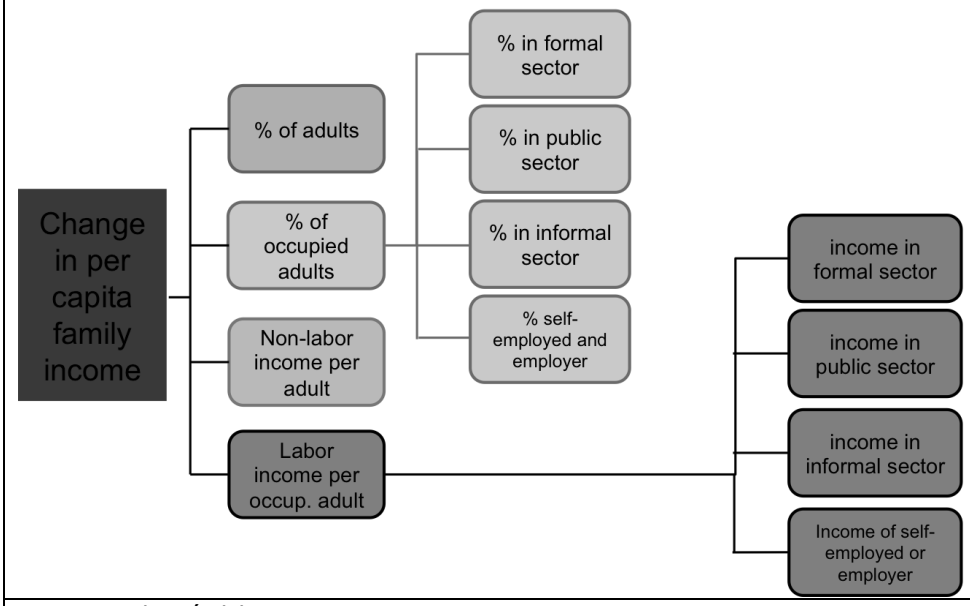
The second decomposition exercise and its results are illustrated in Figures 12 and 13. A family per capita income can be decomposed according to the following equation:

$$y = ar = a(o + t) = a(o + uw)$$

Where:
y is per capita income
a is the proportion of adults in the family
r is the mean income of adults in the family
o is non-labor income
t and labor income
u is the proportion of occupied adults
w is the labor income per occupied adult

Labor income per occupied adult may be further decomposed in occupation and income factors, as displayed in Figure 13.

Fig. 13: Per capita Family Income Decomposition



Source: Authors´ elaboration.

The results in Figure 14 show that the decline in poverty (for the income groups extreme poor, poor and vulnerable) was mainly due to the increase in labor income per occupied adult and non-labor income per adult.

While the labor income growth of the extreme poor was associated with labor income increase in the informal and self-employed sectors, for the poor and vulnerable groups the labor income growth was associated with labor income growth in the private sector. The growth in non-labor income, particularly pronounced for the poorest groups, was associated with the redistribution policies undertaken in the period.

In a nutshell, the rise of the middle class in Brazil observed in the recent past was mostly due to the economic growth of the period which was translated into labor income growth. The increase in labor income is mainly by the growth of occupation and income in the private sector. Therefore, the upsurge of the middle class in Brazil in inextricably linked to the expansion of the formalization of labor relations, which reached mainly the younger more educated individuals, as shown in Figure 15.

Fig. 14: Results of per capita Family Income Decomposition

Factor Contribution to Income Change by Income Groups

	Extreme Poor	Poor	Vulnerable	Lower Middle	Middle Middle	Upper Middle	Upper Class
Percentage of Adults	3%	10%	14%	17%	21%	27%	20%
Non-Labor Income per Adult	41%	28%	19%	12%	7%	3%	2%
Percantage of Adults Occupied	-7%	-15%	-14%	5%	34%	53%	48%
Labor Income per Occupied Adult	62%	77%	81%	66%	39%	17%	30%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**

Occupation Factor

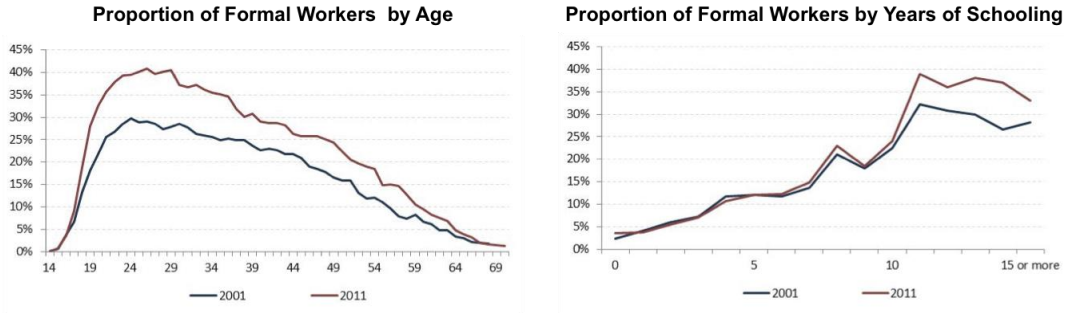
	Extreme Poor	Poor	Vulnerable	Lower Middle	Middle Middle	Upper Middle	Upper Class
Private Sector	0%	29%	-70%	10%	72%	107%	8%
Public Sector	0%	0%	-1%	0%	0%	-15%	17%
Informal Sector	0%	-25%	46%	-4%	-19%	-19%	-4%
Employer or Self-Employed	-7%	-19%	12%	-2%	-19%	-20%	27%
Total	**-7%**	**-15%**	**-14%**	**5%**	**34%**	**53%**	**48%**

Income Factor

	Extreme Poor	Poor	Vulnerable	Lower Middle	Middle Middle	Upper Middle	Upper Class
Private Sector	13%	20%	24%	20%	11%	5%	8%
Public Sector	12%	18%	19%	15%	9%	4%	8%
Informal Sector	17%	19%	19%	15%	9%	4%	7%
Employer or Self-Employed	20%	19%	19%	16%	9%	4%	7%
Total	**62%**	**77%**	**81%**	**66%**	**39%**	**17%**	**30%**

Source: Authors´ elaboration.

Fig. 15: Results of per capita Family Income Decomposition

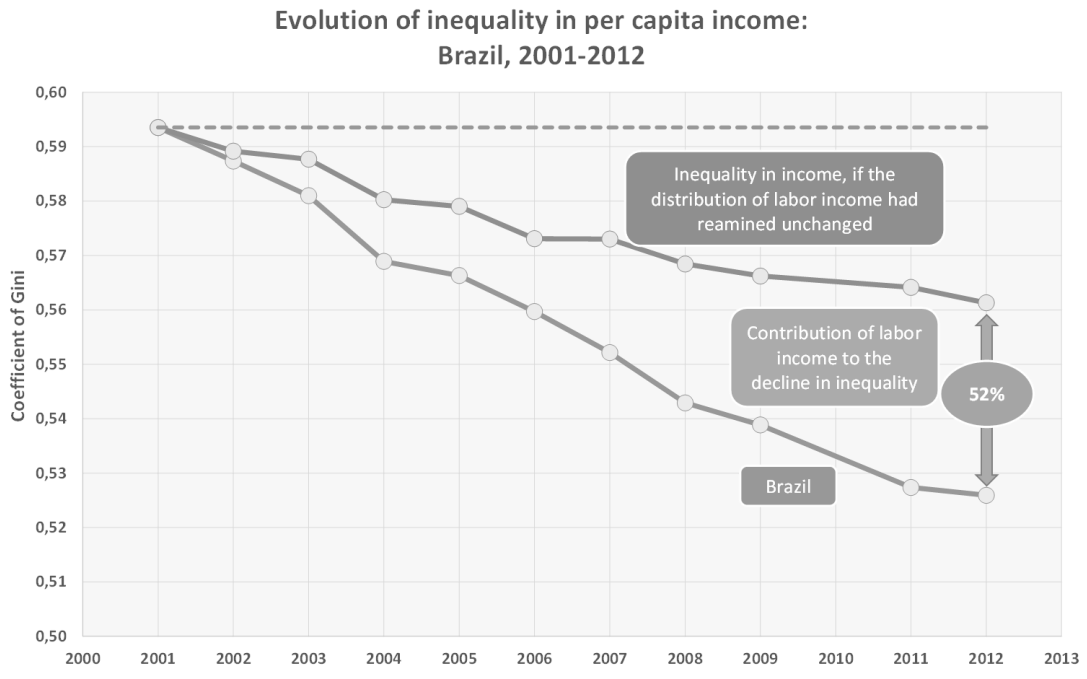


Source: Authors´ elaboration.

4. The Role of the Labor Market

The labor market had a very important role to play in the decline of income inequality. An additional decomposition exercise of the Gini Coefficient (figure 16) shows that, if the distribution of labor income had remained unchanged, Brazil would have been substantially less successful and would have reduced inequality only by half of the total actual reduction in the Gini Coefficient.

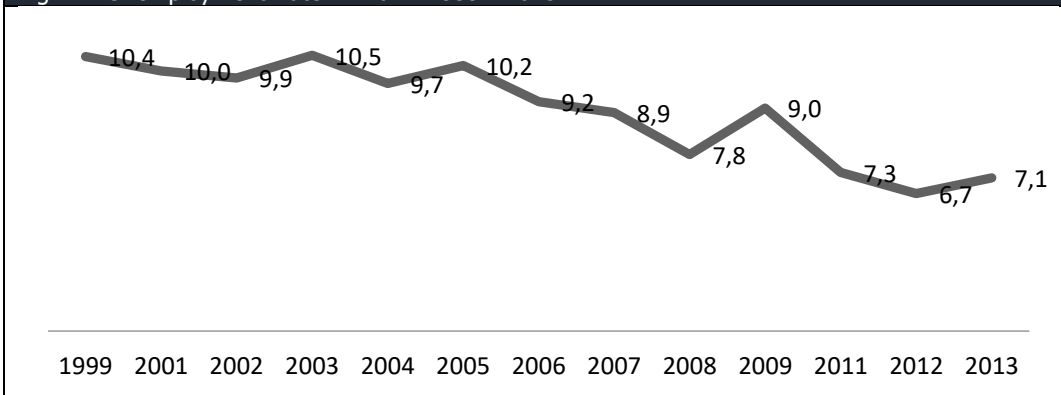
Fig. 16: Gini Coefficient Decomposition



Source: Authors´ elaboration

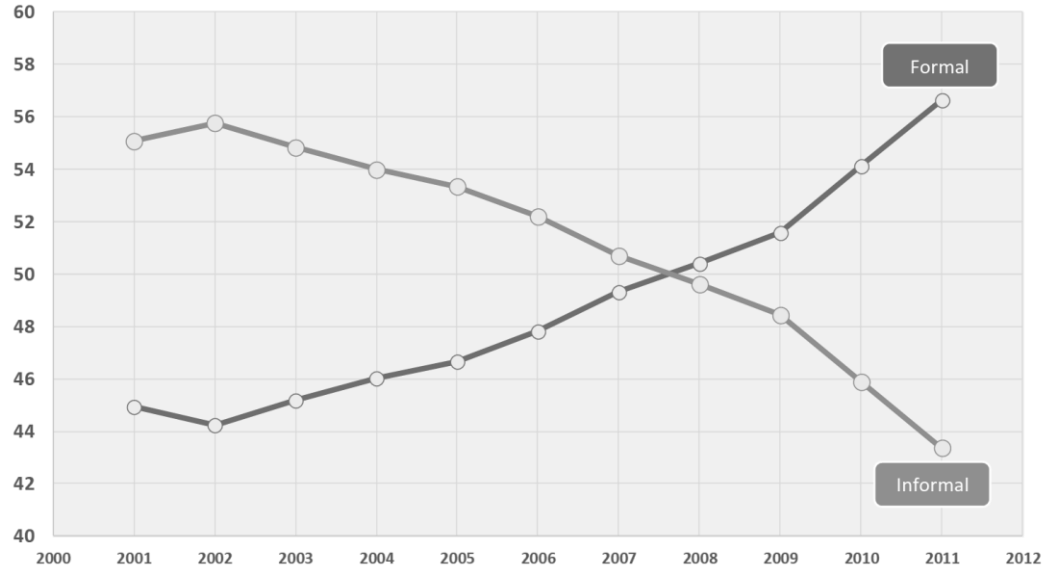
Not only changes in the distribution of labor income were important for the reduction in inequality, but also the variations occurred in unemployment and formalization of the Brazilian labor force. Figures 17 and 18 show that unemployment was reduced from around 10 percent in 2000 to around 7 percent in 2013, with a sharp increase of the formal and decline of the informal jobs.

Fig. 17: Unemployment Rate in Brazil: 1999 - 2013



Source: Authors´ elaboration based on PNAD/IBGE.

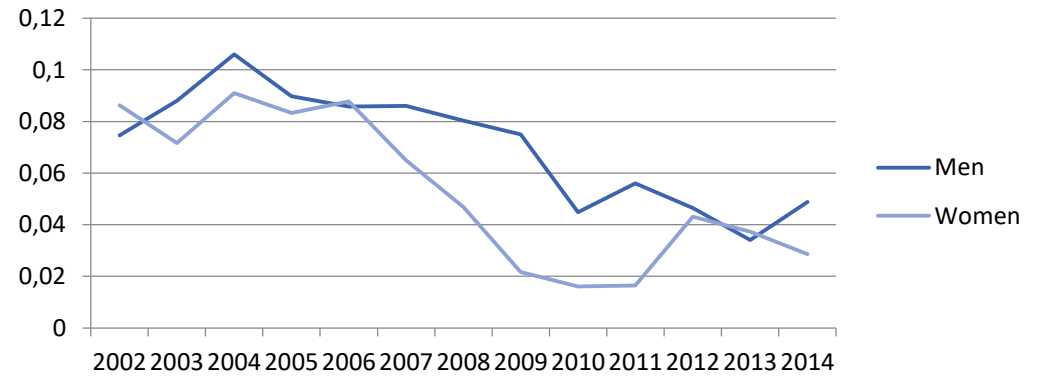
Fig. 18: Evolution of Formalization in Brazilian Labor Force: 2001-2011



Source: Authors´ elaboration based on PNAD/IBGE.

Interestingly, alongside with this trend, the formal informal wage gap has been declining in Brazil. In 2002, women in the formal sector had around 50 percent higher wages than women in the informal sector. This figure has gone down to 7 percent in 2014. Similar trend is observed for the male population, as pictured in figure 19.

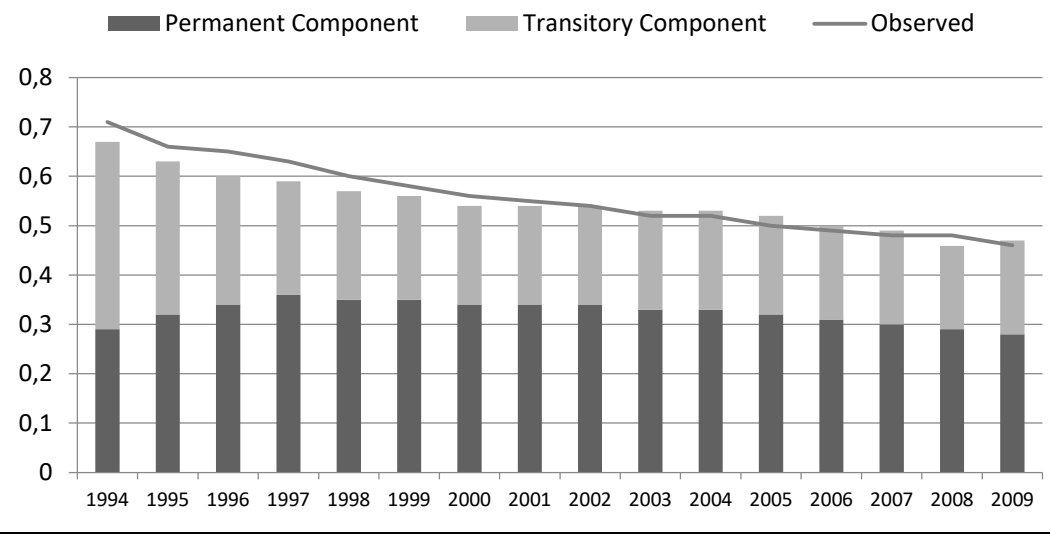
Fig. 19: Formal and Informal Wage Gap: Metropolitan Regions (log points)



Source: Authors´ elaboration.

Another interesting analysis related to the labor market can be drawn from an exercise that decomposes the variance of log earnings - which is a measure of inequality of labor earnings - in two components: i) the permanent component and ii) the transitory component, as displayed in figure 20.

Fig. 20: Decomposition of the Variance of Log-Earnings



Source: Authors´ elaboration.

The intuition behind this decomposition is that income may differ among two people for both permanent and/or transitory reasons. In other words, income variation between two individuals may be either because they have different permanent attributes, such as education and discipline, or it may be because they face different shocks in time, such as losing a job eventually or getting ill.

In Brazil, during the first years of 1990s which were characterized by economic volatility, the transitory component was able to explain most of the variation in earnings. As the economy became more stable, the permanent component became more important over time. Table 1 presents this evidence more explicitly. Between 1994 and 1997, the variance decreased by 11 percent, totally explained by the transitory component and probably due to macroeconomic stabilization. Between 1998 and 2009, the variance decrease was 16,9 percent, mostly driven by the permanent component, which was associated with the reduction in inequality.

Table 1: Contributions of transitory and permanent components

Period	Variance Decrease	Contribution of the permanent component	Contribution of the transitory component
1994 to 1997	11,22 percent	-95,10 percent	195,10 percent
1998 to 2009	16,90 percent	74,96 percent	25,04 percent

5. Challenges

The scenario in Brazil from the findings presented above indicate the country has been drawing up a successful trajectory with economic growth, poverty and inequality reduction. There are, however, some challenges in order to maintain a positive scenario for the future.

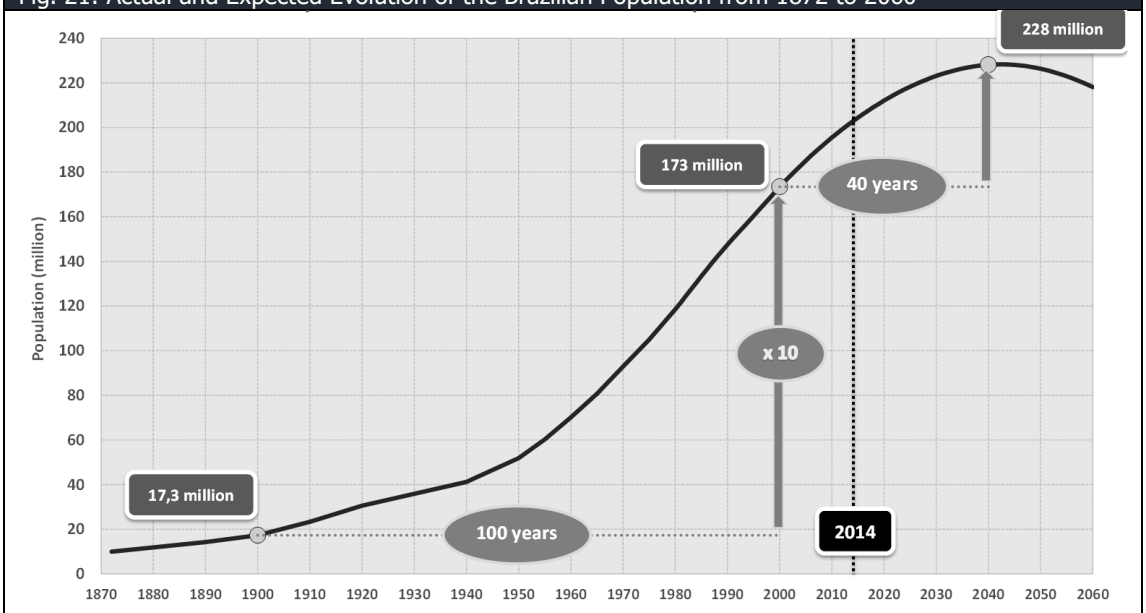
5.1. Brazilian Population is Aging

Population in Brazil has grown from around 17 million in the 1900s to around 200 million in 2014, as pictured in figure 21. This growth is a result of the evolution of the natural growth rate (figure 22), derived from the difference between the birth and death rates.

A sharp increase was also observed in the life expectancy between 1940 and 2014, from 40 to 75 years old, mainly driven by the decrease in the infant mortality rate, as illustrated in figure 23. Fertility has also declined substantially from around 6 births per woman in 1965 to less than 2 births per woman in 2014.

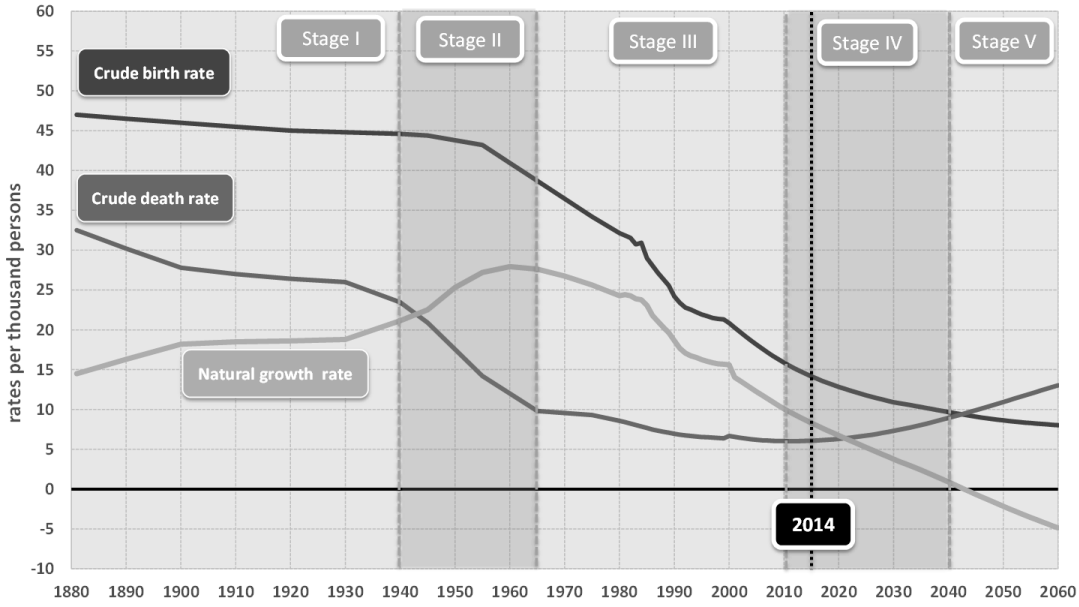
The result of these three trends is that Brazilian population is aging. And it is aging at a very fast pace.

