# ECO INTEGRATION IN LATIN AMERICA

IDEAS INSPIRED BY THE ENCYCLICAL

LAUDATO SI

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# ECO INTEGRATION IN LATIN AMERICA



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## ENVIRONMENTAL HUMANISM

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# Our conviction

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The purpose of regional integration in Latin America and the Caribbean (LAC) has always been to improve the lives of citizens.

The thinking goes that larger integrated markets provide countries with more opportunities for growth as businesses benefit from greater economies of scale and specialization and consumers gain access to more diverse and cost-effective choices.

It is this belief in the benefits of regional integration that has kept integration efforts moving forward since the 1960s and has motivated countries to keep implementing new policies and programs that break down trade barriers, encourage investment, promote cooperation, and deepen integration.

LAC countries have made significant progress modernizing trade policies, removing tariffs and nontariff barriers, improving trade "hardware" like transportation infrastructure, and adopting new technologies to boost trade performance.

This work has translated into more actors participating in global trade than ever before.

However, in the 21st century advances in technology are making trade more efficient and more dynamic, creating new opportunities but also raising new questions about how to move regional integration forward sustainably.

This is perhaps one of the most pressing issues of our time. How can LAC expand economic growth while also protecting the environment? How can we deepen integration in a clean, green way?

To answer these important questions, we are focusing this issue of INTAL's *Integration and Trade Journal* on the critical matter of climate change and sustainable development or, as we have dubbed it, "eco-integration."

In this issue, we ask tough questions about the environmental impact of trade and integration and provide insightful analysis on topics ranging from sustainable global value chains and green transportation infrastructure to the role of carbon markets and environmental taxes.

We also evaluate the role that trade facilitation and government policies can play in eco-integration, as well as disruptive new technologies' potential for fostering green growth.

Now we must find a way to make regional integration work for the planet so that our citizens can continue to reap the benefits of integration and trade.



# Act now

JUAN PABLO BONILLA
Manager, Climate Change and Sustainable Development Sector
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The effects of climate change are common knowledge. The last two years have gone down in history as the hottest on record. Should we be proud? No, of course not. The planet is telling us that it is time to sit up and take action and that the coming years will be even hotter.

"Change is something desirable, yet it becomes a source of anxiety when it causes harm to the world and to the quality of life of much of humanity," Pope Francis rightly said before the Paris Agreement was signed.

Getting past the obstacles on the road to inclusive, sustainable development is a priority for at least the 124 countries that ratified the Paris Agreement and committed to taking measures to meet the targets it contains. Keeping the global temperature rise well below 2°C will require large-scale investment in which players from both the public and private sectors will be essential in transitioning to a resilient, low carbon economy.

Taking action implies a paradigm shift: mitigating, adapting, and finding new meanings. Leaders from around the world are seeking out more egalitarian forms of development that will drive prosperity. Regions like Latin America and the Caribbean are at the forefront of these initiatives and are stepping up to tackle the impacts of climate change. We need to act and we need to act now!

Even though we are working against the clock, with the planet already suffering the consequences of climate change, there is always something we can do.

Always. In addition to providing and implementing financing, multilateral development banks undoubtedly also need to lead and help countries to design and implement sustainable development plans that contemplate their natural capital, disaster risk management, and other issues related to climate change and sustainable infrastructure.

We need to do this hand-in-hand with the committed countries that have already submitted their national contribution plans, and with civil society, governments, the private sector, Pope Francis, and other leaders. And we need to act now.

Why? Because the challenges of climate change are common knowledge, because we have what we need to take them on, and because the road to sustainable development is one that we need to walk together.

# Creative Eco-Integration for Latin America

GUSTAVO BELIZ
Director, Institute for the Integration of Latin America and the Caribbean (INTAL)
Inter-American Development Bank

"Do you agree that commitments on care for the environment should be included in international treaties, even if this would imply paying around 20% more for products?" We asked this challenging question to 20,000 people in 18 Latin American countries. Their answer was categorical: 49% of respondents said that they agreed or strongly agreed with such measures.[1]

Environmental awareness among Latin Americans is an essential starting point from which to analyze this issue, which is closely connected to trade and integration. We need to bring our population's social conscience to bear on the dynamics of policymakers' decisions, in dialogue with the scientific community.

"Start by doing what is necessary, then do what is possible, and suddenly you are doing the impossible." Inspired by this maxim of Saint Francis of Assisi, we have set ourselves the goal of saving a planet that is gravely threatened by environmental damage and climate change. The papal encyclical *Laudato Si'* has proved to be a touchstone for this mission and a source of inspiration for all people, regardless of their religious beliefs.

In it, Pope Francis develops the notion of integral ecology, which connects care for the earth with our responsibility to care for the weak and everything that has to do with the essence of being human.

This issue of Integration and Trade brings together work from high-profile global experts who were inspired by *Laudato Si'* to put forward concrete proposals to make the necessary possible.

We focus on just a handful of the many issues covered by the encyclical, those that are related to the integration of our nations, which has to do with much more than economics and trade. More than ever before, today's integration is social, technological, cultural, and environmental.

The coordination of efforts at the global level has made environmental issues one of the top priorities on government and integration agendas. Through the Sustainable Development Goals and the Paris and Marrakesh agreements, the world's leaders have forged a path toward making production techniques sustainable. Environmental standards now form part of the negotiations for every trade or investment agreement.

The environment is a complex, multidisciplinary issue. This is why we have called on the group of creative minds behind this publication and urged them to follow in Newton's footsteps and stand on the shoulders of giants by taking the encyclical as a source of inspiration for ideas for taking on global warming.

The many concrete proposals that emerge over the course of these pages include reformulating the global governance system through an institution with the power to impose sanctions, along the lines of the World Trade Organization; moving ahead with a global tax reform that imposes levies on pollution and promotes the use of clean energy; including environmental impact assessment in more public works and projects; rethinking infrastructure in terms of resilience; extending the logic of conditional cash transfers to the conservation of natural areas through payment for ecosystem services; reinforcing systems for monitoring pollution to guarantee access to drinking water; and reimagining the very foundations of the economy based on our relationship with the environment and others. This list, which is far from exhaustive, merely hints at the originality of these writings.

There is widespread consensus that global pollution is causing unjust harm in the world's poorest countries because despite the greatest polluters being the most advanced economies, climate change is having serious impacts on agriculture, one of most significant activities within Latin American economies. Around 14% of agricultural output is at risk of being lost due to droughts and floods if the global temperature increases by 3°C. The free rider problem and other externalities will be very hard to solve without sufficient coordination.[1] Productive sustainability is inseparable from environmental sustainability: Latin America's water footprint implies that 15,000 liters of water are used to create a single kilogram of beef, for example.[3]

Latin America contains vast natural riches and is home to 40% of the world's biodiversity, so the need to comply with environmental standards in trade implies the challenge of incorporating new technologies that adapt to increasingly demanding global value chains.[4]

These new technologies are shaping a hybrid form of integration in which the traditional mechanisms of trade—red tape, containers, trucks, roads, and ports—are entwined with the immediacy of electronic trade: the practicality of 3D printing, the ephemeral forms of ownership that characterize the sharing economy, the new information provided by big data, processes that are automated using artificial intelligence, the leap in productivity brought about by the bioeconomy and the responsible use of the soil, and the algorithms that produce new materials. It is also an opportunity to close historic gaps in the

LATIN AMERICANS' AWARENESS OF ENVIRONMENTAL ISSUES IS AN EXCELLENT STARTING POINT

region, such as the infrastructure gap.

Just as electronic money and mobile payment platforms can save billions in banking and financial infrastructure, digital manufacturing brings down logistics costs and puts economies with different levels of competitiveness on a par. This would make it possible to divert resources toward the priority infrastructure needed to address issues such as sanitation so that the 10% of the world's population that has no access to drinking water can obtain this basic right.

In recent months, the US government, the British Parliament, and the Pontifical Academy of Sciences have dedicated special publications and events to analyzing the economic and ethical impacts of artificial intelligence and robotics on employment and daily lives.[5] All three asked the same questions: could machines come to replace human labor in a way that threatens our civilization? And if so, what are we going to do about it?

This is not science fiction—it is already happening. The International Federation of Robotics has predicted that by 2018 there will be 35 million robots in industry (IFR, 2016) and Oxford University has estimated that 47% of jobs run the risk of being automated, a figure that climbs to 66% in developing countries (UNCTAD, 2016).[6] In this context, more developed countries are debating the implementation of a universal income that guarantees a certain standard of living or shorter working days.

Old and new forms of integration coexist in this age of informed consumption, which is also the age of speed. Transience and short-term thinking have gained so much ground as to affect human relations and attempt to make them disposable exchanges of value, in which everything has a price and few things have a value. Lamentably, the influence of throw-away culture is spreading, affecting not only material goods but also people themselves, threatening the very spirit of community life.

Globalization has brought about great inequality, opening up the divide between rich and poor and bringing traditional leadership into disrepute. According to our study "The DNA of Regional Integration," 73% of Latin Americans believe that their countries are governed by powerful groups for their own benefit. However, almost as many citizens are in favor of regional integration as a driver for growth and see their smartphones as a way to connect to others. One surprising finding was that a third of those inhabitants who do not often have two full meals on their tables each day nonetheless own a smartphone.[7]

These findings should propel us toward greater creativity without losing sight of the opportunities and risks they entail. New technologies are rewriting our institutional strategy on integration (IDB, 2015) in terms of both "hard" aspects (material and digital production and physical infrastructure) and "soft" ones (in connection with regulation, institutions, and individuals' preferences and feelings as citizens and consumers). Behavioral economics has arrived at interesting conclusions regarding the incentives that lead us to cooperate, which are not always based on shared interests but also on feelings of empathy and solidarity.[8] This is a simple example of how emotional factors can affect a society's behavior and its feelings toward integration agreements, or even a consumer's behavior when choosing whether or not to trust the label of an organic product for export. As neuroscience and machine learning develop, these issues can help us to better understand the causes and consequences of trade on the production system and the planet.

## WE NEED SCIENCE TO BE GUIDED BY ENVIRONMENTAL AND SOCIAL ETHICS

We need to realize the potential of an inclusive form of integration that, together with Latin Americans' capacity for transformation, has the power to drive a form of development that respects the environment and future generations.

Romano Guardini, the philosopher that Pope Francis often cites in *Laudato Si'* when he warns of the hazards of a technocracy that lacks values, argued that, in the future, what would be important would not be building more power, but mastering this power and taking responsibility for it, and that humans need to choose to be as strong as their power, or else give into it.

This is why we need science with a conscience. A clear awareness and understanding of the power that new innovations are endowing us with, together with an ethics that functions as a compass that will steer us clear of the social and environmental damage that technology causes when no limits are placed on it.

Like the two blades of a pair of scissors, impatience and vertiginous technological change snip away at ethical values until they have vanished altogether. If we do not use our new inventions wisely, they could exacerbate exclusion and cause irreversible harm to our planet. Let us make no mistake about it: it may be possible for intelligence to be artificial, but ethics never can be. Automation and dematerialization, which imply exponential technological change, require us to avoid the form of mental pollution that is thinking about societies with means but no ends.

To construct a creative form of eco-integration, we need to be aware that uncertainties live alongside countless opportunities and thousands of entrepreneurial approaches that we can leverage to encourage positive mutations in the way we do things. These are interwoven with the current trade and integration agenda, a situation that begs certain paradigmatic questions that challenge imaginations within our sector:

- Can we conceive of an environmental shift toward a "double dividend" perspective, one that would allow us to close both the ecological and inequality gaps by driving growth in green jobs in areas such as nontraditional transportation, the certification of standards, e-commerce[9], customized design, and community agriculture that reaches the world via digital platforms?
- Can we use improved statistical and accounting systems to capture a

## TECHNOCRACY WITHOUT VALUES CREATES SOCIETIES WITH MEANS BUT NO ENDS

EXPERTS FROM AROUND THE WORLD HAVE SUGGESTED WAYS FOR US TO STEP UP OUR EFFORTS TO PROTECT THE ENVIRONMENT.

socio-economic paradigm that not only measures growth in traditional GDP terms but also looks at the digital revolution[10] and social and environmental cohesion?[11]

• Can we imagine examples of "*cobotization*,"[12] in which

• Can we globalize regional solidarity by reinventing conditional income transfer systems that are linked to technological literacy and care for the environment, sowing strategic seeds that will one day boost our export diversification?

• Can we create an institutional ecosystem that will guarantee that regional public works are transparent and that will serve to improve the region's global integration but without transaction costs, which have a negative impact on Latin America's competitiveness and the quality of its democracy?

•Can we build a form of eco-integration for Latin America that brings together scientific and technological undertakings to boost the region's scale economies in neuralgic areas that include strategic public procurement in the automotive industry, agriculture, small and medium-sized enterprises, and energy?

The answer is yes. Indifference is the ace up pollution's sleeve. This is why the humanism that is put forward in *Laudato Si'* is so important as an invitation to rethink the institutional urban fabric.

Houses, neighborhoods, cities, and ecosystems are complimentary factors that need solid institutions to protect them on the path to a balanced form of development.

This issue is made up of four sections that move from more general matters to specific issues that affect the intersection of environmental problems and integration. The first section, which looks at **glocal (global+local) governance**, addresses the difficulties of reaching consensus and the benefits of doing so. The second section, which focuses on **sustainable trade**, contains articles on sustainable production and trade and the different areas in which these ideas are being applied. The third section is about **integral ecology**. In it, the authors explore diverse socio-economic areas which could be positively affected by care for the environment. The last section, environmental humanism, revolves around social inclusion and inequality, based on the premise that "we are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental."

In this publication, Nobel laureates, global leaders, academics from Latin America and the world, and members of civil society have suggested ways for us to step up our efforts to protect the environment.

I hope that it will also serve as a source of inspiration for others to join the fight to care for our common home. This is the path we will be quietly following, building the bridge that is eco-integration, moving from the necessary to the impossible.



**NOTES**

[1]This opinion poll, which formed part of the strategic alliance between INTAL and Latinobarómetro, a regional public good, also included this question: "Do you agree or disagree that trade agreements should include commitments on the rights of local and foreign workers, even if this implies paying 20% more for products?" Some 46% said that they agreed or strongly agreed.

[2]See Charles Kolstad's article in this issue.

[3]For more on this issue, see Bitar (2016). The author chronicles the voracious global consumption of natural resources, particularly the growing water shortage.

[4]Recent changes in global value chains are discussed in Curtis (2016) and the article by Arancha González of the International Trade Centre in this issue.

[5]See Executive Office of the President of the United States of America (2016), House of Commons (2016), and the conference on the "Power and Limits of Artificial Intelligence" held in the Vatican in November 2016.

[6]In "Robots at Work," Graetz and Michaels (2015) analyzed the impact of robots in 17 industrialized countries between 1993 and 2007 and concluded that they have contributed to growth and productivity and have reduced the number of hours worked in low- and medium-skilled professions. Nübler (2016) discusses the challenges these changes pose to public policies.

[7]See the IDB report "The DNA of Regional Integration" (Beliz, 2016).

[8]For more on the contribution of behavioral economics to integration and trade, see the presentation and masterclass from the Behavioural Insight Team at the INTAL Regional Integration 4.0 Colloquium

[9]For more on the opportunities for e-commerce in Latin America, see INTAL (2016). THM (2016) describes labor market contexts toward 2050.

[10]Curtis (2016) demonstrates that e-commerce, the technological revolution, and trade in services are barely captured by global trade statistics.

[11]Jean Paul Fitoussi alluded to this challenge at INTAL's annual conference on the basis of his work on the committee he was part of along with Joseph Stiglitz and Amartya Sen. See Fitoussi, Stiglitz, and Sen (2009) and INTAL's annual conference at en www.iadb.org/intal/50 (link in Spanish).

[12]See Méda (2016) on the use of the term cobotization.

[13]See Williamson and Bértola (2016), who analyze, among other issues, the impact of conditional cash transfer programs in Latin America on social equality.

[14]*Laudato Si'* §139.

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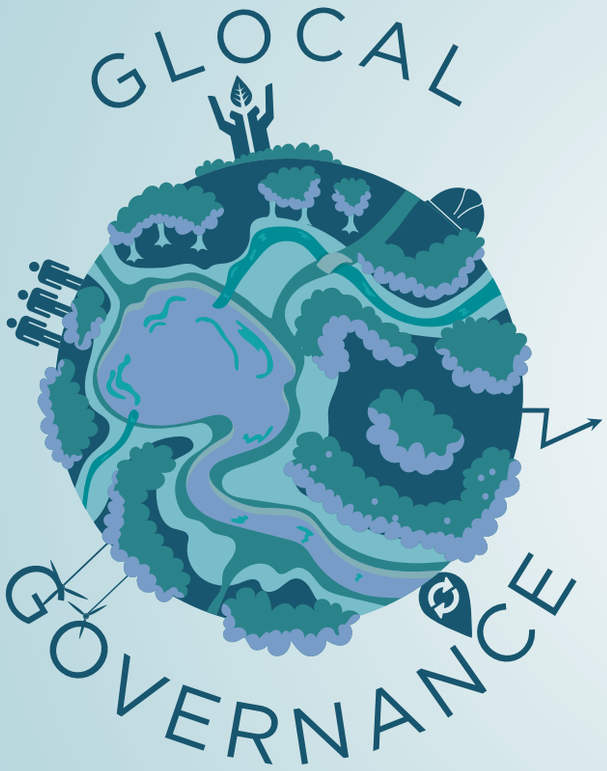
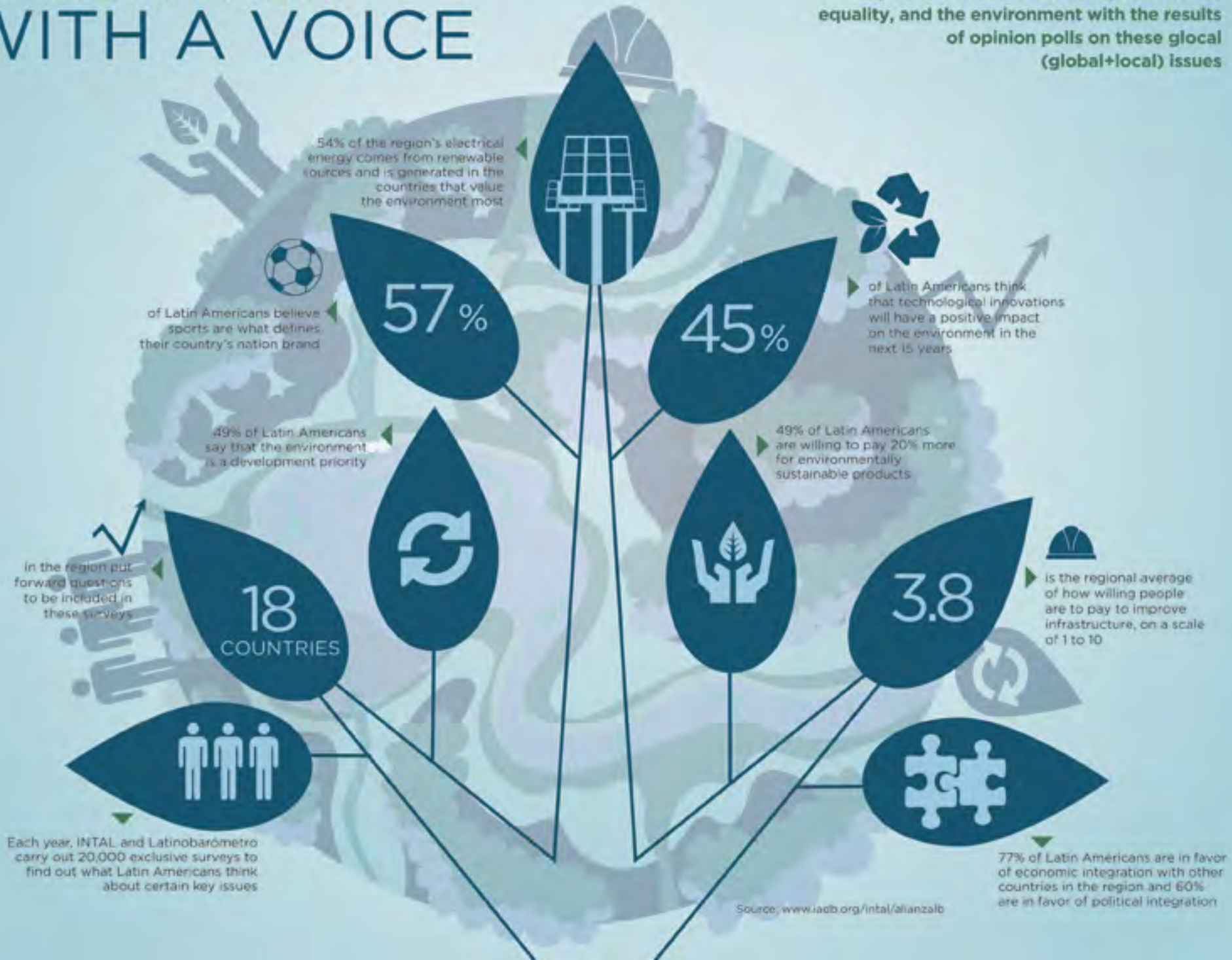



A global consensus
is essential for confronting
the deeper problems,
which cannot be resolved
by unilateral actions
on the part of individual countries.

*Laudato Si'*

# INTEGRATION WITH A VOICE

**The *DNA of Integration* cross-references objective indicators on trade, investment, equality, and the environment with the results of opinion polls on these glocal (global+local) issues**




Source: www.iadb.org/intal/alianzalb

# Fifty Key Points from *Laudato Si'*

MONSIGNOR MARCELO SÁNCHEZ SORONDO
Chancellor, Pontifical Academy of Sciences

**YET WE ARE CALLED TO BE INSTRUMENTS OF GOD OUR FATHER, SO THAT OUR PLANET MIGHT BE WHAT HE DESIRED WHEN HE CREATED IT AND CORRESPOND WITH HIS PLAN FOR PEACE, BEAUTY AND FULLNESS (§ 53)**

*Laudato Si'*

**1.** The appeal that Pope Francis makes in Laudato Si' is both profoundly religious and scientific: it begins with the gospel, faith, and theology, before turning to philosophical and ethical reflections and absorbing the specific knowledge of the natural and social sciences. The Pope argues that the planet we live on is our shared home, and one that we should see as a "sister" who has become sick due to the harm that a few of those among us have inflicted on her and which the majority suffer the negative consequences of. "Ecology" comes from two words, eikos and logos, which in Greek mean "house" and "order"; in other words, it is the science of putting our only home in order, the home that we share.

**2.** *Laudato Si´* is a wake-up call to the men and women of today, who it asks to become aware of and take responsibility for the gravity of our current state of affairs, warning against a "superficial ecology which bolsters complacency and a cheerful recklessness" (§ 59). Mindful of the crisis facing the poorest people on earth as a consequence of climate change, which is caused by human actions that are motivated by greed, Francis returns to the heart of the gospel, to love for all creatures, to the poverty of the Beatitudes and the last judgement, that is, to Matthew 25:40: "In truth I tell you, in so far as you did this to one of the least of these brothers of mine, you did it to me."



**3.** *Laudato Si'* is a foundational document with in the Church's social teaching: it establishes the new concept of "integral ecology" within the churches social thought. It puts is on a par with human dignity, freedom of conscience, fraternity, the universal destination of the world's goods, common good, and solidarity... In other words, although *Laudato Si'* is to be "added to the body of the Church's social teaching" (§ 15) just as previous encyclicals have been (cf. §§ 3–11), its subject matter is entirely new: the care for our shared home or the ecology of our planet which is at risk of collapsing due to human action, causing growing poverty and social exclusion. This "ecological conversion" encompasses ecological equilibrium, social justice, and spiritual responsibility, and it calls for immediate action.

## THE RELIGIOUS VISION OF "SISTER EARTH"

**4.** The main topic and common thread of *Laudato Si'* is a call to each and every human being who believes in the earth and social justice. More than anything, this call is profoundly religious, because it considers the world to be God's house, that is, a gift that God has given to humans, whom He created in His image, for them to love, watch over, and develop its potential for the good of all men and women everywhere, throughout history. As is suggested by the encyclical's title, which comes from the Canticle of the Creatures, this cosmovision was inspired by Saint Francis of Assisi, who wanted to follow the gospel sine glossa—without interpretations, just as it is—looking fondly on the earth as God's creation and loving poverty as way of paradoxically possessing the earth. Pope Francis wants to enact this message here and now and so makes an urgent plea for action: "Humanity is called to recognize the need for changes of lifestyle, production and consumption" (§ 23).

**5.** *Laudato Si'* tries to unite what modernity has torn apart: on the one hand, human beings, and on the other, the earth; on the one hand, the ecology of the natural environment, and on the other, human ecology. More generally, it tries to bring together the compassion of God's providence with the free and loving collaboration of human beings.