Fig. 21: Actual and Expected Evolution of the Brazilian Population from 1872 to 2060



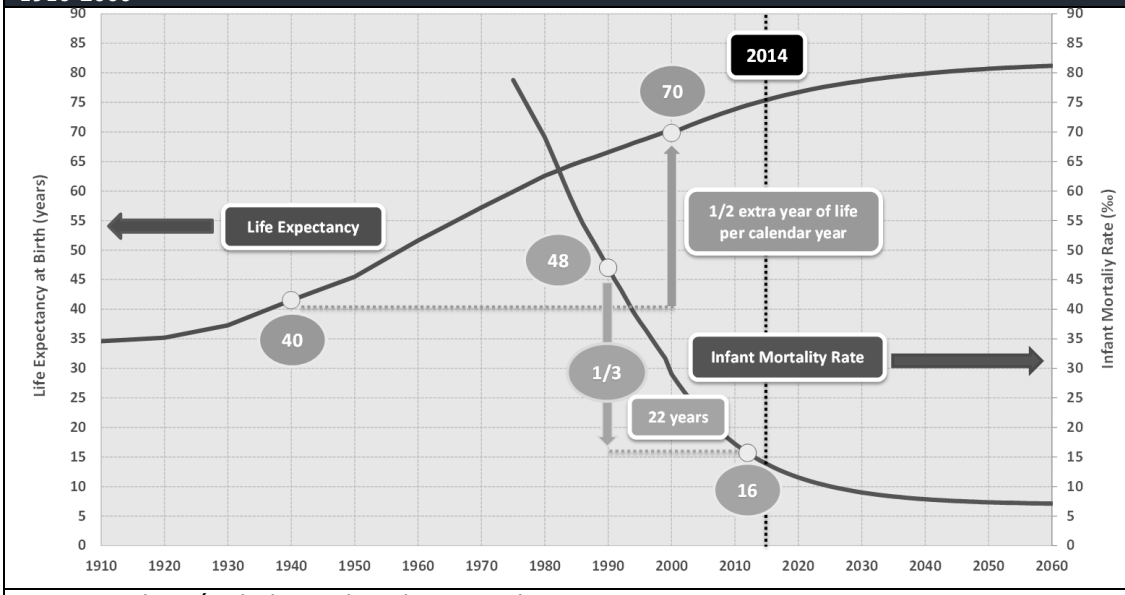
Source: Authors ´ calculations based on IBGE data.

Fig. 22: Brazilian Population Dynamics: 1880-2060



Source: Authors ´ calculations based on IBGE data.

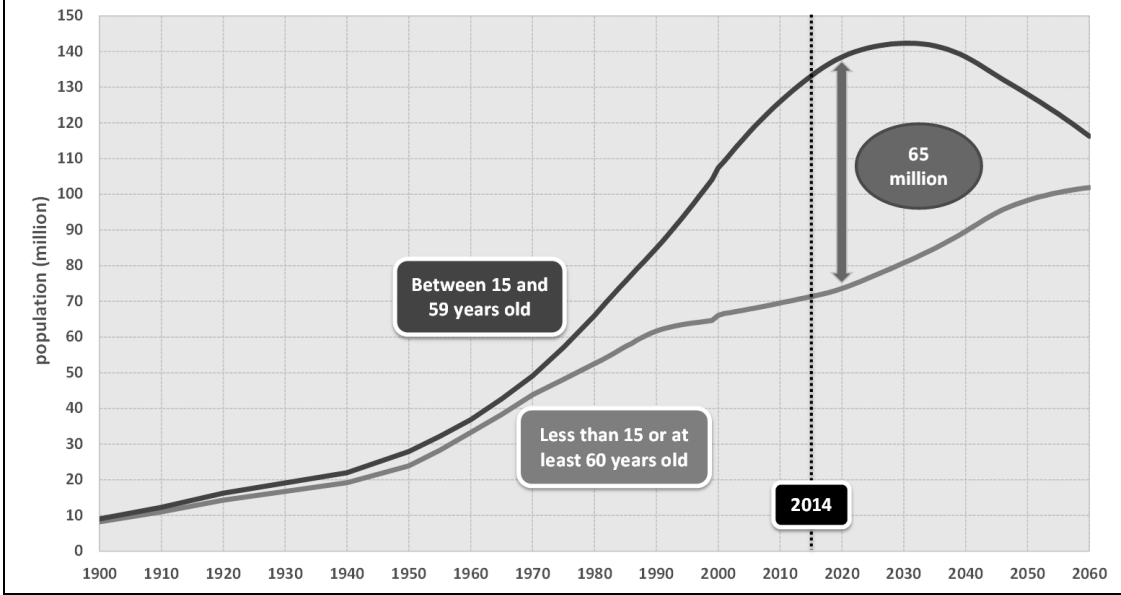
Fig. 23: Actual and Predicted Evolution of Life Expectancy at Birth and Infant Mortality Rate in Brazil: 1910-2060



Source: Authors ´ calculations based on IBGE data

The demographic dynamics observed in Brazil is particularly interesting when compared to a larger sample of countries. Brazil has taken less than 20 years to reduce fertility rate from 3 to 2 and around 50 years to increase life expectancy from 50 to 70 years old. In a comparison based on a sample of 18 countries done by World Bank (2011), including several Asian, Latin American and European countries, the only country that has reached the same figures in less time than Brazil was Korea. Figure 24 shows where Brazil stands in terms of the evolution of its age groups. When looking at the gap between the economic active population (between 15 and 59 years old) and the dependent population (less than 15 and older than 60), it is easy to see that the year 2014 is characterized by the largest disparities between these two groups. In other words, in 2014, the economic active age group had around 65 million more individuals than the dependent group. Given the fertility and life expectancy trends previously presented, the Brazilian population is aging, and hence in the near future this gap will shrink substantially, which poses serious threats to the future sustainability of the Brazilian social security and social protection systems.

Fig. 24: Evolution of the Brazilian Population by Age Groups: 1900-2060



Source: Authors´ calculations based on IBGE data.

Currently, 12 percent of the Brazilian GDP is spent in social security and pensions. Given the demographic dynamics the country is facing, the number of elderlies is growing fast and, with the existing design of the country´s social security system, the share of the GDP to be spent in pensions will grow sharply. Therefore, not surprisingly, the upcoming exponential increase in social security costs is a serious challenge to be addressed in Brazil and raises the important and urgent issue of reforming the social security system.

Another potential solution, in addition to reforming the social security system, is considering the potential benefits of international migration. Brazil was once an open country to immigrants, as in 1900s around 7.3 percent of the population was composed of foreigners. In 2010, however, foreigners only accounted for 0.3 percent of the Brazilian population. As Brazil has moved from a relatively open country to immigrants to a relatively closed one, it is not surprising that the immigrant population in Brazil is also aging. Figure 25 shows that, in 2009, approximately 36 percent of immigrants in Brazil were over 65 years old, an extremely high figure when compared to other regions in the World.

Fig. 25: Age Structure of Immigrants in Brazil and in the World

Region	Immigrants (millions)	Immigrants over 65 years old (millions)	Immigrants over 65 years of age as a percentage of the immigrant population
World	214	24,7	12
Africa	19	0,8	4
Asia	61	6,3	10
Europe	70	9,7	14
North America	50	5,9	12
Latin Amerrica and Caribbean	7	0,9	13
Oceania	6	1,1	18
Brazil	0,6	0,2	36

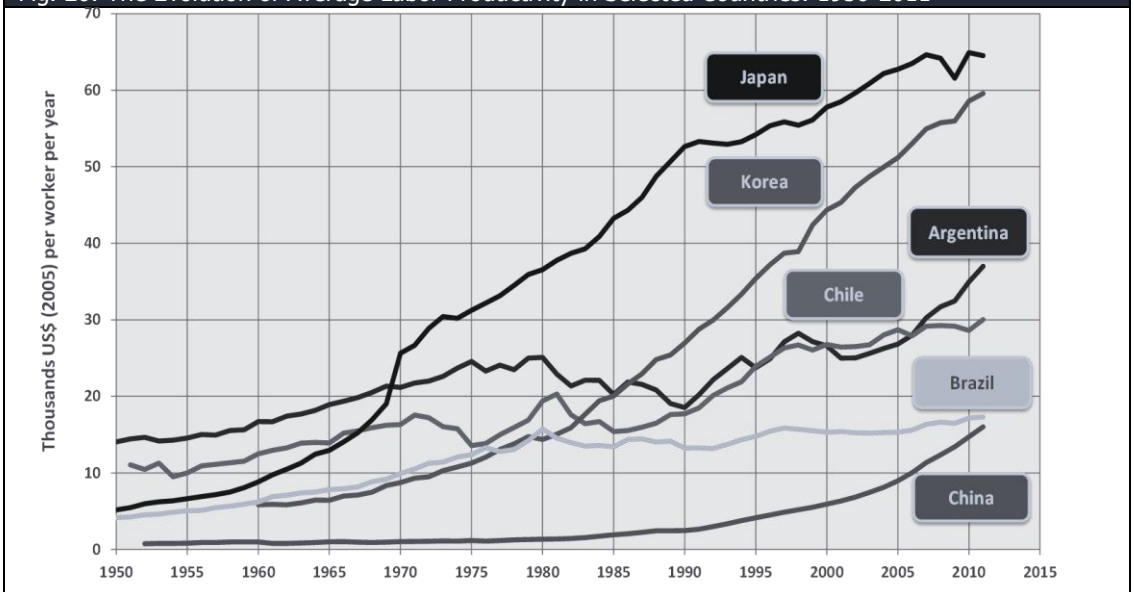
Source: UNDP and PNAD (2009).

5.2. Low Labor Productivity

The average labor productivity in Brazil has grown between 2001 and 2011. However, it has been growing at a very slow pace. When compared to other countries such as Japan, Korea, Argentina and Chile, Brazil not only has a lower level of productivity but also a slower rate of productivity growth.

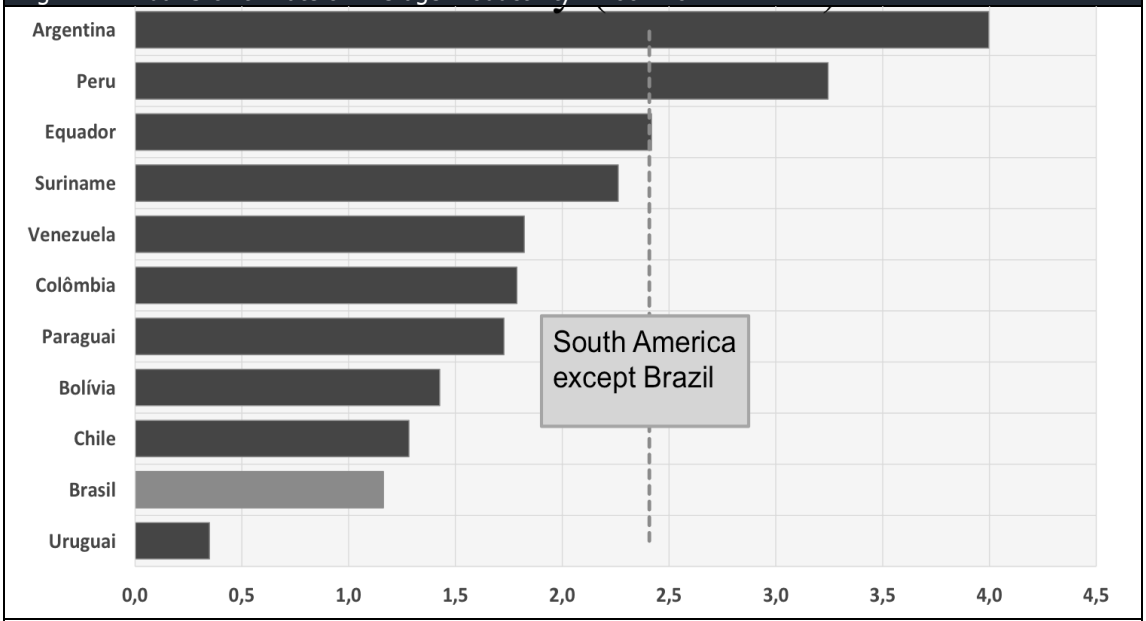
In South America, all countries with the exception of Uruguay have a higher productivity annual growth rate (Figure 27) than Brazil.

Fig. 26: The Evolution of Average Labor Productivity in Selected Countries: 1950-2011



Source: Penn World Tables and World Bank.

Fig. 27: Annual Growth Rate of Average Productivity – 2001-2011



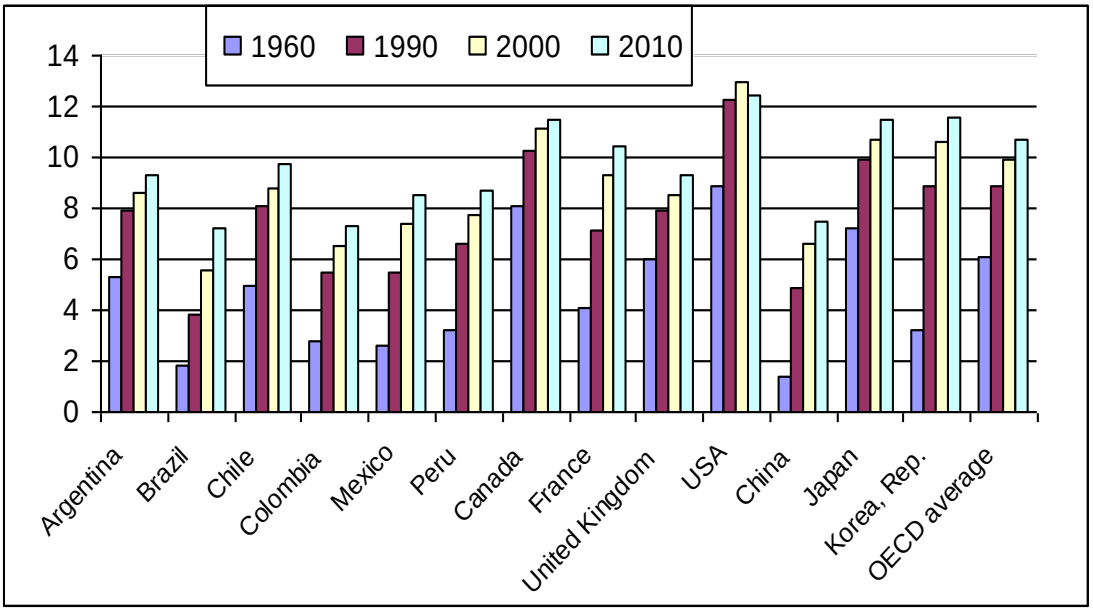
Source: Penn World Tables and World Bank.

5.3. Poor Education

One of the main reasons why Brazil is facing difficulties in increasing labor productivity is its poor education, both in terms of quantity and quality. In terms of years of schooling, Brazil underperforms when compared to several other developing countries, such as Argentina, Chile, Mexico and Peru (figure 28).

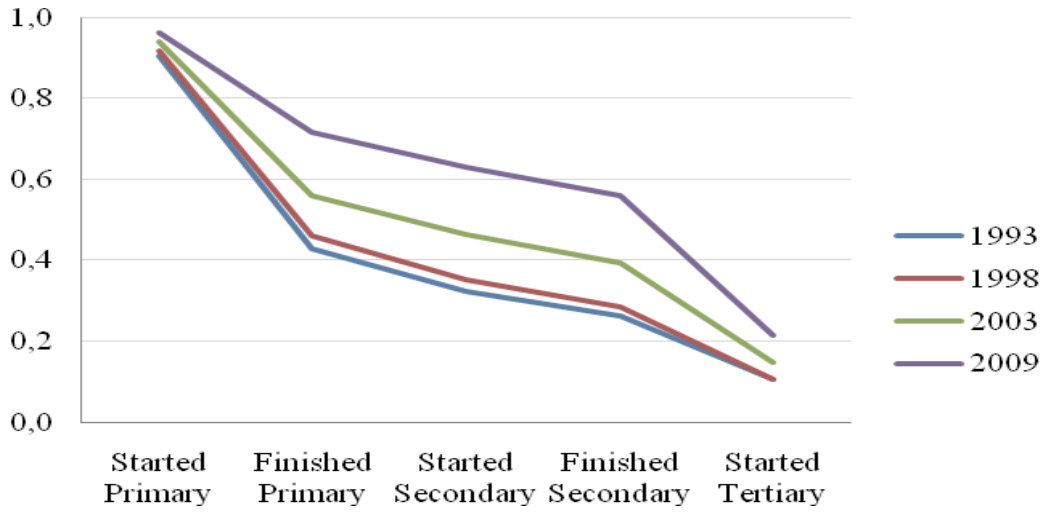
School evasion is also a very serious problem in Brazil. Figure 29 shows that enrollment has increased between 1993 and 2009. Although the vast majority of children enroll in school at an adequate age, data from 2009 show that only around half of students originally enrolled finish secondary school, and just 20 percent end up enrolling in tertiary education.

Fig. 28: Average Years of Schooling of Adult Population: 1960-2010



Source: OECD.

Fig. 29: Schooling Flow in Brazil: 1993- 2009



Source: World Bank, 2010.

Quality of education is also a challenge in Brazil. The results of the PISA exam - Programme for International Student Assessment – show that, in a sample of 65 countries, Brazil performs below the average in mathematics, reading and science, ranking on the 57th, 55th and 58th positions respectively. In math, Brazil not only performs below OECD average, but also below other Latin American countries such as Chile, Mexico, Uruguay and Costa Rica.

Although quality of education in Brazil is still very low, its mean performance in mathematics has substantially improved between 2003 and 2012 from 356 to 391 score points, making Brazil the country with the largest performance gains since 2003. However, despite the recent developments, the quality of education in Brazil is still deficient and demands much attention in order to contribute for the increase in labor productivity and economic growth.

6. Conclusion

Brazil has recently undergone a period of a dramatic reduction in poverty and inequality that was made possible by sustained economic growth as well as redistribution policies. The labor market has played a very important role in this process, with an increase of labor income and the rapid generation of formal jobs.

Several challenges must be confronted though in order to promote a sustainable path of pro-poor economic growth. Brazil´s aging population does not only endanger future economic growth but also threatens the sustainability of the social security system and the country´s weak education and unimpressive evolution of labor productivity are also potential barriers for economic growth.

SESSION 5 - Science for Poverty Eradication and Sustainable Development

Chair: **Jacob Palis Jr** (Brazilian Academy of Sciences)

Lecture for IAP's "Science for Poverty Eradication and Sustainable Development: a Call for Action

Jeffrey Sachs (UN Sustainable Development Solutions Network)
Conference

Good morning and thank you very much for the chance to be here with the Inter-Academy Panel (IAP) and to have a discussion about a very timely theme. Of course, the issue of sustainable development and poverty reduction is always timely, but 2015 is an unusual year regarding these two agendas because it is also a year of unprecedented concentration of global negotiations over the themes of sustainable development and poverty reduction. I wanted to interweave the analytical issues about sustainable development in science with the negotiating issues because I see these two as coming together in a very particular way in 2015. So, I was very appreciative of being assigned the topic of science for poverty eradication and sustainable development, and I think that the academies of science have a tremendous opportunity and responsibility this coming year, and in the future years, as this agenda continues to roll out.

Let me start with a framing of the socio-political environment in which we are operating because I think it is very important to frame the challenges of science and sustainable development within the real global context that we find ourselves in. I would emphasize six complex areas of rapid change. The first is an economic observation that whether we like it or not, the world economy is increasingly dominated by production systems with global scale technological and standardized parameterization, especially in information technology, but also throughout the global production chains.

Second, there is very rapid technological change. It is so rapid that the favorite term in the business schools is called disruptive change, which is a change caused by information and communications technology that permeates every sector of the world economy. It is not possible to find a single sector that is not being deeply transformed by the information and digital revolution. Not only the fact of communications, but the fact of being able to digitize information, whether it is in agronomy, genomics, nanotechnology, material science, communications, finance, entertainment, and so forth. I think there is a massive disruption underway; this is possibly disruption for the good, but it also means a lot of social upheaval will accompany these changes.

Third, there is the dramatic demographic change in the world that really marks two very different worlds of demographic change. On the one side, the most rapidly growing region of the world is Africa, and population growth in Africa is proceeding at an astounding rate that is highly threatening to Africa's long and short-term wellbeing. At the same time, population growth has fallen sharply to zero or even negative rates in much of the rest of the world, so there is rapid aging taking place together with population stabilization or decline. Thus, we have two very different demographic realities, and we have a very disjointed global discussion of these realities. You cannot summarize the global situation in one phrase as we tend to do, whether it is the world's aging population or the population stability and decline or population explosion; it depends on the region. But this rapid demographic change is leading to tremendous social, political, economic, and environmental pressures.

Fourth, there is a jobs crisis that is very widespread and strongly related to technological change. The question of technology and jobs is a complex question that goes back 200 years, to the beginning of the Industrial Revolution. There is evidence that the current advances of robotics, computer-assisted design and manufacturing, and artificial intelligence are leading to a massive loss of jobs in many parts of the world economy right now. It is leaving a large part of the young population without clear pathways to prosperity right now, and this is another factor of social unrest as well.

Fifth, there are the extreme environmental crises that pervade the world. The world economy is growing, and it continues to grow even considering the 2008 crisis. It is not really true that there is a "global" economic crisis because the world economy as a whole has been still growing between 3-4% per year. This is a doubling time of roughly one generation (around 20 years). The global aspect is actually the environmental implication of this continued high growth. A quick number to keep in mind is that the world economy is approaching about 100 trillion dollars per year production. It is probably at about 90 trillion dollars right now when you measure output at purchasing power pricing. In other words, international prices are at nearly 100 trillion dollars of production. Given the current technological patterns, this is too much for the world's ecosystems. So environmental crisis is pervasive, and they break out in every part of the world, not only through global climate change, but also through local trespassing on the ecosystem boundary conditions.

Sixth, we are in a period of tremendous geopolitical change as well. The single most important evidence is the rise of China to the top economy in the world. With the change of economic conditions in Asia combined with the growth of India, the geopolitics worldwide has changed. We are out of the 1945 US-lead global agenda. We actually have been out of that agenda for 20 years, but we do not have a good name for the new agenda. We are in a different kind of world geopolitically, and we need a different kind of governance, new actors, new institutions, new global set of relations, and I emphasize this because 2015 could be part of that process of creating a new global geopolitical framework in the way that 1945 was. Hopefully we do not need more wars to create new frameworks that are consistent with the world geopolitics.