**6.** Francis brings these horizontal and vertical dimensions together to form a single, all-encompassing perspective, which he calls "integral ecology." The house that God has given men and women is a common home, which he likens to "a sister with whom we share our life and a beautiful mother who opens her arms to embrace us: 'Praise be to you, my Lord, through our Sister, Mother Earth, who sustains and governs us, and who produces various fruit with coloured flowers and herbs'" (§ 1).

## THE RESEARCH FROM THE NATURAL SCIENCES THAT FRANCIS HAS ABSORBED AND INTERPRETED

**7.** According to evidence from the scientific community, "this sister now cries out to us because of the harm we have inflicted on her by our irresponsible use and abuse of the goods with which God has endowed her." In the modern age, starting with Descartes and his idea of the res extensa, "We have come to see ourselves as her lords and masters, entitled to plunder her at will." (§ 2).

**ECOLOGICAL CONVERSION ENCOMPASSES SOCIAL JUSTICE AND SPIRITUAL RESPONSIBILITY AND CALLS FOR IMMEDIATE ACTION**

## THE ENCYCLICAL IS A CALL TO EACH AND EVERY HUMAN BEING WHO IS FAVOR OF THE EARTH

**8.** For the first time in the Church's social teaching, Francis points to the climate as being "a common good, belonging to all and meant for all" (§ 23). He defines it at the global level as "a complex system linked to many of the essential conditions for human life." *Laudato Si'* is unprecedented in its adoption of scientific concepts and terms. The Pope argues that "a very solid scientific consensus indicates that we are presently witnessing a disturbing warming of the climatic system" (§ 23).

**9.** Building on these observations, *Laudato Si'* says: "in recent decades this warming has been accompanied by a constant rise in the sea level and, it would appear, by an increase of extreme weather events, even if a scientifically determinable cause cannot be assigned to each particular phenomenon" (§ 23).

**10.** *Laudato Si'* accepts that "there are other factors (such as volcanic activity, variations in the earth's orbit and axis, the solar cycle)" that may also influence global warming. However, taking a characteristically courageous stance against the pressures of certain lobbies, Francis sets out this lesson as part of the doctrine known as the Ordinary Magisterium: "a number of scientific studies indicate that most global warming in recent decades is due to the great concentration of greenhouse gases (carbon dioxide, methane, nitrogen oxides and others) released mainly as a result of human activity" (§ 23).

**11.** So not only does *Laudato Si'* argue that is there now a climate problem that naturally is not described in the Bible (which does, however, describe other problems of its time), it also makes a masterful argument, based on the latest contributions from geoscience, that human use of fossil fuels is the main cause of global warming.

**12.** *Laudato Si'* emphasizes this: "The problem is aggravated by a model of development based on the intensive use of fossil fuels, which is at the heart of the worldwide energy system" (§ 23). It also takes on another significant scientific observation: "Another determining factor has been an increase in changed uses of the soil, principally deforestation for agricultural purposes." In this way, *Laudato Si'* represents the first time that a papal encyclical has placed such emphasis on bringing together not only faith and reason, but also philosophical knowledge and scientific knowledge.

### LOSS OF BIODIVERSITY

**13.** This crucial section of *Laudato Si'* argues: "The earth's resources are also being plundered because of short-sighted approaches to the economy, commerce and production. The loss of forests and woodlands entails the loss of species which may constitute extremely important resources in the future, not only for food but also for curing disease and other uses" (§ 32).

**14.** "Different species contain genes which could be key resources in years ahead for meeting human needs and regulating environmental problems" (§ 32) or simply for allowing evolutionary mechanisms to function correctly, for which the genes of biodiversity are essential. "Because of us, thousands of species will no longer give glory to God by their very existence, nor convey their message to us. We have no such right" (§ 33).

**15.** "We cannot "be silent witnesses to terrible injustices if we think that we can obtain significant benefits by making the rest of humanity, present and future, pay the extremely high costs of environmental deterioration" (§ 36). Deforestation frequently leads to arid deserts.

**16.** "We cannot overlook the huge global economic interests which, under the guise of protecting [biodiversity] can undermine the sovereignty of individual nations." "There are 'proposals to internationalize the Amazon, which only serve the economic interests of transnational corporations'" (§ 38).

**17.** "We cannot fail to praise the commitment of international agencies and civil society organizations which draw public attention to these issues and offer critical cooperation, employing legitimate means of pressure, to ensure that each government carries out its proper and inalienable responsibility to preserve its country's environment and natural resources, without capitulating to spurious local or international interests" (§ 38).

**18.** "Oceans not only contain the bulk of our planet's water supply, but also most of the immense variety of living creatures, many of them still unknown to us and threatened for various reasons. What is more, marine life in rivers, lakes, seas and oceans, which feeds a great part of the world's population, is affected by uncontrolled fishing, leading to a drastic depletion of certain species. Selective forms of fishing which discard much of what they collect continue unabated. Particularly threatened are marine organisms which we tend to overlook, like some forms of plankton; they represent a significant element in the ocean food chain, and species used for our food ultimately depend on them" (§ 40).

Greater investment needs to be made in research aimed at understanding more fully the functioning of ecosystems and adequately analyzing the different variables associated with any significant modification of the environment. Because all creatures are connected, each must be cherished with love and respect, for all of us as living creatures are dependent on one another" (§ 42).

**20.** "Each area is responsible for the care of this family. This will require undertaking a careful inventory of the species which it hosts, with a view to developing programmes and strategies of protection with particular care for safeguarding species heading towards extinction" (§ 42).

### TECHNOLOGY: CREATIVITY, POWER, AND LIMITATIONS

**21.** The scientific and technical revolution and applied rational thought in general have brought laudable benefits for humanity and solved "countless evils which used to harm and limit human beings. How can we not feel gratitude and appreciation for this progress, especially in the fields of medicine, engineering and

## THE ENCYCLICAL BRINGS TOGETHER NOT ONLY FAITH AND REASON BUT ALSO PHILOSOPHICAL AND SCIENTIFIC KNOWLEDGE

## POVERTY IS NOT A SIDE ISSUE TO THE ECOLOGICAL PROBLEM BUT AN ESSENTIAL PART OF IT

communications?" (§ 102). However, technology could become a dangerous contributing factor to the ecological crisis and growing poverty levels if we do not recognize its limitations, and if we shift from using technology to a technocratic paradigm, or when we transform technology and the corresponding ideology (technocracy) from a means into an end and make humanity a function of this (cf. §§ 106–113). "All of this shows the urgent need for us to move forward in a bold cultural revolution" (§ 114). We must stop boiling down human knowledge to the purely instrumental while ignoring ethics. This will require a fresh vision and new responsibility in the face of new challenges.

**22.** "Politics must not be subject to the economy, nor should the economy be subject to the dictates of an efficiency-driven paradigm of technocracy. Today, in view of the common good, there is urgent need for politics and economics to enter into a frank dialogue in the service of life, especially human life" (§ 189).

### KNOWLEDGE FROM THE SOCIAL SCIENCES THAT ARE ABSORBED AND INTERPRETED IN THE ENCYCLICAL

**23.** What is novel about this social encyclical is the vision underlying it. One of the threads that nourishes and runs through all of *Laudato Si'* is the intimate relationship between the fragility of the planet and the world's poor (be they individuals or nations). Poverty is not a side issue to the ecological problem but an essential part of it. Planetary inequality is the focus of a large part of the text which describes the current global situation (§§ 48–52). Throughout it, Francis argues that our priority must always be the poor.

**24.** He is not attempting to do away with private property (§ 93) or the market (§ 210). He is, however, demanding that these be counterbalanced by the moral imperative of social justice and the "principle of the subordination of private property to the universal destination of goods, and thus the right of everyone to their use, [which] is a golden rule of social conduct and 'the first principle of the whole ethical and social order'" (cf. §§ 93 ss.), which also applies to market regulation.

**25.** This has to do with the profound Thomasian conviction (§ 240) that, in the world, "everything is interconnected" (cf. §§ 16, 57, 91, 117, 138, and 240), complex, and interlinked (cf. §§ 23, 70, 92, 120, 137, and 142), created according to the divine model through subsistent relations with the divine persons (cf. § 240). At many points, Francis uses the word "system" to refer to this relational reality of mutual belonging among all beings. Three other words that are frequently expressed by the Pope also appear: "interpretation" (§ 139), "self-absorption" (§§ 204 and 208), and "governance" (§§ 18, 174, 175), which are rooted in modern thought and suggest a new world order based on the Beatitudes of the gospel. In other words: "climate change is a global problem with grave implications: environmental, social, economic, political and for the distribution of goods. It represents one of the principal challenges facing humanity in our day" (§ 25).



**26.** The encyclical is not attempting to be ecological in a romantic green sense, but instead calls for social justice as the force that will unite people for the integral development of the earth.

### THERE IS LITTLE AWARENESS THAT CLIMATE CHANGE CAUSES MIGRATIONS, POLLUTION, AND OTHER EVILS THAT AFFECT THE POOR BY INCREASING THEIR POVERTY AND CAUSING THEIR DEATH

**27.** There is not enough awareness of the fact that "changes in climate, to which animals and plants cannot adapt, lead them to migrate; this in turn affects the livelihood of the poor, who are then forced to leave their homes, with great uncertainty for their future and that of their children. There has been a tragic rise in the number of migrants seeking to flee from the growing poverty caused by environmental degradation. They are not recognized by international conventions as refugees; they bear the loss of the lives they have left behind, without enjoying any legal protection whatsoever" (§ 25).

**28.** "Some forms of pollution are part of people's daily experience. Exposure to atmospheric pollutants produces a broad spectrum of health hazards, especially for the poor, and causes millions of premature deaths" (§ 20).

**29.** There is little clear awareness that climate problems particularly affect the poor and the excluded, and thus multiply poverty and exclusion. Yet the poor and the excluded "are the majority of the planet's population, billions of people. These days, they are mentioned in international political and economic discussions, but one often has the impression that their problems are brought up as an afterthought, a question which gets added almost out of duty or in a tangential way, if not treated merely as collateral damage. Indeed, when all is said and done, they frequently remain at the bottom of the pile. This is due partly to the fact that many professionals, opinion makers, communications media and centres of power, being located in affluent urban areas, are far removed from the poor, with little direct contact with their problems" (§ 49).

**30.** "Yet this should not make us overlook the abandonment and neglect also experienced by some rural populations which lack access to essential services and where some workers are reduced to conditions of servitude, without rights or even the hope of a more dignified life" (§ 154).

### CLIMATE CHANGE IS A BREEDING GROUND FOR NEW EXTREME FORMS OF EXCLUSION

**31.** All these dramatic situations of poverty and social exclusion that are caused or exacerbated by global warming are also a breeding ground for new extreme forms of exclusion, such as slavery and human trafficking in the form of forced labor, prostitution, the sale of organs,

### THE WARMING CAUSED BY HUGE CONSUMPTION ON THE PART OF SOME RICH COUNTRIES HAS REPERCUSSIONS ON THE POOREST AREAS OF THE WORLD, ESPECIALLY AFRICA, WHERE A RISE IN TEMPERATURE, TOGETHER WITH DROUGHT, HAS PROVED DEVASTATING FOR FARMING

## WE NEED A NEW FORM OF EDUCATION TO CREATE THIS PARTNERSHIP BETWEEN HUMANITY AND THE ENVIRONMENT IN ORDER TO BUILD "ECOLOGICAL CITIZENSHIP

and drug use, which are true crimes against humanity. It is clear that full employment and universal schooling, family, a home of one's own, and love for the land are the best antidote and form of prevention against poverty, prostitution, drug addiction, and drug trafficking (cf. §§ 46, 91, 123, and 197).

### THE UNBREAKABLE BOND BETWEEN ECOLOGY AND POVERTY, AND VICE VERSA

**32.** In our globalized world, we cannot help but recognize that social issues are inextricably linked to ecological ones and that, conversely, truly addressing ecological issues always implies addressing social ones. In other words, we need to incorporate notions of justice into discussions about the environment. We need to hear "both the cry of the earth and the cry of the poor" (§ 49).

**33.** Through the widespread warming of the earth through the atmosphere and the biosphere, the air and the oceans, it has become clear that "the warming caused by huge consumption on the part of some rich countries has repercussions on the poorest areas of the world, especially Africa, where a rise in temperature, together with drought, has proved devastating for farming. There is also the damage caused by the export of solid waste and toxic liquids to developing countries, and by the pollution produced by companies which operate in less developed countries in ways they could never do at home, in the countries in which they raise their capital" (§ 51).

**34.** "Hence every ecological approach needs to incorporate a social perspective which takes into account the fundamental rights of the poor and the underprivileged" and vice versa, every sociopolitical perspective must include an integral ecological dimension (cf. § 93).

### INTEGRAL ECOLOGY'S SOLUTIONS: WE ARE IN TIME TO TACKLE THE PROBLEM

**35.** "All is not lost. Human beings, while capable of the worst, are also capable of rising above themselves, choosing again what is good, and making a new start, despite their mental and social conditioning" (§ 205).

**36.** "Developing the created world in a prudent way is the best way of caring for it, as this means that we ourselves become the instrument used by God to bring out the potential which he himself inscribed in things: 'The Lord created medicines out of the earth, and a sensible man will not despise them' (Sir 38:4)" (§ 124). Caring for the earth is not like caring for a museum where all you have to do is look after, clean, and preserve works of art that do not contain biological life as best you can. Looking after the earth actually implies developing it according to its vital possibilities, according to its God-given potential. It is the role of scientists, especially Christian ones, to make discoveries and take action for the common human good, to develop our planet sustainably, showing generational and intergenerational solidarity, in other words, working to benefit the coming generations, to whom we must leave a healthier earth than the one that we made sick.



### AN INTEGRAL AND SUSTAINABLE FORM OF DEVELOPMENT IN ACCORDANCE WITH THE POTENTIAL OF LIVING THINGS

**37.** In relation to the global energy system, the key point that Francis makes is the compelling need to decarbonize our energy production so that it does not pollute the atmosphere, the stratosphere, the air, and the oceans or wreak havoc with the water cycle.

**38.** At the same time, integral ecology implies eradicating social exclusion and marginalization immediately, particularly poverty and the new forms of slavery that drug traffickers and pimps rely so heavily on. It also implies punishing the "consumers" that create a market for these heinous crimes.

**39.** Many of the lungs of our planet or reserves of biodiversity and water have been made into national parks, that is, areas that are protected by a legal status that obliges people to protect them and preserve the richness of their flora and fauna. These and other similar solutions have separated humans from these protected areas, which function almost as museums, where the region in question is preserved. But preserving is not the same as stewarding.

**40.** The solution put forward, for example, by the Amazonas Sustentável project in the Brazilian state of Amazonas integrates human beings with their original habitat, which is Mother Earth, thus creating social inclusion and improving the climate. In other words, it provides a simultaneous solution to the two most pressing issues of our time; social exclusion and global warming. It is a new approach that, if I may say so, is similar in many ways to the Jesuit missions of the 17th and 18th century. Today we need to spread the Amazonas Sustentável model and not just in Latin America.

### A NEW FORM OF EDUCATION, A NEW VISION OF THE COMMON GOOD, AND A NEW LIFESTYLE: THE PARTNERSHIP BETWEEN HUMANITY AND THE ENVIRONMENT

**41.** "In the present condition of global society, where injustices abound and growing numbers of people are deprived of basic human rights and considered expendable, the principle of the common good immediately becomes, logically and inevitably, a summons to solidarity and a preferential option for the poorest of our brothers and sisters." (§ 158).

**42.** "Since the market tends to promote extreme consumerism in an effort to sell its products [...] a change in lifestyle could bring healthy pressure to bear on those who wield political, economic and social power" (cf. §§ 203-206).

**43.** We need a new form of education to create this partnership between humanity and the environment in order to build "ecological citizenship." "Good education plants seeds when we are young, and these continue to bear fruit throughout life" (§ 213). The family, social groups, and political institutions also have an important role to play in raising awareness among the population. The Church and its seminaries, religious institutions, universities, and parishes must also "provide an education in responsible simplicity of life, in grateful contemplation of God's world, and in concern for the needs of the poor and the protection of the environment" (cf. § 214).

**44.** We need "an 'ecological conversion,' whereby the effects of their encounter with Jesus Christ become evident in their relationship with the world around them. Living our vocation to be protectors of God's handiwork is essential to a life of virtue; it is not an optional or a secondary aspect of our Christian experience. The ecological conversion needed to bring about lasting change is also a community conversion" that implies strong social ties (§§ 218-219).

**45.** "Christian spirituality proposes an alternative understanding of the quality of life, and encourages a prophetic and contemplative lifestyle, one capable of deep enjoyment free of the obsession with consumption" (§ 222). "Sobriety and humility were not favourably regarded in the last century. And yet, when there is a general breakdown in the exercise of a certain virtue in personal and social life, it ends up causing a number of imbalances, including environmental ones" (§ 224).

## A NEW FORM OF POLITICS AND CITIZENSHIP ARE URGENTLY NEEDED AND ACHIEVABLE

**46.** "Love, overflowing with small gestures of mutual care, is also civic and political, and it makes itself felt in every action that seeks to build a better world. Love for society and commitment to the common good are outstanding expressions of a charity" and is in some way an act involving the heroic and the divine (cf. §§ 228 ss.).

## THE FUNDAMENTAL HUMAN, CHRISTIAN ATTITUDE AS EXPRESSED IN THE BEATITUDES

**47.** The golden rule of social conduct (cf. § 93) on which all civilizations and religious traditions are built is "do not do unto others what you do not want done to yourself" or, in positive terms, "whatever you wish that men would do to you, do so to them" (Mt 7:12). Today we need to interpret this in accordance with the Beatitudes of the Gospel of Matthew chapter 5, and the protocol by which we will be judged in Matthew chapter 25, which speaks of the other, the neediest, the marginalized, in a situation of real suffering.

**48.** Choosing the way of the Beatitudes and of the poor, of those who suffer, of those who weep, of those who have a clean heart, of the meek, of the merciful, of those who seek justice and are persecuted for it, of the peacemakers, and of the peaceful goes beyond the idea of the golden rule, which is excessively abstract, and urges us to seek out the suffering and the needy.

**49.** The Beatitudes imply "recognizing the implications of the universal destination of the world's goods," but, as the Pope mentioned the Apostolic Exhortation Evangelii Gaudium, "it demands before all else an appreciation of the immense dignity of the poor in the light of our deepest convictions as believers." This is why Francis concludes that "We need only look around us to see that, today, this option is in fact an ethical imperative essential for effectively attaining the common good" (§ 158).

**50.** Jesus Christ has promised those who walk in truth and follow the Beatitudes that they will inherit the earth, that they will be sons and daughters of God, and that they will see God. Let us welcome all those who bear witness to a life of grace in different areas of society, who know how to rethink the world, create systems, and organize institutions inspired by Christ's Sermon on the Mount.

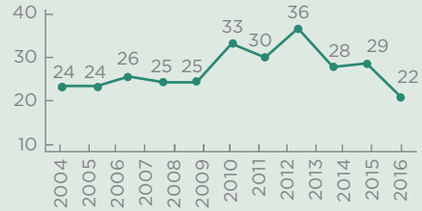


# CRISIS OF CONFIDENCE

LATIN AMERICANS' RESPONSES TO THE INTAL/LATINOBARÓMETRO POLL REVEAL THEIR QUESTIONING OF TRADITIONAL LEADERSHIP. REBUILDING TRUST IN INSTITUTIONS IS ONE OF THE MAJOR CHALLENGES FACING GLOBAL AND REGIONAL GOVERNANCE.

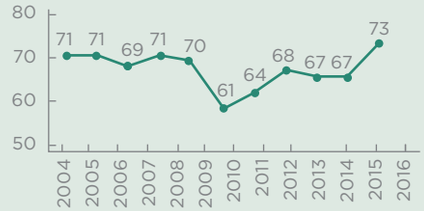
### GOVERNMENT FOR THE GOOD OF ALL

Question: Generally speaking, would you say that your country is governed by a handful of powerful groups for their own benefit or is it governed for the good of the people?
**"Government for the good of the people" is the only answer shown.



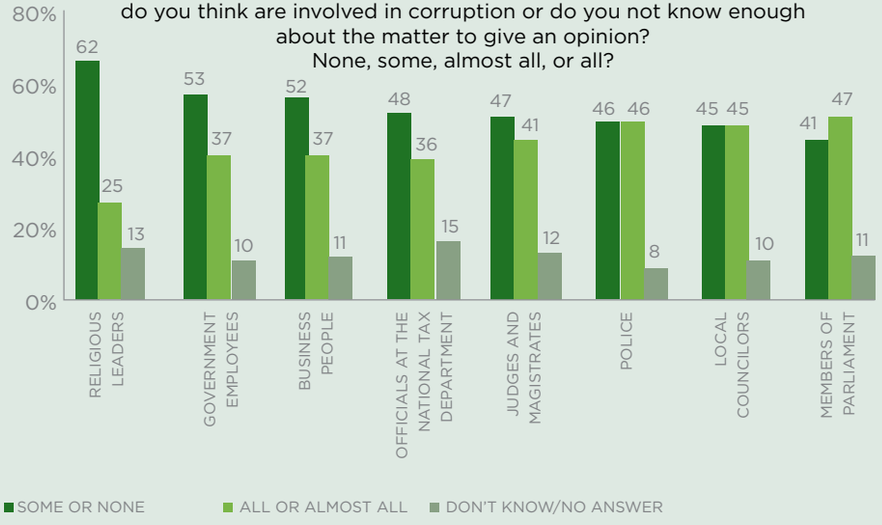

### GOVERNMENT FOR THE FEW

Question: Generally speaking, would you say that your country is governed by a handful of powerful groups for their own benefit or is it governed for the good of the people?
**"Powerful groups for their own benefit" is the only answer shown.




### REPUTATION VERSUS CORRUPTION

Question: How many of the following groups of people do you think are involved in corruption or do you not know enough about the matter to give an opinion?
None, some, almost all, or all?

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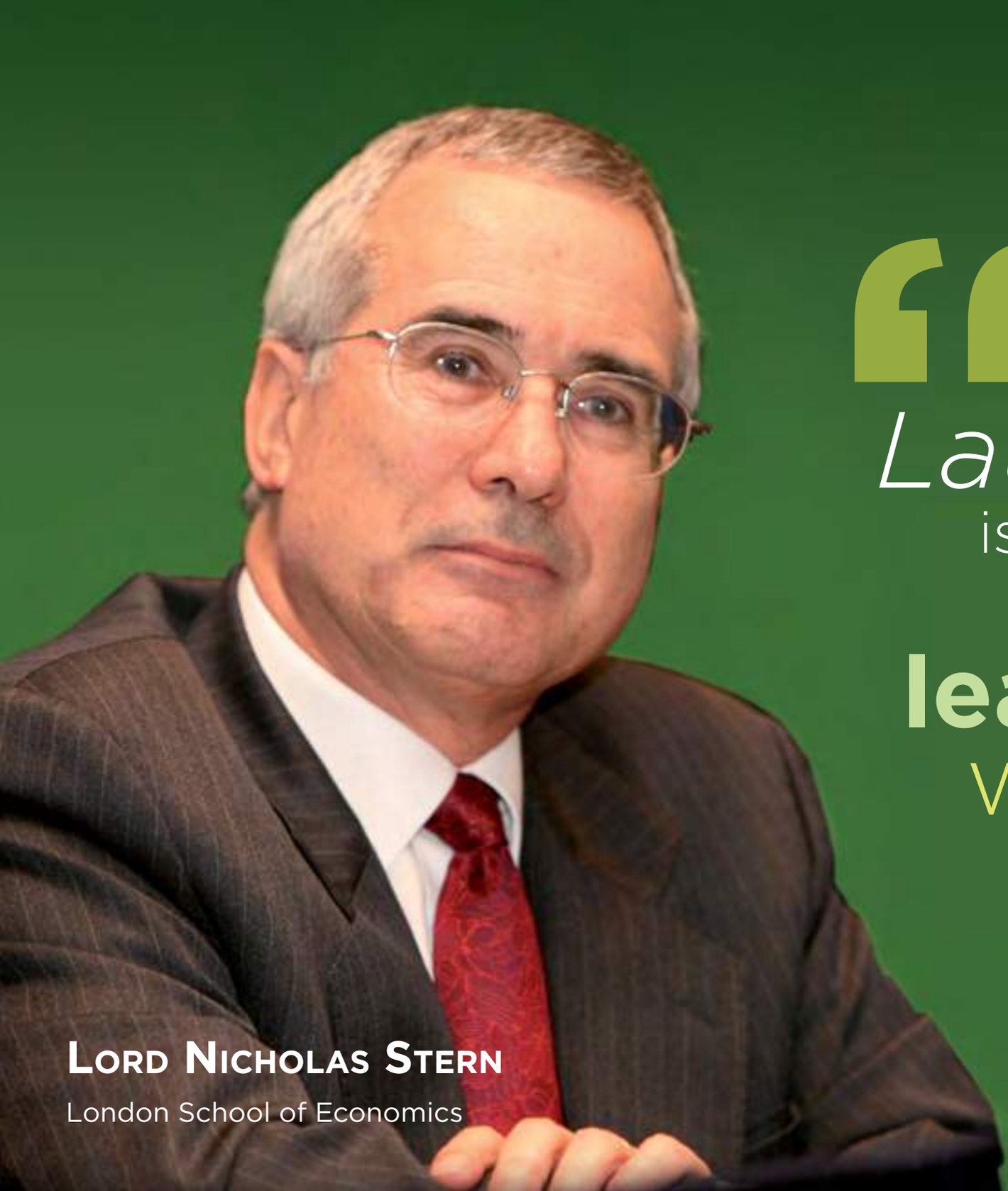


“*Laudato Si’* is the type of **moral leadership** we need”

**Lord Nicholas Stern**

London School of Economics

The Stern Review on the Economics of Climate Change, led by Lord Nicholas Stern at the request of the British government, was a milestone in the struggle against climate change. The 700-page text describes the costs of global warming and compares its consequences to those of a war or a great recession. Since the publication of the review in 2006, Lord Stern has become one of the most authoritative global voices on climate change. In this exclusive interview with the Integration & Trade Journal, Lord Stern, who is now a professor at the London School of Economics, analyzes the need to invest in resilient infrastructure, the opportunities that new technologies offer, the pace at which global environmental governance is moving forward, and the moral leadership of *Laudato Si'*.

**How can we encourage investment in sustainable infrastructure?**

In the first place, it is important to understand the issue of scale. The infrastructure that will be put in place in the next 20 years will be twice the size of what we currently have. That will imply enormous investments, and we face the challenge of keeping the process sustainable. Policies to achieve this could be regulatory or they could be based on carbon pricing. However, it will be fundamental to maintain the credibility and consistency of that policy over time, because these are very long-term investments. Another key point will be generating the financing structure for those projects.

**How can we finance projects that are respectful of the environment?**

I think that multilateral development banks have a key part to play in expanding lending capacities. This is true for the traditional ones and also the newer ones, such as the Asian Infrastructure Investment Bank and the New Development Bank, as well as for national ones like the Brazilian Development Bank (BNDES). I think these institutions will have an important role for a number of reasons. One is that their presence reduces risk and the cost of capital, because if investors trust in the project's credibility, there will be more investment supply and costs will go down. Alliances with the private sector are also important as they can multiply this effect. At present, multinational credit entities lend around US$70 billion a year. We should be aiming to triple that figure. With a modest amount of extra capital, we could make a very big difference to the ability to lend and finance projects. Multilateral organizations are particularly important at the initial stages of infrastructure projects because those stages can be very risky. A good development bank can bring equity and provide long-term loans and guarantees vis-à-vis political risk, so it can be very important in getting through the initial phase. But once that phase is complete, then it is time to look to private institutional markets, such as pension funds and insurance companies.

**Do you think that global governance pays enough attention to infrastructure?**

Increasingly so. I think infrastructure is at the heart of the Paris Agreement. Around 60%–70% of emissions come from or are associated with infrastructure. Furthermore, around 60% or 70% of new infrastructure will be in emerging markets and developing countries. In that sense, nearly half of the problem is about how to build sustainable infrastructure in developing countries.

Nicholas Stern holds a doctorate from Oxford University and has had a notable career as an economist in the service of his country and the international community. Between 2000 and 2003, he was the Chief Economist at the World Bank. In 2006, he published his well-known review on climate change and global warming, in which he predicted many of the climatological events that subsequently took place and also warned of the economic costs that would ensue should countries decide not to engage in a resolute, organized struggle to defend the environment. In 2007, he was created Baron Stern of Brentford. He is currently chair of the Grantham Research Institute on Climate Change and the Environment at the London School of Economics.

MULTILATERAL ORGANIZATIONS SPEND **US$ 70 BILLION** ON FINANCING INFRASTRUCTURE

**How important is the concept of resilience?**

There is a consensus about the changes that are taking place in the climate. Global temperatures are high and we know they are going to change much more due to the emissions we have already made and the emissions we are about to make. As a result, resilience is going to be very important, particularly around water and extreme weather events like storms, floods, and droughts. On average, the world will get wetter as it gets warmer. Some places will not only get wetter but might receive twice their normal rainfall in half the number of days. Other places will dry out, so hydroelectricity will not work and houses and infrastructure will suffer from subsidence as the land dries out and cracks up. Water and weather are not the only things we should be looking at: there are other kinds of threats, too. We really need to face these changes with resilience and prepare people for a new resilient infrastructure.

**How would you assess global efforts in the struggle against climate change?**

It is remarkable how far self-chosen action can take us. Since Paris, countries have begun to recognize that people are getting involved and are much more willing to act. I have become more interested in the voluntary side of global governance, as it seems to work better than attempts to make things compulsory. Making things compulsory is generally not workable, it is not feasible because there are no real sanctions. On the other hand, when people work together and agree on something voluntarily, they are ready to put it into action and move towards the goals they have set themselves as serious obligations. They feel an obligation to their own people even when there is not necessarily any formal sanction. A very interesting change is taking place in the world which should lead us to reflect a bit more on what we mean by global governance.

**In your famous 2006 review, you predicted consequences of global warming and natural disasters that have already come to pass. Are you more optimistic about the future now?**

Today, I would have to give a new answer. The science on climate change has given us new perspectives over the last ten years, in the sense that some of the things that we thought were likely to happen actually happened sooner and on a bigger scale than we imagined. Technology has moved remarkably fast, much faster than we thought it would. One obvious example is that in those ten years the cost of a solar panel has fallen by a factor of ten; by 90%. That is just one example, there are less dramatic examples in other areas. But there have been rapid improvements in the type of control that is possible through digital techniques and the ways these can assist management. Material technology has also changed remarkably and has turned out to be more promising than what I thought possible ten years ago. However, I still think that political will is the main obstacle, and it has moved much more slowly than we would have liked. The Paris Agreement was important, and I think it could be the start of a sort of acceleration. But the problem is that we are moving much too slowly. The next 20 years will be absolutely critical due to the new gross domestic product (infrastructure that I talked about before and population movements. In short, I am optimistic up to a point, but I am also worried about the pace of change.

**60%**

OF NEW INFRASTRUCTURE PROJECTS WILL BE BUILT IN DEVELOPING COUNTRIES

**Do you think *Laudato Si'* can contribute to building consensus?**

Definitely. I think that *Laudato Si'* did make a big difference. That is the type of moral leadership that we need. Although it does not bring immediate answers, it is a very important part of the story.

## THE CONCLUSIONS OF THE STERN REVIEW

The Stern Review on the economics of climate change is a publication that the British government commissioned Lord Nicholas Stern to lead and which was published in 2006. Over time, it has become a fundamental point of reference in the struggle against climate change. The review estimates that if no action is taken, the global costs of climate change will equal losses of at least 5% of global gross domestic product (GDP), but these could be as high as 20% or more if a greater variety of risk is taken into account. In contrast, the costs of taking action to reduce greenhouse gas emissions and thus prevent the worst impacts of climate change may be as low as 1% of global GDP. In economic terms, the benefits of decisive early action to combat climate change considerably outweigh the costs of doing so. However, there is a coordination problem among agents around taking the necessary action to mitigate climate change. As a consequence, protecting the environment implies an international response based on a common understanding of the long-term goals and a global agreement on the action to be taken.

# THE IMPORTANCE OF THE ENVIRONMENT

**49%**

THE PROPORTION OF RESPONDENTS WHO SAID THAT CARE FOR THE ENVIRONMENT WAS A KEY DEVELOPMENT ISSUE

**2ND**

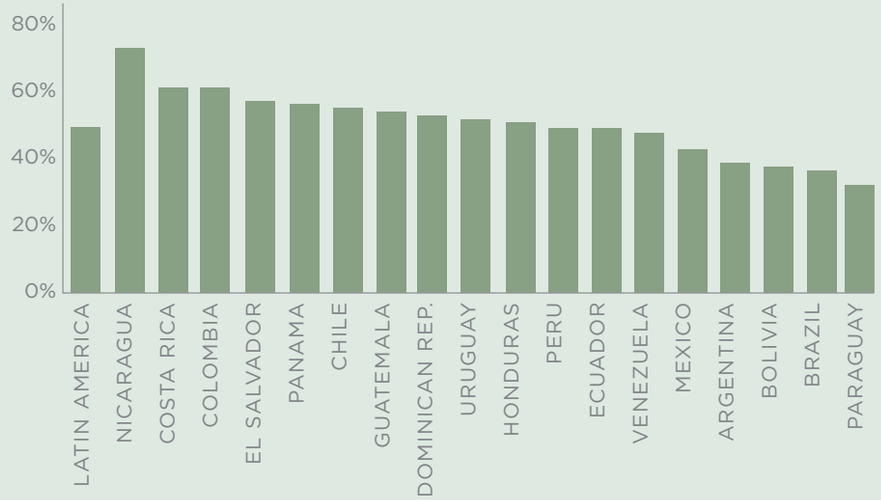
WHERE LATIN AMERICANS RANK THE ENVIRONMENT ON THEIR LIST OF PRIORITIES (ONLY SOCIAL POLICIES RANKED HIGHER)

**40**

THE DIFFERENCE, IN PERCENTAGE POINTS, BETWEEN THE COUNTRIES IN THE REGION THAT PLACE MOST AND LEAST IMPORTANCE ON THE ENVIRONMENT

**CARE FOR THE ENVIRONMENT AND DEVELOPMENT**

Question: Which of the following topics are most important for development in your country? Responses for the environment and climate change




Source: www.iadb.org/intal/alianzalb

ANALYSIS

Thomas Sterner
Collège de France and University
of Gothenburg

# Environmental taxes

## Laying the foundations for global fiscal reform

GLOBAL REGULATORY NORMS ARE NEEDED TO IMPOSE OBLIGATIONS AND PREVENT UNACCEPTABLE ACTIONS.

*Laudato Si'*

In the Paris Agreement, nearly every country in the world agreed to undertake individual actions and pursue common objectives. However, the individual actions contained in the agreement are not enough to achieve those objectives. It is to be hoped that the process following the Paris Agreement will imply a gradual scaling up of countries' commitments and will include more effective instruments, including a price on carbon. This price could be derived from a cap-and-trade system with very restrictive $CO_2$ emissions targets or could be achieved via a tax. Many countries need a tax reform that includes environmental taxes that provide revenue for the state but with the least possible market distortion. A fuel tax would meet these requirements and help remedy the environmental damage caused by emissions.

In April 2016, representatives of practically all nations in the world, including French president François Hollande, signed the climate pact at a UN ceremony in New York. People do perhaps feel some relief that we are finally seeing some success for international climate policy, but many are still confused by the apparent contradiction between one perspective that tells us that this is a historic treaty because so many countries signed and because its goals are quite radical, and another that argues that the agreement contains little of substance on instruments or real commitments. In particular, there is nothing on setting a price on carbon.

To understand the current predicament better, we need to start with a historic background. The first World Climate Conference was held in Geneva in 1979 and was sponsored by the World Meteorological Organization (WMO). It was one of the first major international meetings on climate change and led to the WMO and UNEP creating the Intergovernmental Panel on Climate Change (IPCC) in 1988. That same year, NASA scientist James Hansen gave his well-known testimony to the US Senate during which he explained the science of climate change. At this point, the US was a leader. Also in 1988, a large climate meeting of both policy makers and scientists in Toronto concluded that carbon emissions should be reduced 20% from 1988 to 2005. This was assumed would be done through individual country commitments. In reality, emissions increased by about 30% in



# ENVIRONMENTAL TAXES

spite of many more climate meetings and major treaties such as the United Nations Framework Convention on Climate Change (UNFCCC), a framework treaty that opened for signature at the Earth Summit in Rio in 1992 and entered into force in 1994.

## AFTER KYOTO

The first UNFCCC Conference of Parties (COP) took place from March 28 to April 7, 1995, in Berlin, Germany. Since then, the parties, or country representatives, typically meet annually in a COP, which is the highest decision-making authority of the UNFCCC. Negotiations started to strengthen the global response to climate change, and, two years later, the Kyoto Protocol was adopted. The Kyoto Protocol was supposed to be different since it builds on legally binding commitments. Because carbon dioxide has been accumulating in the atmosphere since before the industrial revolution, low-income developing countries argued that they had not created the problem and should be allowed to develop before reducing emissions. Hence the protocol "legally" binds only developed country parties to emission reduction targets. The protocol's first commitment period started in 2008 and ended in 2012. The second commitment period began in 2013 and will end in 2020.

The Kyoto Protocol, however, has serious problems. Not only did few important players commit to emissions reductions but no mechanism was specified to enforce agreed reductions. The US never ratified it because there are no limits imposed on large developing countries like China and, furthermore, those countries that have ratified it can leave at will, as Canada did in 2011. Its Kyoto target was a 6% reduction between 1990 and 2012, but its emissions had actually increased almost 25% by 2008. The Canadian environment minister's main argument to defend Canada's withdrawal from Kyoto was that the treaty did not bind the world's two main emitters: China and the USA.

Leading up to the 15th COP in Copenhagen 2009 there were very high hopes of dramatic climate action, and the meeting attracted the highest possible political participation. Almost 115 world leaders attended and in total about 40,000 people, representing governments, nongovernmental organizations, intergovernmental organizations, faith-based organizations, media, and UN agencies applied for accreditation. It started off with aims of climate emission reductions through a system like Kyoto but at the global level. However, it failed completely, and in the end the only outcome was the Copenhagen Accord, which goes back to a system of voluntary individual country commitments. In the Paris Agreement, these were formalized through the adoption of a system of Intended National Determined Contributions (INDCs). Thus, on the one hand, the Paris Agreement has very radical goals of making sure the global temperature increase stays well below 2°C[1] and in fact commits to "pur-

sue efforts to limit the temperature increase to 1.5°C" (UN, 2016). On the other hand, and in spite of positive results in some countries, the international level is marked by a miserable track record in terms of the 30 previous years of commitments. The Paris Agreement contains no particular method for enforcing reduction commitments other than rounds of discussions concerning the INDCs, which each country formulates on their own. These INDCs are often hard to interpret and they may be contingent on external funding. Scientists agree they will not guarantee us keeping the temperature increase below 2°C—rather we are on a path to somewhere between 2.7°C and 3.7°C[2].

## THE THREAT OF IRREVERSIBLE CHANGE

Some see the overall picture as very dark because of how little we have achieved since Rio 1992—and, in fact, since the first Earth Summit in 1972. The IPCC clearly shows that we have just a tiny window of a few years to act before the carbon budget locks us into irreversible, and, at least potentially, very dangerous climate change. One could argue that the negotiations simply have gone around in circles and achieved nothing. On the other hand, it could be said that the general understanding of the problem has improved and that the degree of commitment and understanding in Paris were unique. There are a few other positive developments: most importantly, the fact that renewable energy is making incredibly fast progress. Wind makes up almost half of Denmark's electricity and more importantly, perhaps, solar photovoltaic supplies 8% of Germany's electricity. Investments in renewable energy are also increasing very fast in developing countries, including in Latin America[3]. Costs have been slashed repeatedly every decade—but will this be enough?

CARBON DIOXIDE EMISSIONS HAVE INCREASED BY

**30%**

DESPITE GLOBAL ENVIRONMENTAL SUMMITS

The enormity of replacing all fossils is still daunting. Many of the world's biggest companies are fossil fuel companies and their power to lobby is enormous, and so is their power to innovate. Fossil fuel costs are also coming down very fast thanks to aggressive new methods like fracking. The coal industry has had serious problems over the last five years, as have many oil-exporting countries and companies, but they are far from dead. The US is in the midst of a major fossil gas boom. This has admittedly had the positive effect of reducing US domestic demand for coal, but some of this coal is exported. Coal consumption in China remains at unprecedented levels, although its growth has recently slowed significantly (EIA, 2016). Most importantly, climate scientists predict that if India were to burn its huge coal reserves to provide electricity to the more than 300 million Indians that currently have no access to power, warming targets would be overshot by a large margin, not to mention the other billion people who have no access to electricity in Africa and other parts of the developing world[4].

All this brings us back to the question of how to actually implement the Paris Agreement. The world's best economists have argued for more focus on carbon prices, but the negotiators in Paris ignored them because the issue was considered too divisive. We economists must perhaps do some soul searching. Clearly, we are right in the sense that if there had been a carbon price then good solutions would be promoted efficiently. But we must be bad at explaining this—or are we maybe saying it in the wrong way? This is a point where we need to be self-critical: maybe we put the cart before the horse? We should know that the most fundamental things must come first: property rights, institutions, principles, and, in this case, environmental goals.

### FAIRNESS IN CLIMATE NEGOTIATIONS

The USA and are India the two large countries with the most obviously different interests since one is a very high per capita emitter and the other is very low.

| | $CO_2$ (Mt) | % share | Population (millions) | % share |
|---|---|---|---|---|
| India | 2,070 | 6 | 1,295 | 19 |
| USA | 5,300 | 15 | 319 | 5 |
| World | 34,600 | | 7,000 | |

The table shows emissions and population shares for both countries in 2011. India has 19% of the world population but only 6% of global carbon emissions, while the US has 4.5% of the world population and accounts for 15% of emissions. Thus $CO_2$ emissions per capita are ten times higher in the US (17 tons/capita compared to 1.6 tons/capita for India). If future emission reductions are allocated by so-called grandfathering—that is, percentage reductions based on current shares—then the US would always get 15% of the global total, and India, 6%. This appears fair from the US perspective and can be defended as a proportional amount of effort. On the other hand, India might reasonably appeal to another concept of fairness and claim, for example, that emissions per capita should be equalized. This would give India 19% (depending on how population shares develop over time) and the US roughly 5%. It is clear that the difference between these two principles represents very significant differences in burden and could translate into very different financial flows.

## A SEAT AT THE TABLE

The Nobel laureate Elinor Ostrom insisted that the most difficult part of a negotiation is to get the participants to the table. She built on considerable experience in negotiations on common-pool resources like water resources in California or the Law of the Seas, where it took years to gather the parties around the table. One can argue that Paris achieved that. Reaching unity proved tough. The small island states demanded temperature increases be limited to 1.5°C rather than 2°C. The truth is that although the average global temperature on earth has increased by "only" 0.8°C degrees since the industrial revolution, increases of 1.5°C by 2100 are inevitable, due to the long time lags embedded in the climate system. However, one has to understand that the representatives of small island states and other sensitive areas would hardly have signed a document that simply doomed them to drown. On the other hand, some rich and powerful nations with fossil resources would not have signed if the document had appeared to be a treaty (which in the US would require ratification in Congress) or contained language that was too prescriptive (explicit mention of carbon prices).

**8%**

OF GERMANY'S ENERGY SUPPLY COMES FROM SOLAR PHOTOVOLTAIC

The result is thus no more than a first step. The remaining carbon budget before we hit temperature increases of 2°C is way below 1000 Gt of $CO_2$ equivalent—more like 700–800 Gt (forever)—and the INDCs will collectively use up most of that (600 Gt) by only 2030. Indeed, existing and planned coal plants alone will use up more than 400 Gt. At the same time, new research shows that the expected economic damages of climate change will be much higher than thought earlier. So the situation is precarious, but on the positive side, we can at least say that there has been a mental shift. More and more world leaders have understood the reality of climate change as more local damages have become visible, and climate deniers have virtually no credibility or visibility today. The Paris Agreement puts all the governments in the world on record as striving to exit the fossil fuel–dependent era. Given the circumstances of our imperfect world, the Paris Agreement was a big step forward, and we have a duty to use it as proactively as we can.

Another development that was very prominent at the Paris COP was the strong engagement of many nongovernment entities and initiatives. There was greater participation on the part of cities, regions, the business sector, and various NGOs than in previous meetings. The position taken by the Catholic Church in the encyclical *Laudato Si'*, published on May 24, 2015, is symptomatic of this. The encyclical's subtitle is On Care for Our Common Home, and in it Pope Francis calls all people of the world to take swift and unified global action to deal with global warming. Notably, the encyclical has a strong, clear focus on poverty and emphasizes that "we are faced not with two separate



crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental." This is particularly relevant given the large discrepancy between carbon emissions per capita in different countries, which is at the heart of the disagreements between rich and poor countries when it comes to burden sharing in the design of future climate agreements and policies.

Now every country must ratify the Paris Agreement. At the time of writing (August 2016), it had been signed by 180 countries and 22 had deposited their instruments of ratification. Full participation and ratification are very important, but that is still just the start. The INDCs must be tightened considerably since they do not collectively represent a sufficiently ambitious set of emission reductions. It is clearly difficult to initiate both a process for ratification, verification, and control which requires stability, on the one hand, and a process for tightening the INDCs, which implies making them more ambitious, on the other hand. The allocation of emission reduction obligations between countries has always been an obvious point of controversy since emissions intensities varies greatly. Those countries that have high emissions tend to believe that percentage reductions from the status quo are an obvious and fair method.

One could simply say that there is a lot of money involved in international climate negotiations and perhaps this is one reason that they take so much time. Per capita equality of emissions is never going to be acceptable to rich and energy-guzzling countries like the US, who will argue that needs are very different in different countries depending on their temperature, population density, and industrial structure. On the other hand, equal percentage reductions from the status quo are so blatantly unfair to poor countries that this has no chance of being accepted either. Clearly, a compromise is needed. This is where the INDCs are potentially interesting. Since they are determined autonomously by each country, one can argue that they are politically acceptable by definition. If, for the sake of global climate stability, larger reductions are needed, it would seem promising to discuss percentage reductions—not in proportion to current emissions but as percentage reductions that take the INDCs as their starting point.

## EFFECTIVE ECONOMIC INSTRUMENTS

Another aspect to consider if we are to end the fossil era within a generation is that we need effective economic instruments, which means a price on carbon. This is all the more urgent because of current low fossil fuel prices—and these issues are related. The fossil industries are not going to give up voluntarily; they will fight back. The recent fall in oil prices from US$140 per barrel to US$40 per barrel will provide impetus for increased consumption, and emissions may soon rise again. The price of fossil fuels and other raw materials may swing drastically because of market imperfections and because investments on both the consumption and production sides are long term. The current drop in prices may have been somewhat magnified by the expectations of stricter climate policies. Fossil producers may have understood that

SWEDEN HAS A WELL-FUNCTIONING CARBON TAX OF

**US$ 130**

PER TON

come 2030, business will not be good, so they have done everything in their power to maximize capacity and sell now: This has come to be known as the "Green Paradox" (Sinn, 2008). The Saudis appear to have abandoned their old strategy of defending OPEC in order to control the oil market. It seems that they, too, just want to pump while the going is good, and as all producers are constrained by liquidity, they need the cash since they have adapted their spending habits to past revenue streams.

The crucial rhetorical question for understanding these issues is whether we want high prices for oil and other fossil fuels. The argument is often made that such high prices are needed in order to boost interest in renewables, energy efficiency, and other ways of reducing carbon emissions. Or do we want low prices for fossil fuels, so that new mines and coal power plants are not opened and to kill off prospecting for tar sands, fracking, and ordinary exploration for more fossil-based resources. This is the "supply side" argument. The truth is that we want both! We want a high price to the consumer to promote efficiency in use, energy savings, and renewables, but we want low profits for the fossil fuel industries as this is the only way we will ever be able to "leave it in the ground."

All this is just a long-winded way of saying that we need taxes or other policies that put a price on carbon emissions. Now is the best possible moment for importing nations to start taxing fossil fuel—and taxing it heavily. The current low oil (and other fossil fuel) prices imply that consumers will not notice and complain too much. By taxing fossil fuels now, we are likely to prolong the period of low fossil prices, reduce import bills, and reap large benefits in balance of trade. The low current prices also mean that we do not have to worry about causing a green paradox reaction. Some people do not believe in this anyway, but it is conceivable that if carbon taxes are badly managed they could provoke a fall in the price of fossil fuels that would counteract the tax, but since prices are already so low they cannot really fall much further.

We, the consuming importers, would be stupid if we did not seize the opportunity to tax fossil fuels now. This is the best way of stimulating efficiency and renewables, giving money to the treasury (instead of to the producers), while helping to keep fossil prices and thus rents low. This is good for the balance of trade of the importing countries and it makes it easier to close mines.