These are all challenging conditions. There is a lot of disruption within societies and around the world and a need to build new patterns of relations. I would say that the environmental crisis in particular makes all this exceedingly urgent because many of the other challenges are challenges of political management and economic flux that are familiar to humanity. However, we have not handled those challenges very well either. After all, we are on the 100th anniversary of World War I this year, and that is an example of absolutely calamitous mismanagement of basic diplomacy. But what makes our time unique or unprecedented is the environmental crisis, because we now have, for the first time in human history, a true global-scale environmental crisis. There is no place to run, no answer through migration, and no possibility of addressing these issues on a local scale. So global scale change is called for, but we lack the institutions, the mindset, the motivations, and the direction for that kind of global scale change. For 40 years, we have been trying to find handles for global scale directed change and we still lack them. The only global scale institutions we have are markets, and while they are highly effective at many things, they are not effective at addressing environmental crisis or the tensions that arise from them.

The proposal on the table at the UN, and my preferred proposal, is that we view sustainable development as our best hope as an organizing principle for this new era. What is interesting is that even though this is not a well understood concept and not one that is embraced by the general public or by our politicians necessarily, it is one that has been politically agreed on during two major occasions in the past 22 years. It notably took place in Brazil both times and gave us a way forward. In the Earth Summit in 1992, which was the most important event in recent environmental history, sustainable development was adopted as the organizing principle. It did not take hold effectively, unfortunately. At the time, it was defined in a way that was not extremely useful. It was defined by the Brundtland Commission as meeting today's needs in a way that enables future generations to meet their needs. That definition of intergenerational sustainability was very hard to put into practice in an operational sense. So even though the concept was adopted at the Earth's Summit, it did not sink in very deeply into the global political and institutional arrangements. 20 years later, in 2012, another important meeting took place in Rio, which was on the 20th anniversary of the Earth's Summit. In June 2012 at the Rio+20 Summit, sustainable development was again adopted by all the world's governments. That is important, because even if it is a formality, it is a unanimous formal adoption of the concept. This time around at the Rio+20 Summit, sustainable development was given a different definition, and in my view a much better one that was more operational. Sustainable development in 2012 was defined as a holistic framework for combining economic,

social, and environmental objectives. Rather than defining sustainable development as meeting today's needs in a way that future generations can meet their needs, which is fine in an intergenerational context, it was rephrased as balancing economic, social, and environmental goals of society.

My experience in teaching sustainable development over the past dozen years as a field, a major, and a PhD class, is that that the three-sector definition works a lot better. People understand, politicians understand, and the general public understands that there are economic goals. They understand that there are social goals of keeping social cohesion; there are environmental requirements for protecting ecosystems and stopping human induced climate change; and the idea of a holistic framework that unites the economic, social, and environmental is a very intuitive idea. This is the way that sustainable development was adopted in 2012; as a holistic integration of economic, social and environmental objectives. I would say also that sustainable development has two parts to it: the positive, or analytical part, which is an integrated systems analysis that integrates economic, social, environmental and governance systems from an analytical point of view; and the normative framework, which says we should have multiple dimensions of our social goals. To move beyond GDP, as one expression of it is, so that instead of chasing just one measure or economic growth, we aim for three dimensions: economic, social, and environmental. We define those dimensions and then we have a multi-objective function problem as a societal problem. How do we invest our resources in society and organize our institutions so that we are achieving all three dimensions? This was how it was expressed.

At Rio+20, the idea was set to adopt Sustainable Development Goals in 2015. That is one of the main reasons why 2015 is a unique occasion. From the 24th to 26th of September, there will be a three-day head-of-state summit at the UN to adopt the Sustainable Development Goals. It will be the largest gathering of heads of state in history, around sustainable development. It is a very important occasion. If these concepts are adopted and embraced, it could make a very big difference. In fact, there are three major summits next year that are all interconnected and quite complicated to bring to success. The first one, a conference on financing sustainable development, will be in July 2015 in Addis Ababa. It will be on the 13th anniversary of the Monterrey International Conference on Financing for Development, which occurred just after the Millennium Development Goals were adopted. Governments had convened in March 2002 to adopt a financial framework for the Millennium Development Goals. It was only implemented in very small way, but it was an important meeting in terms of setting a normative framework for international finance. The upcoming meeting in July 2015 will be even more important because the financial agenda is even more complex. The question in 2015 will be how to finance the end of poverty, and how to finance sustainable development including financing climate change mitigation and adaptation. So, the agenda for the 2015 finance meeting is really full and deeply underdeveloped, I can tell you. We are here in December; there is no draft document; there is no shared agreement on even the pillars for that outcome; and the traditional so-called donor countries of Europe and the United States basically are saying "Don't come to us for any money". They are saying "we're broke", which is of course ridiculous. They are not broke; there is more wealth than ever before, but they just do not tax the wealth. They say "we are broke as governments", but then the question is how will we actively finance sustainable development? So that will be 2015 July meeting.

Following this July meeting will be the Sustainable Development Goals summit that I just mentioned, and then the final key meeting of next year is COP 21. We have COP 20 running next door, in Peru right now, which is a preparatory to a successful climate change agreement in Paris in November and December 2015. We all know how fraught those negotiations are because it has been 22 years since the signing of the UN Framework Convention on Climate Change, and we still have not yet put into place a workable framework of action. Whether Paris will agree on one is anybody's guess, but I will give you some reasons for optimism of what could be done.

Well this is a huge agenda and it is trying to steer the world! Some people would say it is madness to even think that one could move such a complicated 7.3 billion person, 100 trillion dollar world economy in a chosen direction. My view is that we have to, because what was said 42 years ago in Limits to Growth has proved to be right: that there are limits to the traditional economic model; we have arrived at them; and we have to recalibrate a world institutional economic system that reflects those ecological realities. This is extremely difficult to do. There is extremely strong inertia in the socio-political economic system. There are powerful interests; our politics are all organized around wealth and growth. They are not organized around the three agendas; they are organized around one agenda of the three. The momentum is strong. Steering anything in this world is very hard. Anyone in the driver's seat gets shot at by the 7.2 billion people behind them. So, it is very hard

to steer the vehicle without everybody yelling go left, go right, go straight, go backwards, etc. And in my view, this is really what we face. Can we choose some goals? Can we agree on them? Can we think that it is important to avoid an ecological cliff that is looming ahead? And can we consciously design institutions and adopt technologies that can get us past this crisis?

Now why do we have any reason to expect success? A small group of those who are most deeply entrenched in the status quo say we have no problem and recommend that we just go on as we are. I call that Rupert Murdoch land because that is the message we get from Mr. Murdoch in the United States, in the Wall Street Journal or Fox TV, and also from the UK right or the government in Australia, and so forth. That Anglo-Saxon view that "the world is great and just keep going ahead even faster" is a small component of global ideology. But the rest is truly hard, even if we did not have that kind of confusion and vested interest. How do we move a world economy in a direction that preserves the chance for economic improvement, but also de-couples the economic system from environmental harm? This is a tremendously daunting scientific and technological challenge. Even if it were a pure optimization exercise, it would still be extraordinarily hard. How do we take a global energy system and move it from a high to low carbon energy system while still providing the free energy needed to run a modern world economy? And finding out how to do this in real time during the next 30 or 40 years is an extraordinarily difficult, unsolved and unproven challenge.

One reason I personally like to think that we have a chance is that we are living in a scientific and technological revolutionary age. A recommendation I give to all my economist friends and others is to read at least the first half of Science and Nature each week. That is the readable part for me, not the individual articles in the second half, but the "Science this week" summaries. Because every week there are more advances in scientific and technological knowledge per week than was there ever was per year or per decade. We are in the middle of an explosion of scientific and technological creativity. I believe that it is right to say that the information revolution is underpinning it in a fundamental way. I do not mean through specifically individual devices or even computerization, but actually I mean that it is through the realization of Alan Turing's vision that all information could be long strings of 0's and 1's. And this could be true in areas such as material science, biology, agronomy, finance, entertainment, and communications. This is really playing out.

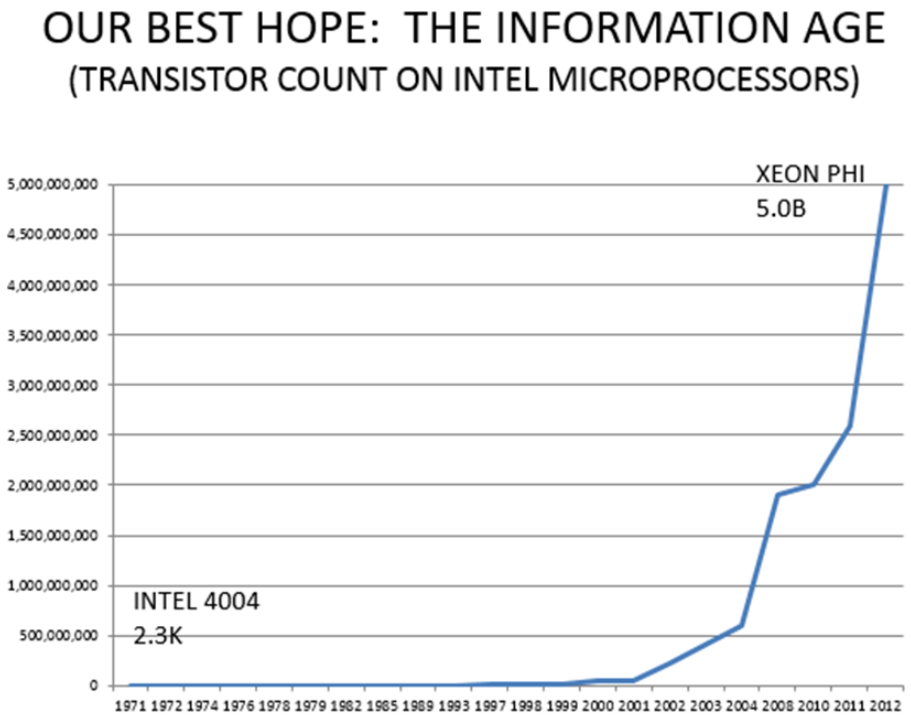


Fig. 1: Transistor Count on Intel Microprocessors.

The ability to manage bits of information has now improved roughly 5 billion times from the start of the Information Revolution in 1959 with the first integrated circuit. From 1959 till now; from putting one transistor on a chip, Intel now has now 5 billion transistors on its latest micro-processor, and that is a great revolution. I like to tell my students that this has made possible the absolute pinnacle achievement of humanity: you can

now watch movies on your phone. Of course, this goes beyond the ability to watch movies on your phone; we may be able to actually solve problems of poverty, environment, and so forth by this advance of information technology.

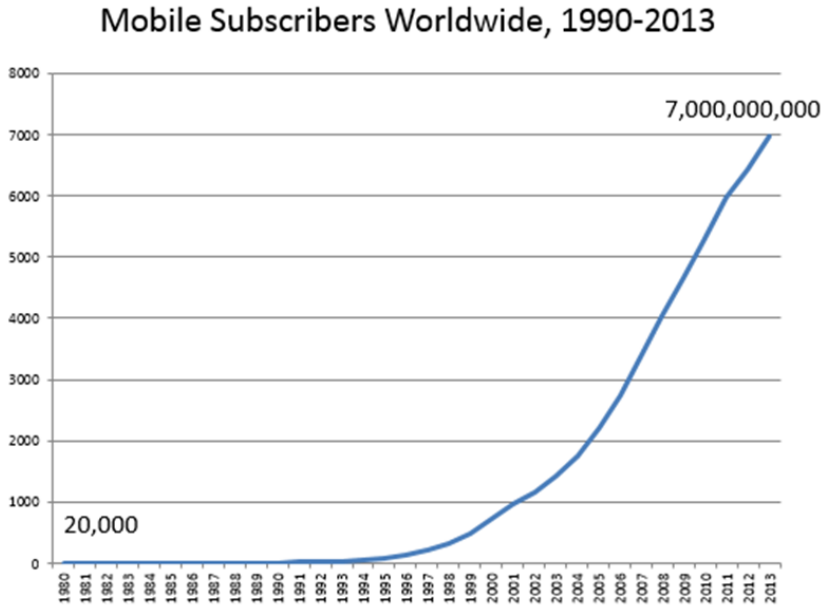


Fig. 2: Mobile Subscribers Worldwide, 1990-2013.

One example of this is through the mobile connectivity that is now universal. It is estimated that there are 7 billion mobile subscribers in the world now, up from some tens of thousands in 1980. So, we have had the fastest diffusion of a useful technology in human history in our generation, and that revolution continues. I think it is extraordinarily positive. I work a lot in very poor villages in many parts of the world, and the arrival of mobile communications has been positive and transformative.

The first human genome to be sequenced was roughly a 10-billion-dollar investment. By the time that sequence had been successfully announced in the year 2000, the incremental cost per genome was estimated to be 100 million dollars. At that point the US National Institutes of Health convened a task force to ask what the goals for genomic sequencing should be. The task force said it should be a 1-thousand-dollar sequence by the year 2015 – a 100 thousand time improvement in the reduction of cost. That goal was achieved this year; there was a 100 thousand factor improvement in 13 years in genomic sequencing.

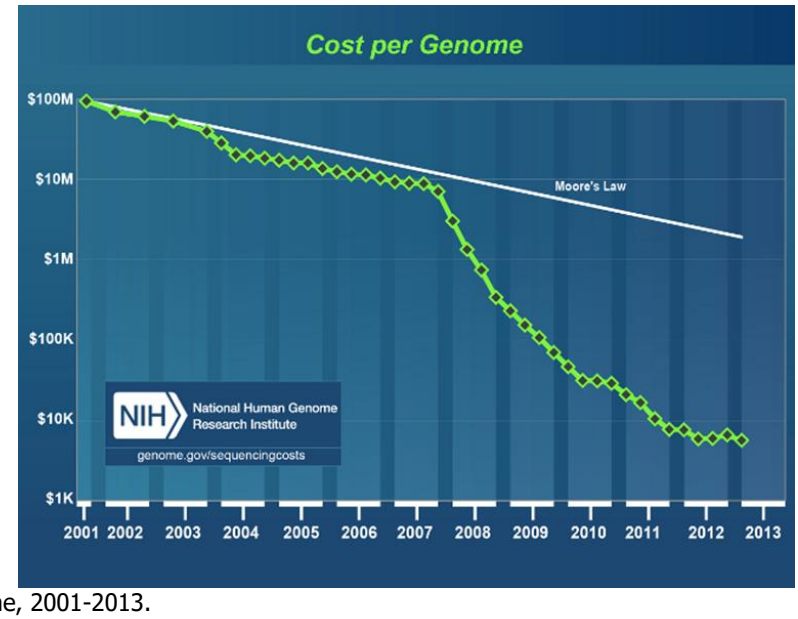


Fig. 3: Cost per Genome, 2001-2013.

This is revolutionizing biology, evolutionary studies, anthropology, not to mention human health and veterinary health. This is a semi-log table. You can see the straight line in Figure 1, which is Moore's law rate of decline. This is doubling or a halving of costs every 24 months. You can see also that the genome sequence has beaten Moore's Law, which is pretty dramatic actually. That is what a 100 thousand-fold improvement is.

Fig. 4: Progress during the MDG Era.

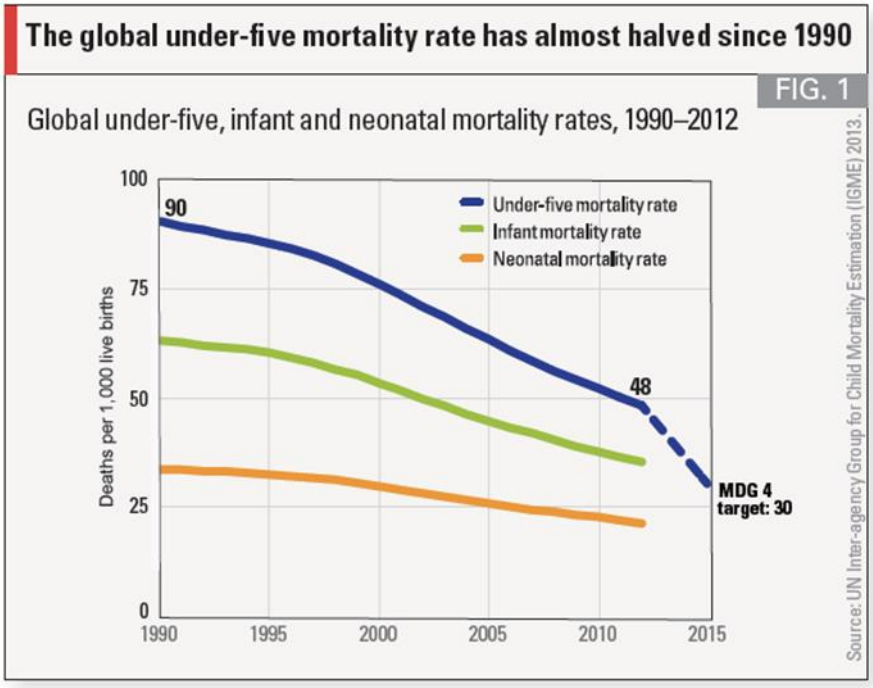


Fig. 5: The global under-five mortality rate since 1990.

It is also possible to have dramatic progress on related dimensions of poverty such as for under-five mortality rates. There still is a massive crisis of under-five mortality in the poorest countries of the world, but almost all of the mortality is from diseases such as water-borne diseases, respiratory diseases, or unsafe childbirth. These are preventable or treatable, but are not prevented or treated because of poverty. There is nothing in the health

agenda that blocks the way to a universally dramatic reduction of mortality rates except from organization and finance.

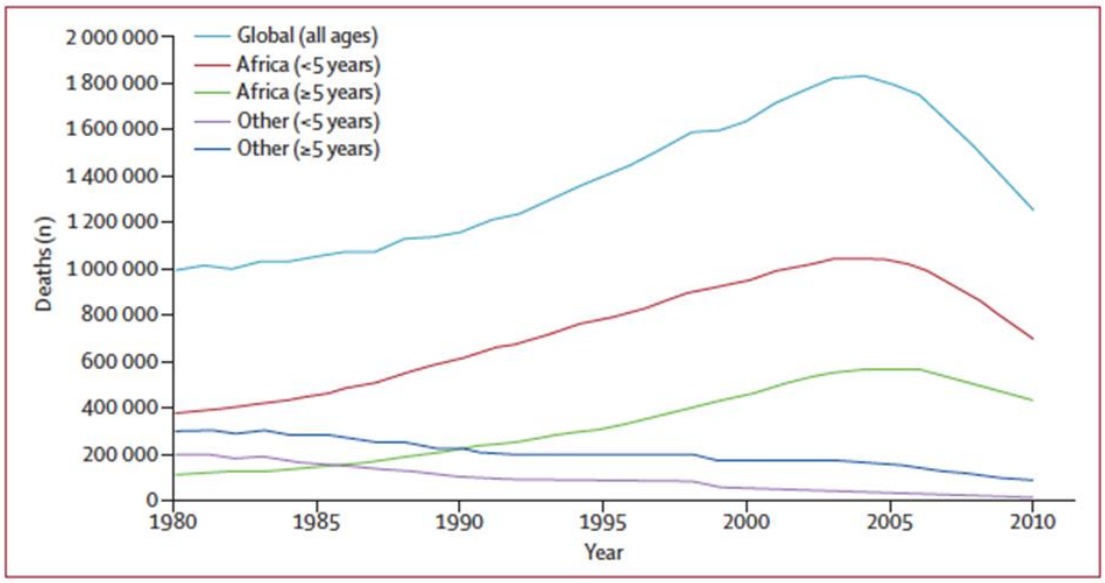


Fig. 6: Trends in global malaria deaths by age and geographical region, 1980-2010. Source: Global malaria mortality between 1980 and 2010: a systematic analysis. Christopher J L Murray, Lisa C Rosenfeld, Stephen S Lim, Kathryn G Andrews, Kyle J Foreman, Diana Haring, Nancy Fullman, Mohsen Naghavi, Rafael Lozano, Alan D Lopez. Lancet (2012) 379: 413–31.

I have been involved very much in the fight against malaria in the last 10 years. There have been huge improvements in the technology: long-lasting insecticidal bed nets, rapid diagnostic tests, new-generation Artemisinin combination therapies, mobile phone applications used by community health workers, etc. If you take the package together, then it is very effective for malaria control in low income settings. That is why the malaria death-curve has turned down after 2005. If we had a few billion dollars a year of funding, which is nothing out of a 90 trillion-dollar world economy other than a bit of moral effort, then malaria deaths could be brought down to near 0. The big problem with malaria control is lack of adequate finance, not lack of technology, at this point.

So, all of that is good news, but there are two huge barriers to success of sustainable development. One is that there is growing income inequality and social exclusion, and second is there is a looming environmental crisis. We have a very powerful push from science and technology; we have a growing world economy, but the whole point is that we have an economic model geared towards producing economic growth, quite effectively generally, but not effective towards insuring that this growth is fairly shared or that it is environmentally sound. That is why sustainable development is so crucial; it requires a change of the normative framework for the world economy in a way that addresses three objectives, not just the one objective. There are huge increases of income inequality in the major economies of the world. Brazil is one of the few places where income inequality has actually declined over the past 25 years, primarily because of the spread of primary and secondary education on a universal basis. However, in most other parts of the world, there has been a rising income inequality.

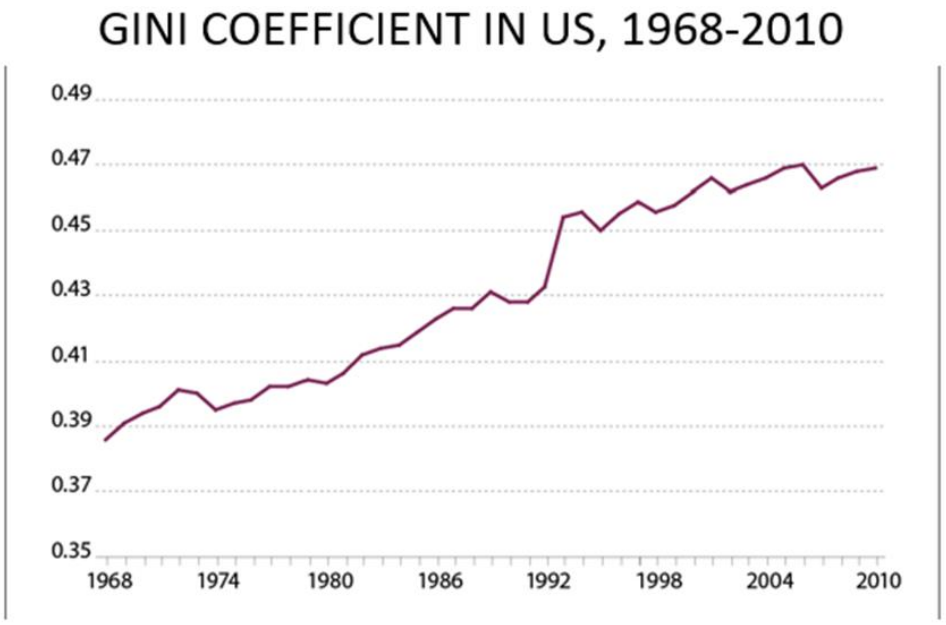


Fig. 7: Gini Coefficient in the US, 1968-2010. Source: US Congressional Research Service, 2012.

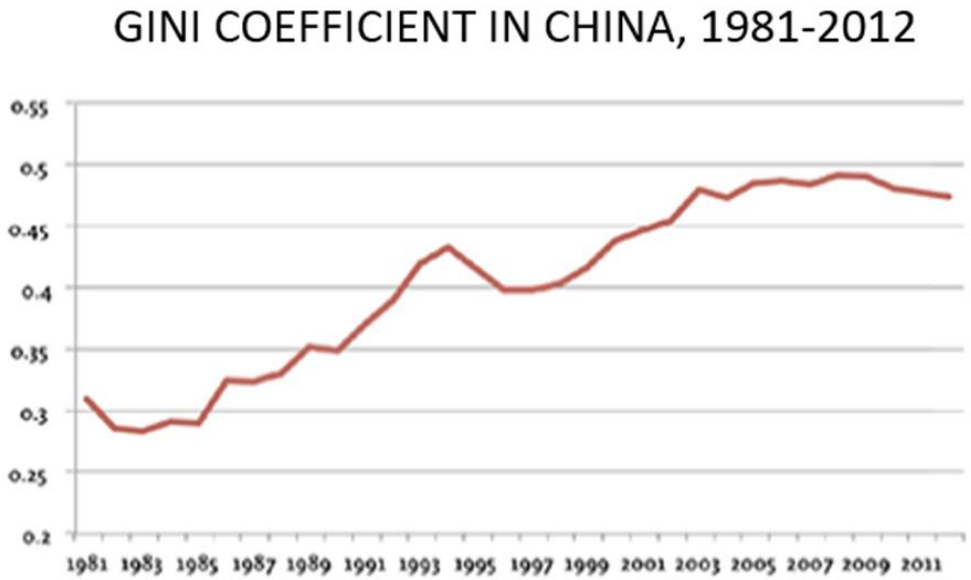


Fig. 8: Gini Coefficient in China, 1981-2012. Sources: Gini coefficients for the years 1986 are from Ravallion and Chen (2007). 2002 is from Gustafsson et al. (2008). 2003-2012 are from the National Bureau of Statistics.

China also has had a huge increase of income inequality as an accompaniment of its rapid industrialization of the last 30 years. There are several reasons for this growing divide. Where this comes from is a very complicated analytical question; there is no simple consensus on this. I would mention the following: there have been rising economic returns to good skills, and so a rising gap between skilled and unskilled work. There is a huge technological displacement of factory work, in particular. Political systems are highly corrupted almost everywhere, and so policies are directed towards the wealthy. There is decreasing educational mobility of the poor in the United States and other countries because the cost barriers for higher education have become even larger than before. There are massive ecological losses incurred primarily by the poor because the poor live in more fragile ecological regions to begin with, and those regions are being hammered by climate change and by other environmental losses. And the globalization of financial flows has opened up avenues for two kinds of problems: the first is mega-corruption and the second is the so-called "race to the bottom", where different jurisdictions compete with each other by promising tax breaks and tax loopholes. "Come here and work. You'll

never pay a tax again". So, we have that kind of race to the bottom taking place globally. All of this means that the social agenda at a time of unprecedented plenty is also growing rather than narrowing in important ways, and there is a lot of political instability that has resulted from this. You can find it in Brazil; you can find it in the United States; you can find it all over the world.

For a while, every city I came to have a riot and I thought it was a personal greeting, but then I realized it was not really about me after all. It was a little bit more general than that, but it is a very serious matter.

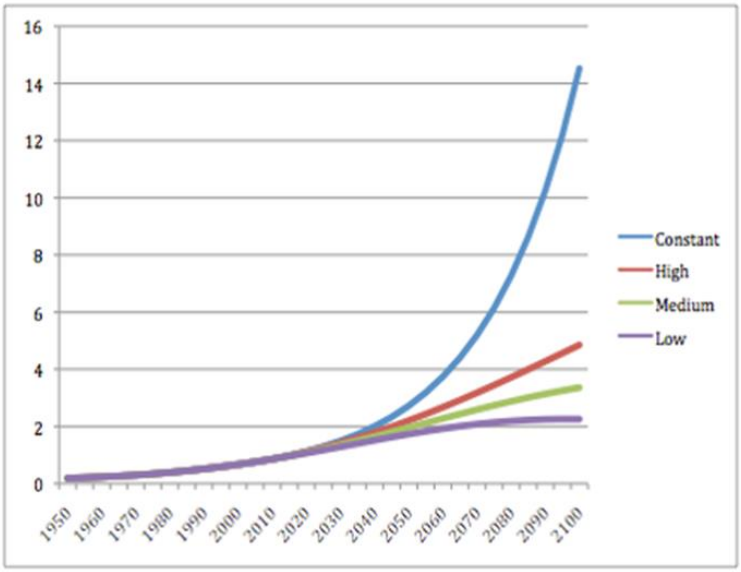


Fig. 9: UN Scenarios for population in sub-Saharan Africa, 1950-2100.

Let me add that the population dynamics will exacerbate this problem in a few regions: Africa, parts of the Middle-East, and parts of South Asia, are demographically running out of control. Africa particularly has a demographic dynamic that is unprecedented, and I think unmanageable. To give you the specifics, the UN estimate for 1950 is that sub-Saharan Africa had a population of 179 million people. As of 2015, that estimate will be 1 billion people.

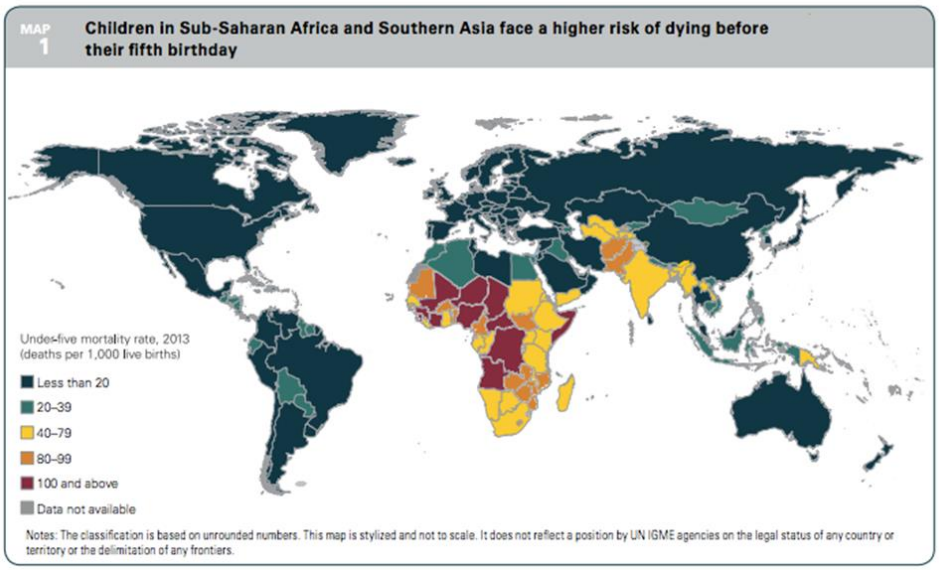


Fig. 10: Under-five mortality rate, 2013 (deaths per 1,000 live births).

This went from 179 million to 1 billion. On the current medium fertility scenario of the UN, 1 billion increases to 3.9 billion by 2100, which is a twice doubling in the 21st century. I believe it is impossible for Africa to achieve sustainable development with 4 billion people. There would be a massive crisis implied by these fertility rates. There simply are not the resources, the water, the other underlying resources, the ability of poor households

to give education to 5 or 6 children as needed, etc. if these current fertility rates remain. I think the consequences would be very severe, but I can tell you this is almost not discussed in polite company anywhere in the world. The UN did not mention it during the past two years of discussions about Sustainable Development Goals. Almost no government takes it up and it is almost not mentioned at all. It is quite troubling, as you can imagine the forces against mentioning it, but it is a very serious problem.

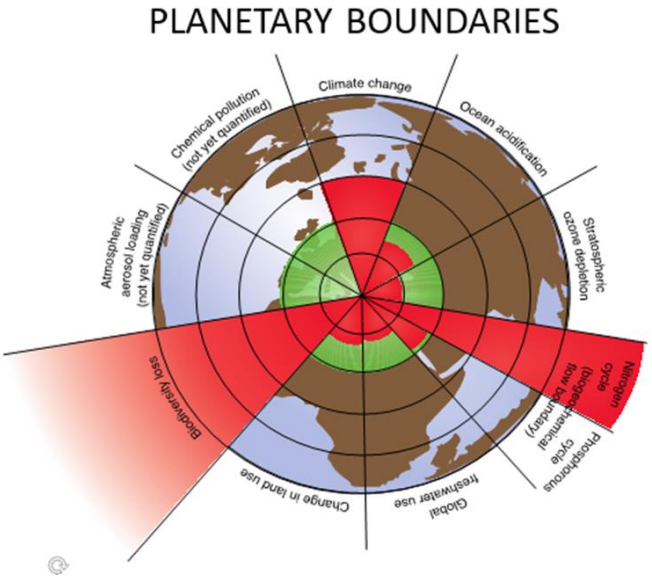


Fig. 10: Planetary Boundaries. Source: Rockström et al. "A Safe Operating Space for Humanity". Nature. 2009.

Let me just turn to the second dimension and try to be very quick as this is more familiar. The fact that the world economy reached the planetary boundary limits is now far more understood than it was in 1972, and I believe that the concept of planetary boundaries is a very useful one. In the 2009 famous Nature article on the "Safe operating space for humanity", the emphasis was on a range of 10 areas: Climate change, biodiversity loss, nitrogen and phosphorous flux, ocean acidification, ground-water depletion, aerosol loadings, chemical pollutants, O-zone depletion, and so on. These are all manifestations of a world economy that has grown so large relative to the finite ecosystems, and that is driven by particular industrial processes that threaten the functioning of the ecosystems as well as by the fact that humanity appropriates roughly 50% of primary productivity on the planet now. We clear pasture, we take crop land, and we pave over land in order to feed 7.3 billion people in the way that the industrial food system has fed them, which is not a sustainable way either of eating or of producing food. So, we have multiple, simultaneous, complementary, overlapping, and synergistic risks.

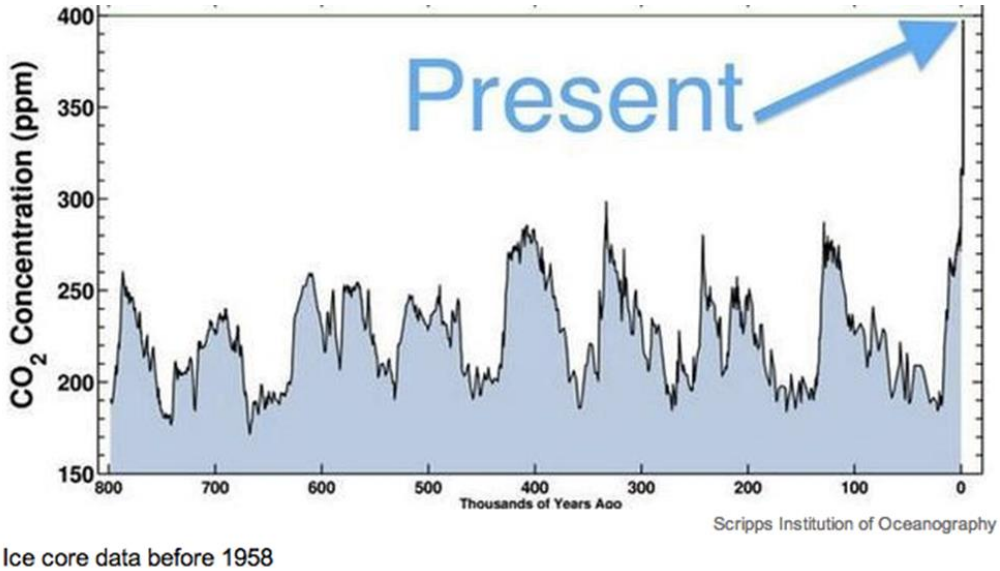


Fig. 11: CO2 Concentrations (ppm) over time. Source: Scripps Institution of Oceanography.

Climate change is by far the most threatening risk and it is an eminent disaster that is looming. All of you know Figure 11; we have reached 400 parts per million of CO2 this year, which is a level of CO2 concentrations not seen on the planet for the last 3 million years. Everywhere I visited this year, starting with the meetings in Brazil, I was witness to environmental catastrophes already ongoing early in the year. We knew about the droughts in São Paulo, but the message was "Shhh! Don't say anything about it. We have the World Cup, we have elections, we don't want to talk about this", and that was really the reality here. Then in Indonesia, there were massive drought and fires in Sumatra. When I was in the Balkans in Belgrade, there was an unprecedented 1 in 500-year floods experienced there.

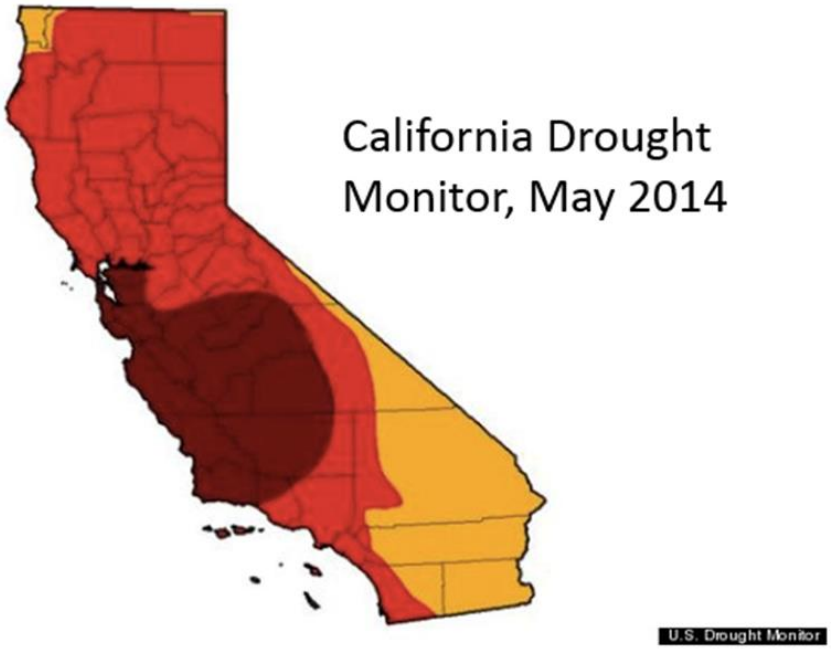


Fig. 12: California Drought Monitor, May 2014. Source: US Drought Monitor.

California has the worst drought in modern history underway, with a complete loss of the water reservoirs. There is drought all over the world this year: in the Middle East, in the Mediterranean basin, in the American West, in large parts of Brazil, and in large parts of Southern Africa. There were huge floods when I was in Japan just a few weeks ago, with also unprecedented flooding. We now have the hottest ever April, May, June, August, September and October on record as of the 2014 seasons.

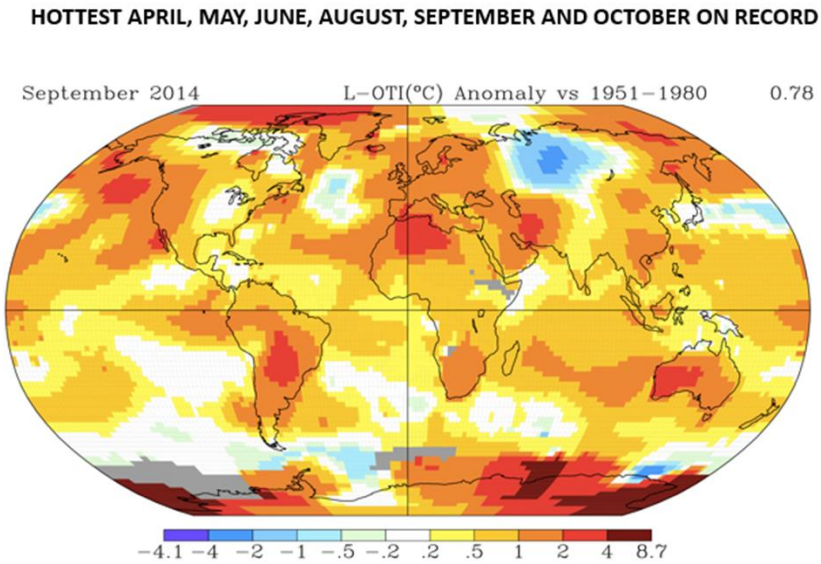


Fig. 13: Surface Temperatures in 2013 Compared with 1951-80. Source: GISS/NASA.

The World Meteorological Organization (WMO) announced yesterday its expectation that 2014 will be the hottest record instrument year in history. This seems very likely now. We have unprecedented heat waves and a weak El Niño that is of course amplifying this.

We also have plenty of emerging zoonotic diseases that are resulting from climate change and the new interfaces of human systems with the animal reservoirs, as well as with the genetic recombination probably driven by industrial food production. Of course, there is a lot that is not known about this, but we have the Ebola outbreak, the Middle East respiratory syndrome, SARS, Avian flu, and so on.

CURRENT DRAFT LIST OF SDGS

END POVERTY
END HUNGER
HEALTH FOR ALL
EDUCATION FOR ALL
GENDER EQUALITY
SUSTAINABLE WATER AND SANITATION
SUSTAINABLE ENERGY FOR ALL
SUSTAINABLE GROWTH AND JOBS
SUSTAINABLE INFRASTRUCTURE AND INDUSTRIALIZATION
REDUCE INEQUALITIES
SUSTAINABLE CITIES
SUSTAINBLE CONSUMPTION AND PRODUCTION
TACKLE CLIMATE CHANGE
CONSERVE MARINE ECOSYSTEMS AND RESOURCES
CONSERVE TERRESTRIAL ECOSYSTEMS AND RESOURCES
ACHIEVE PEACEFUL AND INCLUSIVE SOCIETIES
STRENGTHEN THE MEANS OF IMPLEMENTATION

Therefore, it is a big agenda, and there are many things to do to achieve sustainable development. I will just put at the top of the list a rapid technological transformation that decouples the economic system from a lot of the primary resource drivers. The number one technological transformation needed can be simply stated, but is hard to achieve, and that is to decarbonize the world energy system. On a time scale of 30 to 40 years, this is unprecedentedly difficult because we have a world energy system that is fundamental for the world economy and that has been built up over 200 years through a base of coal, oil and gas. This world energy system runs 80% of its primary energy from fossil fuels, and we have 30 years to move decisively towards de-carbonization. You could say, "Thank you very much, Professor Sachs, that is impossible", and that is a view that many people have. However, it is an extraordinarily dangerous view, and it is our responsibility to give a good reply. There are many other things that are needed, but it is important to say how critical it is to adopt some clear goals.

There is a working list of 17 goals that the UN has taken up, which I have to emphasize is too long to be clear. We need to reduce that number sharply. For some reason it was difficult to negotiate the 17 goals, and governments have been saying "We don't want to touch that". Brazil is one of the governments that is saying "Don't touch the number!" But there is a common understanding that if these goals are to be useful, the number has to come down. This can work quite well with commas and semicolons. For instance, instead of having a "goal on marine ecosystems" and another goal on "terrestrial ecosystems", you could say, "a goal on marine and terrestrial ecosystems". That would be an effective way to get the number down. I am campaigning hard to reduce the number because I think we should have a maximum of 12 and ideally around 10 of these Sustainable Development Goals.

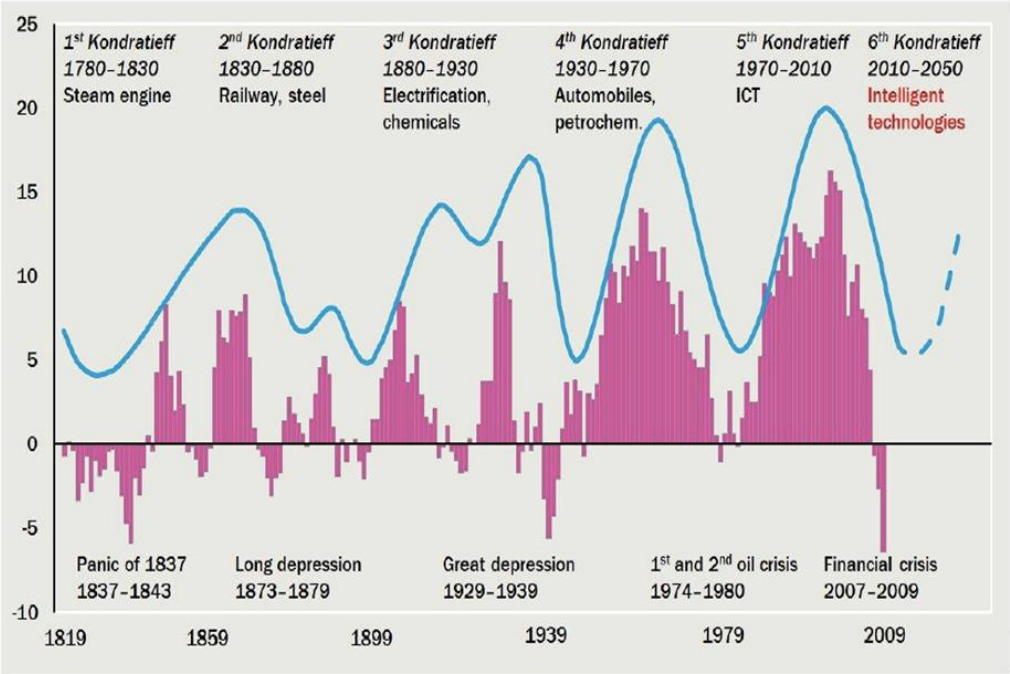


Fig. 14: Kondratieff Waves. Source: Robert J. Shiller, Stock Market Data used in "Irrational Exuberance," Princeton University Press, 2005, Datastream; Allianz GI Global Capital Markets & Thematic Research.

We need a major technological revolution, or what is sometimes called the sixth Kondratieff wave of moving towards sustainable technologies.