## SWEDEN'S ENVIRONMENTAL TAX

It would be rash to attempt to say something on whether taxation or permit trading is the best solution in a single paragraph. There are good arguments on both sides and ultimately it depends on many national circumstances. Exiting the fossil-based world is so urgent that the only criteria worth the ink it is written on is really which instrument will deliver the most stringency—that is, the highest price on carbon and the fastest reduction in use. It seems reasonable to leave this, and many other details, up to individual nations. Sweden has a carbon tax of around US$130 per ton which works fairly well. The best "proof" of this is that entire sectors like heating are decarbonized, the economy is doing fine, and no one complains or even thinks about the issue. I would also point to the fact that the whole of the EU, Japan, and numerous other countries have what I would call sectoral carbon taxes—that is, gasoline and diesel taxes that are even higher than the Swedish carbon tax in practice—and they, too, work fine, in that EU per capita consumption of transportation fuel is a fraction of that of the US. On the other hand, some jurisdictions have already chosen well-designed cap-and-trade mechanisms, like California, and clearly that instrument can also work very well. And maybe there are combinations to be explored. The one concern I have is that one needs to pay special attention to the fact that cap-and-trade is hard to combine with other policies. While a tax on fossil fuel and a subsidy on alternatives are largely additive in their effect, ancillary policies are more problematic with cap-and-trade since the cap tends to dominate and other policies just create leakage. This requires special consideration but could be dealt with.

Another issue that is very important to consider is the politics of fuel prices. Price increases are never popular, and many politicians are wary of raising fuel taxes for fear of popular protest. There are, in fact, several very good arguments for raising taxes on fossil fuels, but it is very important to be clear and pedagogical about such tax increases. The first argument in favor of doing so is that the state needs revenue to provide basic services, the second that these price increases are not inflationary, and the third that they are not regressive. The first argument requires the state not to be perceived as corrupt, because then politicians are just accused of stealing the money. To understand the second argument, we should distinguish between a tax from an increase in the price of imported oil, which does make the country poorer and does fuel inflation. A rise in one tax, however, would not make the country poorer, as the money would stay within the country and could be used, for instance, to lower another tax (an Environmental Fiscal Reform) or to provide better public services.[6] The most important argument, however, is often that fuel taxes are regressive. This argument is, however, typically wrong: in low- and middle-income countries, fuel taxes are generally progressive since it is the rich who have cars and use most gasoline and diesel and hence benefit more from subsidies (Sterner, 2012). If the state wants to help the poor, it should provide education, sanitation, health services, infrastructure and many other goods that are more important to the poor than cheap gasoline.

The above paragraphs discuss national policy instruments. However, we also need to think of the international aspects. To date, most international treaty efforts have focused on agreements

in which each country would get some form of emissions allocation or emissions reduction mandate. If an agreement were made that tightened INDCs, as discussed above, that would also be an agreement based on a duty for each country to stay within a given emissions corridor. A natural addition to such an agreement would be some form of "joint implementation," which could perhaps develop into a global program for the trading of permits. If this worked, if control and verification could be made credible, if all countries participated and did not withdraw from the treaty, then we would have a working solution and a price on carbon would emerge as a natural consequence. On the other hand, as suggested by Weitzman (2014), negotiating emissions allowances for each country is quite complicated and conflict-ridden. His proposal is that negotiations should just focus on creating agreement on a minimum carbon price level and each nation should then choose the methods it sees fit to make sure the minimum price applies and is gradually extended to all sectors.

## THE ROLE OF PRESSURE GROUPS AND LOBBIES

Both carbon taxes and cap-and-trade schemes tend to meet resistance from lobbyists from the fossil fuel sector who will try to keep the price on carbon emissions low. The energy sector only accounts for a few percent of GDP yet it is typically an industry with a high degree of concentration. The top positions on the Fortune 500 list are dominated by oil, gas, and coal together with the automobile, steel, and other fuel-consuming industries. Their lobbying power is significant. Perhaps the only feasible policy is one that brings down the price of renewables and thus demonstrates the availability of an alternative source of energy.

The scale of decarbonization necessary also speaks to the need for developing clean alternative sources of power. If all we had to do was reduce carbon emissions by a few percent, that could be achieved through gains in efficiency or changes in consumption patterns, both of which are easily attainable by raising the price of fossil fuels. For a complete phase-out of fossil fuels, however, we clearly need new sources of nonfossil fuel or energy. Over the last few years, wind and even solar power are becoming more and more competitive with fossil fuel. As Michael Liebreich, chief executive of Bloomberg New Energy Finance, stated, "the perception that fossil fuels are cheap and renewables are expensive is now out of date. The fact that wind power is now cheaper than coal and gas in a country (Australia) with some of the world's best fossil fuel resources shows that clean energy is a game changer which promises to turn the economics of power systems on its head."

The fact is that the cost of crystalline silicon photovoltaic modules has fallen by 99% since 1978 and by more than 80% since 2008, partly driven by climate and energy policies and more efficient manufacturing. Global wind- and solar-power capacities have grown by 40–50 Gigawatts each year since 2008 (Wagner et al., 2015). Much of this development is due to the determined policy in Germany of the Energiewende (energy transition), which subsidizes renewables such as roof-top solar with quite considerable subsidies. At the same time, China has taken solar cell production to scale and lowered production costs considerably. It is likely that this combination of developments is one of the decisive factors that will make it possible in the future for countries to envisage more radical climate policies including either cap-and-trade or carbon taxation policies. One of the mechanisms involved will be that politicians will find it easier to put policies into action if there are realistic alternatives within reach. Another mechanism is that the rise of a new renewables industry will weaken the fossil industry and its lobby and thus reduce resistance to policies that imply a higher price on carbon. Such prices will still be needed even if renewables are cheap, otherwise, there is a risk of us simply consuming more energy, both renewable and fossil-based.

This brings us back to the UN process and COP22 in Morocco. France, as presidency of COP21, has been working hard to prepare for the transition. For instance, a High-Level Forum was organized at the French Ministry of the Environment and at the Elysée Palace on June 10, 2016, where France and Morocco were able to discuss strategies. The meeting focused explicitly on the importance of bringing in carbon pricing. Thus the French presidency appears to be striving to respond in some manner to criticisms that the Paris Agreement is weak on actual instruments. The strategy may thus have been to first secure unanimity, which failed in Copenhagen and could have failed in Paris, too. Now that we have unanimity over goals, it is time to address the instruments necessary to reach these goals.

**NOTES**

[1]This is taken to mean the stabilization of carbon concentrations in the atmosphere that will limit global warming (with at least 66% probability) to below 2°C by 2100, relative to pre-industrial levels.

[2]Levin, K., and Fransen, T. 2015. "INSIDER: Why Are INDC Studies Reaching Different Temperature Estimates?" *World Resources Institute Blog*, November 9. http://www.wri.org/blog/2015/11/insider-why-are-indc-studies-reaching-different-temperature-estimates. A somewhat more optimistic assessment states that INDCs (now typically called NDCs, as "Intended" has been dropped since Paris) would lead to somewhere between 2.6°C and 3.1°C—for more on this, see Rogelj et al. (2016).

[3]Investments are in fact surging in developing countries and even surpass the emblematic US$100 million mark often discussed in climate finance discussions. For more on this, see the Climatescope website, http://global-climatescope.org.

[4]Lindeman, T. 2015. "1.3 Billion Are Living in the Dark." *Washington Post*, November 6. https://www.washingtonpost.com/graphics/world/world-without-power/. This highlights the importance of the renewable investments mentioned.

[5]Basically, it takes a long time to heat the oceans and for the planet to find a new equilibrium temperature, but the fact is that even if we stopped emitting carbon completely today, then the current content of carbon in the atmosphere would eventually lead to a warming that would be close to 1.5°C.

[6]Big deficits in the public budget are very inflationary. Getting rid of such deficits through better taxes can, in fact, remove this source of inflationary pressure.

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ANALYSIS

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# Governance and the Environment

**WE NEED AN AGREEMENT ON REGIMES OF GOVERNANCE FOR THE WHOLE SPECTRUM OF SO-CALLED GLOBAL COMMON-POOL RESOURCES.**

*Laudato Si'*

# GOVERNANCE AND THE ENVIRONMENT

What are the main challenges to improving environmental performance by strengthening governance in Latin America and the Caribbean? This article analyzes the effects of competitiveness and the benefits that derive from the existence of widespread environmental protection policies. Business prestige, water and energy savings, lower operational costs, better financial conditions, and the possibility of accessing new markets are just some of the advantages that derive from sustainable development strategies. The article also analyzes the current state of environmental governance and the measures needed to strengthen it.

Environmental deterioration entails real economic costs for countries. Country Environmental Analyses (CEAs) carried out by the World Bank for Colombia, Mexico, and Peru conservatively estimate the costs associated with environmental degradation processes that could be prevented locally, such as damage to people's health, loss of productivity due to soil erosion, and the costs of repairing specific environmental liabilities. The results of these studies suggest the economic costs of environmental degradation to represent approximately 3% of the GDP (World Bank, 2006, 2007). These environmental costs imply a slowdown in real economic growth but not reflected in national accounting practices, which makes it hard for governments to prioritize public investment decisions in relation to them.

As well as affecting economic growth, environmental performance is an important factor in countries' competitiveness. In this sense, a growing number of studies have concluded that the relationship between companies, the environment, and natural capital could entail opportunities for creating value and making firms more competitive (Porter and Linde, 1995; Esty and Winston, 2009). Specific studies report, for example, benefits that include reducing in operational costs through water and energy savings (Berchicci and King, 2007); improving business prestige and market access (Bishop, 2012); and accessing better financing conditions (Hanson et al., 2008; TEEB, 2010; Houdet, Trommetter, and Weber, 2012).

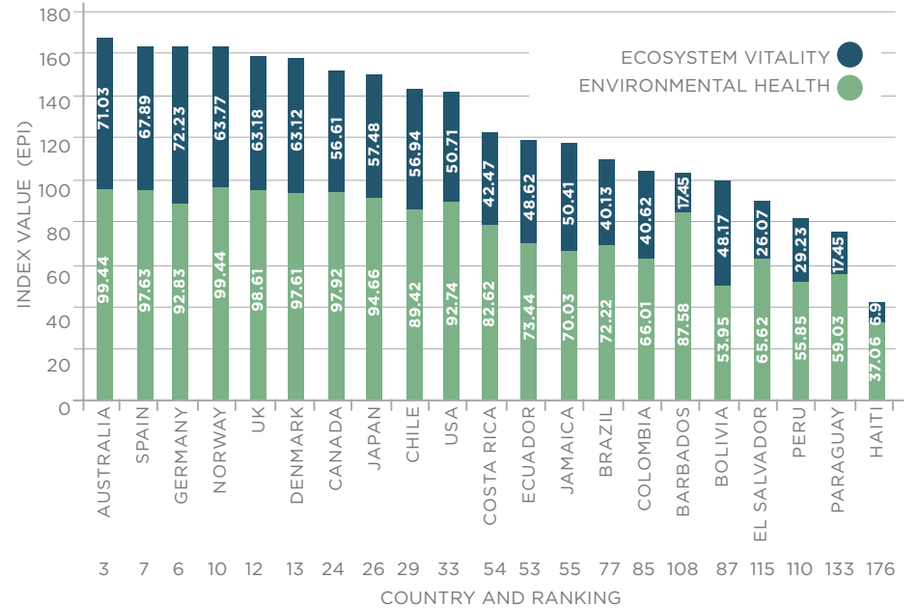
Given the importance of the environment to countries' economic growth and competitiveness, understanding the role of environmental governance[1] is a necessary condition for improving environmental performance. Esty and Porter (2005) found that environmental performance is directly related to the development of a regulatory regime, institutional capacity, and the social and economic context in which these operate. Similarly, other studies highlight the importance of governance for the effective administration of environmental performance (Larson et al., 2006; Mahon, Fanning, and McConney, 2011; Mazur, 2011; Wever et al., 2012; De Castro, Hogenboom, and Baud, 2015).

The first part of this paper reviews LAC's environmental performance and presents existing empirical evidence on levels of environmental pollution and the state of the natural resources and ecosystem services that make up the region's natural capital. The second part contains an assessment of the state of environmental governance. Finally, the third section presents public policy proposals to strengthen environmental governance.

## THE ENVIRONMENTAL PERFORMANCE OF LATIN AMERICA AND THE CARIBBEAN

As a region, LAC is rich in natural capital. At the global level, the region accounts for 40% of the planet's biodiversity (Bovarnick, Alpízar, and Schnell, 2010), it supports 11 of its terrestrial bi-

FIGURE 1
**COUNTRIES' ENVIRONMENTAL PERFORMANCES**

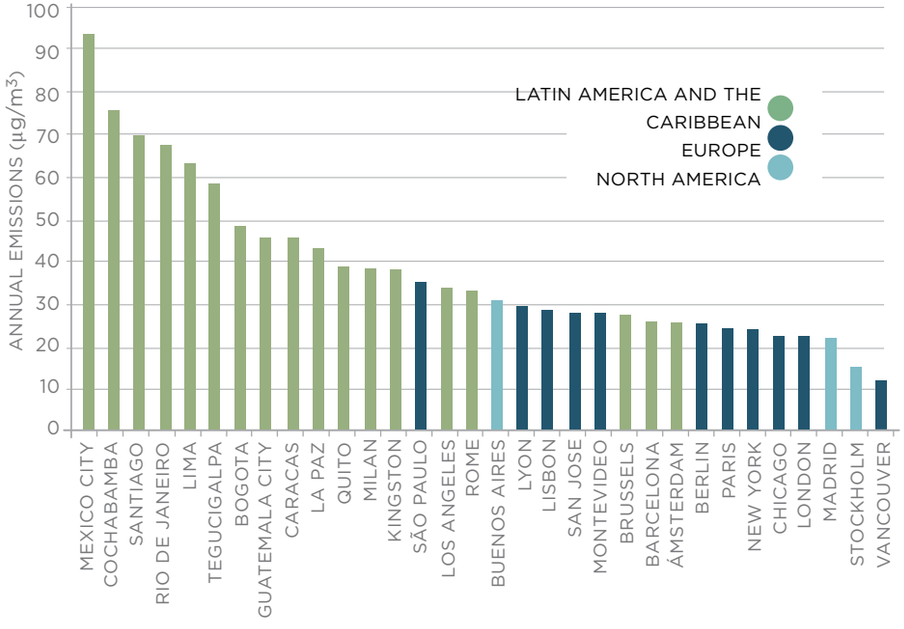



Source: Yale University (2014).

omes (Blackman et al., 2014), 6 of the 17 megadiverse countries, and 7 of the world's 25 biodiversity hotspots (UNEP, 2010a). It is estimated that the region contains almost 9 million km$^2$ of natural forests, including a quarter (37,000 km$^2$) of the world's mangrove forests (FAO, 2010; Siikamäki et al., 2012). Likewise, over 30% of the available freshwater and approximately 40% of water resources are located in LAC (UNEP, 2010a). The region has almost 700 million hectares of potential arable land, 570 million hectares of grasslands, and over 800 million hectares of native forests (Bovarnick et al., 2010).

LAC's abundant natural capital contrasts starkly with the process of environmental deterioration and the growing threats to its sustainability, which are partly due to the region's demographic and economic growth, which is demanding ever-greater exploitation of its natural resources. The Environmental Performance Index (EPI) (Yale University, 2014) shows that LAC countries rank relatively low in relation to countries that are considered benchmarks for good performance. Figure 1 compares selected countries in terms of environmental health and ecosystem vitality and shows a clear, significant gap between countries in the region and benchmark countries. In general terms, environmental performances vary greatly among LAC countries, which is also the case in Asia: countries like Singapore and South Korea performed relatively well while countries like China, India, and Vietnam ranked among the lowest.

FIGURE 2
**ANNUAL PM10 EMISSIONS (G/M3) IN CITIES IN LAC, EUROPE, AND NORTH AMERICA.**




Source: ECLAC, 2015.

## ENVIRONMENTAL POLLUTION LEVELS (ENVIRONMENTAL HEALTH)

Among the major environmental challenges facing LAC are the pollution of water courses by effluent run-off and growing levels of water stress. These impact human health, ecosystem quality, and economic development. In terms of water pollution, the situation in LAC is critical, as is reflected in the levels of degradation of major aquatic ecosystems, both terrestrial (rivers, wetlands, lakes) and marine coastal. Although the region has improved its wastewater coverage indicators, it is estimated that over 70% of wastewater in LAC is not treated at all before being discharged into rivers, lakes, or the sea (Jouralev, 2014). Chile treats nearly 100% of urban wastewater but the levels for the remaining countries in LAC are very low: Mexico, 48%; Brazil and Uruguay, 35%; Belize and the Caribbean, 20%; Colombia, Peru, and Bolivia, 20%; Ecuador, Argentina, and Venezuela, 10%; and Central America, 5% (Mahlknecht and Pastén Zapata, 2013).

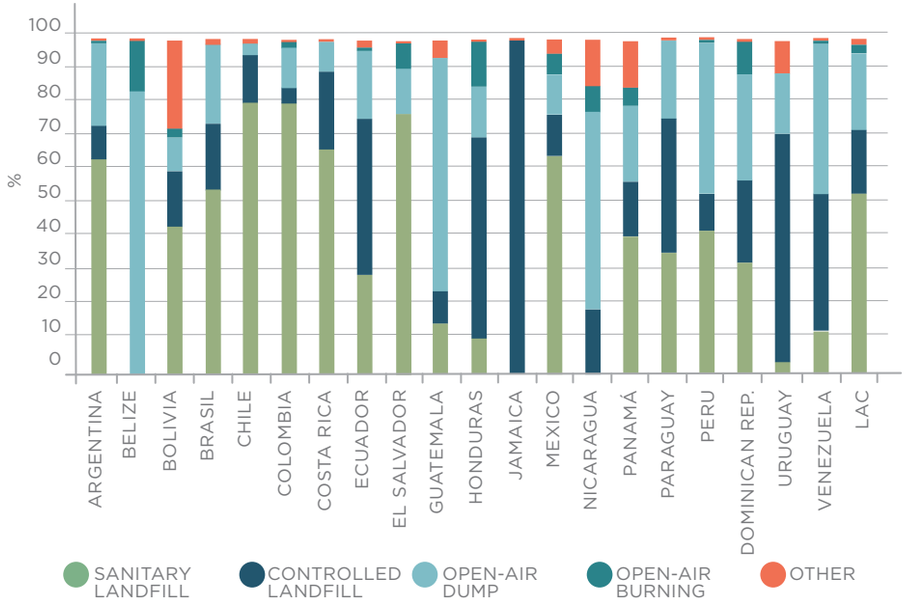
**40%**

OF THE WORLD'S BIODIVERSITY IS IN LATIN AMERICA AND THE CARIBBEAN

Other water pollution factors include agricultural run-off (chemicals and pesticides) and mining effluents, especially from scattered, informal mines and industries. For example, although Chile's levels of domestic wastewater treatment are high, the country's official Water Quality Index (WQI) reports that eight stretches of 33 catchment areas are in a bad state, notably as a result of high levels of chemical pollution caused by heavy metals in the VI Region (Mahlknecht and Pastén Zapata, 2013). In El Salvador, on the other hand, 20% of watercourses are catalogued as being in a bad environmental state, and contain indicators of contamination by organic effluents and pathogenic (coliform) organisms that are much higher than acceptable levels. These indicators are associated with a child mortality rate of 16 children per thousand live births dying due to gastrointestinal disease (MARN, 2013).

LAC's urban centers have extremely high levels of air pollution that are above the standards recommended by the World Health Organization (WHO). Despite the improvements that cities such as Mexico City, Bogota, São Paulo, and Santiago have made in recent years, at least a hundred million people in LAC are exposed to atmospheric pollution at levels that are higher than WHO recommendations (Green and Sánchez, 2013). In 2012, 3.7 million people died in the world of causes that are directly associ-

FIGURE 3
**PERCENTAGE OF THE POPULATION WITH ACCESS TO SOLID WASTE DISPOSAL SYSTEMS**




Source: Tello Espinoza et al. (2010).

ated with air pollution, and 4% of these deaths were in the Americas (WHO, 2014). One factor that is particularly serious is particulate material (PM10), levels of which in LAC cities are far above the WHO's accepted annual of 20 µg/m³, as can be observed in figure 2.

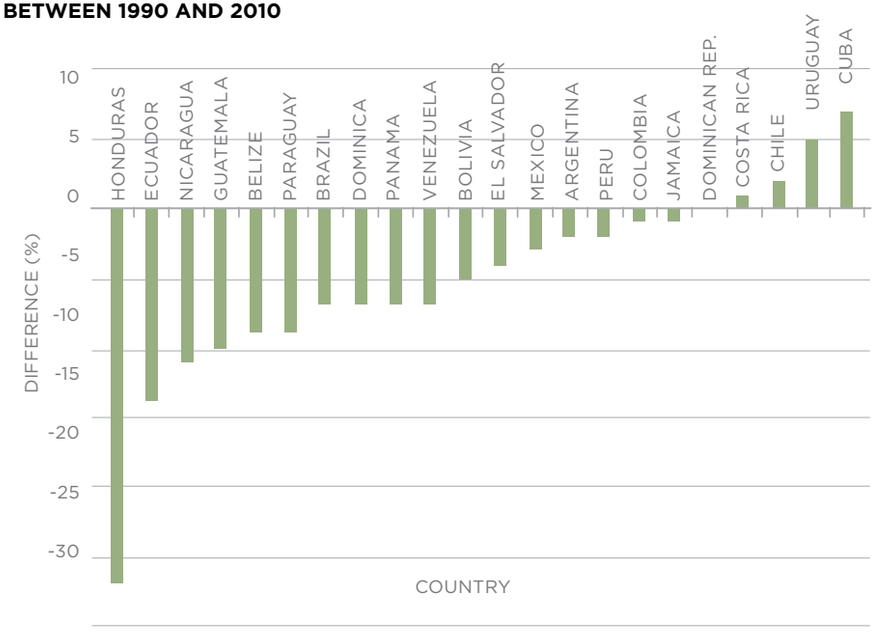
Similarly, greenhouse gas emissions in the LAC have grown steadily since 1999 at an average annual rate of around 1.2%, which is close to the global average (ECLAC, 2010). $CO_2$ emissions have gone from 1,006 million tons in 1990 (2.3 tons per inhabitant) to 1,701 tons in 2010 (2.0 tons per inhabitant). Different studies point to motorized transportation and the steady increase in vehicle numbers as being the main cause of atmospheric pollution in cities (CAF, 2011). Countries in the region have increased their investments in infrastructure and transportation and mobility schemes with the goal of reducing their carbon footprints (Li and Colombier, 2009). Examples of these initiatives include the implementation of mass public transportation systems in Brazil, Mexico, and Colombia. The region has also developed a clean energy supply that leverages the potential of its renewable energy resources (Galindo, 2009). All these efforts are necessary and will make a significant contribution to reducing current pollution levels, but substantial changes to policy and economic behavior will still be needed in the fields of energy and transportation, in addition to higher levels of both public and private investment (UNEP/ECLAC, 2010).



Open-air dumps prevail as final disposal sites for garbage and are an unsolved problem for the environment and public health. Specifically, solid waste management is one of the main environmental challenges facing LAC as a result of the lack of final disposal sites in both urban and rural areas. This has direct impacts on population health and ecosystem pollution. Although there have been improvements to garbage collection services, which now cover an average 93.4% of the population (Tello Espinoza et al., 2010), the main environmental problem is the treatment and disposal of solid waste. As figure 3 shows, in most countries solid waste is disposed of in controlled landfills, open-air dumps, or through open-air burning.

It is estimated that 55% of the population in LAC has access to garbage services that use sanitary landfills to dispose of their solid urban waste (Tello Espinoza et al., 2010), but this is probably an overestimate due to the fact that some municipalities tend to report controlled landfills as sanitary landfills. Landfills and dumps (both controlled and uncontrolled) are not always located in appropriate areas and are often found in sensitive locations such as hillsides, ravines, and riverbanks. Nor are they always appropriately run, which leads to emissions-related problems and leachate run-off that are not properly managed while and also creating

FIGURE 4
**CHANGES IN THE PERCENTAGE OF FORESTED LAND BETWEEN 1990 AND 2010**




Source: ECLAC (2015).

conditions that favor the spread of disease vectors (Díaz, 2009). The absence of planning tools and capacities at the municipal level is one of the main hurdles we need to overcome if we are to tackle the waste problem. Only 19.8% of municipalities in LAC have solid waste management plans and the only countries in which this is the case in over 50% of municipalities are Uruguay (73.9%), Argentina (74%), Peru (57.2%), and Chile (53.4%). It is estimated that only 2.2% of waste in LAC is recovered and recycled, although some countries and cities have begun to promote these practices (IDB, 2010; UN/ECLAC, 2012).