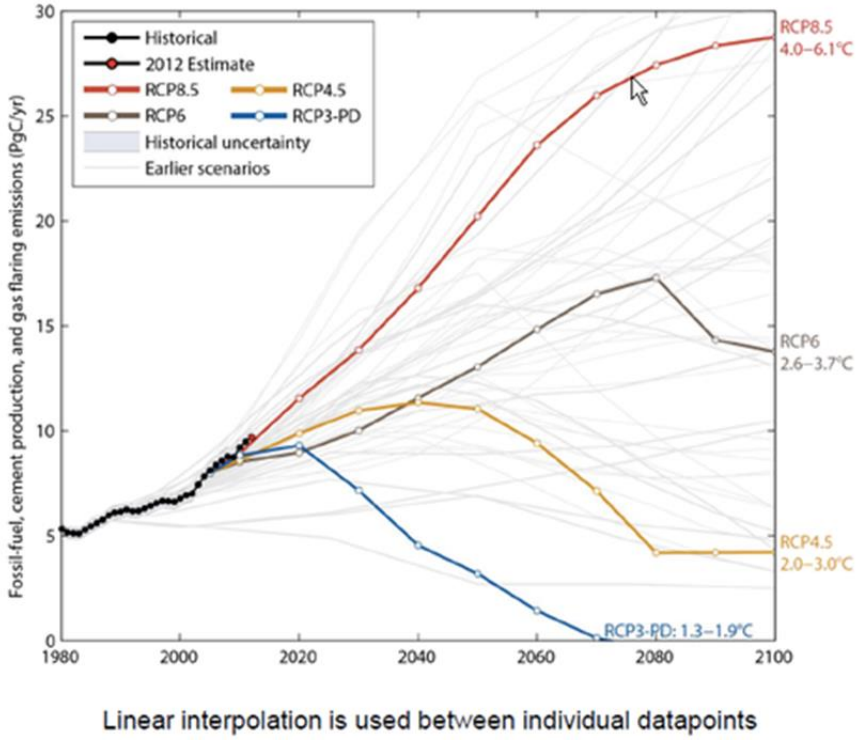


Fig. 15: Emission pathways. Source: Peters et al. Global Carbon Project. 2012.

I like the graph in Figure 15. These are the four main representative concentration pathways of the Intergovernmental Panel on Climate Change (IPCC), showing the businesses as usual concentration of greenhouse gas emissions in this upward red line, which would be a 4 to 6-degree Celsius warming of the planet. And the blue line is the emissions curve that we need globally to achieve the maximum 2 degrees Celsius target that has been agreed. Take note of three things: first, we have to peak by around 2020; second, by mid-

century we have to be somewhere around 60% below the 2014 emissions level of 36 billion tons; and Third, by around 2070 we have to get to net zero emissions. In other words, you have to get to zero to stabilize greenhouse gases. We need to be a net zero CO2 world economy within roughly 50 years - that is a huge undertaking! It is feasible, because it means moving from coal, oil and gas, to wind, solar, nuclear, advanced bio-fuels, carbon-capture sequestration, hydro, geothermal and other zero or near-zero energy sources that are abundant if tapped properly. But it is a system and an economic change that is phenomenally significant and very rapid. It would have to be directed rather than simply expected to emerge out of market forces. Examples of reasons for success come back to the advances of the information age.

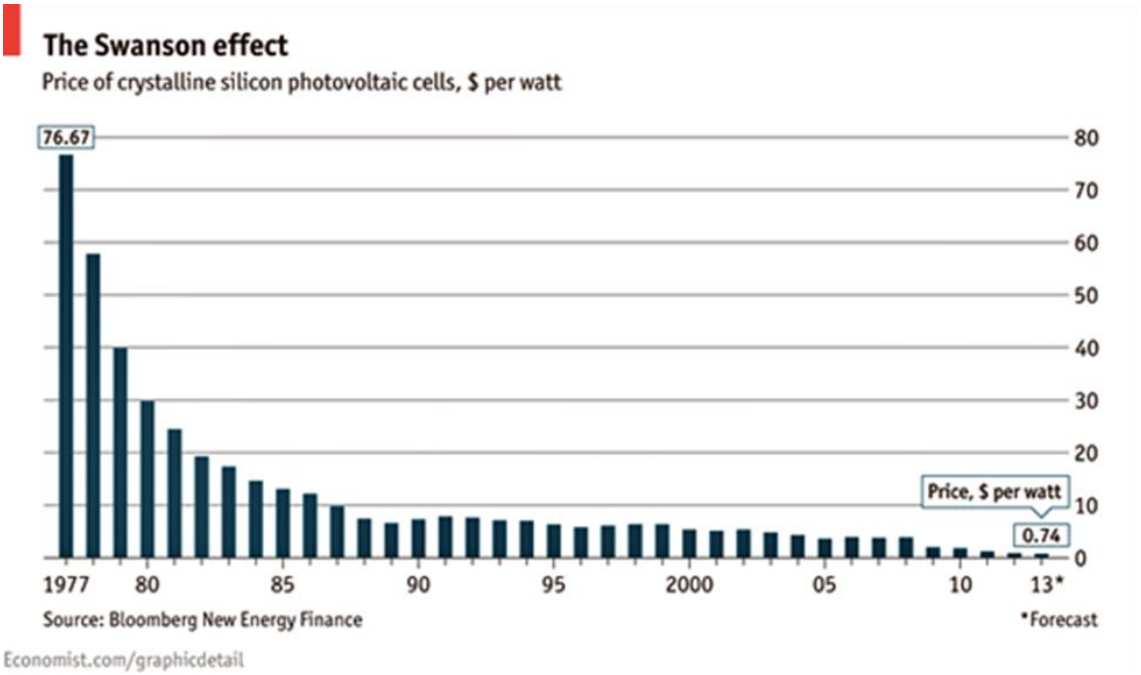


Fig. 16: The Swanson Effect. Source: Bloomberg New Energy Finance.

Illustrated in Figure 16, the semi-conductor revolutions reduced the cost of polysilicon photovoltaic cells by a factor of 100. Between 1977 and 2014, the costs came down from 70 dollars a watt to 70 cents a watt. That makes it possible to have mass solar energy worldwide tapped, but it requires massive systems organization as well. What are the critical priorities? Sustainable, meaning low-cost and low-carbon, reliable energy is a priority. Sustainable agriculture and nutrition are another, where food production systems are less burdensome on the physical environment than our current food systems. These should be more water sparing, more land sparing, and more nutritious that the current staple-grain focused and beef-focused systems. We need smart cities that integrate a lot of information technology into the infrastructure of power-transport and urban governance. We need universal access to the basic services of health and education and these require technological breakthroughs.

I am a huge fan of the concept of directed technological change, which means that science is not open-ended, and curiosity is driven significantly by industrial needs or by societal needs. By far, the main driver in the last century has been the military. The military has purchased almost every early-stage breakthrough technology to make it into a feasible commercial technology. That is true of the computing age because effectively the first computer was built by John van Neumann to simulate thermo-nuclear explosions. The semi-conductor revolution came from NASA buying semi-conductors throughout the 1960s to go to the moon. We need to have a similar mission-led process that is not driven by our military. That is the question for humanity: can we do this not out of fear or out of will to power, but out of instinct for survival and goodwill in a different way? In America we are told every day and most people believe that there no such thing as driving technology, and it is the geniuses of Steve Jobs or Bill Gates or others that drive technological change. This is an optical illusion that is not well understood, because Steve Jobs and Bill Gates would not have been there had it not been for the Computing Age, the invention of the semi-conductors, and the systematic application of science towards mission-driven problems on which these applied solutions were found. We must tell our governments that they need to invest heavily in sustainable development solutions now, including the whole value chain from basic science to direct-application. They need to understand that it includes vaccines, radar cryptography, nuclear

energy computing, semi-conductor space science, internet, genomics, particle physics, and brain initiatives - this is driven technology! We are saying we can do the following by harnessing science and engineering to solve human problems. So, we need global public-private partnerships for low carbon energy systems and resilience in sustainable agriculture. I want to put the focus on the words, resilient and sustainable. Resilient here means resilient to the environmental crisis, and sustainable means to stop making new environmental crises from agriculture. We need both of these concepts because the causation goes in both directions. There should be smart ICT-enabled urban systems, ICT-enabled health education, and good governance. To my mind that is an agenda that is big and absolutely practical.

So, 2015 is the decisive year and likely our last chance for a safe climate. We need to reinvigorate development assistance, adopt sustainable development goals, create a climate agreement based on the 2-degree Celsius limit, ensure health and education for all, and bolster public-private partnerships for sustainable technologies. Finally, there are six key roles of science in this agenda.

(1) Understanding mechanisms: climate, biodiversity, economic dynamics. This is something that only the scientific community can do. They can understand the mechanisms of climate, biodiversity, economic dynamics and so forth.
(2) Monitoring and mapping Earth system states. We still have a huge fundamental observational challenge to know what is happening and need to measure fluxes in Earth's states in real-time in relation to policy-time.
(3) Developing integrated Physical-Human systems frameworks. ("Green economy," "smart cities," "circular economy"). Economics lost the sense of geography and ecology about 150 years ago. It became a field divorced from physical nature. It is only in the last 20 years that economics as a field is re-embracing basic concepts that there is energy, space, land, ecology, and so on, and we need to bring the physical, the human and social sciences back together more effectively for directed technological advancement.
(4) Directed technological advancement (e.g. "deep decarbonization" through RDD&D)
(5) Institutional Innovation for Sustainable Development
(6) Shared global framework and communication. We need to ensure that the scientific community is a global community. This, by itself, is of inestimable value. The scientific community is one of the only communities in the world that has a universal language. Maybe FIFA is the other one. Scientists in every part of the world can speak the same language and say to governments everywhere, "this is real, this is important, we all share this". Religion, race, region, income level – they do not matter. We are all scientists and we all share the same common vision. It is incredibly important for humanity to explain that this is a global challenge, not a sector or specific challenge, and not an "us versus them" challenge.

Thank you very much.

Why is science important?

Michael Clegg (Inter American Network of Academies of Science)
Conference

My goal is to say a few words about science and about the institutional resources that science has begun to mobilize that were alluded to in the closing remarks by Jeffrey Sachs.

So, why is science important? Science is the world's most powerful means of knowledge creation. It deals exclusively with arguments based on evidence and the results of science have to be subject to independent confirmation. The independent confirmation criterion insures that scientific results are correct, and it gives an ethical dimension to science, because it places the highest priority on honesty and accuracy. The ethical dimension of science helps to underpin a global scientific community with shared ideals, independent of cultural or linguistic differences. The distinction between science and technology is that science provides the fundamental knowledge that precedes technological innovation. Thus, the close relationship between science and technology is clearly evident from the beginnings of the industrial revolution through to the transportation revolution and forward into the information revolution.

There is every reason to believe that the history of the last 200 years, marked by a vast accumulation of scientific knowledge, will continue into the future especially as the global investment in basic scientific research is continuing to grow. And from that will flow technological innovations that cannot even be imagined today.

But there is no guarantee that these new technologies and innovations will solve the twin problems of sustainability and poverty eradication. To achieve the goals of sustainability and poverty eradication it will be necessary to develop policies and incentives that direct the scientific community towards finding solutions to these twin challenges.

So, how do we harness science to find solutions for these hard challenges? To begin to answer this question, we must first ask who speaks for science? And how do global decision makers obtain advice on issues with substantial science and technology content? Let's look at the United States as a case study of the ways that decision makers get scientific advice: (1) One important source of information and advice is informal (or back channel) advice from respected experts. An excellent example is the letter that Albert Einstein wrote to President Roosevelt advocating the atomic bomb project. (2) Another major source is inside-the-government advice from science agencies that are part of the government. There is no ministry of science in the US; instead science is represented in a large number of departments of government, each with their own experts. Examples are the US Geological Survey, Department of Agriculture, Department of Energy, Department of Health and Human Services and many others (at least 12 come up on the US government web site when science is used as a search term). (3) A third source of scientific advice is the modern think tank such as RAND or the Brookings Institution, and many others that have emerged in the advice business during the post-WWII era. And (4) the US National Academy of Science (US NAS) was established as a private organization during the American Civil War to provide science and technology advice to the US government. The unique feature of the US NAS was that it was formed with a service mission in addition to the traditional roles of promoting scientific communication and recognizing scientific achievement. The original Congressional charter granted to the US NAS requires that the Academy, "whenever called upon by any department of government, to investigate, exam, and experiment and report upon any subject of science or art of interest to the government, but to do so without compensation." This model has evolved over the past 150 years into a powerful source of independent advice on a wide range of major policy issues.

Why are academies important and credible players in the advice arena? First, they are merit based and typically include the scientific leadership of a country. Second, academies are self-renewing institutions that are typically free from political interference. Third, owing to the stature of national academies they can typically get the best to serve, thereby insuring the highest quality advice. And fourth, as independent non-governmental institutions, academies have the credibility to inform the public and policy makers about looming problems and potential solutions.

So, what can science communities do to promote a better future? Science communities and their constituent academies must be strong voices for the use of science and technology knowledge in policy development. Academy leaders often have access to high-level decision makers, especially in the developing world where traditions of informal advice may be strong. It is essential to use this advantage to amplify the voice of science and to ensure that policies that are based on scientific knowledge are adopted. Most nations regard their science and technology assets as a key element of their economic development strategy and as essential for a better future, so the voice of science can be powerful.

Let us now consider the issue of environmental sustainability in the context of scientific advice. The notion of sustainability grew out of a report by the Brundtland Commission appointed by the United Nations Secretary General almost 30 years ago. As Jeffrey Sachs indicated in his presentation, the Brundtland Commission adopted an intergenerational equity definition of sustainability, as, "development that meets the needs of the present without compromising the ability of future generations to meet their own needs". The notion of intergenerational equity, while appealing is not consistent with human behavior which tends to favor immediate consumption over deferred gratification. The future is uncertain, stock prices can crash, or inflation may devalue savings, so most opt to consume in the present.

In the 30 years since the Brundtland Commission the world has grown from about 4.5 billion people to about 7.3 billion people, representing a more than 60% increase of the global population with only modest progress in addressing the large issues of environmental sustainability. It appears that population growth and its attendant environmental degradation is occurring on a much faster time scale than the policy response time scale.

Why is the assimilation of scientific knowledge into policy slow? First of all, science works relatively slowly. Typically, the accretion of scientific knowledge takes considerable time. Despite the fact that technological advances can appear to be revolutionary, they are often based on the creative intersection of separate areas of knowledge that have slowly merged into a new field of application. Moreover, the process of repeatability and the emergence of a consensus in the scientific community about the validity of novel findings is time consuming. Secondly, the channels between science and policy are very noisy – there are many different individuals and institutions that claim to speak for science, often with different voices, different agendas, and different purposes. And thirdly, policy makers need broad syntheses while most scientists work on narrowly defined problems. Most scientists are not well trained in presenting the sorts of broad syntheses that aid policy makers in formulating approaches to major global problems.

So, it is essential that the science community become more effective in communicating appropriate evidence-based policy options on sustainability and poverty eradiation to governments and decision-makers. In formulating an advice strategy, it is important to understand that most environmental policy decisions are made at the local or national level. There is no global system of governance that drives changes in sustainability and poverty eradiation policies, so we must be able to influence the policies of individual governments one at a time. The need to work with many countries and many levels of government leads to the final point of this presentation and it concerns the power of networks.

The global scientific community has created networks of science academies to address global and regional issues. Most countries have science academies and these institutions can play a powerful role in offering advice in the context of their own countries and cultures. Global organizations like the Global Network of Science Academies (IAP) can and do aid local academies in advancing science-based options to local and global challenges. Because academies are respected local institutions that often include the science leadership of a country, they can reach high-level decision makers and influence policy on key issues.

The science academy network for the Americas is the InterAmerican Network of Academies of Sciences (IANAS); an organization created in 2004 that is comprised of the science academies of South America, Central America, the Caribbean and North America. It includes 22 members and it has led to an ambitious cooperative program aimed at advancing human and natural resource development in the Americas. Two of the original architects of IANAS were Hernan Chaimovich and Marcos Cortesão of the Brazilian Academy of Sciences. Today IANAS is largely supported by its member academies, the Mexican Academy of Sciences which hosts the Secretariat and the IAP. So, this is very much an organization that has been led from Latin America, but includes the entire hemisphere from Canada in the North down to Chile and Argentina in the South.

What does IANAS do? IANAS addresses several key global challenges where each national academy reaches out to national and local policy makers. For example, a major challenge in every country of the Americas is to manage the quality and quantity of increasingly limited water supplies. The IANAS network has focused on this key sustainability challenge and it has worked to inform policy makers by publishing a hemisphere wide evaluation of water resource challenges. A unique book in Spanish and English (Diagnóstico del agua en las américas) provides a country-by-country assessment of water challenges and it provides local recommendations for action. The IANAS Water Program has just completed a sequel volume on Urban Water Challenges in the Americas (also in Spanish and English). The American hemisphere is among the most urbanized regions in the world (>80% according to UN statistics). We rely on water for essential services including food production, sanitation services and health. Managing water resources effectively is one of the great sustainability challenges of the 21st century. These IANAS assessments offer policy makers in every country a view of local challenges and an opportunity to compare solutions across nations, thereby advancing the spectrum of approaches to sustainability.

A recent sustainability problem that is also intertwined with the challenge of poverty eradication is the proposed transoceanic canal though Nicaragua. In November 2014, the Nicaraguan Academy of Sciences with support from IANAS and from the International Council for Science Regional Office for Latin America and the Caribbean (ICSU – ROLAC) held an international workshop to identify the sustainability questions presented by the development of a trans-oceanic canal through Nicaragua. The results of the workshop have received wide press attention, including CNN and Bloomberg news, as well as extensive coverage by the local press in Nicaragua. The findings of the workshop can be viewed and downloaded from the IANAS web site (IANAS.org). The canal project presents important threats to the largest fresh water lake in Central America and it will displace many

indigenous peoples. At the same time, it could help one of the poorest countries in the Americas advance its economy. Careful studies are needed to both minimize the threat to Lake Managua and to develop strategies to insure equity in the distribution of the economics benefits from the canal project. This is an excellent case study where both social and natural science has much to offer in shaping policies associated with a major project.

IANAS also focuses on human resource development as a means to advance poverty eradication. A major focus is on the advancement of women in science. One project aimed at a larger public awareness and at attracting young women into scientific careers, led to the publication of a book of biographies of distinguished women scientists from most of the countries of the Americas. The book of biographies is available for free in both Spanish and English on the IANAS web site and has received many thousands of downloads. IANAS has also worked to advance science education in the countries of the Americas. Education and careers in science, engineering and health are keys to poverty eradication and empowerment.

The cooperative network approach is powerful, and it works to connect the science community across national and regional boundaries. Moreover, working together science academies are able reach national governments and to aid them in addressing critical sustainability and poverty eradication issues. The science academy network approach is in its infancy, but it has achieved tangible results in a short time and shows great promise for the future.

Science for Poverty Eradication and Sustainable Development - Global Views

Hernan Chaimovich (Institute of Advanced Studies/USP and Brazilian Academy of Sciences)
Conference

It is an honor and a pleasure to participate in this important Meeting. After Dr. Jeffrey Sachs' Conference, there is very little to add, but since I was in the program I have to add something I am going to touch, hopefully, in my allotted time on 6 points, that is two points a minute.

It was not only a pleasure, but an honor to listen to Jeffrey Sachs because his view is global and I think that one of the things we are missing in dealing with policy is instead of worrying only with urgent details, produce global views that can be translated in a language such as that, not only politicians understand, because that should be one of our focuses, but the other stakeholders, like the people that are suffering from climate change, that are suffering from poverty, and that are our natural allies in this global fight for sustainability. The points I want to add to the magnificent presentation, is that in the Africa case, there's an added problem; apart from the population explosion. The shape of the age pyramid is not supposed to change in the next 40 years, and that is a problem, or a solution, which is different from population growth, but can determine the pathway and can probably be one of the added causes for either stability or instability in the region. I think that the both problems are different and should be tackled by the world together.

Another point I want to add, is the example of Brazil. Brazil has been regarded- probably 6 years ago- as a very peculiar country that had about 60 or 70% of the energy from renewable sources. There was a global discussion whether our way of dealing with bioenergy was opposed, or not, to our way of dealing with food production. Land use was presented as a big problem 8 years ago; there was intense discussion especially coming from some scientific organizations from the US and Europe, affirming that the Brazilian model for sustainable growth was impossible because it placed food production in conflict with bioenergy production. From the Science point of view that apparent conflict is unimportant nowadays. The Scientific Committee on Problems of the Environment (SCOPE) and Brazil have just had a very important meeting a couple of months ago in Paris, and the final document was very clear. Properly managed from the technological, policy and economic points of view, there is no contradiction between land for food, and land for bioenergy. Those are the two comments I wanted to add to the magnificent presentation of Dr. Jeffrey Sachs.

The second point I want to make has been made by Mike Clegg. We have worked together for the last, I don't know how many years, so I'm going to repeat something of what was said. I think that we have seen and listened a lot about technology. I want to emphasize that more fundamental science is needed in order to face problems that are extremely complex, and that are only solved by the present technologies to a very limited extent. And I'm going to give you 3 examples:

One, the CO2 problem. We are thinking inside the box in terms of CO2 sequestration. New science is needed because we don't understand completely, how does CO2 hydrate. Very simple problem. If we don't understand how CO2 hydrates perhaps we'll be using in-the-box technology thinking to take the CO2 out of the atmosphere. And mind you, if we don't decrease the amount of CO2 in the atmosphere, the future generations may be doomed. It's not a question only of decreasing emission, but it's a question of decreasing the concentration of CO2 presently in the atmosphere, that has reached the numbers that were shown, and are absolutely, absolutely unsustainable.

The other example is what was mentioned – the rise, the explosive rise of the cellular phone that makes all of use happy. Without quantum mechanics, that was discovered in the early 1900's, there wouldn't be any GPS possible. Of course, I understand and scientists at that time were not thinking of the cellular phone, but it would be quite difficult if not impossible to have the cellular phone system without understanding the quantum mechanics behind it, and the problem of having a GPS, which by the way is a total mystery to humanity, with very few exceptions.

DNA sequencing is another example. If you look at it carefully, why has the price decreased by orders of magnitude in such a short time? The answer is extremely simple; new chemistry. It's the new chemistry that has allowed different types of sequencing and probably we will get another factor of 100 in a couple of months from now but that is going to go even further down. It is expected that in about 5 years, that cost of full sequencing of any person´s genome will be down to about $US 100. So, more fundamental science is absolutely essential because present technology can only solve a limited amount of problems.

Now we come to the third point, which is probably one of the most difficult questions that we scientists face. And that is, how do we integrate, science, technology, policy, and stakeholder interests? We have been extremely effective, increasingly so, to integrate science and technology. Whether it is pull or push this is coming very fast, and even cultures that were accustomed to separate science from technology and live in an ivory tower are breaking those bonds, those frontiers, and the integration of science and technology is now a reality essentially everywhere in the world. Linking those two things to policy is something totally different, and it's even more difficult to link science, technology, policy, and define stakeholders. Because as long as we keep defining stakeholders as those that will own the technology, as long as we keep separating the people that are suffering from the effects of global change and poverty, from the science, technology, policy discussion, it's going to be extremely easy to have a science technology policy that is pervasively against a social demand, which is different.

Point number 4 is the role of the academies, professor Michael Clegg has described that, I just want to add on the effect of IANAS, the InterAmerican Network of Academies of Science, in the case of Nicaragua. I don't know whether you are all aware, the Nicaraguan government is building a transoceanic canal Nicaragua doesn't have diplomatic relations with China. However, a Chinese company, and a company in Nicaragua, are starting this month, to build an inter-oceanic canal that will link the two oceans, and nobody really knows what's going to happen with the ecology, with the Mesoamerican corridor for species migration, for the Atlantic to Pacific biological flux, and so forth. Invited by the Academy of Sciences of Nicaragua, with the support of IANAS and the International Council for Science (ICSU) scientists from all over the world were invited to Nicaragua not to interfere into an independent government, but to raise scientific questions[4]. I think that that is a very important role for the academies; to raise the fundamental scientific questions. But to raise fundamental questions that have a very clear and solid scientific base and are stakeholder-related. Not only from the technical point of view but protecting or thinking about who's going to be affected by the scientific or technological change – I think the workshop in Nicaragua is a good example.

All this brings me to ask, how are we going to ensure something that was clearly proposed in a document, signed by Professor Jacob Palis, about 8 years ago: Inventing a Better Future[5]. The document states that every country, and everybody, has the right to understand what is happening in the world today when you think of science and technology. If we don't ensure scientific literacy all over the world, it's going to be extremely difficult

[4] Scientists Raise Alarms About Fast Tracking of Transoceanic Canal through Nicaragua. Available at: https://pubs.acs.org/doi/abs/10.1021/acs.est.5b00215.

[5] Available at: http://www.interacademycouncil.net/24026/25995.aspx.

for the people to demand knowingly for their rights without being scientifically literate, and without this condition sustainability is lost. This condition is not a long-term project, it is as urgent as everything that has been said today, because policy makers worry about voters. And if the voters don't understand what the issues are, it's going to be very difficult for the policy makers to respond only to the demands of the scientific community.

I want to end by agreeing totally what has been said, I'm not going to repeat of course, that we live in a multipolar world. And it's in that world, and China and the United States were mentioned, that there must be a hope for this region. The Americas must become an actor on the global scene in not a very distant future. Certainly Brazil, with the neighbors, have a responsibility to come within that club, because a mono-polar world, or a bi-polar world, still doesn't give space to this continent. And so, we have a responsibility as scientists, as citizens, as informed people, to make this continent an actor in a multi-polar world, to go and to try for a governance which is different than that that was created in 1945. Having said this, I think this meeting is a most wonderful occasion for the Academies to have the conscious of their role in a multi-polar world that is not sustainable if things go the way they are.

Reflections on the IAP-SPEC Conference "Science for Poverty Eradication and Sustainable Development: a Call for Action"

Tim O'Riordan (University of East Anglia)
Conference

This meeting took place at a critical time for science. We should capitalize on this opportunity if we are to make the best use of the hugely experienced participants' knowledge and active support, as well as the BAS/IAP commitment to a call for action.

This briefing seeks to make the case for extending global change science into an emerging global science for sustainability. One of its primary tasks would be to eradicate poverty which is the overwhelming priority of the commitment to sustainable development goals.

Global sustainability science is grappling with three challenges.

First: this science has to prove it is credible. Credibility means that science-based evidence is overwhelmingly unavoidable, and that this is communicated in such a way as to convince and to persuade. Critical to credibility for global sustainability science is that this process is conducted in such a manner as to enable all target audiences to feel they have a say in the interpretation of the evidence, along with its policy requirements and their behavioral expectations and ultimate support. A credible science is a conversing and engaging science where all participants reach a common understanding and accept any resulting calls for action. This has not entirely been the case so far. Nowadays a media savvy public is becoming aware of the ideological and evidentiary disputes which underlie global change science. Global sustainability science is grappling with issues which depend not simply on public understanding and cooperation. Credible and participatory science translates into accommodative shifts in policy regulation and behavior. This hugely alters the longer-term predictions of current evidentiary trends. Thus, a credible science strengthens the bases of predictive accuracy and narrows the "fan-spread" of contingent policy and behavior-dependent outcomes. Such a relationship crucially underpins the progress of global warming and future patterns of biodiversity losses over the coming decades and beyond.

Second: this science is currently facing huge uncertainties in its predictions of future states of society, environment and economy, as well as the institutions of governance and the role of culture. These weaknesses in prognoses can undermine the confidence of politicians, business people, active citizens and the media in the value of global change science as t is currently practiced. Global sustainability science is also tackling ways of profoundly challenging ways of measuring and assessing fairness of treatment for present and future generations because it does not have adequate means of acquiring all the relevant evidence. But critically much of what it has to predict depends on changes in the ways the institutions of governance wield their power, and on human behavior, and all of this is turn depends on the credibility of science. The emerging global science of sustainability and poverty eradication seeks to create and compassionate outlook and a moral framing, empathetic to culture, which ultimately should embrace all citizens.

Third: this science may well have to be both to be doom-mongering to justify being listened to, and optimistic to be identified with. But in each case science has to act with credibility. We are entering a period of "awe and shock". We are awed by the potential power of the human species to transform and to degrade the life support functions of the planet. But we are also capable of being sufficiently shocked by the consequences of continuation that we are nudged into taking appropriate action. Thus, it is very timely for any action plan.

Global sustainability science can act in the following ways to combine a plan of action for eradicating poverty within a framework of sustainable development.

First: It can become even more open and accessible. The reason for public skepticism is that for many nowadays this science is tainted by politics, by business and by commercial dependencies, and by approaches which favor managerialist and technological advances without seemingly taking into account the "wake" effects on skills development, personal confidence building, and resonant supportive behavior changes. This weakens its perceived capacity to acknowledge the vast and slow-moving shifts in moral outlooks and societal behavior adjustments which have to accompany such approaches.

Second: It must address emerging social anxieties and frustrations. Vociferous elements of the public are becoming increasingly skeptical over the failures of democratic politics; over the seemingly answerable economic determination of governance and the markets to carry on with more of the same; and of the failure of national governments to preside democratically over global economic and political structures that appear overwhelmingly dominant. Add to this that many young people all over the planet are scared of the very real insecurity for their economic and social futures. They feel left out, abandoned and increasingly unemployable. We are in danger of creating a "lost generation" forced to live with relatives, increasingly impoverished, and growing in resentment, especially over what they regard as "unacceptable inequality". Furthermore, such young people (and especially young men who are in a majority over future female spouses) are quite capable of damaging their mental and physical health, of criminality, and of social intolerance. At the very least this is a recipe for high future social costs. But it could be a basis for social migration and convulsive economic disorder. We are in a new age of uncertainty and insecurity especially for current 18 to 30-year old. Relative poverty is increasing not decreasing: inequality is growing, yet global sustainability science seems silent in the face of these momentous changes. We face an emerging "new poor" to add to the existing "old poor" which is the prime target of any call for action.

Third: this science needs to address ways of understanding the factors which shape both existing poverty as well as the emerging poverty which are found in combination in every country. Trying to grow economies in the present age and maintain sustainable development is just not possible. Such a move would require redistribution of wealth and natural capital availability on an unimaginable political scale. The poor cannot progress unless they are targeted for specific capacity building. Yet for most of the "two poors", capacity building is not taking place, especially for women. If ever there is to be poverty improvement, then women need to be freed and enabled to flourish. What may be especially important here is a contribution from this extended global science for sustainability to assess and audit the outcomes of the new science and technology for sustainable development for the wellbeing of the "two poors".

Fourth: this suggests a role for a different science. We are talking of a science of engagement as well as a more conventional science of data brokering and massive data analysis. This is a science which seeks information from communities and from civil data gathering. A crucial role for this science is to train people to become "civic research agents": the best and most reliable sources of scientific information especially for identifying their interests, their fairness of treatment, and their hope. If you want to know about non-sustainable use of resources such as fishing and forestry practices, ask such people. If you want to know of hazard and vulnerability and how to assess hazard proneness in land use and buildings, ask such people. This community-driven science could be enhanced by the use of GPS-linked phones and tablets, together with advances in meta-data gathering and analysis. Right now, such a valuable addition to science effectiveness in constrained by limitations in training. But it is also restricted because there are few incentives in place to enable such data gathering (which would cover social and personal attitudes and propensities for behavior change as well as physical and biological data) to create social enterprise companies and "start-ups" for the "two poors" to be socially valuable and incentivized to earn an income.

Fifth: this science needs to address two emerging generations. One is the researcher; the other is the school pupil. For the global science of sustainability to succeed the next generation of researchers should be comfortable with both specialized disciplinarity and open-ended interdisciplinarity. This adaptive learning should also extend to ways of measurement and of auditing changes in such challenges as the distribution of fairness and flourishing arising from any set of policy prescriptions. The researcher should be trained to be an ambassador for any peaceful and equitable transition to a more sustainable state. This in turn may mean periods of learning in business, government civil society organizations and community groups, particularly amongst the "two poors". Ideally the researcher, and indeed all graduates, should be role models for the kinds of leadership integrity which will prove vital for any successful eradication of poverty. Leadership integrity means having the capability to inspire others to acquire the strength to carry on when confronted with resistance and skepticism. All of this is leading to new patterns of learning. The student becomes the teacher and the teacher shares the learning. Modern communications technology enables students to create learning networks across cultures and disciplines. Schools in the developed and emerging economies are already creating a new breed of "eco-entrepreneurs". Such people are so important for sustainability ambassadorships. But this exciting development is very confined: it certainly does not extend to the schooling for the "two poors". Part of the role of this new global science for sustainability would be to work with teachers and pupils throughout the world to develop such capacity set in patterns of culture and social relations, suitably adjusted to accommodate.

Sixth: this science should seek novel ways of financing the transition to poverty eradication and sustainable development. There are already many discussions around the "Tobin tax" and various forms of socially responsible investment to make a promising, if inconclusive, start. But a key element of this plan for action should be the creating of a "contribution" from all forms of development. This would range from commodities extraction (such as oil and gas to mining to forest removal and water resource depletion); to any infrastructure and buildings; to products (such as food and pesticides) which affect ecosystem functioning and social wellbeing. These contributions would generate funds to restore the fabric and reliable functioning of both ecological robustness and resilience (sometimes referred to as "natural capital") and social cohesion and cooperative and compassionate behaviour (sometimes referred to as "social capital"). It is unwise to think of this as a tax or a levy as these are not the messages to convey. We are talking about a supportive contribution from all aspects of "development" to restore and to enhance the fundamental building blocks of sustainability. These are the continuation of ecological and geo-physical evolution and the preparation of a humanity which cares for itself and its future offspring by bestowing on them the moral framing and empathetic behaviour set within supportive cultures and social structures. The point of this briefing is that through the attention to the kinds of actions offered here, it should become possible to begin the process of calculating such contributions as well as designing ways of fairly and justly redistributing the funds. Such an agenda is massive and daunting: it should be addressed at the Financing for Sustainability Conference to be held in Addis Abba in July 2015.

Seventh: these points form the basis of an action plan for the eradication of existing and emerging poverty to be adopted by the International Academy Panel and led by the Brazilian Academy of Sciences. This briefing has argued for an emerging global science for sustainability which is credible, participatory, just, capacity building, enterprise creating, and preparatory for a future generation of researchers and citizens ready for sustainability living and sharing. There is scope for creating a small working group systematically to open out these proposals, to add to them and to amend them, and to forge a basis for an IAP commitment to an effective global science for sustainability that not only addresses the eradication of existing and emerging poverty. It should also help to shape, to coalesce (where relevant), and to audit the passage and conduct of sustainable development goals at all points on the planetary surface.

Science and sorcery

Julian May (University of Cape Town)
Conference

In addition to the presentation just made by Prof. Sachs, and the comments of my colleagues, I will draw on other discussions that have made a strong impression on me over the past few days.

Let me start by returning to the call to action that the organizers have asked for.

We need to decide whose action we are calling for. I guess science academies, scientists, funders of science and users of science;

We will need to decide upon what action we are calling for. I guess for more support for the scientific analysis of poverty reduction and sustainable development, and the use of such analysis as one source of evidence for decision-making.

So far, so good but we do not have science if we have not tried to frame the problem that concerns us. And if this article in the Economist mentioned by Prof. Sachs is anything to go by, do we still have a problem to solve?

Prof Sachs thinks so, and I agree with him: I would like to suggest that our problem might be phrased as:

The contribution made by science to the sustainable reduction of poverty is inadequate and is sometimes a cause of poverty production. As absolute poverty is morally unacceptable and economically inefficient and relative poverty is politically and ecologically unsustainable, further action by the scientific community is required.

I offer this image as my evidence. It is taken in what is said to be the most polluted place on the planet, the suburb of Agbogbloshie in Accra Ghana. E-waste, the detritus of ICT development, is burnt to extract metals. I have chosen this image as in the face of a jobs crisis, activities such as this are likely to be the future for many young people. I chose it because this is this is an unintended outcome of the technology that both Prof. Sachs and I think might bring about a reduction of poverty but is also bringing about the amplification of existing dynamics, some of which are negative, as well as disruption and re-configuration.

But perhaps this is not enough, and you are not convinced?

Ship breakers in India; homeless in Japan, and street beggers in Germany. In all cases, these are not poor people. I am willing to bet my dollar that they all earn more than $1 a day and would not be defined as living in extreme poverty? Are they the socially excluded? Or are they adversely included (du Toit) and the product of development rather than the "left behinds".

To answer this, I am going to distinguish two forms of poverty that have often been debated. The reason why this debate is important was neatly summarized by Peter Townsend during his debate with Amartya Sen:

"Any statement of policy to reduce poverty contains an implicit if not explicit explanation of its cause. Any explanation of poverty contains an implicit prescription for policy. Any conceptualization of poverty contains an implicit explanation of the phenomenon." (Townsend, 1979: 64)

We can identify other forms of poverty such as subjective poverty, multi-dimensional poverty, structural poverty, capability poverty and so forth. We could debate what is well-bring as do John Finnis and Martha Nussbaum, and I could spend time explaining why I think that $1, $2, $2.50 or $40 are poor tools with which to measure poverty. But I don't have time and so will not but wanted scientists to know poverty researchers do consider alternatives to moneymetrics.

So why is poverty morally unacceptable?

That is easy: below a certain calorie intake, we have a shorter life. We can covert this into the money required to buy calories, relate this to the well-known Preston curve that relates life expectancy to income, and come up with an ethically poverty line, which turns out to be above most international poverty lines (Edward). We can probably all agree that it is morally unacceptable that the lack of income shortens the lives of people living in world characterized by abundance.

Economically inefficient: also easy.

People who are poor have economically viable projects and are highly rational decision-makers. They have to be in order to survive. However, if the resources that they command are insufficient to translate these projects into sustainable activities that can survive stochastic and covariate shocks, economic opportunities will be

squandered, and their resources will be degraded. This is structural poverty, the dilemma of Mr. Micawber in Great Expectations: you can't get ahead for falling behind (Barratt and Carter). You adapt to have rational but not great expectations.

This gives us the bridge to relative poverty. And also brings me to my discomfort with the idea that we should commit ourselves to the eradication of poverty.

To again defer to Townsend, relative poverty refers to lacking "…the resources to obtain the types of diet, participate in the activities and have the living conditions and amenities which are customary, or at least widely encouraged or approved, in the society to which they belong." Where this does not take place…

Thus, what is considered to be widely encouraged or approved will affect preferences and behavior, and thus the threshold at which one is categorized is relatively poor.

There are several ways of doing this. The OECD approach is one way, the upper bound approach which using the cost of food and adds a non-food component another, and the consensual approach a third. Whichever approach is used, the notion is that relative poverty is much harder to eradicate than absolute poverty. Probably some part of the population will always been relatively poor, certainly if the OECD approach is used. If we commit ourselves to merely eradicating poverty, then we will miss this kind of poverty, and need no concern ourselves with the men and women that I depicted earlier.

My second concern is that relative poverty is politically and ecologically unsustainable: There was an interesting reaction to Linxui's suggestion that the Chinese should eat more meat. Although she obviously used this as a metaphor, I did a little arithmetic on the back of a digital envelope. If the Chinese like this idea and can afford it, and have the meat consumption of, say, Germans, we would need to harvest the equivalent of an additional 163 billion cows each year. If the Nigerians catch on to this, an increase their per capita meat consumption from 8.8 kg per year to 88 kg per year, we will need another 56 billion cows. And if we use current methods of intensive beef production, this will produce 22 billion kilograms of methane gas each year.

It is politically acceptable to say that standards that apply one group should be different from another? Do we need to question who it is that has the development problem? Japan or Nigeria?

As a South African who grew up in the era of apartheid, I would find that difficult to do. And as Prof. Sachs has pointed out, we are in a new era of geopolitics in which global apartheid would not be tolerated.

So with these examples, I would like to propose that as absolute poverty is reduced and eventually eradicated, development itself brings about dynamics that will undermine its sustainability unless we change how we behave. Poverty reduction deals with a wicked problem in which there is no finite set of solutions, solutions are impermanent, and solutions create more problems.

Yesterday it was said that scientists wear many hats and I must now take off my academic mortar and put on the balaclava of an activist in order to propose how we might achieve this.

For those of us that work with policy-makers on a regular basis, we have some tough choices to make in working how we will influence. Do we become a high priestess: a term that I read was used to describe Anne Glover, or a vizier or guru, terms that have been applied to Prof. Sachs.

I am sure that neither Anne Glover nor Prof. Sachs are comfortable with such terms and there is a lesson here for science. For most of us, our role is far more humble: at best we be might no more than horse whisperers. We whisper into the ear of the finance minister and cajole the Minister of Water Affairs. We lecture the public, scold them through our sermons and op-eds and throw bones with our scenarios. I certainly have felt like a village shaman hoping that a guru or high princess from the World Bank won't arrive wearing more exotic feathers to give examples of something that might have worked in Costa Rica or Uganda and so undo my efforts to influence? We are at risk becoming engaged in sorcery.

We need to more considered opinion formers ourselves, and the strategy for achieving this is something that we need to work out at this conference and whatever follows. To be effective, we will need to critically reflect

on why we are doing this, even if it means confronting some hard facts about ourselves as McGregor wrote about the poverty activists of the nineteenth century.

Finally, there is content of our call for action

I don't have a proposal for this, but I have been influenced by my current vice chancellor, Prof. Brian O'Connell of the UWC. He suggests that scientists concerned with human development should convey two messages:

- First, we need to persuade those living in high income countries that they must prepare themselves for a humbler future. We had a presentation yesterday on Japan which shows that this has started;
- And we need to persuade those living in low- and middle-income countries that they cannot seek to emulate the lives of those in rich countries. We must find other pathway to well-being.

I want to add a third:

- We need to persuade those in Africa, and those not in Africa that this continent is neither a basket case, nor a golden goose. It is a shared responsibility upon which our collective future may rest. We need interventions such as those described by Ernst, long term, fundamental and thoughtful.

To succeed, Like Prof. Sachs, I think that we need to step out of a narrow view of science, to the more embracing notion. The German notion of "Wissenschaft" might be a good point of departure. We need political scientists, political ecologies, political economists and the humanities to refine our research problems, improve our methodologies, collaborate with our analysis and interpretation, and share our messages. We cannot avoid the science of politics, and in this meeting, we have mentioned politics at least as often as science.

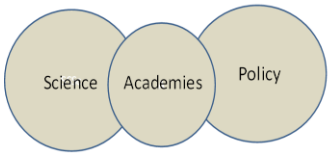
Related to this, we need to identify the weasel words that cloud our thinking and rid ourselves of these. Perhaps "holistic" might one such word. Eradication might be another.

We need to find ways of integrating toad's eye and eagle's eye research. Perhaps we can call this human's eye research. We need to be offering the science appropriate for the Anthropocene, the era in which human intervention is shaping the fabric of this planet and its future. We need to be more ambitious than eradicating extreme poverty.

A Call for Action: the Role of Science Academies

Bahru Zewde (Addis Ababa University)
Conference

As you can see from the title of my presentation, the emphasis is on the second rather than the first part of the theme of our conference. I felt that so much has been said about the first part and so much remains to be said about the second. Hopefully, as Tim O' Riordan mentioned earlier, this session will come out with some concrete recommendations on how to go forward. And also, I think it is in tune with the opening statement and the concluding segment of Professor Sachs's presentation – the scientific and the negotiating aspects of the role of science academies. This presentation pertains more to the negotiating rather than the scientific aspect and highlights the role that science academies in Africa have played and could play in the future in impacting on policy.



I will begin my brief presentation by sketching the interface between science, academies and policy. Then I will introduce some qualifiers that determine the parameters of my presentation. This is followed by a brief overview of the academies of sciences which I am representing here at both the national and regional levels, namely the Ethiopian Academy of Sciences (EAS) and the Network of African Science Academies (NASAC). I will also raise the various issues that have been raised by sister African Academies of

Sciences that pertain to the issues that we have been discussing these past three days.

What we have is a very crude diagrammatic presentation of the interaction between the three spheres of science, academy and policy. As you can see, academies occupy an intermediary role between the two spheres of science and policy, serving as agents of translation of science into policy. Very much along the lines of Michael Clegg, I would argue that academies are ideally positioned for this, partaking as they do of both worlds. Most members of academies come from the scientific community; at the same time, they do have fairly good access to policy makers. In our own experience at EAS, we often discover that some of the ministers and other government officials were actually our students; so, we have a possibility to interact with them intimately. It does not mean that they follow everything that we tell them, but at least they approach us with the understanding and belief that we do not really have any hidden political agenda.

Thus, academies can play an important role in translating science into a usable package, packaging science for the benefit of policy makers so that they would implement the scientific recommendations and findings. What I am going to do in this presentation is to identify certain issues that African academies of sciences have identified and have taken positions on after careful examination and then tried to convey them to policy makers. Before I do that, I have to make the following qualification. When we say science, it has to be understood as the sciences in the plural. Tim O' Riordan was very passionate about interdisciplinarity in his presentation. I am equally passionate about it; EAS has also been very passionate about it. It has always said that all the sciences, including the humanities and the social sciences, have a bearing on the resolution of national and regional problems. You can just mention a few issues like nutrition, climate change and so on. These are things that you cannot try to address by deploying just one particular discipline; you have to employ all or deploy a vast array of sciences.

My presentation is going to be more empirically oriented than theoretical. In the previous sessions, we have had some very heated discussion about this issue of poverty eradication. I think we will probably have to come to some kind of consensus on the issue. If by poverty eradication we mean extreme poverty, it makes sense. Otherwise, poverty has become such a relative term that the possibility of eradicating it altogether does not seem to be a likely proposition in the near future. At any rate, we have to be very clear about the issue and I am glad that the debate has continued also in this session.