## THE STATE OF THE REGION'S NATURAL CAPITAL

The loss of forested areas and the pressure to expand the agricultural frontier are ongoing problems. In recent years, most countries in the region have adopted new forestry policies or updated their forestry legislation by introducing environmental and sustainability criteria in their use of forests. One example of this is the creation of incentives to reduce deforestation through the REDD+ Program and the application of community forestry management systems, which have brought positive results (Cronkleton, Bray, and Medina, 2011). However, the region is still experiencing increasing changes in land-use, so much so that it is estimated that LAC lost 7% of its forest cover between 1990 and 2005 (ECLAC, 2015). From the 1960s onwards, over 150 million hectares of land have been added to those used in agricultural production (Kaimowitz et al., 2004). The average annual rate of deforestation in the region between 2000 and 2010 was 0.46%, twice the global rate, which represents a loss of 4.2 million hectares of forest per year, although this trend seems to have slowed slightly in recent years (ECLAC/FAO/IICA, 2012). Figure 4 shows that although some countries such as Cuba, Uruguay, Chile, Costa Rica increased their forest cover (both of native forests and forestry plantations) between 1990 and 2010, deforestation has sped up in most others, especially in comparison with previous five-year periods. This is particularly true of Honduras, Ecuador, Nicaragua, Guatemala, Belize, and Paraguay. The loss of forest cover is one of the factors that most directly affects biodiversity and ecosystem vitality.

THERE ARE

**700**

MILLION HECTARES OF POTENTIAL ARABLE LAND IN THE REGION

Biodiversity and terrestrial and marine ecosystems are severely under threat, and rates of loss and degradation are high. The terrestrial ecosystems of the different regions of LAC, including Mesoamerica, the Amazon, the plains, Chaco, and the Andean areas, are extremely rich in biodiversity. Their wetlands, forests, aquifers, lakes and rivers, mountains, grasslands and natural desert provide numerous ecosystem services. However, the pressure on all





TABLE 1
**PROPORTION OF LAC COUNTRIES WITH SPECIFIC LEGISLATION ON PRIORITY ENVIRONMENTAL ISSUES**

| LEGISLATION | ENVIRONMENTAL MANAGEMENT FRAMEWORK LAW | URBAN WASTE | WATER | PUBLIC INFORMATION | FORESTRY | PROTECTED AREAS |
|---|---|---|---|---|---|---|
| SHARE OF COUNTRIES | 25/25 | 13/25 | 15/25 | 7/25 | 23/25 | 20/25 |

| LEGISLATION | ATMOSPHERE | BIODIVERSITY | SOIL | ENVIRONMENTAL IMPACT | FISHING RESOURCES | TERRITORIAL ORGANIZATION |
|---|---|---|---|---|---|---|
| SHARE OF COUNTRIES | 11/25 | 19/25 | 6/25 | 20/25 | 12/25 | 13/25 |

Source: Compiled by the author.

ecosystems is growing. For example, the area covered by mangroves in LAC decreased by 40% between 1980 and 2001 (Valiela, Bowen and York, 2001). Similarly, 67% of the region's coral reefs are damaged and they have shrunk to almost a third of their historic size (Sherman et al, 2009). At the same time, the period between 1992 and 2008 saw an increase in the indicators for overexploitation of fishing resources in LAC, which went from 24% to 33% (FAO, 2012). According to the United Nations Food and Agriculture Organization (FAO) (2014b), LAC's oceans supplied around 20% of global fishing catches in 2012. However, these catches have shrunk by 8.5% over the last decade, going from 20.06 million tons in 2000 to 12.3 million tons in 2010.

A comparison of species that are in some way threatened between 1996 (IUCN, 1996, 1998) and the present (IUCN, 2015) reveals that the situation is critical. LAC contains 5 of the 20 countries with the greatest number of threatened or endangered animal species in the world, and 7 of the 20 countries with the greatest number of threatened plant species (UNEP, 2010b). The number of animal species that are extinct in the wild increased from 99 to 128 between 1996 and 2014; the number of critically endangered species has gone from 255 to 1,065; and the number of endangered species has grown from 500 in 1996 to 1,624 in 2014. As a result of biodiversity losses, the regions genetic reserve is declining rapidly. Approximately 40% of the medicinal plants species in South America are threatened, and the region has lost around 75% of the genetic diversity of its agricultural crops over the last century (UNEP, 2010b; CBD, 2014).

The long-term availability of water for different uses is another challenge, especially considering that water distribution is very unequal: two-thirds of the region are classified as arid or semi-arid, including the center and north of Mexico, the northeast of Brazil, and various Andean regions in Argentina, Chile, Bolivia, and Peru. According to the FAO (2014a), the main uses for water are: agriculture (73%), domestic consumption (18%), and industry (9%). The need for increased irrigated surface area, large-scale hydroelectric projects, and the growing urban population point to potential conflicts of use between the different sectors and greater environmental pressure in general (Mahlknecht and Pastén Zapata, 2013). The Organisation for Economic Co-operation and Devel-

opment (OECD) (2012) foresees a 55% increase in demand for water by 2050 and estimates that 40% of the population will be living in severely water-stressed catchment areas by then.

## THE STATE OF ENVIRONMENTAL GOVERNANCE

The environmental challenges facing the region are the consequence of poor governance, which is what has led to its disappointing environmental performance. This result largely reflects the fact that public policy and investment in the conservation of natural capital and environmental management have yet to become political and economic priorities. Although the region has witnessed developments in legal and institutional terms in recent years, challenges and weaknesses that hamper the creation of solid environmental governance still remain.

In terms of institutions and legal frameworks, every country in the region has some sort of general (nonsectoral) framework law for environmental management, and many have specific sectoral laws and regulations, including EIA regulations, as is shown in table 1.

Despite the existence of these legal frameworks, several diagnostic exercises and studies on this issue (Gómez et al., 2006; INECE, 2009; Bovarnick et al., 2010; Acerbi et al., 2014; Blackman et al., 2014) have highlighted the following challenges and weaknesses:

a. Weak environmental institutions. Within hierarchical and budgetary structures, environmental institutions generally have low budgets, inadequate technical equipment, and limited capacities for attracting skilled technical personnel with cutting-edge knowlege. These weaknesses are evident at the national level but even more marked at the local (provincial and municipal) levels.

**19.8%**
OF MUNICIPALITIES IN LAC HAVE WASTE MANAGEMENT PLANS

b. Limited development of environmental capacities in sectoral institutions. Recent years have seen environmental initiatives in productive and infrastructure sectors such as transportation, energy, agriculture, tourism, and housing, among others. However, factors that would aid coordination between such sectors to apply environmental legislation generally remain scattered and isolated. In addition, there are inconsistencies in many sectoral policies in relation to given resources (water, for example) or geographic areas.

c. Low levels of investment in and public spending on the environment. Several studies have tried to determine the levels of public spending toward protecting environment and natural capital using a range of methods (Eurostat, 2005; OCDE, 2007b; etc.) and the United Nations' System of Environmental-Economic Accounting (SEEA) (Oleas-Montalvo, 2013; United Nations, 2014). The results of these studies suggest that investment in public spending on the environment in LAC stands at less than 1% of GDP. Only Brazil, Mexico, and Costa Rica spend more than 0.6% of their GDP, which is far below the OECD average of around 1% of GDP (IDB, 2012, 2013; ECLAC, 2012; UN, 2014). This state of affairs suggests how difficult it is to access the resources needed to tackle the environmental problems and threats that affect LAC.

d. Deficiencies in the application of the EIA and environmental permit systems. Although the application of EIA procedures has been established in most LAC countries and the relevant authorities have considerable experience with these, the failings and limitations of these are evident (Sánchez-Triana and Enríquez, 2007; Acerbi et al., 2014). The lack of institutional capacity is especially noteworthy in relation to project monitoring, which often does not take place after the appropriate license or permit has been issued (Gättgens, 2006). All of these factors have affected the credibility of the EIA system. There are significant limitations and gaps in the process of including environmental factors at the strategic level in the design of policies, plans, and programs. In most cases, this aspect has not yet been sufficiently developed within the legislative framework (OECD, 2007a; IUCN/ORMA, 2007; VBRFMA, 2007; CAF, 2009; Jiliberto Herrera and Bonilla Madriñán, 2009; Utrilla, 2011).

e. Noncompliance with laws. The weaknesses described above give rise to a relatively widespread situation in which standards and provisions are not properly implemented or their enforcement is not verified. In many cases, companies prefer to pay fines than to meet environmental standards (Russell and Vaughan, 2003; Akella and Cannon, 2004). In this sense, permit systems become transaction costs with little added value for either companies or environmental protection.

f. Insufficient application of economic instruments. The use of economic and market instruments for environmental management in LAC has emerged in different contexts, such as the introduction of tradable property rights for fishing or the implementation of landfill charges. However, management still depends mainly on administrative and command control systems that are based on permit and fine mechanisms that are generally inefficient or badly managed.

g. Lack of information for environmental management. In LAC there is a notable lack of systematized environmental information at the sectoral level which could be used to design both environmental policies and monitor compliance with these. As a consequence, natural capital and environmental degradation cannot be properly considered in national accounts or economic policy decisions (Ferraro and Pattanayak, 2006; Pullin and Knight, 2009; Arroyo et al., 2010; CEPAL, 2012; Blackman et al., 2014).

h. Limited involvement of the private sector in environmental initiatives. Increasing numbers of companies in LAC are adopting environmentally friendly practices due to the existence of financial incentives to do so, especially in connection with clean manufacturing and initiatives to reduce carbon footprints. Nonetheless, many challenges remain, and there are gaps in compari-

son with firms in Europe, Canada, and the United States. The number of ISO 14001-certified firms in LAC has grown from 711 in 2000 to 10,996 in 2013 (ISO, 2015), yet these numbers only account for 3.6% of total certifications at the global level.

j. Lack of involvement of local communities, indigenous groups, and people of African origin. There has been some progress in strengthening the role of local communities in environmental management, but these schemes are still in their infancy and are fragmented (Pacheco et al., 2008; Bowler et al., 2011).

## PUBLIC POLICY PROPOSALS

The evidence presented here and the assessment of the environmental challenges facing the region indicate that environmental performance is determined fundamentally by the quality of institutions and governance structures and the allocation of the public budget for environmental management. There are, therefore, two main courses of action which public policy must influence to improve environmental performance. The first is strengthening national and regional environmental governance systems using efficiency and effectiveness criteria. This strengthening needs to go hand-in-hand with increases in and improvements to the quality of investments to reduce pressure on the environment. There now follows a more detailed description of the main activities that could contribute to each of these courses of action. The strengthening of environmental governance systems needs to carry out work in the following areas:

a. Strengthening management capacities, monitoring, environmental auditing and prosecution at the local and sectoral levels responsible for enforcing laws and standards, including provincial and regional governments and municipalities.

b. Designing and developing environmental and natural resource policies that include appropriate sustainability incentives and reduce disincentives to private investment.

c. Implementing appropriate economic and financial instruments for internalizing or correcting market failures that generate environmental externalities.

d. Developing national environmental accounting systems that allow the state and evolution of natural capital to be measured, monitored, and compared, including information systems based on modern monitoring technology.

e. Modernizing national EIA processes and environmental permit systems, together with capacity building to implement SEEs to make them effective management instruments that add value to sustainable social and economic initiatives.

f. Strengthening mechanisms to favor the involvement of civil society and local communities in processes relating to environmental management and the use of natural capital.

g. Strengthening instances and mechanisms of cross-border governance (for example, international territorial waters, shared catchment areas, marine coastal zones, biological corridors, and protected areas).

Increases and improvements in the quality of investments that reduce pressure on the environment and natural capital can be fostered through the following lines of work:

a. Establishing policies based on the polluter pays and user pays principles that internalize the costs associated with environmental remediation and the use of natural capital in the private sector.

b. Promoting and creating green markets for goods and services with high social and environmental impact.

c. Driving environmental certification programs that are linked to accessing domestic and international markets and other sustainability protocols.

d. Creating tax incentives and/or subsdies that target environmental adjustment initiatives, such as cleaner production in SMEs with the aim of improving environmental quality and profitability.

e. Circulating information on environmentally sustainable technologies to promote private-sector investment in the adoption of these.

f. Strengthening financial mechanisms to expand conservation efforts and the effective handling of protected areas, biological corridors, and threatened ecosystems, including large-scale cross-border ecosystems and biological corridors of regional importance.

g. Implementing sustainability strategies in sectors with high environmental and social impact, such as mining, hydrocarbons, hydropower, and urban development, among others.

**NOTES**

[1] Environmental governance refers to the institutional, regulatory, and legal framework and the administrative instruments for applying that framework.

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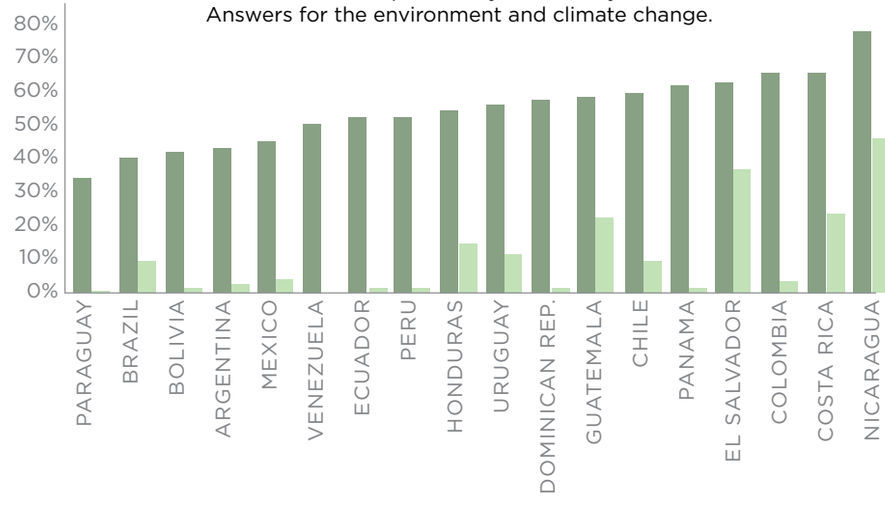
# CARE FOR THE ENVIRONMENT AND CLEAN ENERGY

What distinguishes the energy matrix in countries where there is greater concern for the environment? What is the relationship between the importance of environmental awareness and the use of clean energy? A comparison of how important people say the environment is with indicators on the use of clean energy reveals a trend toward new forms of energy production playing a greater role in countries with higher levels of concern for the environment.

This is true for Nicaragua, Costa Rica, and El Salvador, which are part of a group of countries which produce larger amounts of energy from alternative sources and where people rank care for the environment high among their concerns. Both variables show a positive correlation of 0.66.

## ENVIRONMENTAL CONCERN AND THE USE OF ALTERNATIVE ENERGIES

Question: Which of the following topics are most important for development in your country?
Answers for the environment and climate change.




- % of the population that believes that the environment and climate change are important development issues.
- Electricity generated using renewable sources, with the exception of hydropower (% of the total)

Source: www.iadb.org/intal/alianzalb

Marcelo Caffera
University of Montevideo

# Pollution Control

## Recent Experiences in Latin America

ALTHOUGH THE SUMMIT WAS A REAL STEP FORWARD, AND PROPHETIC FOR ITS TIME, ITS ACCORDS HAVE BEEN POORLY IMPLEMENTED, DUE TO THE LACK OF SUITABLE MECHANISMS FOR OVERSIGHT, PERIODIC REVIEW AND PENALTIES IN CASES OF NON-COMPLIANCE.

*Laudato Si'*

Latin America has extensive experience with economic instruments (EI) for pollution control. This article describes the issues that environmental policymakers should take into account in the future in the light of this experience. Its main lesson is to confirm the importance of countries having institutions and resources that allow them to implement these instruments effectively. It is also key for the revenue thus obtained to be used at least in part to finance emissions reduction technology and to monitor and audit the program as a way of gaining the support of those involved. The political will of regulators is also essential for these controls to be more than just tokens.

Environmental economists have put forward two instruments to control pollution and address other shortcomings in coordination that may lead to a "tragedy of the commons." These two instruments are emissions taxes and tradable emissions permits. With the former, the regulator establishes an amount of money that those emitting a certain pollutant must pay for each kilogram or ton that they emit. With the latter, the regulator establishes a total maximum quantity of emissions that all regulated sources can emit over a specific period of time (a year, for example) and then it assigns each of them (freely or through an auction) an initial quantity of permits. Each permit legally empowers its holder to emit one unit of the pollutant in question in that time period. These permits can be traded among emitters on a permit market.[1]

The main reasons for which environmental economists have been proposing these economic instruments (EI) over other more "prescriptive" instruments (Ellerman, 2007) such as maximum emissions limits or technological standards are as follows: (1) they are the cheapest way of achieving the aggregate emissions levels that the policy is targeting (in other words, they minimize the aggregate costs of reducing emissions); (2) they leave the decision as to the best (least costly) way of reducing emissions in the hands of the sources; and (3) they are an ongoing incentive to reduce emissions.

Why have EIs to control emissions been observed mainly in developed countries, but much less in developing ones? Relatively recent literature points to the following factors as possible causes: the political economy of instrument selection (sources prefer not to pay to emit—see Stavins, Keohane, and Revesz, 1998); the lack of institutional capacity (lack of resources and standards—see Eskeland and Jimenez, 1992; Russell and Powell, 1996; O'Connor, 1999); and cultural issues (Bell, 2002; Bell and Russell, 2002; Bell, 2003; Russell and Vaughan, 2004; Bell, 2005). Russell and Powell (1996) suggest that the choice of EI must be compatible with a country's institutional capacity, by which they are implying a transition from instruments that are more easily audited and less connected with environmental quality targets toward those that are based on emissions measurements, with tradable permits as the long-term aim.

Latin America's experience with EIs to control emissions is limited to the following three programs: the Compensation Program for Emissions of Total Suspended Particles in Santiago de Chile; Retribution Rates in Colombia, which specifically tax discharges of biochemical oxygen demand (BOD) and total suspended solids (TSS); and Costa Rica's Environmental Fees for Discharges, which tax discharges of chemical oxygen demand (COD) and TSS. These programs challenge the above recommendations by trying to directly adapt EIs to the economic, social, cultural, and institutional conditions of these countries (Huber, Ruitenbeek, and Da Mota, 1998; Serôa da Motta, Huber, and Ruitenbeek, 1999). Learning more about these experiences is therefore crucial to being able to draw conclusions that inform environmental policymakers on which points to repeat and imitate and which to avoid when it comes to applying EIs to control emissions in Latin America. This is the aim of this article, which updates Caffera (2010).

# POLLUTION CONTROL

## LATIN AMERICA'S EXPERIENCE

This section reviews Latin America's experience with EIs to control emissions of specific pollutants.

### Retribution Rates for Industrial Discharges in Colombia

In 1993, article 42 of Colombia's Law 99 established that emissions were subject to retribution rates. The design of these rates was regulated in Decree 901 in 1997. In the first place, the decree established that these rates would apply to the kilograms per day of BOD and TSS that were discharged by specific sources into bodies of water. To calculate this rate, the Ministry of the Environment had to establish a national minimal rate which needed to reflect the costs of removing hazardous substances from waste waters. The initial values of minimum rates were set

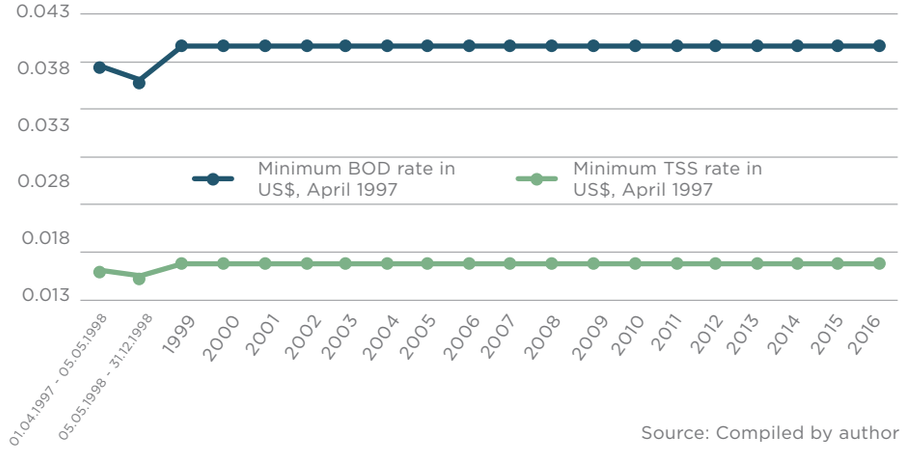
**INSTITUTIONAL QUALITY** IS KEY TO CONTROLLING EMISSIONS IN DEVELOPING COUNTRIES

at US$17/t of BOD and US$7/t of TSS. As the environmental economics manuals suggest, Decree 109 also anticipated a rates value adjustment mechanism based on the reductions observed in pollution rates in comparison with the target. Regional rates were established for this purpose. The value of the retribution rate for pollutant j = BOD, TSS in a certain region in the six-month period t (tR_(j,t)) was established as being equal to the minimum national rate for pollutant j during that year (TM_j) multiplied by the regional adjustment factor for that pollutant for the six-month period in that regionFR_(j,t); TR_(j,t)= TM_(j )× FR_(j,t). The regional factor would initially be set at one and would increase 0.5 units for each six-month period in which it did not reach the emissions reduction target or no new target was established (the target would be reviewed every five years). The decree also established that the emissions reduction target would be defined by the relevant environmental authority for each body of water or water course. To establish this target, the relevant environmental authority was to use a participatory process involving the interested parties through a procedure that was set out in the decree.

This adjustment mechanism became the main obstacle to the effective implementation of these rates. Municipal public wastewater companies did not submit their emissions reports, pay rates, or take measures to reduce their emissions (Blackman, 2009). This caused rates to rise, which led to growing complaints from the industrial private sector, which argued that it was paying for the noncompliance of municipal wastewater companies.

As a consequence, in 2003, President Uribe overturned Decree 901 and issued Decree 3100. This established different pollution reduction targets for wastewater firms and companies

FIGURE 1
**EVOLUTION OF MINIMUM RETRIBUTION RATES IN US$ (APRIL 1997–2016)**




Source: Compiled by author





that emitted more than a fifth of total emissions. The relevant environmental authorities at the urban or regional level were also able to establish sectoral levels. Finally, this new decree changed the way in which rates were adjusted. Instead of taking place every six months, the adjustment process became annual. The regional factor also went from being a fixed figure (0.5) to being based on the difference between the emissions reduction target and the actual reductions achieved by all regulated sources in the watershed at the start of the five-year period, without taking wastewater companies into account. In any case, the upper limit to the regional factor was set at 5.5 and would only be applied to those sources that violated their individual, sectoral, or global targets. In terms of emissions reporting, the decree established that firms had to present reports every two years rather than annually, as had previously been the case.

The rates were modified again a few years later, in 2011, by article 211 of Law 1450 (National Development Plan 2010–2014). This modified article 42 of Law 99 of 1993 and basically established that retribution rates would even be applied to pollution that was over the legal discharge limits and that revenues would be used to finance projects that invested in remediating and monitoring the quality of the resource at stake. Likewise, in the subsequent Decree 2667 of 2012, the calculation of the regional adjustment factor was modified again. To determine the amount of the tariff to be applied, the discharge and individual or group target were compared. Those sources that did not comply with their targets were charged the regional factor calculated for the corresponding body of water or watercourse

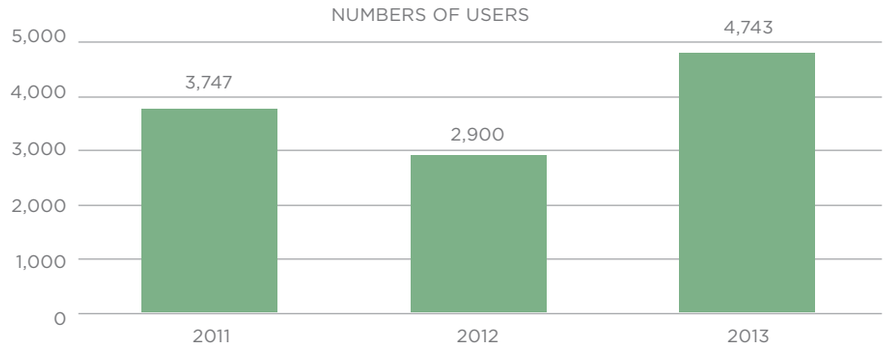
## RETRIBUTION RATES

THESE ARE CHARGED ON THE BASIS OF DISCHARGES AND REQUIRE TRANSPARENT INFORMATION SYSTEMS TO BE IMPLEMENTED

for the year of noncompliance. Sources that were located in an emissions catchment area where the global target had not been reached but which met its individual or group target at the end of the five-year period would begin the following five-year period with a minimum rate if they met the new target for the first year of this period.

The only evidence of the functioning of retribution rates following these reforms is a 2014 report from the Ministry of the Environment (Ministry of the Environment and Sustainable Development of Colombia, 2014), which compiles information provided by the relevant environmental authorities for 2011, 2012, and 2013. It has several shortcomings and these illustrate the current situation in relation to applying rates. First, not all the relevant environmental authorities submitted the information required by the ministry. The number of authorities that did so varied from 29 to 30, out of a total of between 39 and 42. In 2013, the number of authorities that submitted information remained at 29, but the total grew to 42 (four new environmental authorities were included in the program in 2013). One initial issue worth pointing out is the large number of sources covered by the rates, as figure 2 shows.

FIGURE 2
**NUMBER OF SOURCES COVERED BY COLOMBIA'S RETRIBUTION RATES (2011–2013)**




Source: Ministry of the Environment and Sustainable Development of the Republic of Colombia (2014).

The evolution of the number of sources largely responds to whether the environmental authorities in question submitted reports each year. All the same, figure 2 shows one of the effects of Decree 2667 of 2002: the number of sources that rates applied to increased considerably in 2013 following the inclusion of sources that make some sort of discharge without the relevant permit.

It is impossible to assess the effectiveness of these rates as only 33% of the authorities in question reported baseline information on the state of water bodies, 47% reported having quality targets for water bodies, and 42% reported having reduction targets.

Taking all the above points into account, analyzing the behavior of the polluted effluent being discharged seems futile. The report also mentions that the program only managed to collect 34% of the average rates charged over those years.

The assessment of the implementation of retribution rates following this report is therefore mixed. On the one hand, the program pioneered the direct levying of taxes (rates, in legal terms) on specific sources of emissions in Latin America exactly as suggested in the economics textbooks. It has remained operational since 1997 and its coverage continues to grow. On the other hand, it is only being partially implemented in most aspects, which is reflected in the information generated for analyzing it.

## Environmental Fees for Discharges in Costa Rica

At the start of the 2000s, Costa Rica implemented an environmental fees system for discharges that was very similar to Colombia's retribution rates. The decree which established these fees was passed in 2003 and established January 1, 2005, as the program's start date. However, the program was disputed by the Agro-Industrial Sugarcane League, which delayed its implementation until 2006, when the Supreme Court declared it to be constitutional. These firms continued to lobby ceaselessly, which led to a new decree being passed in 2008



(Executive Decree 34431). This substantially changed three aspects of the original fees, which were defined according to whether the concentration of the pollutants in question (COD and TSS) in discharges (Cvj): (1) were lower than the pollutant concentration level at the water extraction point (Caj); (2) Cvj>Caj, but lower than the maximum (standard) discharge limits established by the law (Csj); and (3) Cvj>Csj. Fees were set at US$0.22 per kilogram emitted for COD and US$0.19 per kilogram emitted for TSS. Fee payment was exempted for effluents that there are concentrations of in the first reach of water. Sources with concentrations in the second reach are to pay 75% of the fee. Finally, sources with concentrations in the third reach must pay 100% of the fee for the kilograms of pollutant in the second reach, plus 3.5 times the fee for the kilograms of the concentration that exceed the acceptable level (see the box below). Firms must report their discharges once per year. If they do not, the government can infer these levels using past reports, the number of employees, production level, inputs, industrial sector, or bibliography.

**ENVIRONMENTAL FEE SCHEME**

IN COSTA RICA, FIRMS PAY ACCORDING TO THE LEVEL OF POLLUTION THAT THEY CAUSE, WHICH IS WHY PERMANENT MONITORING IS NECESSARY

Costa Rica eventually implemented the Environmental Fee Scheme for Discharges in October 2008, almost six years after the first version of the decree was published. The scheme began to operate at the beginning of 2009. However, there were major obstacles to its implementation. For example, the Water Department at the Ministry of the Environment, which was responsible for the scheme, did not have the necessary resources to actually levy the fees. During the program's first few years, fees were mainly levied in the Tárcoles basin, where 60% of Costa Rica's industry and 65% of its population is based (Zeledón, 2009). As was the case in Colombia, Costa Rican regulators found the greatest obstacle to implementation to be the reluctance of the Costa Rican Institute of Aqueducts and Sewers to comply with the scheme.

There is still no literature that analyzes how well the Costa Rican Environmental Fee Scheme for Discharges functions. According to Peña Chacón (personal communication with the author, 7/18/2016), the effectiveness of the fee scheme has been questioned on multiple occasions. The Comptroller General of the Republic of Costa Rica (2013) has argued that there is insignificant monitoring of specific discharges. Despite this, the scheme has raised CRC909 million (approximately US$1.66 million) since it was first implemented. However, these funds have not been able to be used due to imprecise instructions on how they should

## EMISSIONS PERMITS

FOR EXPECTED EMISSIONS CAN BE PURCHASED IN CHILE

be handled, the relevant authority, and the procedure to be used (Comptroller General of the Republic of Costa Rica, 2014).

### Santiago de Chile's Emissions Compensation Program

In 1992, Chile embarked on the first tradable permits system in a developing country. Santiago's Emissions Compensation Program (ECP) (Supreme Decree 4, March 1992) was contemporary to the Sulfur Dioxide Allowance Trading Program (EPA-$SO_2$) and Regional Clean Air Incentives Markets (RECLAIM) in the US, the first examples of this type of instrument in the world. Santiago's ECP began operations in 1993 using permits (known as initial daily emissions, IDEs) that were not defined in terms of the quantity of emissions but rather the maximum daily emissions capacity for total suspended particles (TSPs). The system determined that each IDE would enable its holder to emit 1 kilogram per day of TSPs in perpetuity. The reason behind this decision was that it was easier to monitor emissions defined in this way, as there was no information or means available for measuring emissions continuously. Chilean authorities decided to assign IDE permits at no cost at the start of the program (according to historic emissions) as an incentive for unidentified sources to register. The sources that are regulated by the program are industrial boilers, residential heating boilers, and steam generators in the Santiago Metropolitan Region with an emissions discharge at full load that was greater than 1000 $m^3$/hour as of March 1992. Other sources of TSPs, such as industry, were not included in the program because of the difficulty of estimating their maximum daily emission capacity (Palacios and Chávez, 2005).

The name of the program responds to the fact that, following its launch, anyone wishing to install a new boiler or steam generator in the Santiago Metropolitan Region had to buy IDEs from existing sources to be able to do so. Once this transaction had been approved by the Metropolitan Environmental Health Service (SESMA), the permitted daily emissions (PDEs) were assigned to the new source. PDEs are the same as IDEs, except that they are only used for new boilers.

As in the case of Colombia's rates system and Costa Rica's fee system, under the ECP system, boilers and generators in Santiago are subject to an upper limit for emissions concentrations regardless of the amount of IDEs and PDEs they possess.

As part of the inspection process for permits, sources report their declared

### THE STRUCTURE OF THE ENVIRONMENTAL FEE SYSTEM FOR DISCHARGES IN COSTA RICA

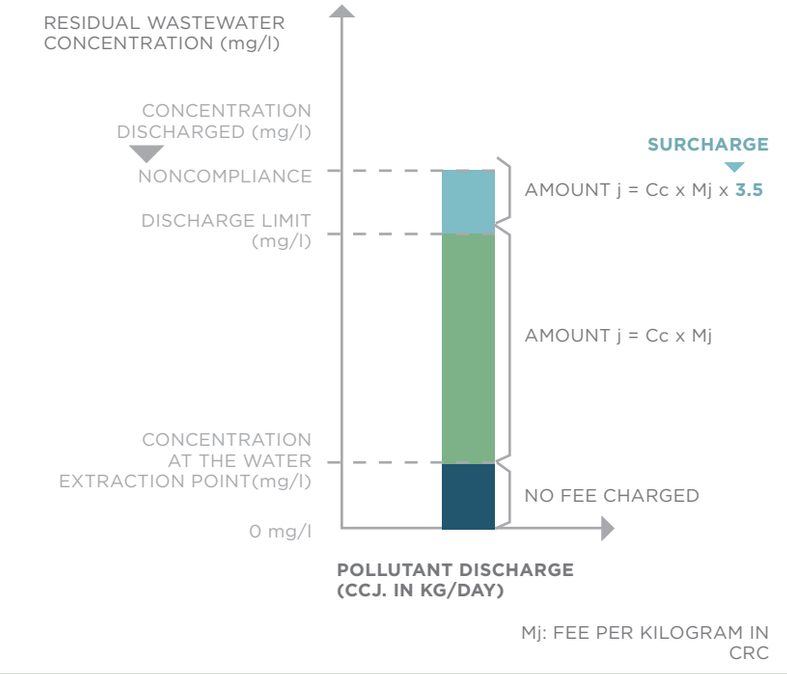
The revised version of the constituent decree of Costa Rica's Environmental Fee System for Discharges (Executive Decree 34431 of 2008) uses a three-tier fee system depending on the levels of concentration of the pollutants in the discharge to which taxes apply (COD and TSS). These three levels were defined as follows:

The concentration levels of the pollutant in discharges (Cvj) are lower than the concentration levels of the pollutant at the extraction point (Caj): the fee is waived. This segment is shaded dark blue in Figure 3.

Cvj>Caj, but lower than the discharge limit established by law (Csj). The source must pay 75% of the fee. This segment is shaded green in Figure 3.

Cvj>Csj (shaded light blue in Figure 3). The source must pay 100% of the fee for the kilograms corresponding to the segment described above, plus 3.5 times the value of the fee for each kilogram of COD and TSS emitted above the acceptable level.

FIGURE 3
**THE STRUCTURE OF THE ENVIRONMENTAL FEE SYSTEM FOR DISCHARGES IN COSTA RICA**




Source: General Water Directorate of Costa Rica

daily emissions to the Subdepartment of Air Quality, which must be lower than their IDEs or PDEs. SESMA monitors the voracity and quality of these reports through audits.

One feature of the ECP system that quickly became evident was that too many permits were assigned initially. Regulators attempted to respond to this by changing the average concentration used to determine the number of perpetual permits that corresponded to each source (Coria and Sterner, 2010). Likewise, the permit exchange rate between new and existing sources was changed. Originally 1:1, it was changed to 1.2:1 in 1998 (an existing source had to forego 1.2 kg/day of perpetual emissions capacity to enable a new source to emit 1 kg/day), and to 1.5:1 after 2000 (O'Ryan, 2002) As a result of these measures, the number of permits held by sources went down 46% between 1997 and 2007, and all excess permits were confiscated.

However, these measures were not successful in promoting transactions: only 214 transactions took place up to 2007 (Coria and Sterner, 2010). The lack of market activity may also have been the consequence of the regulatory in certainty brought about by these changes, the high costs of transactions due to the lengthy approval process (which took several months), the fact that permits were permanent, and the limited scope of the ECP program (4% of TSP emissions in Santiago), which could have generated market power (Montero, Sánchez, and Katz, 2002; O'Ryan, 2002).

Another feature of the ECP program in Santiago was noncompliance. A fundamental factor of this could have been the fact that fines were established as fixed sums that ranged from US$4.5 to US$90,000, rather than being defined in relation to the scale of the infringement or the price of permits (Palacios and Chávez, 2002). As a consequence, if a permit costs US$3,160 in 2007, with a maximum possible fine of US$90,000, any infringement greater than US$90,000/3,160 = 28.5 kg/day made economic sense.

### LESSONS LEARNED

At the end of the 1990s, Huber et al. (1998) and Serôa da Motta et al. (1999) recommended that the implementation of IDEs be made compatible with institutions, gradual (starting with experimental pilot projects or programs before scaling up to the regional or national level), and flexible (allowing for low-cost legislative reviews). They also recommended that the implementation of EI programs guaranteed the involvement of affected parties and generated tax revenues through an approach that prioritized recouping program costs over correcting prices.

The main lesson to be learned from the implementation of the EIs described here is the confirmation of the importance of countries having institutions and resources that allow them to implement these instruments effectively. This lesson is supported by the observation that attempting to adjust the design of these instruments to the institutions and resources available can lead to there being an insufficient incentive for reducing emissions (because of their low cost, in the case of taxes, or because the market does not function, in the case of tradable permits) or to their not being cost effective (because different sources end up facing different taxes or because the instrument does not determine emissions endogenously).

## TAXES

MEXICO TAXES $CO_2$ EMISSIONS THROUGH AN INDIRECT TAX ON FUELS

## REGULATORY MATTERS

THE KEY TO THE SUCCESS OF MONITORING MECHANISMS LIES IN THE REGULATOR'S POWER OF OVERSIGHT

Recent experience also reconfirms the recommendation to include those affected by the EI in the process of designing it, establishing targets, and other key aspects of implementation, as this builds support for it. The same is true of ensuring that the revenue obtained from the EI is used at least in part to finance emissions reduction technology and for the monitoring and auditing of the program.

The lessons described above are important because experience shows that implementation or performance problems with the program can cause political support for it to wane.

Finally, despite these recommendations, the sectors or companies that are affected by EIs will lobby for them not to be introduced. As a consequence, it is obvious that, in addition to the above points, regulators need to have political will if they wish to implement EIs effectively.

### Emissions Taxes in Chile and Mexico

The most recent examples of EIs to control emissions in Latin America are the $CO_2$ emissions taxes in Mexico (2013) and Chile (2014).

In September 2014, at the start of Michelle Bachelet's second term in office, Chile's congress passed a tax reform (Law 20780), article 8 of which established: "a tax (...) on emissions of particulate matter (PM), nitrogen oxides (NOx), sulfur dioxide ($SO_2$), and carbon dioxide ($CO_2$) produced by establishments whose fixed sources, including boilers or turbines, individually or collectively represented thermal power greater than or equal to 50 MWt (thermal megawatts)."[2] The tax on $CO_2$ was set at US$5/t and will become operational in 2018 (Ministry of the Environment of Chile, 2016).

In 2013, Mexico passed a fiscal reform to introduce a tax on $CO_2$ emissions. Unlike Chile, Mexico does not tax emissions from fixed sources of $CO_2$ through a direct tax, but instead taxes mobile sources through an indirect fuels tax. This tax is levied when the fuel is sold or imported on the basis of its $CO_2$ content. The value of the tax is set at around US$5/t of $CO_2$.

Mexico's instrument has been in place for very little time, while Chile's has not even begun to operate, so it is too early to draw any conclusions. However, it is worth noting that US$5/t is far from signifying an internationaliza-


tion of the marginal damage costs of the emission of a ton of $CO_2$ according to the estimates available in the literature. It is also far from constituting a sufficient incentive for using alternative energy sources. In this sense, these current initiatives appear to be repeating the experience of the 1990s, when the EIs that were implemented ended up being timid taxation mechanisms rather than cost-effective instruments for controlling pollution (Huber et al., 1998; Serôa da Motta et al., 1999; CEPAL, 2000; and Acquatella, 2001, 2005).

## Medium-Term Prospects

Latin America's experience with EIs to control emissions of specific pollutants suggests there is reason not to be overly optimistic regarding their future application. However, despite these problems, Latin American regulators continue to attempt to use them, as the recent $CO_2$ taxes in Mexico and Chile show. The fact that these taxes are being levied on a greenhouse gas (GHG) is worth examining. Climate change may be a major source of EIs in the near future. Despite their capacity restrictions, Latin American countries should take measures to adapt to climate change and decide how to achieve the reductions in GHG emissions that they committed to in signing the Paris Agreement. An important aspect of this agreement is the possibility set out in article 6.2, which lays the foundations for there to be links between the GHG emissions permit markets in different regions, countries, and other jurisdictions, and even between these and other instruments such as taxes (Bodansky et al., 2015). This implies both opportunities and challenges for Latin America.

On the opportunities side, developed countries need to have an incentive for seeking to link their GHG emissions permit markets with similar markets or other instruments in developing countries, as this would surely reduce compliance costs for sources in developed countries. This link could be one directional (one country accepts another country's permits or credits to be traded on its market, but not vice versa) or bidirectional (both countries recognize each other's permits) (Wagner, 2014). One well-known example of a bidirectional link is the markets of California and Quebec.

The challenge that such links pose to the countries of Latin America are related to the need for these to reform their institutions if they are to be credible partners. One of the reasons for which the Clean Development Mechanism failed was because it was impossible to monitor emissions capture reliably and sustainably over time in the countries receiving clean development projects, that is, developing countries. A core aspect of EIs is that the regulator must have the capacity to monitor compliance, for which a continuous emissions monitoring system must be implemented along with some form of penalty for noncompliance. This paper has shown how these issues have proved to be a determining factor for the relatively poor performance of the EIs that have been implemented in Latin America to date. The countries in the region must work to move beyond this and other restrictions if they are to benefit from the potential linkages between GHG emissions monitoring programs that are contemplated in the Paris Agreement.



**NOTES**

[1] The author wishes to thank Natalia D'Agosti for her assistance with the drafting of this article.

[2] Law 20780 of September 26, 2014. Tax reform that modifies the system for taxing profit and introduces a variety of adjustments to the general tax system.

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CASE STUDY


# B CORPS

## BUSINESSES WHERE MONEY ISN'T EVERYTHING

We all know that money can't buy you happiness, but you might not have heard that this saying has moved beyond the individual sphere and is sweeping the business world. B Corporations, or B Corps, include social and environmental sustainability objectives in their statutes and develop business models in which economic gain comes second to a higher purpose: care for the planet. Over 220 companies in 21 economic sectors with a turnover of US$3.7 billion have already been certified as B Corps in Latin America. María Emilia Correa, who founded Sistema B, tells us how these companies were started.

**What are the advantages of becoming a B CORP?**

B Corps are a type of company that now exist throughout Latin America and they use the power of the market to find concrete solutions to social and environmental problems. Their starting point is a commitment to operating in line with social, environmental, and transparency standards. Shareholders modify the firm's articles of incorporation to allow the company to make decisions that consider the interests of society and the environment as well as shareholders' financial interests. This new paradigm redefines the meaning of success in business by inviting us to think seriously about what the purpose of a company is within society. This, in turn, allows us to see financial profit as an indispensable tool for reaching certain objectives but not as the only reason for a firm to exist.

**How can be an ordinary company become a B CORP?**

Many companies are already B Corps but aren't aware of it. The process of becoming a certified B Corp begins with the B Impact Assessment, which is free. This process establishes a benchmark of companies with similar standards, which facilitates learning and knowledge transfers around best practices and business models and sets out a roadmap to guide the best social and environmental management practices for the firm. If companies are awarded more than 80 out of 200 points on the assessment, they can opt for B Corp certification. This certification protects the company's mission by supporting shareholders so that they can expand their fiduciary management mandates in a legally binding fashion to include nonfinancial results. This sets B Corp certification apart from a mere declaration of good intentions or just "good marketing." Assessment and certification to become a B Corp opens up opportunities for improving the quality of conversations with those who are seeking to invest in companies making a positive social and environmental impact. There are currently more than 1700 certified B Corps in 51 countries and in 130 different industries.

**How many B CORPS are there in Latin America and the Caribbean?**

As of mid-2016, there were 222 certified B Corps in Latin America with a turnover of nearly US$3.7 billion. These companies operate in 21 economic sectors, including professional services, recycling, printing, manufacturing, education, and agriculture, to name just a few. Nearly 1200 companies have undergone the B Impact Assessment without opting to go through with certification. And 2016 marked the start of the Measure What Matters program, in which large companies invite their suppliers to complete the B Impact Assessment process. We are hoping to spark enthusiasm among thousands of business owners in Latin America and get them to measure their social and environmental management standards.

**How does SISTEMA B work?**

Sistema B is a Latin American organization that promotes the idea of an economy in which success is measured in terms of the well-being of people, societies, and nature. We started in 2012, and since then we've been working toward building a business ecosystem that will allow us to establish a new, regenerative, and inclusive economy.

**Can you give us an example of a B CORP?**

One example is Triciclos, the first certified B Corp in South America. It's seeking to bring about a cultural shift toward more responsible consumption which will reduce waste. Today it is pursuing that goal by managing re-


cyclable domestic waste and providing sustainability and ecodesign consultancy services to other companies. Its waste management program includes so-called clean spots in Chile, from Arica to Castro, and in Brazil, all of which are run by people who are trained to educate users on the impact of their consumer habits. Triciclos wants all the material that it collects to be reinserted as raw material in the production cycle and for inputs to be 100% traceable. Recycling is one of the key pieces in a circular economy, which fosters closed consumption and production cycles so as to make more efficient use of our resources and reduce nonreusable waste to the minimum. Even in economies like Latin America's, which still have not reached these levels of optimization, recycling is a really important practice for reducing the consumption of natural resources and moving towards a new economic model.

**How would you define responsible consumption?**

Responsible consumption asks us to analyze the possible consequences of consuming a certain product when we are deciding whether or not to buy it. We need to ask ourselves whether we really need to consume that good in those particular circumstances. With regard to recycling, a responsible consumer includes sustainability parameters in their purchasing decisions, thinking about what was used to produce the product and its packaging and what can be done with it once its service life comes to an end. A good habit to begin with is not choosing products with excessive amounts of packaging but instead choosing ones that come in recyclable containers.

**What are the most important recycling initiatives in the region?**

The most significant initiatives include public policies such as the National Solid Waste Policy, in Brazil and Colombia, and the Law for the Promotion of Recycling, in Chile. Chile currently has a rather unique ecosystem that could very reasonably lead to the development of a recycling system.



# RESPONSIBLE CONSUMPTION

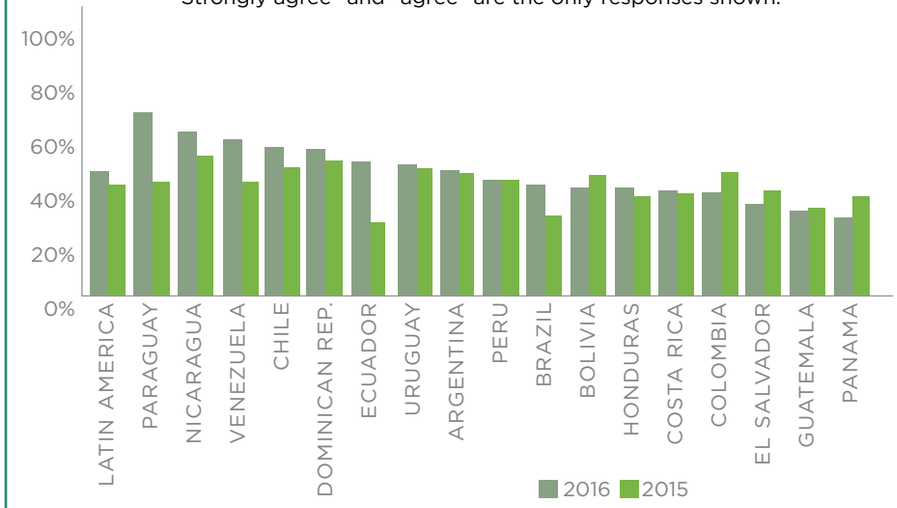
LATIN AMERICAN CONSUMERS
ARE WILLING TO PAY **20%** MORE
FOR SUSTAINABLE PRODUCTS

**49%**
SAID THEY AGREED OR STRONGLY AGREED
THAT INTEGRATION AGREEMENTS SHOULD
CONTAIN ENVIRONMENTAL COMMITMENTS

WILLINGNESS TO PAY MORE TO
CONSUME SUSTAINABLE GOODS INCREASED BY
**5** POINTS IN 2016

**WILLINGNESS TO PAY FOR SUSTAINABLE PRODUCTS**

Question. Imagine that your country signs an integration agreement with other countries in the region (Latin America and the Caribbean). Would you agree on the need to include commitments relating to care for the environment in this agreement, even if this implies paying approximately 20% more for products? "Strongly agree" and "agree" are the only responses shown.




Source: www.iadb.org/intal/alianzalb

ANALYSIS

Mariana Conte Grand
Universidad del CEMA

# Environmental impact assessment methodologies

ENVIRONMENTAL IMPACT ASSESSMENT SHOULD NOT COME AFTER THE DRAWING UP OF A BUSINESS PROPOSITION OR THE PROPOSAL OF A PARTICULAR POLICY, PLAN OR PROGRAMME.

*Laudato Si'*

# ENVIRONMENTAL IMPACT ASSESSMENT METHODOLOGIES

This article summarizes the main aspects of environmental impact assessment methodologies in a way that is accessible for an informed public even if they are not experts on the matter. To do so, if first defines what environmental value is; what types of values exist, distinguishing between use and nonuse; and what environmental impact assessment is used for in practice. It then introduces the reader to the different available methodologies: indirect, direct, and benefit transfer.

The branch of economics that focuses on the environment is known as environmental economics and it dates to the 1960s (Pearce, 2002).[1] Indeed, the economy and the environment are interconnected. On the one hand, human activities depend on the natural environment. On the other, nature is influenced by economic growth. The word "economics" comes from the Latin *oeconomia*, which is from the Greek *oikonomía*, which means "management of a household" (*oîkos* means "house" and *nemein*, "manage"). This etymological origin is intermingled with the ideas that Pope Francis discusses in his encyclical *Laudato Si'*: *On Care for Our Common Home*. There is no doubt that nature, mankind, and the economy are all intimately related to one another.

Environmental economics is based on the premise that the environment's capacity for absorbing the pollution generated by human activity is limited. Another core premise is that, when it comes to environmental issues, markets generally do not function as efficient mechanisms for allocating resources. The imperfect functioning of the market system is caused by externality problems. That is, there are economic agents that harm others but do not compensate them for this. For example, a country produces greenhouse gases that accumulate and contribute to increasing the average temperature of the planet, but it does not compensate the rest of the world for doing so. Public policy (at the different levels of government) thus has an opportunity for improving welfare. This is why regulations exist: that is, standards (quantitative limits to pollution), green taxes, tradable permits, deposit-refund systems, legal liability schemes, and so on.