On the question of sustainable development, I would like to thank Professor Sachs for giving us a very succinct and very helpful definition. I would like to particularly underline the term holistic. I think this is an important qualification. This is particularly important for Africa, which has seen some of the most remarkable cases of economic growth, with a number of countries, including my own country Ethiopia, in the fastest growing economies category. Economic growth is meaningless unless it comes down to the ground. The reality in Africa is that there is not really much to be seen in terms of changing the lives of the common people. There are many issues – such as wealth distribution or the problem of social exclusion, the population dynamics that was mentioned earlier and so on – which make it really difficult to equate economic growth with sustainable development. I also think that we should really include in that definition the political element, the issue of governance. In other words, there are social, economic, environmental, and political considerations that we have to bear in mind when we talk about economic growth. As we know, most African countries suffer from poor governance – including corruption, authoritarianism – which makes it difficult to really attain the kind of sustainable development that we hope to achieve.

I am going to address the topic of my presentation from the perspectives of the three organizations that I have been involved in closely – the Ethiopian Academy of Sciences, the Annual Meeting of African Sciences Academies (AMASA), which have been taking place since 2005, and the Network of African Science Academies (NASAC), which has been in existence since 2001 and which currently has 21 members.

Every year (almost invariably in November), African Science Academies meet at changing venues to discuss an important issue that affects Africa. Just a month ago, in November in Uganda, we had a very lively discussion on the issue of country ownership of the post-2015 development agenda and came up with a series of recommendations to African governments. These recommendations were made on the basis of a very thorough study of the subject of country ownership in Africa. The study was commissioned by the International Organizing Committee of AMASA 10, as the particular edition of the annual meeting was known. The study group came up with five major recommendations, identifying five measures levels of development: community engagement,

(i.e engaging the traditional communities), education, health, capital (broadly defined, not only financial capital but also resource capital and technology capital), and institutions (as distinct from leaders).

As you know, so far, the reality has been that Africa has been more or less forced or urged to adopt a developmental agenda that is not of its own making. These have generally come from outside, whether it be the notorious Structural Adjustment Program (SAP) imposed by the World Bank or the more benign Millennium Development Goals that are reaching their terminal phase. So, the issue now is whether Africa has to continue to adopt these prescriptions that come from outside, or whether it should craft an agenda suited to its own particular conditions. Put another way, how does Africa customize the global agenda of sustainable development goals (SDGs) to its own peculiar condition?

Another issue that has much preoccupied African Science Academies has been climate change. It was the theme of AMASA 8 (i.e. the eighth edition of the Annual meeting of African Science Academies), held in Abuja in 2012. As is the custom with these annual meetings, it came up with a declaration to be conveyed to respective African governments. Even if they would not implement all the recommendations, they should at least be aware of them. The declaration particularly highlighted the paradox of the low emission of carbon gas by Africa and the fact that Africa bears a disproportionate burden of its consequences, with especially injurious impact on agriculture and health. It also identified the role of Science Academies in engaging African governments to cope with climate change.

A continuation of this focus on climate change is the establishment by the Ethiopian Academy of Sciences of the Ethiopian Panel on Climate Change (EPCC) about a year ago. The panel is very much modeled after the International Panel on Climate Change (IPCC). It is intended to supplement and amplify the IPCC country reports pertaining to Ethiopia through findings from local sources by local scientists. The panel has been engaging sixty-six scientists from all the disciplines, including the social sciences, physical sciences and agricultural sciences. Only two weeks ago, EAS held an important workshop to discuss the preliminary report of this panel.

Water has been another important preoccupation of African science academies. The pressing issue of water and health was addressed by the 3rd Conference of the African Science Academy Development Initiative (ASADI), the precursor of AMASA, in 2007. Earlier this year, NASAC (the Network of African Science Academies) came up with a very important document on water entitled "The Grand Challenge of Water Security in Africa", with nine key messages which it has been trying to convey to African governments and the African Union. As a matter of fact, if you look at the NASAC website, you will see the Chair of NASAC presenting the document to the African Union Commissioner in charge of Science and Technology. The key messages of the document include: the importance of water for food, health and energy, the nexus between the three elements, the need for providing access to safe water and sanitation for poor people in particular, managing trans-boundary water systems (an issue that we discussed two days ago in this conference), and the issue of financing.

Biotechnology is another theme of the AMASA meetings. This was the theme of the conference that was held in Addis Ababa in November 2013. As you all know, there is an ongoing debate on the subject which has generated more heat than light. In particular, there has been an impassioned objection to the introduction of biotechnology. African science academies therefore in effect said to themselves we cannot be taken in by this kind of debate, we have to examine it scientifically and see if it can be useful. It was a very free, open debate – not taking either this side or that side but trying to identify what the benefits and drawbacks of biotechnology might be. Eventually, as all AMASA meetings do, AMASA 9 came out with a declaration, calling, among other things, for an objective assessment of the benefits and challenges of introducing biotechnology, relaxing the policy environment for biotechnology research, and establishing regionally biotechnology networks and strengthening those that already exist.

I talked earlier about the close connection between the Academy's leaders and the government (or the political leaders). The conference was opened by the Ethiopian Deputy Prime Minister, who was actually a student of one of our Fellows. More significantly, the conference and the ensuing declaration appears to have had some impact on the government, as one can see from the serious efforts it is currently making to revise the rather restrictive biosafety laws that have been in force up to now. Thus, there is a distinct possibility that the door will be opened for research in this area.

My final point has to do with an emergency situation, namely coping with the Ebola epidemic. You might think it is of an episodic nature, but it shows what science can do to increase public awareness, to promote an intelligent understanding of an epidemic. One of the things that we have noticed about the current Ebola epidemic is the hysterics and the panic that have prevailed. There is really no rational discussion, no attempt to understand the problem in an objective manner. The other day a Nigerian colleague told us about the quacks that have been making a lot of money and, unfortunately, killing more people with their concoctions than Ebola has been doing. So, there is a need for public awareness and science has a role to play in such situations. That is why the Ethiopian Academy of Sciences and the Ethiopian Public Health Association got together to organize a very well attended public discussion on the subject. I talked earlier about interdisciplinarity. What is very interesting about the discussion was the social dimension of the epidemic - in particular the class and gender dimension of the Ebola epidemic.

The above are some important ways in which African science academies have been playing an important role in translating science into policy.

Poverty eradication and sustainable development

Hyun-Ku Rhee (Seoul National University)
Conference

First of all, I would like to thank the organizers for inviting me and giving me this opportunity, and also for the wonderful hospitality.

I am quite confident to say that Korea and its people, based on their past experience, are probably one of the strongest supporters of the MDGs and SDGs, and we are anxiously looking forward to the Post-2015 SDGs to participate in the leading role in this endeavor.

Incidentally, the UN Secretary General Ban Ki-Moon is from Korea. There is no doubt in that he is highly respected, and we would like to give him a very strong back-up along with Prof. Sacks' endeavor. Korea, as one of the most rapidly developing countries, has been and is still considered as one of the role models for poverty eradication and sustainable development. I think, therefore, it would be somewhat useful and meaningful to many of you for me to present a brief overview of our experience in this evolution. Hopefully, Prof. Sacks may get interested in some of the features I am going to address here.

Now let me begin my presentation on our experience for poverty eradication and sustainable development and make some suggestions later on. I am going to first make a brief introduction, discuss the process of industrialization in the earlier days together with the R&D support for science and technology, and then move on to the human resources development, which is considered essential not only for the industrialization but also for the development of the country. Next, I will explain the Saemaul Undong, which is basically a new village movement for rural areas, and then sustainable development measures that we have been taking in Korea. Finally, I am going to conclude with remarks on what made it happen and how it did happen, and some suggestions on the Post-2015 SD Goals.

Korea is a small country in the Korean Peninsula, located between the gigantic China and the highly developed Japan. We have a long history of about 5,000 years, during which we had several kingdoms and dynasties, and the people had lived there peacefully, as the Indian poet Tagore described it as "the Land of Morning Calm". Early in the last century, however, Japan attacked Korea to occupy the Peninsula and ruled for 35 years. After independence along with the end of the World War II in 1945, the Korean War broke out by the invasion of North Korea in 1950 and the War lasted for four years. So, you can imagine that at the end of this Korean War, the country was really poor - one of the poorest ones in the world.

In 1961 President Park Chung Hee came into power from military but he has been well recognized worldwide for his great leadership for the development of the country. He clearly had a vision for the people and the country. As soon as he held the power, he set the national goals in two tracks; one was for national security. Because we were divided into two parts, we needed to put emphasis on the heavy and chemical industries including the defense industry. Then to get out of poverty, we had to pursue economic development, and this led to the export-oriented industrialization of the country. To accomplish these two tracks, we certainly needed

back-up from science and technology and human resources. President Park recognized this very clearly and put much effort for R&D support to promote the science and technology and for the human resources development (HRD).

Starting from 1961, we had indeed established a series of 5-year economic development plans and carried out those successfully for 25 years. Over this period, major manufacturing industries were developed step by step successively, nearly one or two industries in almost every decade; for example, in 1960's petroleum refineries and petrochemical industries to supply energy and materials for other industries and to produce fertilizers, synthetic fibers, engineering plastics and so on for mankind´s everyday life; then in 1970's, steel manufacturing and shipbuilding industries; Steel manufacturing certainly supported shipbuilding and automobile manufacturing; in 1980's, automobile manufacturing; in 1990's, semi-conductors; and then coming into this century, we became strong in displays and cell phones. During this process of industrialization, we provided those industries with a very strong support in terms of the science and technology by promoting the R&D activities. I will come back to this later.

At this moment, perhaps, I should point out that we first started by importing foreign technology on the turn-key basis; i.e., after completion of the plant, we were just given the key to operate the plant, but soon after we gradually began to absorb the advanced technology and then improve and/or upgrade the imported technology by ourselves; i.e., those excellent domestic engineers and scientists. Then we became so highly experienced that we were able to pursue independent innovation of technology within the country; for example, product innovation led to new industries while process innovation led to improved productivity. This is how we first imported foreign technology and then transformed it into our own.

As an example, I am showing here the original site where we have now the Ulsan Petrochemical Complex. We see that it was nothing more than a sandbank along the seashore except for some lands cultivated. Now there is a huge industrial complex; what about the sustainability or environmental aspect? With respect to air pollution this area is better than other big cities in the country and Taewha River flowing through the region is very clean with fish swimming in water. Later on, we moved to China and established again a huge complex in U Han by a joint venture project between SK Innovation and Sinopec of China.

As shown in the figure, by virtue of the export-oriented industrialization, the export volume had been increasing rapidly starting from 1964, when we had only $100 million for export. Within three years, the volume was tripled, then became tenfold to mark one billion dollars in a six-year period and within the next seven year period another tenfold to 10 billion dollars, and then within the next two years another tenfold to record 100 billion dollars. I would say the growth had been surprisingly rapid.

To give you some idea on how the economy in Korea grew over the past 50-year period I would like to present you a table showing the trends in economy and R&D indicators. The GDP that was mere $1.7 billion in 1963 reached now the level of one trillion 316 billion dollars that is the 13th largest in the world. Per capita income increased from mere $100 to $26,204. This year it is going to be over $28,000 and next year we expect to reach $30,000. Export volume, as I mentioned earlier, was extremely low in 1963 but grew to $560 billion last year. Along with this development the R&D investment also increased rapidly from four million dollars in 1963 to $54.1 billion last year, which is ranked on the 6th worldwide. The government support amounts to 27% of the total investment. The ratio of R&D investment to GDP reached now 4.15, which is supposed to be the highest in the world. The number of researchers also increased rapidly to more than 410,000 in 2013.

The next slide shows more dramatically the increasing trends in some of those indicators. The red curve represents the export volume and the green one for the GDP per capita while the blue one shows the number of researchers. We see here that after the induction period from 1960 to 1970 each curve picks up quite rapidly and each of the three indicators demonstrates a similar trend.

As mentioned in the above, the government strongly supported the process of industrialization by providing R&D investment to promote the science and technology field. A representative example would be the Korean Institute of Science and Technology (KIST), which was considered as the "National Symbol of Modernization". When President Johnson of the U.S. met President Park of Korea in 1965, he mentioned, "I am going to offer you a gift. What would you like to have?" Then President Park responded, "We need a research institute for science and technology." I would imagine that President Johnson might have been surprised quite a bit, but he

must have also been very much impressed. They then moved very quickly to establish the KIST only after two years? The Korean government made it a non-profit, private organization with full funding by the government and thus they were able to enjoy the full autonomy, which is very important for a research institute. This slide shows the scene where the two presidents got together in 1965. In the beginning they had only 50 researchers and most of them were invited from outside the country. The president personally called them back with substantially high incentives. Now they have 727 researchers and much larger annual budget of $270 million.

The role of the KIST in early days was to provide a brain shelter for national industrialization planning and to perform reverse-engineering mostly and cooperation in industrial R&D. It also assumed to be a role model of R&D management and the incubator of specialized government-funded research institutes (GRI); there are 27 spin off GRI's specialized like in chemical technology, biotechnology, nuclear energy, and so on. They have branch institutes in Germany and India and operate cooperative programs or hold annual symposia or workshops with many research organizations in other countries. They even have their ODA programs. In fact, Korea joined the DAC in 2009 and we started to help developing countries in various areas. The KIST runs the International R&D Academy; they have graduated 219 alumni from 34 countries with full scholarships on both M.S. and Ph.D. degree levels. They collaborated with the Indonesian Government to set up a pilot production plant for bioenergy. It was completed three years ago with $2.2 million investment. We then have the V-KIST project; it is the KIST in Vietnam, but Vietnamese want to call it V-KIST. This is a joint venture project of $70 million, half and half on both sides, and we just started to construct the institute this month. We are going to not only provide them with a master plan and training program but also pay for the construction as well as for the equipment. So, it is a full-scale cooperation project with the Vietnamese Government.

Next, how did we secure the human power we needed for the industrialization and R&D activities? First of all, there were fairly large pools of Korean scholars and graduate students mainly in the U.S. but in Japan and Europe, too. We called them back successfully to realize the reverse brain drain and they formed intellectual groups in various sectors within the country. On the other hand, the number of universities had been continuously increased; now we have more than 200 four-year colleges and universities and the enrollment percentage has been extremely high, probably one of the highest; i.e., 75% of high school graduates used to go to those universities. Usually the science and engineering schools attracted the top class of the students and they were the important human resources to create an excellent man power pool. Also, the government established the science and technology institutes such as KAIST, GIST, DGIST and UNIST similar to the COPPE in Brazil and also Science High Schools, Schools for Talented Students and Meister High Schools.

Along with the economic development via industrialization of the country the quality of life in urban area was improved remarkably; on the other hand, the life in rural areas did not catch up the life style in urban areas. With this in mind President Park Chung Hee initiated the so-called Saemaul Undong (New Village Movement) in 1970, which was a rural reconstruction campaign. This movement introduced the spirit of "we can do it" to the people in rural areas and persuaded successfully the people to believe in it. Thus, it was not a simple physical movement but it really touched on the mentality of the people in rural areas. The working principles were diligence, self-help and cooperation; it was quite obvious that without self- help there would be no way. The aim was to have a better life, not only for individuals but also for the people as a whole in the traditional communities. Having gone through several stages of development, this movement achieved a great success to reach now a stage of autonomous growth. Right after the initiation of Saemaul Undong, fortunately enough, we were able to generate a new species of rice; we call it "Tongil Breed Rice" symbolizing unification of Korea, and the production yield grew 40% more than that by the regular species. With this the problem of the people's hunger had gone away almost completely.

As a consequence, the quality of life in rural areas indeed became as good as those in urban areas. Naturally, the movement diffused out to urban areas, which is a very interesting phenomenon, so it became a nationwide movement and the leadership was transferred to a private organization instead of government-driven as in the beginning. In recent years their activities have become globalized along with the ODA programs. Most notably, they operate the training programs for Saemaul Undong leaders from different countries. So far, they have trained nearly 50,000 leaders from 103 countries either in Korea or in their respective countries. Currently, the focus is on Rwanda, which has been so successful over the past 10-year period, and Laos, and then Myanmar will come into the scene very soon. Incidentally, in China they also started the Socialist New Countryside Construction Project that appears to be very similar to Saemaul Undong.

Now I am going to show you a series of slides presenting some of the typical activities of Saemaul Undong. The first slide shows the villagers carry cement blocks, ladies on their heads and men on their backs, to construct or repair the infrastructure in their own village. Of course, the materials were provided by the government. In the second we see the villagers work together to construct a new bridge by themselves and then we see the villagers, men and women together, clean the roads in their village. Next slide shows the villagers cooperate to cultivate their farm lands, and then we see the children and young people studying in their village library and the children having their evening class outdoors. In this 7th slide we see a well-developed new village along a river with a freeway passing nearby and the last slide shows a scene of a classroom for training Saemaul Undong leaders from abroad.

In terms of sustainable development, we have been putting our emphasis on several measures. The first one is concerned with the low carbon, green growth policy, including the green car (Electric vehicle, Hybrid EV and Fuel cell car) together with secondary batteries and fuel cells, and solar power and wind power, etc. We have introduced the emission trading scheme to be practiced starting from next January. We have attracted the Secretariat of the Green Climate Fund to Incheon, Korea while the Global Green Growth Institute, which was established in 2010 with its Secretariat in Seoul, has been playing the central role as a bridge between developed countries and developing countries for the green growth policies and strategies. We also operate the Green Technology Center to develop related technologies and transfer them to those developing countries in need.

Over the four-year period from 2009 to 2012 we carried out the Four Grand River Restoration Project; restoration of the main streams was completed but upstream branches are to be restored yet. Another feature is involved with the nuclear power plants (NPP); currently we have 23 NPP's in operation, five more are under construction and we have a fixed plan to design and construct six more NPP's until 2024. The National Plan for Energy Development proposes to have eight more NPP's by the year of 2035 and then about 29% of the total electricity demand will be generated by nuclear power plants. The current government of Korea has brought in the "Creative Economy" as the major economic development policy; this is concerned with the ICT enabled technology and business. President Park Geun-hye recently announced to establish "The World Peace Park" inside the DMZ. Another important subject to be mentioned is the expansion of the ODA program. We spent $1.74 billion last year to help less developed countries around the world in various areas and the ODA fund is expected to increase further to reach the level of 0.15% of the GDP next year. Currently, the number of countries with major emphasis is 12 in Asia, 2 in Middle East, 8 in Africa and 4 in Central and South America, respectively.

At this point I would like to bring your attention to the issue on "What made such a remarkable development happen?" and "How it did happen?" Perhaps, the answers could not be described in any condensed form of writings but I may suggest to sum it up as follows: (1) Outstanding vision to the future and well-designed long-term strategy; (2) Strong leadership and government-led drive; (3) Establishment of a brain hub; (4) Good "Plan" and consistent "Do"; and (5) Presidential pledge of substantial R&D investment for science and technology.

Finally, let us return to the subject of Post-2015 Sustainable Development Goals (SDGs). The SDSN's view of architecture for SDGs suggests that, based on the foundation of security and good governance, it is important to deal with (1) Economic development and ending poverty; (2) Social inclusion; and (3) Environmental sustainability. We figure, however, that the environment can be improved along with economic development and that according to our experience economic growth with environmental sustainability is in line with the low carbon, green growth policy - a new paradigm for economic development. We may, therefore, argue that take off of economic development is the most important in this endeavor. The question is then how to set the take-off. For this we need to proceed with (1) Establishment of brain hub; (2) Education and training (human resources development); (3) Industrialization from which job creation will ensue; (4) Building the spirit of "Can-do" among the people; (5) Strong leadership and government-led drive; and (6) Consistent government policy and strategy.

Thank you very much for your attention!

Biotechnology for sustainable growth of Indian agriculture and poverty eradication

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Article

1. Introduction

India has the highest population pressure on per unit of land with current population of 1.2 billion. From the last five decades, fruits of green revolution could able to feed this population. However, with the fast growth in population there will be severe pressure on the natural resource base of land, water and bio-diversity by 2030. The condition will further worst with the massive increase in population, substantial income growth, demand of an extra about 2.5 MT of food grains annually along with increase in the need of supply of livestock, fish and horticultural products. Only sustainable green revolution can meet such challenges. Agricultural biotechnology is one of the potential tools in the hands of plant breeders to bring in evergreen revolution which will help in poverty eradication and malnutrition from India. The power of biotechnology has already been demonstrated successfully by the cultivation of Bt cotton over one and half decades in India. This report is focused on the status of Indian agriculture, present day challenges before it, beginning of biotech era in India and biotech products waited for entry in the Indian market for making it a hunger free nation. Thus, present article emphasized on how science-led agricultural innovations gave dividend to the Indian economy and how it has been helpful in the eradication of poverty.

2. Indian Agriculture

Agriculture is the oldest sources of livelihood in India. Plants and animals were considered essential by the Indians to their survival and therefore they stated to be worshiped and venerated. Indian agriculture is almost 9000 years old. Crops like wheat, barley, millets, rice, sugarcane, cotton, pulses and many fruits are cultivated in India. Historical records show that irrigation and mixed farming practices had been initiated in India date back to 4500 BC. Due to the reasonably good monsoon, two harvests per year was the norm of the country. Agriculture in India was also flourished with systematic reforms in farm practices. Land management practices were very strong under Chola and Akbar Empires. The Mauryan Empire (322–185 BC) categorized soils and made meteorological observations for agricultural use. Even during those days' irrigation was possible to increase agriculture production by building of big dams. Kallanai dam, which was built around 2000 years ago on river Kaveri for irrigation during Chola Empire, is one of the great examples in the world.

Under British rule Indian agriculture went global with cotton, indigo, opium and rice entering in the international trades. Irrigation by canal network was systematically established in Punjab, Narmada valley and Andhra Pradesh. Agricultural production expanded at an average rate of about 1 percent per year by the later 19th century. British government established Department of Revenue and Agriculture in 1881 and one of the most important achievement of Indian agriculture was the establishment of Imperial Agricultural Research Institute (IARI) in 1905; which is now renamed as 'Indian Agricultural Research Institute' a deemed University. This institute changed whole scenarios of Indian agriculture. The Royal commission on Agriculture was also appointed in 1926 and various institutions for agriculture related research in India were organized under the Indian Council of Agricultural Research (ICAR). Agriculture performance during 1891 to 1946 was depressing having annual growth rate of 0.4% with stagnant food grain production. The situation was more pathetic in Bengal province. Production of rice in Bengal had below-average growth rates. The food grain output in Bengal declined at an annual rate of 0.7% whereas population growth was increasing at the rate of 1%. This results into most devastating famine known as, 'The Bengal famine 1943' not only for Indian Agriculture but for the entire world. Because of this, more than 2 million peoples died due to food scarcity. More than one million cattle either died or were sold off and 0.5 million people became destitute and life standard of nearly 4 million deteriorated (Mahalanobis, 1946).