However, environmental economics' greatest contribution to the field of economics as a whole is, undoubtedly, the development and application of nonmarket valuation methods. The need for this methodology is connected to the argument mentioned above: that markets rarely work when it comes to environmental issues. That is, there are very few markets for environmental quality (or pollution) whose prices—the balance of supply of and demand for the good (or bad) in question—can be used in a valuation.

However, although the environment tends not to have a *price*, that does not mean it has no value. The value of a good within economics has to do with the level of satisfaction that the good in question generates for each individual. This vision tends to be described as being anthropocentric, because it is humans that assign the *value* of the environment (in other words, it is not *ecocentric*, meaning that nature has a value in and of itself). This perspective coincides with that of *Laudato Si'*, as the Pope argues that humans need to manage nature responsibly (Pope Francis 2015, 116).

People assign value to the environment for two reasons: use and nonuse. As figure 1 shows, use value could be extractive (the direct use, for example, of the wood in forests to make furniture or the enjoyment of leisure activities in that same forest) or nonextractive (for example, the ecosystem functions that the forest may perform, such as carbon fixing or flood control). Nonuse value is given by the option value (which is individuals' willingness to pay for using the environment in the future even if they are not doing so now) and quasi option value (which reflects the value that could be obtained from the environment if new information became available that would make its use attractive—for example, if certain plants in the forest were discovered to have medicinal benefits). Another form of nonuse value is the value that the environment has for people when they want it to be maintained or to exist regardless of whether they use it or are planning to use it. Finally, any environmental characteristic can have nonuse value if its availability must be guaranteed not for those that currently value it, but for their descendants or others.[2]

Capturing the value of the environment is necessary in at least three instances: when evaluating the environmental impact of investment projects, when determining the sums of environmental damages in legal cases, and when designing environmental regulations (indeed, socially desirable environmental quality is the result of comparing the benefits of this, such as less disease, with the costs it entails—increasing environmental quality implies, for example, using cleaner technology). The budgets for environmental impact valuations and the skills needed to carry them out are high, but doing so tends to be contemplated as part of projects financed by multilateral organizations.[3] For example, the IDB contains provisions on this in its regulations on social and environmental safeguards (OP-703 *Environment and Safeguards Compliance Policy*, B.5 and B.9), which establish that environmental impact assessments must include economic estimates of these impacts whenever relevant.[4] Indeed, this type of analysis has been

THE DISCOUNT RATE USED TO VALUE ENVIRONMENTAL IMPACT CALCULATIONS CAN AFFECT THE CALCULATION BY AS MUCH AS

**84%**

used, for example, for wastewater treatment plant and hydropower projects that the IDB has financed (see Dixon, 2012, 2013).

The valuation of environmental impacts is based on the idea that individuals' satisfaction with the environment can be expressed in monetary terms because the consumption of an environmental good implies that the consumption of another good (and thus the expense associated with it) must be substituted. This notion is the basis for the methodologies that have been developed to estimate demands that are not directly observable.

## ALTERNATIVES TO COST-BENEFIT ANALYSIS

The economic analysis of projects or policies compares the cost of protection with the benefits derived from this (or, conversely, costs due to environmental damages with the benefits of the activities that cause these).

One alternative to valuation as summarized in this article is to not treat all benefits and costs as equal, independently of who receives or is responsible for them, but rather to weigh them using a distributional criterion. For example, when considering improvements to equality, greater weight should be given to benefits for poor people so that resources are directed to them. This type of analysis is called cost-benefit with distributional weights.

Another alternative to the standard cost-benefit approach is multicriteria analysis. When this is applied, instead of monetizing all environmental impacts, various metrics are used in addition to environmental impact, such as job creation and impact on gender or income equality. Based on a ranking of the alternatives available for each factor, the best alternative is chosen. Table 1 contains an example of this.

TABLE 1. MULTICRITERIA ANALYSIS.

| CRITERION | WEIGHT PER CRITERION | PROJECT A SCORE | PROJECT A IMPACT | PROJECT B SCORE | PROJECT B IMPACT |
|---|---|---|---|---|---|
| **EQUITY** | 0.6 | 2 | 1.2 | 4 | 2.4 |
| **EMPLOYMENT** | 0.2 | 1 | 0.2 | 1 | 0.2 |
| **ENVIRONMENT** | 0.2 | 4 | 0.8 | 2 | 0.4 |
| **TOTAL** | | | **2.2** | | **3** |

Source: Asian Development Bank (2013, 33).
Note: Score is impact 1 (week), 2 (moderate), 3 (significant), 4 (very high).

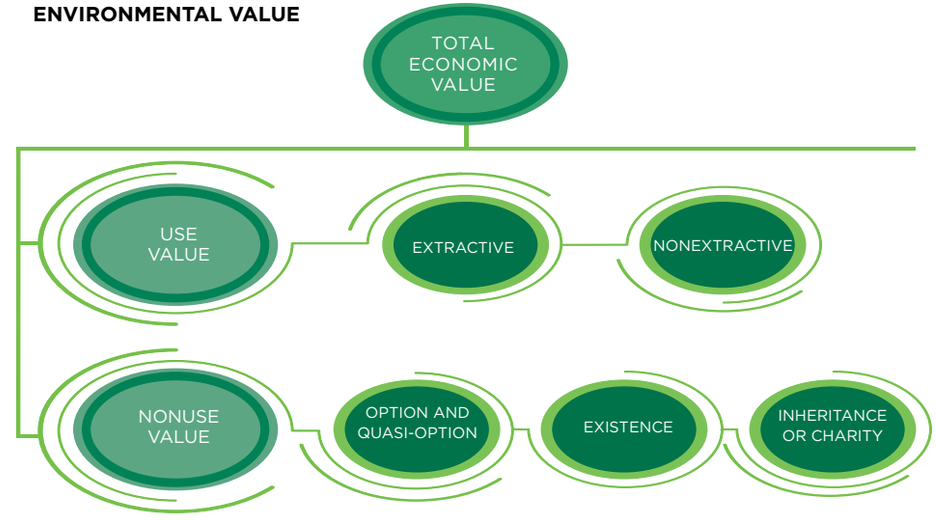
Finally, environmental care objectives are often established using other criteria, in many cases by organizations whose focus is not economic issues. In this case, the type of analysis that should be carried out is not cost-benefit, but rather cost-effectiveness—that is, the cheapest way possible of achieving the established objectives.

The literature differentiates *indirect or revealed preference* methods from *direct* or stated *preference methods*. The former are based on the behavior of individuals that is observed in prices in a market related to that of the environmental good you are seeking to value. For example, you can obtain the implicit price (value) that a green space has for individuals (whether they live near it or far away) through property prices. It is also possible to obtain a measure of the value that individuals assign a park by considering how much they spend to visit it or, for example, through what they save on healthcare by being able to do recreational activities in an unpolluted place. These methodologies are always indirect in the sense that the person does not state the value they assign to the environmental good in question, but rather reveal this through their spending behavior in relation to other goods. The second set of methodologies is based on obtaining a statement from individuals about their preferences regarding a certain environmental quality. These are usually based on surveys. Finally, there is a third option which only began to be applied in the 1990s: the value transfer method. This is based on transferring the results of valuations obtained using either of the above two methodologies to another instance of valuation.

THE COST OF INACTION ON ENVIRONMENTAL ISSUES COULD BE AS HIGH AS **20%** OF GLOBAL CONSUMPTION

Before analyzing the available methods for the valuation of environmental impacts, including the strengths and

FIGURE 1
**ENVIRONMENTAL VALUE**




Source: Compiled by the author.


limitations of each one, it is worth pausing to review three fundamental factors when valuing environmental impacts. First, the importance of specifically defining the impact you are aiming to value. Second, the need to distinguish between willingness to pay (WTP) for an improvement in environmental quality and willingness to accept compensation (WTA) in return for lower environmental quality. Third, the importance of deciding the discount rate to be used in these calculations.

The first point has to do with the need to quantify the environmental impact to be valued. In any environmental impact, you need to consider what physical medium is altered (that is, soil, water, air, etc.). You then need to take into account how this impact will develop over time. That is, how many days, months, or years will it take for the consequences of the impact be felt, and whether this will be constant or will vary over time. The area (the spatial limits) of the impact also must be estimated. Only once you have established this can you think about who will be affected and which of these individuals' "values" will be altered.

The second point concerns the fact that the value we place on the environment is based on the substitution of other costs. As a consequence, WTA is greater than WTP, except when the change whose impact you are seeking to value is small or the environmental good can be perfectly substituted by other goods (which is rarely the case, given that environmental goods tends to have distinctive characteristics which make them hard to replace).[5] Only in these cases will the WTA be equal to the WTP. The difference between these two concepts was confirmed in a review of 45 studies which led to the conclusion that WTA is, on average, around seven times greater than WTP (Horowitz and McConnell, 2002). When carrying out actual valuations of environmental impacts, the suggestion is to opt for a conservative position and estimate WTP rather than WTA (Arrow et al., 1993).

Finally, the third question concerns the rate at which to discount the costs or benefits of changes to the environment. This is no minor issue, as with an exponential discount and a rate of 10%, we would be willing to pay less than one cent today to avoid an environmental impact valued at one dollar in a hundred years' time (that is, $1/((1+10%)100)), or in other words, the value of that environmental damage today would be less than one cent.[6] If the rate were 1%, this value would be around 35 cents. How do we decide what rate to use? Should it be a rate that is derived from observed behavior (that is, a descriptive rate) or should it be based on regulatory matters (a prescriptive rate that takes intergenerational equality into account, for example)? There is no single answer in either the academic literature or in practice. Some authors, such as Nordhaus (2007), tend towards the first option, suggesting a rate of approximately 5%. Others, such as Stern (2006), opt for the second, which led Stern to take 1.4% as the discount rate for the costs and benefits of the climate change policies he evaluated in his review.[7] Stern arrived at 1.4% as follows: in principle, the discount rate should be 0% because the future generations who will be impacted by climate change are just as important as present ones and the only justification for using an intertemporal discount rate other than zero is a risk of disaster so great that it could imply death (that probability is estimated at 0.1%) and that future generations will be richer than present ones (1.3% is the long-term estimate of the average annual rate of growth of the global economy). As Tol and Yohe (2009) show, the consequence of this is that, in the case of the Stern Review, using different values for the discount rate and other relevant parameters in the model can reduce the estimated cost of climate change impacts by 84%. This is undoubtedly a large margin and it illustrates the significance of the discount rate chosen when valuing environmental impacts.





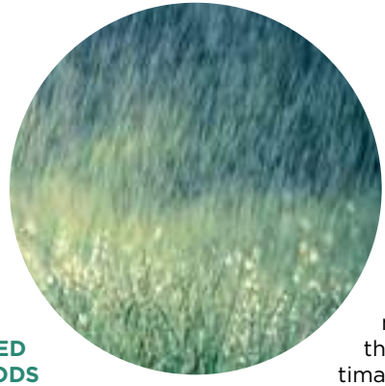
**APPLICATION OF ENVIRONMENTAL IMPACT VALUATION METHODOLOGIES**

As I have argued in the main text of this article, the valuation of environmental impacts is frequently used in practice, especially by national or multilateral agencies that finance investment projects. Some examples of these are reviewed below.

Dixon (2012) summarizes the techniques used in four studies of projects to expand and improve the drinking water supply system and sanitation services in Georgetown (Guyana), Chaco (Paraguay), Trinidad and Tobago, and Montevideo (Uruguay). The method chosen for valuing the improvements each project was expected to bring was contingent valuation. The number of respondents ranged from 500 to 1,500. In Uruguay, due to time constraints, the study used the benefit transfer technique using contingent valuation results calculated for IDB-financed projects in other countries in the region. In Trinidad and Tobago, the benefits from improvements were estimated at between US$3 and US$16 per household per month, depending on the situation of each prior to the project (that is, what access the household had to drinking water and sanitation services prior to the intended improvement). WTP reached US$7 per household in Guyana; almost US$19 in Paraguay; and a little over US$22 in Uruguay for access to sanitation services only.

The World Bank reports in Lange et al. (2010) that valuations of environmental impacts have been carried out in 21 of the 80 investment loans it has authorized. In most cases, indirect methods were used (estimations of healthcare costs and the cost of reductions in greenhouse gas emissions, and benefit transfers), but there has been no widespread use of stated preference techniques.

The Asian Development Bank has been promoting this type of valuation—Asian Development Bank (2013) draws attention to the good practices used in a water supply expansion project in Sri Lanka where the joint analysis or contingent choice method was applied. Respondents were asked to choose from three alternatives that varied in terms of cost, type of access, quantity of water received each day, the times of day when water would be available, and potability. All types of methods have been used to value transportation and electricity production projects financed by the ADB.





## INDIRECT OR STATED PREFERENCE METHODS

The main feature of indirect methods is that they are based on information from existing markets. The most frequently used of these methodologies is hedonic valuation. This consists of valuing a good as a set of characteristics. The example that has been most studied in environmental impact applications is the real estate market. The idea is that real estate consumers are willing to pay for properties according to their attributes. Some attributes are valued by the market (for example, whether a property has a parking space, given that these can even be sold separately), but other attributes have nonmarket value. For example, whether home buyers would be willing to pay more to live closer to quality green spaces (that is, whether they assign a value to this). If there were two identical houses, but one was hundred meters closer to a park, the difference in the price of the property would indicate the implicit price that individuals assign to living that distance from a green space. However, there is no specific market for this characteristic, in contrast to garages or parking spaces.

The conceptual basis for hedonic prices is Rosen (1974), which models equilibrium in the real estate market as coincidences between buyers, who are seeking the features of the property and who aim to maximize their utility within their budget restrictions, and developers, who choose the attributes of the properties that they build to maximize their benefits. Each buyer-seller group will therefore exchange houses when the valuations of each characteristic coincide. Opinions differ over the origin of the application of this method. Some argue that it was first used to estimate valuations of car features; others that it arose from estimations of the value of agricultural land attributes; and some even attribute its origins to an estimation of WTP for fresh vegetables (Vásquez Lavín, Cerda Urrutia, and Orrego Suaza, 2007).

The empirical technique consists of using the variations in property prices together with the particular qualities of each property, the characteristics of the neighborhoods where they are located, and the environmental attributes to be valued, so as to deduce implicit prices for each of the latter. Although the technique has its limitations (when you do not have all the variables that determine property prices, there is a correlation between the different features or no clear answer to the functional relationship you choose to model the relationship between house prices and their features, for example), applying it has become increasingly easy due to the large quantities of available data and, above all, the use of geographic information systems, which allow each house or apartment on which the impact valuation is based to be rapidly geolocated.[8] There are already examples of this type of study for Latin America, such as Rabassa, Zoloa, and Epele's (2013) work on the value of flood risk in the city of La Plata.

Due to space constraints, I will not describe all indirect methods in detail here, although one more deserves at least a brief mention: the travel cost method. This consists of collecting information on how much people spend to travel to a certain place with natural attractions. Travel demand is then estimated based on that expense, the number of visitors to each place, and a series of characteristics of both the site and the visitors. This method tends to be used in the valuation of natural parks and areas with high aesthetic value (in fact, this was the reason it was first developed in the 1950s in the United States in response to suggestions from Hotelling, 1949). Examples of studies in Latin America that use this method include Jaime Torres and Tudela (2011) for Parque de las Aguas in Colombia or Cerda Urrutia, Orrego Suaza, and Vásquez Lavín (1997) for their valuation of Dichato beach in Chile.

## DIRECT OR REVEALED PREFERENCE METHODS

Direct methods, in turn, are not based on individuals' spending behavior in other markets, but on what surveys report them as valuing. This category includes two main techniques: contingent valuation and stated choice experiments. Both are based on the random utility model and the empirical developments for estimating this (starting with McFadden, 1973). These methods were first used for transportation choices, but then spread throughout the environmental sphere.

The first of these methods is the oldest—its origins date back to the work of Ciriacy-Wantrup (1947) to value the benefits of preventing erosion. Its referendum format consists of presenting the survey respondent with an improvement to the environment and an expenditure that corresponds to this which the individual either accepts or rejects. Based on these answers, the value of an environmental good can be deduced, using nonlinear logit or probit regression models or nonparametric methods. One example of the application of this type of method is Conte Grand and Chidiak (2010), which studies the value of beaches on the Uruguay River in Argentina. In the event of a hypothetical deterioration in the environment, the individual is asked to consider relocating to a similar, more distant beach (expenditure is equal to travel costs). The IDB has used this method to value WTP for water and sewage works in different countries and these estimates are reported in Ardila, Quiroga, and Vaughan (1998).

The second stated preference technique, stated choice experiments, consists of presenting the individual with two or more alternatives and asking them to choose which they prefer. These alternatives are defined by different levels of several attributes. They generally include the state of the environmental good (for example, pollution level), a payment instrument (charging a specific amount), and other characteristics that the exercise is seeking to value (this could be a choice between different policies for implementing an improvement to the environment). The individual chooses between the alternatives, which allows their valuation of each attribute to be deduced based on the payment factor.

Contingent choice is being used increasingly as it has certain advantages over contingent valuation. One such advantage is that it allows you to value not only the average WTP but also to assign value to the different attributes (that is, to the different policy choices). It can also avoid protest responses, as it includes a choice between alternatives (which include a cost) instead of asking directly about an improvement to the environment in exchange for a cost. Despite this, the inclusion of too many alternatives and attributes in the choice can be excessively demanding for re-

spondents and affect the results (see Meyerhoff, Oehlmann, and Weller, 2015). There are also examples of valuations that use this method in Latin America, one of which examines the nonuse value of moss in a region of Chile (Cerda, Barkmann, and Maggraf, 2013).

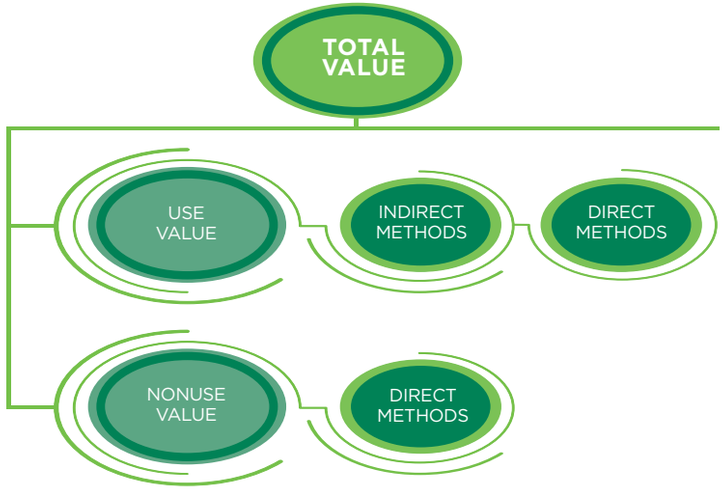
## BENEFIT TRANSFER

Benefit transfer is the practice of transferring the values obtained in one environmental impact assessment study to another case (in the jargon, this is described as the transfer from a study site to a policy site). It began to be used because it cheaper and quicker to apply than other methods.

According to Freeman (2003), this practice was already being used in the mid-1980s to evaluate environmental regulations in the United States. However, it became more widely accepted following the publication of a special issue on this approach in *Water Resources Research*. Today, benefit transfer is seen as an environmental impact valuation technique in its own right.[9]

The steps for carrying out a value transfer have been widely studied and are detailed in Johnston et al. (2015). There are basically two alternatives. The first is a value transfer, which implies taking a value that was calculated as part of another study and transferring directly it to the study at hand or, more often, transferring it after adjusting it to account for the difference in income between one case and the other. The second approach consists of estimating a benefit transfer function that has previously been estimated based on various studies depending on the characteristics of the place and people involved (this sort of estimation is generally based on meta-analysis). There is no consensus as to which of the two approaches is more precise (Johnston and Rosenberg, 2010).

FIGURE 2
**METHODS BY IMPACTED VALUE**




Source: Compiled by the author.



## CONCLUSIONS

Choosing a valuation method depends on the value that will be affected. There are various possible techniques for any given situation, and the data (and resources) available when carrying out the study are what determine the chosen method in most cases.[10] For example, in a valuation of the impact of a landfill in a certain location, both use value and nonuse value will be affected. The hedonic price method could be used if real estate data is available; healthcare costs could be used if information was available on the increased risk of disease (or even death) that the landfill would cause; or a survey could be carried out. The key point is that the same two methods cannot be used to value the same impact, as this would duplicate results. The idea is that if the value of a house near a landfill is lower, this is at least partly due to the discounting of the healthcare costs that this closeness entails from the house price. However, it is true that nonuse value can only be calculated using stated preference methods as it cannot be captured through markets such as housing, healthcare, or tourism. In other words, the latter only allow you to quantify the environmental benefits that derive from use (see figure 2).

These valuation methods were originally applied in developed countries, but in recent decades they have begun to be used in developing countries, too. In conclusion, it should be said that there are also limitations to the economic valuation of environmental impacts. Criticisms of the practice of assigning monetary values to the environment vary (Kelman, 1981; Hwang, 2015), but they are mainly connected to the fact that people do not always know what values to assign to environmental goods (there are goods that result in forms of satisfaction that cannot be measured or are unquantifiable, which are not the same thing). Another factor is that money is a measure that does not take justice into account (people with higher incomes have higher budgets and thus can value the environment more highly than poorer people, which means that valuation through money could be considered unfair or inequitable).

**NOTES**

[1] The difference between environmental economics and ecological economics is that the former deals with environmental problems on the basis of the microeconomic principles of welfare theory. The latter uses a method of study that is closer to the natural sciences (see Ma and Stern, 2006). As Kolstad (2011, 6) says: "environmental economics tends to involve ecologists who have extended their discipline and paradigms to consider humans and the economy, while ecological economics tends to involve economists who have extended their discipline and paradigms to consider the environment."

[2] This classification may vary from source to source. Some authors, for example, classify option value as use value. In both cases, however, the general idea is the same.

[3] Other organizations, such as the World Bank, also include this sort of valuation. According to a recent report (Lange, Belle, and Kishore, 2010), the World Bank's use of valuation techniques had become widespread but then decreased towards the end of the 1990s and beginning of 2000s. After examining recent environmental analyses on countries, the same study found that 22 of 28 assessments carried out between 2003 and 2009 contained environmental valuations. This would seem to demonstrate a revival of the use of this type of valuation by the World Bank.

[4] It is important to bear in mind that the valuation of environmental impact is different from the environmental impact assessment, as the latter involves an estimation of impacts on the environment but does not quantify these in money terms.

[5] Another explanation for why WTA is greater than WTP comes from prospect theory (Kahneman and Tversky, 1979), according to which people take the status quo as their point of reference. They thus ask for more compensation to abandon something than what they would pay to improve it.

[6] Some authors recommend using a hyperbolic discount rate (1/(1+rate*t)) rather than an exponential one (1/(1+rate)[t]), as there is evidence that people discount the short term more than the long term, which implies that the discount should be variable over time and not constant. Another nonconstant discount option is the use of a Gamma function, which was introduced by Weitzman (2001), who argued that over 2000 holders of PhDs in economics from 48 different countries had responded that this was the correct form of function to use. Despite this, valuations that form part of government or multilateral organization projects continue to use constant discount rates (see Campos, Serebrisky, and Suárez-Alemán, 2016).

[7] The conclusions of the Stern Review were, in the first

place, that the costs of inaction range from 5% to 20% of global consumption. These estimations are far higher than the costs of action to tackle climate change, which are estimated at 1% of global production, with uncertainty ranges of approximately +/- 2%.

[8] These advances have come hand-in-hand with the development of spatial hedonic valuation methods (see Anselin, Florax, and Rey, 2004).

[9] According to Kolstad (2011, 137), Kerry Smith and William Desvousges first used the term "benefit transfer" in a publication in 1986.

[10] If resources are limited, the most logical choice would be value transfer, followed by one of the revealed preference methods, and finally stated preference techniques, which are considerably costlier.

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# AN ISSUE THAT MATTERS TO MEN AND WOMEN

The issue of the environment concerns of men and women equally. The proportions of men and women among the 50% of the region's inhabitants who expressed their concern for environmental issues were similar, which reflects how widespread this demand is.

## CARE FOR THE ENVIRONMENT AND DEVELOPMENT

Question: Which of the following topics are most important for development in your country? Responses for the environment and climate change


## WILLINGNESS TO PAY FOR SUSTAINABLE PRODUCTS

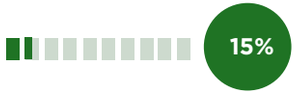
Question: Imagine that your country signs an integration agreement with other countries in the region (Latin America and the Caribbean).
Do you agree or disagree on the need to include commitments relating to care for the environment in regional integration agreements, even if this implies paying approximately 20% more for products?