After independence, the major challenge for Indian government was to feed millions of people. It could happen with the introduction of semi-dwarf varieties of wheat, which were developed by Dr. Norman Borloug in Mexico. Dr. MS Swaminathan introduced these dwarfing genes into traditional Indian varieties at Indian Agricultural Research Institute to make them semi-dwarf. These high-yielding varieties combined with modern agricultural production techniques brought "Green Revolution" in India. Along with the use of dwarfing genes, development

of irrigation facilities, availability of improved hybrid seeds, use of chemical fertilizers, proper pest management, availability of farm credit to the farmers and strong willpower at political levels were some of the reasons for the success of green revolution in India. After wheat, use of dwarfing genes in rice was another reason of self-sufficiency in India. Further growth of Indian agriculture was noticed in other agricultural sectors and we saw the revolutions in other fields like milk, fish, meat, fruit and vegetable production. From 1951 till date, total food production increased from 51 MT to 260 MT. Production of milk increased 8 times from 17MT to 127 MT and India ranks first in milk production. During this period fish, meat and egg production increased 11-fold, 8-fold and 27-fold, respectively. Poverty in Indo-Gangetic plain has decreased from 1973 and incidence of hunger has also decreased in this region. Similarly, life expectancy has increased from 57 years to 67 years. Thus, India having world's 2% of land, 4% fresh water is now feeding 16% of the world's population.

3. Challenges for Sustainable Agriculture in India

India has achieved a lot in terms of agricultural production in last five decades. India changed its image from 'Ship to mouth' to 'self-sufficient' country in terms of food production. However, there are many challenges ahead for Indian agriculture. The major challenge is its growing population. India's population was 547 million in 1961 and currently it is 1210 millions, which is further expected to increase up to 1620 million by 2050. There is huge gap between rate of food grain production and the population growth rate (Chand, 2009). Because of this growing population India´s Global hunger indexes (GHI) is also very high. According to an estimate around 62% of the world´s hungry lives in Asia and out of these 25% are present in India alone. The level of India's GHI is alarming among BRICS countries. Hence, India has a great challenge to feed millions of hungry mouths. Migration of people from farming business to the cities is another important issue because of which only 48% of the population will remain in the rural areas by 2050. Changes in climatic conditions is one of the biggest worries for India as most of the India's farming is still depend on the monsoon. Breeding program in various crops help to cope up with these challenges till today, but now some technological inventions are seriously needed for the drastic improvement in the crop production scenario.

4. Biotech era in Indian agriculture

During the era of green revolution, India was solely dependent on dwarf varieties of wheat and rice for cultivation followed by the hybrid technology which improved the yield potential in other crops. All India Coordinated Research Projects (AICRP) run by the Indian Council of Agricultural Research played important role in yield improvement. Further, advancements in agricultural biotechnology have provided new methods of developing new high yielding crop varieties. One of the first biotech products developed in Indian Agriculture was the release of an oilseed Brassica variety Pusa Jai Kisan (Fig. 1). It is a very high yielding mustard variety developed by ICAR-National Research Centre on Plant Biotechnology (NRCPB). It has 17 to 20% higher yield and is cultivated in more than three states which are predominantly growing oil seed mustard. It was released in 1994 and is still ruling mustard growing area for the past 20 years.

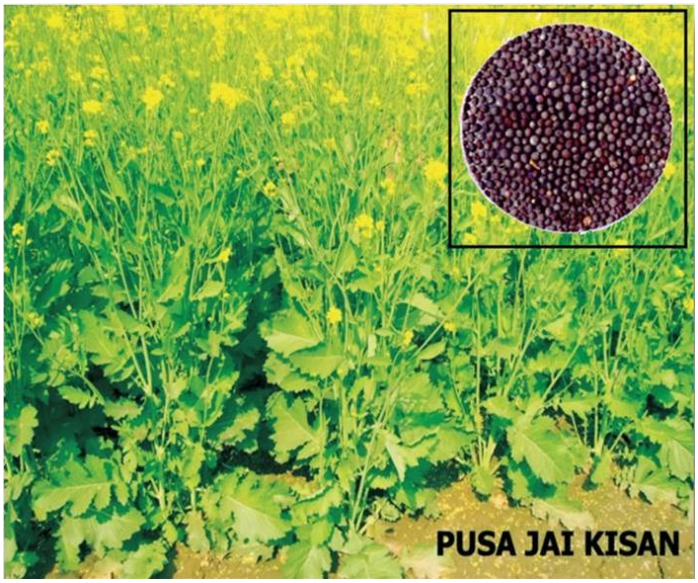
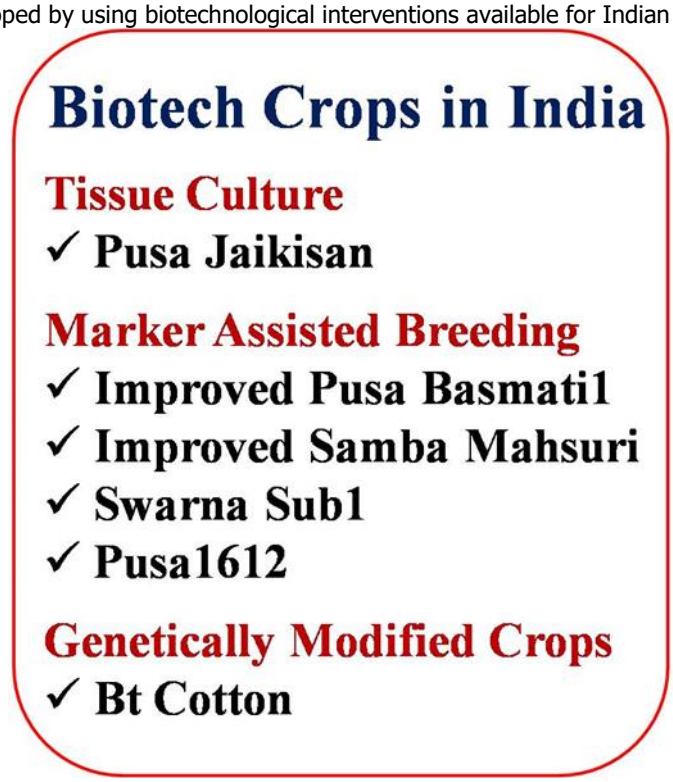


Fig. 1: Pusa Jai Kisan, a mustard variety developed by ICAR-NRCPB by somaclonal variation.

Other biotech derived products presently being cultivated in India can be categorized as the crop varieties developed by using molecular breeding and transgenic approaches are given in Box1. These are briefly described below.

Box 1: Crop varieties developed by using biotechnological interventions available for Indian farmers.



Products developed by using Marker Assisted Breeding

In India, the first marker assisted breeding derived product was a rice variety named as Improved Pusa Basmati 1 released in 2007. This variety has basmati characteristics along with pyramiding of bacterial leaf blight (BLB) resistant genes xa13 and Xa21 using background and foreground selection. This variety has superiority of 11.9% over the existing varieties of basmati rice (Joseph et al., 2004). Using MAS another rice variety was released in 2008, i.e. Improved Samba Mahsuri for Southern India by pyramiding three BLB resistant genes, xa5, xa13 and Xa21 (Sundaram et al., 2008). This variety is being cultivated by the small and marginal farmers of India. Similarly, another important trait important in rice for subsistence farmers is rice blast disease which kills whole rice plants. The gene Pi54 cloned at NRCPB is providing resistance to rice blast disease and a variety namely Pusa1612 pyramided with two genes Piz5 and Pi54 using MAB and released for commercial cultivation in 2013. In the case of Maize, marker assisted selection was used to develop quality protein maize hybrid. In 2008, Vivek QPM 9, a high yielding maize hybrid was developed (Gupta et al., 2009). Its yield is more as compared to the existing varieties of maize. Besides high yielding, it also contains high protein which is very important for the poor farmer as well as large section of Indian population.

Eastern India is highly prone to flood and all rice crop get damaged due to floods resulting huge yield losses every year. A gene named as Sub1 has been incorporated into Indian varieties using MAB (Neeraja et al., 2007) grown in Southern- Eastern India. Because of the transfer of this single gene all these varieties can survive under flooding conditions when floods remain 10-15 days. This single gene incorporation in Swarna using MAB was released as a new variety, Swarna Sub1 that has occupied a large area in Southern- Eastern part of India and making a huge difference in India's rice production.

Genetically Modified crops

The success story of Bt cotton in India is a classic example of use of biotechnology in poverty eradication. Bt cotton was introduced in India during 2001-02. So more than one and half decade time is sufficient to access the impact of any technology. Bt cotton in India increased income of the farmers from 14.6 million USD in 2001-

02 to 2100 million USD in 2012-13. The pesticide use on cotton reduced to 222 MT from 5748 MT in this period (Rao and Sheetharam 2014; Brookes and Barfoot, 2014). An interesting analysis has been done in various studies on the role of BT cotton in poverty eradication in India. It has been shown that adoption of Bt technology in India reduced use of chemical pesticides by 37%. These studies revealed that due to Bt seeds, crop yield was increased by 22% whereas farmer profit increased by 78% (Herring, 2013; Klumper and Qaim, 2014). Reports also correlate improvement in calorie consumption by the farmers with the adoption of Bt technology. Income gained from Bt adoption has improved per household access to the food, which lead to higher calorie consumption and better dietary quality. Thus introduction of Bt technology has reduced food insecurity by 15 – 20% among Indian cotton growers and Bt cotton adoption has raised consumption expenditures by 18%, a common measure of household living standard, by 18% during the 2006–2008 period (Kathage and Qaim, 2012; Qaim and Kouser, 2013). This shows that the application of technologies, if used judiciously, can play dividend to the farmers as well as to the different stakeholders.

5. Conclusions

Till date biotech products are proved to be important tools for the benefit of resource poor farmers in India. There are other products in the pipeline like golden rice, Bt brinjal, barnase/barstar based hybrid system in brassica and many herbicide and insect resistance crops. There are some considerations, which need to follow to encourage these new technologies as well as science-led agriculture. There is need to provide more allocation of parts of GDPs for agriculture, health and education. There should be increased access to food and education for rural masses and to bridge the increasing gap between the poor and rich by making agriculture more remunerative. Thus, making proper use of technology, farmer's income can increase. This can finally reduce the poverty to a great extent in a country like India, where large population is still dependent on agriculture for their livelihood.

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Building basic sciences in low-income countries - the International Science Programme

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Article

1. Introduction

In this presentation we highlight the need for providing support to basic sciences to higher education and research institutions in the developing world. The International Science Programme (ISP) at Uppsala University in Sweden was established in 1961 as a fellowship program. Nowadays it provides long-term support for research capacity building in the fields of chemistry, mathematics and physics to a number of developing countries in Africa, Asia and Latin America. We give a brief presentation of the way the program works and of the outcomes of the program. We demonstrate that ISP mode of operation is in line with recent recommendation by DFID.

2. A rationale for supporting basic science in developing countries

Support to basic sciences (mathematics, physics, chemistry, biology) is important for the development of applied sciences, e.g. agriculture, medicine, engineering, of quality education, and of technology to tackle development challenges. The nurturing of science stimulates evidence-based, critical thinking, and may also impact on democracy development, economic growth and poverty alleviation.

A major fraction of donor support in science to low-income countries is dedicated to the applied sciences, while support to the basic sciences is relatively small (e.g. Gaillard, 1998). However, the basic sciences are the pillars on which all the applied sciences stand. To give a few specific examples with relevance to developing countries: epidemiology (studying the statistics of disease spreading and vector behavior, etc.), gene modification in agriculture (basic chemistry), water purification (chemistry, i.e. the use of clay and other filters, and physics, i.e. photocatalysis), and the development of solar cells (chemistry and physics: polymeric solar cells, dye-sensitized solar cells), the development of mobile and smart phones (physics and engineering), etc.. Apart from the aforementioned research fields, basic sciences are urgently needed to prepare for the impact of climate change.

Another motivation to give donor support to basic sciences in low-income countries is that governmental and other local support to those is generally extremely low. The plethora of research funding agencies that is present in the developing world (research councils, industry, research foundations) is usually absent in developing countries.

The evaluation report of ISP by GHD) lists a number of additional arguments for supporting basic sciences in developing countries (GHD, 2011):

- Research in the basic sciences is a global "public good".
- Market forces are such that OECD research institutes, and companies, rarely invest in research of direct interest to developing countries.
- Basic science provides the evidence base for responding to many of the most basic challenges facing developing countries.
- Research and training need long-term investments.

3. The International Science Programme, ISP

3.1 What is ISP?

The International Science Program is a unit at Uppsala University that works exclusively with research capacity building in the basic sciences chemistry, mathematics and physics at universities in developing countries.

The most important characteristics of the ISP program can be summarized as follows:

- ISP in a university-based organization, meaning direct scientist-to-scientist cooperation thereby avoiding too much bureaucracy.
- ISP's credo is to respond to demands and not to propose, implying that local universities and institutions can plan according to their needs and possibilities.
- The ownership of the research and its outcomes lies with the local university.
- ISP offers universities in developing countries the possibility to work with long-term goals and to tailor their research plans to best respond to local needs.

3.2 History and mode of operation

Uppsala University established the International Science Programme (ISP) in 1961. It has earned international recognition for effectively strengthening research and postgraduate education capacity in low-income countries in the basic sciences physics, chemistry, and mathematics. The ISP model commits long-term (often at least 10-15 years) support to institutionally based research groups and scientific networks. The support model is based on collegial scientist-to-scientist collaboration, linking supported groups and networks to cooperating partners mainly at Swedish but also at universities in other industrial countries, and at universities in other low-income countries.

ISP's vision is to efficiently contribute to a significant growth of scientific knowledge, thus promoting development. The expected outcome is more well-qualified postgraduates, and an increased production and use of high-quality scientific research results. Collaborating universities all gain an expanded global perspective.

Today ISP includes currently three programs:

- The International Programme in the Physical Sciences (IPPS), initiated in 1961,
- The International Programme in the Chemical Sciences (IPICS), from 1970, and
- The International Programme in the Mathematical Sciences (IPMS), from 2002.

ISP's core program provides support to both research groups and regional research networks. Regional research networks are very important because of limited access to advanced equipment, and the limited number of scientists in any given scientific field. Also, the number of MSc and PhD level students in the basic sciences is usually small, making it expensive for an individual university to run such advanced programs. Thus, networks can be a cost-effective way to utilize equipment and human capital.

The list of countries that are eligible for support has evolved over time. As of 2009, ISP adheres to the list of so-called focus countries selected by the Swedish government. There are twelve focus countries of which the following nine are included in the ISP program: in Africa: Burkina Faso, Ethiopia, Kenya, Mali, Rwanda, Uganda and Zambia and in Asia: Bangladesh and Cambodia. Support to other non-focus countries has been phased out, with two exceptions: four research groups in Zimbabwe and two research groups in Laos. The activities in Laos are now mainly financed through the support from Stockholm University (see below).

In addition to the core program, ISP coordinates a number of bilateral projects financed by the Swedish International Development Cooperation Agency (Sida). Since these activities differ substantially from the ISP's core program, these bilateral projects are not included in the statistics and outcomes presented below.

3.3 Funding

ISP's total budget for the six-year period 2008 to 2013 amounted to about 160 million SEK (about 23 million USD using an average exchange rate). The major contributor (89%) was Sida, with additional contributions from Uppsala University (9%) and Stockholm University (2%, since 2011).

3.4 Outcomes

During 2008-2013, ISP supported on average 32 research groups and 16 research networks per year, with an average budget per activity of about USD 60,000 per year.

The outcomes can be summarized as follows: per million USD invested in these groups and networks, the outcomes of the ISP program were:

- 7.5 PhD graduations, plus
- 26 MSc graduations, plus
- 51 publications in scientific journals, plus
- 61 conference contribution, plus
- 8 arranged scientific meetings.

In the following tables some of the major outcomes of the program are listed. The numbers presented here are more or less constant over the years: the reason for this is that as time goes by the stronger, self-supporting research activities are phased out from ISP support, and new less resourceful groups join the program.

Table 1: Scientific publications and arranged meetings reported 2008-2013 by ISP-supported research groups and scientific networks, per region.

	Africa	Asia	Latin America	Total
Publications	842	312	21	**1175**
Conf. contrib.	818	515	38	**1371**
Total dissemination	1660	827	59	**2546**
Arr. meetings	180	85	8	**273**

Since 2010 ISP has kept track the Thomson-Reuters Impact Factors of all publications: during 2010 to 2013 about 45% of the publications were in journals with impact factors.

Table 2. Total number of graduations reported 2008-2013 by ISP-supported research groups and scientific networks, per region.

	Africa	Asia	Latin America	Total
PhD sandwich	53	5	1	**59**
PhD local	92	16	5	**113**
PhD total	*145*	*21*	*6*	***172***
MSc/MPhil sandw.	8	1	1	**10**
MSc/MPhil local	415	163	4	**582**
MSc/MPhil. total	*423*	*164*	*5*	***592***

3.5 Low brain drain

The 2011 evaluation of ISP points out that there are indications of a lower risk of students moving or remaining abroad while they are studying under the sandwich model, but that closer monitoring is needed to support this indication (GHD,2011).

A tracer study of Sri Lankan graduates (se section 3.2 below) seems to confirm the low brain drain in the program. Only seven out of the 53 respondents currently live outside Sri Lanka. The main contributing factor seems to be the sandwich model training, which has allowed the PhD students to keep strong ties with their home institution.

More studies are needed to benchmark the rate of brain drain in the program. According to ISP's experience, however, brain drain varies considerably from country to country.

4. The impact of ISP

Over the years, it has become more and more important for actors working with development aid to demonstrate the impact of their interventions. At this moment only few systematic studies of the impact of ISP exist. A few years ago, ISP took the first steps towards working with Results Based Management (RBM) through

establishing a logical framework, including measurable objectives to follow up on the provided support. However, a record of ISP's most important quantitative indicators, i.e. publications and graduated students, has been kept for several decades resulting in an extensive longitudinal record of ISP's core activities.

What have been lacking, however, as also noted in the evaluation of ISP in 2011 (GHD, 2011), are more systematic and qualitative studies of the impact of ISP work. In recent years, ISP has increased its efforts in this area, and some studies, mainly focusing on Asia, have been initiated. Some preliminary results of these studies will be presented here.

4.1 Independent studies

In an independent MSc thesis, Kuhn (2012) analyses different forms of North-South development assistance. The focus is on ISP's involvement in chemistry and physics in Bangladesh, and a comparison to more traditional forms of development assistance provided by major donors. Her conclusion is that "Following the indicators of successful North-South cooperation established to assess the ISP's approach in Bangladesh, i.e. local ownership, empowerment and partnership, which were operationalized in six themes relevant to research capacity building, the case study revealed that the ISP can be viewed as a fruitful example of North-South development assistance. ISP's success is achieved through its mode of operation, its long-term support and its egalitarian way of interacting with Southern collaborators".

4.2 Independent evaluation of ISP

Sida initiated an evaluation of ISP in 2011 covering the period 2003 to 2010 (GHD, 2011). Two case studies of supported groups in Kenya and Ethiopia show that there is a good alignment of ISP's activities with national government priorities as well as high quality of the research conducted in these groups: (…) ISP activities are highly aligned with the priorities of the national governments. An analysis by the World Bank indicates that other countries in Sub-Saharan Africa will have similar needs for capacity building in the sciences for higher education. Quality of the scientific programs supported by ISP is variable from country to country. However, evidence is provided to show that at least the quality of planning and research activity proposals increases with ISP support and that the outputs (published papers) reveal high to satisfactory levels of research work with a level of citations which is above world benchmarks.

4.3 Studies by ISP

Preliminary results from a tracer study and evaluation of the now concluded ISP support to research groups in physics and chemistry in Sri Lanka are now available [Andersson et al., 2015]. The study shows that ISP had a significant role in building up of research in the country, through the establishment of physics PhD programs on a sandwich basis, and provision of equipment and consumables. One of the conclusions is that: "At this stage of development the ISP support can be said to have made a considerable difference in terms of building local research capacity as well as improving the conditions for research and postgraduate training at the supported departments."

In this study there are also several examples how ISP supported graduates have used their knowledge to benefit the Sri Lankan society. Staff members and graduated from one of the supported groups have for instance trained electricians and people working in related fields, lightning proofed buildings and acted as consultants to Sri Lankan government agencies as well as to research institutes in other countries. Group leaders of supported groups point out that the ISP support has contributed to the building up their scientific reputation, which has had impact on the career development of both staff and students at the supported departments. Many of the group leaders have been appointed to committees and boards at Sri Lankan institutions of relevance for the development of Science and Technology in the country.

5. Discussion - Impact of investment in research

In a recent literature review by the UK Department for International Development (DFID, 2014) a number of assumptions made by many donors of scientific development aid were scrutinized: investment in research will drive economic growth, increase human capital, lead to the development of pro-poor products and technologies and provide evidence to inform policies and practices. The main conclusion is that there is little evidence to

back up some of these assumptions, mainly concerning economic growth but also to some extent regarding human capital and impact on evidence-based policies and practice. They do, however, find evidence of positive impact of the investment in research. This corresponds well with ISP's way of working, and ISP activities can serve as examples.

Concerning human capital, the study concludes that clear links can be found between the quality of research and the quality of teaching, but that there is little evidence for the creation of critical thinking through research capacity building programs, which is an assumption that many governments and donor agencies make (including ISP). However, there is evidence that research capacity building efforts can create experts that with their expertise in relevant fields can contribute to socioeconomic development and secure positions within policymaking institutions. The study also finds some evidence that the knowledge generated from public investment in research can have an impact on decisions regarding policies and practices, but that the links generally are indirect and hard to follow.

ISP has several examples where former graduates or group leaders of supported groups have been appointed members of national committees, boards or working groups relevant to the development of their countries. It is very difficult to demonstrate evidence for the impact the ISP supported research has had on policies and practices, but ISP has some documented examples of where graduates and group leaders of ISP supported research groups have made contributions to national policies and guidelines or have served in governments. There are many examples of where research resulting from ISP supported groups has had an impact on the life of people in country or region of question. Most importantly, the research is conducted locally and respond to challenges specific to their own countries and regions, research topics which otherwise might be overlooked or under-prioritized by the international research community. Research of drugs related to tropical diseases, the interaction between herb medicine and drugs, and studies of the use of local natural products serves as some examples. An ISP supported chemistry research group in Zimbabwe has, for instance, discovered a genetic variance common for African people explaining why Africans show more side effects to anti-HIV-drugs. A test is now being developed to be able to tailor the dose of the HIV-drug depending on the need of the patient.

6. Conclusions

Support to basic sciences is important for the development of applied sciences, of quality education, and of technology. In all, ISP's mode of operation has turned out to be very consistent with guidelines compiled in the DFID report concerning efficient capacity building efforts; e.g. the importance of long-term support, local ownership of the programs, and understanding the local context. The current evidence thus points to that there is value to the continuation of ISP's investment of research in low-income countries.

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