## THE IMPACT OF NEW TECHNOLOGIES

Question: In 15 years, which areas do you think that scientific and technological innovations will have a positive impact on? Responses for the fight against climate change and environmental protection.


## TOP INNOVATION PRIORITY

Question: What do you think the number one priority for scientific and technological innovations should be in the next 15 years? Women's responses for the fight against climate change and to protect the environment.




Source: www.iadb.org/intal/alianzalb

CASE STUDY

# A CHALLENGE FOR THE CARIBBEAN

## NATURE AND TOURISM


One of the greatest injustices of pollution is that its consequences are not limited to those who produce it. The Caribbean is one of the least polluting regions in the world but it is also one of the most exposed to global warming due to the importance of the tourism sector within its economy.

Carlos Fuller, an expert from the Caribbean Community Climate Change Centre, explains the consequences of the region's dependence on petroleum and analyzes the potential of public policy for supporting renewable energy.

**How is climate change impacting the Caribbean?**

The Caribbean's greenhouse gas emissions are very small because we have a small population, we are not very industrialized, and we don't do a lot of agriculture, so we don't emit a lot. However, mitigation is important for us because of the high cost of fuel and energy. Most of our islands depend on petroleum as a source of energy, and when oil prices were above US$100 per barrel, we were spending more than 60% of our foreign exchange on importing petroleum products into the Caribbean. In that respect, we really want to transition to renewable energy sources as we have considerable amounts of solar, wind, geothermal, and biomass energy potential.

**Has climate change started to affect tourism?**

It has. Climate change is severely impacting our natural attractions, our tourist attractions. For example, we have a significant amount of erosion because of sea level rise, wave action, and storm surges, which is causing tremendous erosion and affecting our beaches. Our coral reefs, which are a big attraction, are also suffering a lot of bleaching which is impacting our fish stock. Those resources are being affected significantly. We do have significant protected areas; however, we need more resources to enforce the protection of these.

**What role do public policies play in developing renewable energy?**

In some countries, with doing reasonably well on this front. In Belize, for example, we now have independent coal producers and we have transitioned to an increased use of hydro, solar, and biomass, so more than 50% of our domestic electricity supply is from renewable energy sources. However, on many of the islands, we need to create an enabling environment to allow renewable energy to penetrate the market. We are going to need a lot of assistance from the international community to put in the regulatory framework that will allow us to develop renewable energy in these places. We then need to attract potential investors to provide sources of renewable energy in the region. Of course, the Caribbean is, tourism is an important sector of the economy, which is one of the reasons we need to protect our reserves and natural parks. We are also trying to make our buildings more resilient to the effects of extreme weather. That is the focus of our work.

**How does the Green Climate Fund work?**

The Green Climate Fund is headquartered in South Korea and it has an independent board of management. However, various agencies can be accredited to access the fund directly. We have already applied for a project to preserve the barrier reef and another to promote biomass use in the Caribbean. So, we have two projects in the pipeline through the Green Climate Fund which are valued at around US$20 million.

**Do you think that the Paris and Marrakesh summits brought concrete results for the region?**

We were very pleased with the outcome in Paris. The objectives that the Caribbean Community wanted were achieved: the limit for warming was set at 2°C; adaptation was considered along with mitigation; finance, technology transfer, and capacity building were included; and a compliance system was put in place. All the things that we wanted out of Paris, we achieved, and so we are very happy with that.

Francisco Alpízar[1]
and Róger Madrigal[2]
Tropical Agriculture Research and Higher Education Center (CATIE)

# Conditional cash transfers and payments for ecosystem services

MANY OF THE POOR LIVE IN AREAS PARTICULARLY AFFECTED BY PHENOMENA RELATED TO WARMING, AND THEIR MEANS OF SUBSISTENCE ARE LARGELY DEPENDENT ON NATURAL RESERVES AND ECOSYSTEMIC SERVICES SUCH AS AGRICULTURE, FISHING AND FORESTRY.

*Laudato Si'*

# CONDITIONAL CASH TRANSFERS

Conditional cash transfer (CCT) programs to promote health and education targets and payment for ecosystem services (PES) for environmental targets are two major public policy instruments. Both seek to align the interests of society with those of individuals, families, and landowners. Making cash transfers conditional on, for example, compliance with education-related goals, leads in principle to better education levels, a better future for recipients of transfers, and a more prosperous society, all without placing excessive burdens on the poorest families. Obviously, the success of these instruments depends on their design. This article provides conceptual descriptions of CCTs and PESs, analyzes some of their main applications in Latin America and the Caribbean, framing this analysis in the public policy recommendations that Pope Francis outlined in his encyclical *Laudato Si'*

In *Laudato Si'*, Pope Francis calls on us to be creative in designing social and environmental public policies. In his words, "political and institutional frameworks do not exist simply to avoid bad practice, but also to promote best practice, to stimulate creativity in seeking new solutions and to encourage individual or group initiatives" (Pope Francis, 2015, 52). Conditional cash transfer (CCT) programs to promote health and education targets and payment for ecosystem services (PES) programs to foster environmental targets are two public policy instruments that have become increasingly important over the last 20 years. Their popularity has surged largely because, rather than punishing negative environmental practices and social decisions, they reward decisions that benefit society.

The starting point for CCTs and PESs is a public policy target that requires a change in a given target population's behavior. For example, suppose that society wishes to reduce school dropout rates within a vulnerable population to guarantee them better future working conditions and well-being. However, it is the family unit that makes the decision for a child to drop out of school. Based on this premise, a payment or transfer is defined which is conditional on a change in the behavior at stake. In this case, families in the target population would be offered a payment in cash or in kind provided they can prove that their children are still actively attending elementary or high school. Consequently, the fundamental difference between these policies and traditional state welfare programs is that beneficiaries formally commit to carrying out a series of verifiable activities in exchange for money.

CCTs and PSEs are very different from one another in terms of their objectives and the fact that programs vary greatly in terms of their scale (from national to regional), coverage (from large segments of the population to very specific target groups), the types of conditions they entail, and the sums of money at stake. Despite this, there are three features that are common to all schemes:

1. All CCTs and PSEs make payments conditional on the verification of compliance indicators.

2. Beneficiaries' involvement in the programs is voluntary, in other words, the families, farmers, or landowners in question must freely decide to take part.

3. The implementing agency or government structure responsible for the program establishes the rules that define the target population in advance. This should preferably be done such that the benefits that the program entails would not have been achieved had the incentive not existed. For example, if the target is reducing deforestation, programs should prioritize those landowners whose forests are most likely to be lost in the absence of a PES scheme (see Persson and Alpízar, 2013, and Fizbein and Schady, 2009, for more on the design of conditional incentives).

The main justification for the use of CCTs and PESs is the need to provide incentives for private agents (e.g., families or farmers) when they are making decisions, such that they themselves become providers of public goods. Specifically, PESs are used to reduce deforestation or ecosystem degradation rates so that these natural spaces can continue to provide key ecosystem services for all of society. For example, Costa Rica's PES scheme is widely celebrated for having been one of the factors that contributed to the recovery of the country's forest cover from 1996 onwards (figure 1) (Porras et al., 2013). Stopping deforestation and the degradation of natural cover is one of the greatest environmental challenges facing Latin America: according to ECLAC data, between 1990 and 2005 the region lost almost 69 million hectares of forest, approximately 7% of its cover (ECLAC, 2006).

Likewise, CCTs seek to nudge families' decisions toward options that improve health and education indicators, which ensure healthier, more prosperous societies with greater access to opportunities. For example, despite substantial improvements in health coverage, many Latin American countries still have immunization rates that are well below average. In the case of poliomyelitis, most countries' vaccination programs cover over 90% of children under the age of one, but the rates are lower in others, such as Guatemala (65%) and Panama, (80%) (PAHO and WHO, 2015). Increasing the coverage of a vaccination that is so simple to apply entails convincing families to visit health centers, which can potentially be achieved through a transfer program that is conditional upon this visit.

In short, PES and CCT schemes are market instruments that change the relative prices and costs of the decisions of families or key ecosystem owners to encourage them to make choices that coincide with certain environmental and

THERE ARE
**200**
PAYMENT FOR ECOSYSTEM SERVICES IN THE WORLD

social public policy targets. The main innovation these instruments entail is that they are based on conditional rewards. Instead of punishing or fining those who deforest or decide to take their children out of school, such schemes reward families that decide to act in line with social and environmental objectives. Rewarding them with cash transfers or payment in kind is also expected to increase the income and well-being of vulnerable groups in the process.

## CONCEPTUAL FRAMEWORK

*Laudato Si'* is a rich source of ideas for defining public policies that favor social and environmental goals. First, the encyclical calls on people to "seek comprehensive solutions which consider the interactions within natural systems themselves and with social systems" (Pope Francis, 2015, 41). Not only is the use of CCTs and PESs based on the desire to meet social and environmental targets, it hopes to achieve these without negatively affecting family incomes. In contrast, the use of prizes in place of punishments can, in principle, improve the income levels of families that choose to meet the condition.

Another key principle in the encyclical that justifies the use of CCTs and PESs is the principle of the common good: "Society as a whole, and the state in particular, are obliged to defend and promote the common good" (Pope Francis, 2015, 121). However, the encyclical also argues that the quest for the common good cannot be used as a justification to impose excessive costs on people or companies. The use of CCTs and PESs seeks precisely to increase the provision of public goods such as better education or lower deforestation rates without imposing excessive costs on the economic agents who must change their behavior.

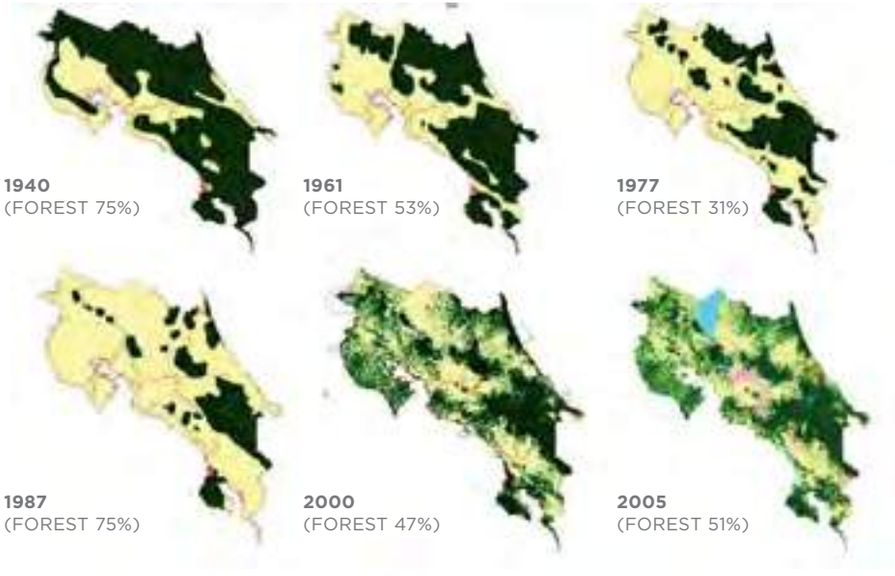
Finally, citing the Pontifical Council for Justice and Peace, the Pope argues that "decisions must be made 'based on a comparison of the risks and benefits foreseen for the various possible alternatives'" (Pope Francis, 2015, 53), especially in cases where there is uncertainty around the impact of our decisions on current and future well-being. This message points to two major public policy requirements. First, Pope Francis's text is a call to action, even when there is uncertainty around costs and benefits. Lack of information regarding the future consequences of our actions cannot be used as a justification to put off measures to reduce the impact of climate change or promote public health policies, for example. Second, the costs and benefits of alternative actions need to be analyzed rigorously to ensure that solutions achieve their goals at the lowest possible cost. This call for efficiency in public policies is important in the design of CCTs and PESs.

The next few paragraphs describe, in very general terms, the main concepts underlying the design of PES and CCT schemes and some of the challenges that more complex designs entail. PESs and CCTs are policy tools that can be analyzed within the framework of supply and demand for a public good (figure 2). The suppliers of a PES are all owners of lands that could potentially provide ecosystem services. Identifying these lands precisely can be a technically complex and costly task (e.g., determining water recharge areas), which is why we need to invest resources in obtaining the best possible estimates. In a CCT, supply refers to the target populations whose welfare indicators the policy is seeking to improve (e.g., teenagers living in poverty). These populations tend to be identified through surveys or censuses. However, the intrinsic problem in the identification process is the availability of reliable criteria or indicators for identifying poverty or any other key indicator used for the selection of beneficiaries. As we mentioned above, including these suppliers in the provision of specific public goods is promoted via payments that are conditional on their meeting certain requirements that are laid out in service provision agreements.

The implementing agency or relevant government structure (which does not necessarily have to be a government entity or operate at the national level) is responsible for defining the rules regulating the involvement of suppliers and supervision of contract. This government structure needs to have sufficient legal backing and form part of an institutional framework that guarantees legitimacy and credibility to

A **3.5%**
TAX IS LEVIED
ON FOSSIL FUELS
IN COSTA RICA
TO FINANCE
THE PES INITIATIVE

FIGURE 1
**EVOLUTION OF FOREST COVER IN COSTA RICA**




Source: Studies of forest cover in Costa Rica, FONAFIFO.

direct stakeholders and civil society in general. This support is particularly important because the government structure or implementing agency in question must administer funds provided those demanding the service. Who the latter are can vary greatly depending on the context and specific focus of each program. For example, some PES programs are a response to the needs of users of water for agricultural purposes, domestic consumption, or to generate energy, or to members of the international community wishing to mitigate the effects of climate change through reforestation or avoided deforestation. It is also clear that a country's government, representing its citizens, can be a key source of demand in these programs, which aim to reach environmental conservation targets or improve social indicators that promote a more equitable, environmentally sustainable form of development.

Finally, the financing structure for PESs and CCTs is directly associated with demand and takes the form of different voluntary or compulsory mechanisms. The most commonly used of these are water tariffs, donations, loans, and taxes. The financial sustainability of a given mechanism depends specifically on the scale of each source used and on how diverse the sources are.

## EXAMPLES IN LATIN AMERICA AND THE CARIBBEAN

There are around 200 PES programs in the world (Pattanayak, Wunder, and Ferraro, 2010). Latin America has considerable experience in implementing PESs, particularly on a national scale. Nonetheless, there are important differences between these initiatives in terms of their financing structure, the sums involved and forms of payment, and the monitoring and operational mechanisms they use (Wunder, Engel, and Pagiola, 2008; FONAFIFO, CONAFOR, and Ministry of Environment, 2012). To illustrate this point, table 1 shows some of the main PES programs in Latin America and the differences between them.

Two of the pioneering PES initiatives are the national programs in Costa Rica and Mexico. Costa Rica's PES program seeks to promote the protection of scenic beauty, biodiversity, water resources, and carbon capture (see table 1). Historically, the main source of financing for the program is the 3.5% tax on fossil fuels used in the country. To date, using around US$360 million, the program has managed to include 1.1 billion hectares of land in different forest protection categories and around 6 million trees in agroforestry systems (FONAFIFO, 2016).

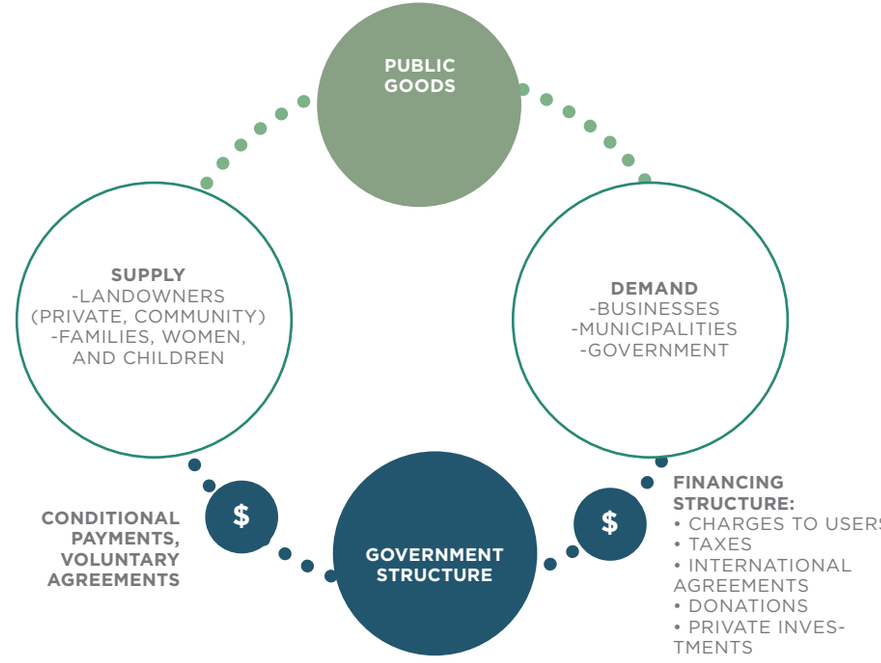
Mexico's Payment for Environmental Services Program has been managed since 2003 by CONAFOR (the National Forestry Commission), under the auspices of the General Law for Sustainable Forest Development (see Box 2). Although financing for this project has mostly come from the state, it is now more diversified following a shift to include concurrent funding, an approach which allows the program to bring together efforts to preserve areas that are of interest to both the private and public sectors. One of the program's main

### NATIONAL PAYMENT FOR ENVIRONMENTAL SERVICES PROGRAM IN COSTA RICA

FONAFIFO (the National Forest Financing Fund) is the Costa Rican government body that has been responsible for managing the country's PES program since 1997. This is based on the 1996 Forestry Law, which also establishes tax on fossil fuels as the source of income for the program. Candidates wishing to take part in the initiative are selected using a grid that allocates scores based on a range of criteria, such as whether the site is located in biological corridors, water recharge zones, or less socioeconomically developed areas. Given that the program can only pay around 40% of the total suppliers of ecosystem services who apply to it (FONAFIFO, 2016), one of the biggest challenges it faces is finding enough permanent sources of income to fill this gap.

The payments that suppliers of ecosystem services receive and the length of contracts vary. For example, forest owners receive an equivalent in local currency of between US$300 and US$400 per hectare, depending on the location of the forest, using renewable five-year contracts (FONAFIFO, 2016). The sites in question must be between 2 and 300 hectares in size. Owners of agroforestry systems receive payments in local currency of between US$1.71 and US$2.54 per tree, using five-year contracts, with minimum and maximum limits of 350 and 10,000 trees per year, respectively (FONAFIFO, 2016).

FIGURE 2
**CONCEPTUAL FRAMEWORK FOR CCT AND PES PROGRAMS.**




Source: Compiled by author.

objectives is preserving forests that are in danger of deforestation. Thanks to investments of around US$500 million, the program has made payments to protect around 3 million hectares of forest (FAO, 2014).

CCTs are another increasingly popular tool, especially in developing countries. Most of the CCT programs that have been implemented in the world are based in Latin America and the Caribbean (figure 3). It is estimated that CCTs are currently operating in 18 countries in the region and benefit around 25 million families (between 113 and 129 million people); that is, 19% of the population of Latin America and the Caribbean at a cost of approximately 0.4% of the region's GDP (Cecchini and Madariaga, 2011; Paes-Sousa, Regalia, and Stampini, 2013) (figure 4). It is estimated that these transfers range from between US$5 to US$33 per month per child included in the program (The Economist, 2010).

Some of the best-known national programs are Bolsa Familia in Brazil and PROSPERA in Mexico, which have also inspired similar initiatives around the world. The Bolsa Familia program, which was created in 2003, seeks to benefit

### PAYMENT FOR ENVIRONMENTAL SERVICES PROGRAM, MEXICO

To implement this program, CONAFOR receives recourses from the Mexican Forest Fund, a financial instrument that aims to promote the conservation, sustainable use, and restoration of forestry resources. The Mexican Forest Fund channels resources from different sources, such as funds from the national and municipal governments, the private sector, and water users, among others. It allocates an estimated US$60 million annually, of which US$25 million come from federal funds (FAO, 2014).

The program works with private property owners, cooperatives, and indigenous communities. It makes payments for two types of services: water services and biodiversity conservation. Landowners are selected according to specific criteria and sign a contract with CONAFOR in which they commit to maintaining forest cover and carrying out sustainable management practices in exchange for a fixed compensation per hectare for a five-year period. Payments range from US$28 to US$100 per hectare per year, approximately, depending on the ecosystem in question and the risk of deforestation. As a consequence, cloud forests at high risk of deforestation receive the largest payments (FAO, 2014).

Between 2003 and 2011, the program has allocated US$489 million to preserve around 3.2 billion hectares of forest. It has benefited more than 5967 smallholders and owners of land in collectives and communities, all of whom have voluntarily decided to implement good land management practices (FAO, 2014).

Landowners' commitments are monitored annually via satellite imagery and field visits. When program beneficiaries do not comply with their commitments, the contracts stipulate sanctions that include nonpayment, contract cancellation, or refunds to the program.

TABLE 1
**EXAMPLES OF PES IN LATIN AMERICA**

| | ECOSYSTEM SERVICES | | | | | |
|---|---|---|---|---|---|---|
| **EXAMPLE, COUNTRY** | **FOCUS** | **PAID FOR BY** | **WHO IS BUYING?** | **WHO BENEFITS MOST?** | **WHO IS SELLING THESE SERVICES?** | **START YEAR** |
| **LOS NEGROS, BOLIVIA** | Biodiversity and watershed protection | Páramo and forest conservation | Pampagrande Municipality, US Fish and Wildlife Service | Local water users, mostly irrigators | Farmers from Santa Rosa (46 owners) | 2003 |
| **PIMAMPIRO, ECUADOR** | Watershed protection | Páramo and forest conservation/r estoration | Urban water users with meters (20% quota) | Users without water meters, irrigators | América del Norte Coop. (81% of members) | 2000 |
| **PROFAFOR, ECUADOR** | Carbon capture | Reforestation and afforestation | FACE (electricity consortium) | Beneficiaries of climate change mitigation | Owners of common and individual land | 1993 |
| **PAYMENT FOR ENVIRONMENTAL SERVICES, COSTA RICA** | Water, biodiversity, carbon, scenic beauty | Forest conservation, timber plantations, and agroforestry | FONAFIFO (independent state agency) | Tourism industry, water users | Private landowners, indigenous communities | 1997 |
| **PAYMENT FOR ENVIRONMENTAL WATER SERVICES (PSAH), MEXICO** | Watershed and aquifer protection | Existing forest conservation area | CONAFOR (state forest agency) | All water users in the watersheds and that use the aquifers | Owners of common and individual land | 2003 |

Source: adapted from Pattanayak et al. (2010).

families living in poverty and extreme poverty; that is, all families with incomes per capita of up to BRL77 (US$20) and families with incomes per capita of between BRL77.01 and BRL154 (US$40), provided the family includes boys, girls, and teenagers of between 0 and 17 years of age (PSAN, 2016). Heads of families must enroll minors in elementary school and high school and demonstrate their monthly attendance levels to be at least 75%. They also commit to following the vaccination plan recommended by healthcare workers and to carrying out other specific health checks (PSAN, 2016). The Bolsa Familia budget is estimated to represent 0.5% of Brazil's GDP (Gazola Hellman, 2015).

The PROSPERA program (formerly known as "Oportunidades") was launched in 1988. It is the Mexican government's main strategy for tackling poverty in the country and currently reaches 6.8 billion families (Government of Mexico, 2016; Dávila Lárraga, 2016). The main beneficiary—generally the mother or whoever is responsible for the household—must ensure that the family complies with certain requirements relating to health (e.g., attending medical appointments) and education (e.g., demonstrating attendance at educational establishments) to be able to receive this financial support (Government of Mexico, 2016). The budget for the

TABLE 2
**IMPACT ASSESSMENTS OF NATIONAL PES PROGRAMS**

| STUDY | LOCATION | IMPACTS |
|---|---|---|
| Pfaff et al. (2008) | Costa Rica | -1 % deforestation |
| Robalino et al. (2008) | Costa Rica | -0.4 % deforestation |
| Alix-García et al. (2010) | Mexico | -10 % deforestation |
| Robalino and Pfaff (2013) | Costa Rica | -1 % deforestation |
| Alix-García et al. (2014) | Mexico | -40-50% deforestation |

Source: Compiled by the authors.

PROSPERA program is around US$3 billion (approximately 0.5% of GDP) (PSAN, 2016).

## FUTURE CHALLENGES

It is worth underlining that neither PESs nor CCTs are panaceas for solving countries' environmental and social problems. The success that some of these initiatives have shown is relative and not necessarily applicable in other places, as it often depends exclusively on each country's intrinsic conditions. So, for example, CCTs have led to positive results in larger countries like Brazil and Mexico, but they have not seemed as successful in poor countries or those with lower levels of human development (Cecchini and Madariaga, 2011; Fiszbein and Schady, 2009). In fact, CCTs only reach a small fraction of families living in extreme poverty, and transfers are too small to remedy this situation (Cecchini and Madariaga, 2011). A major challenge

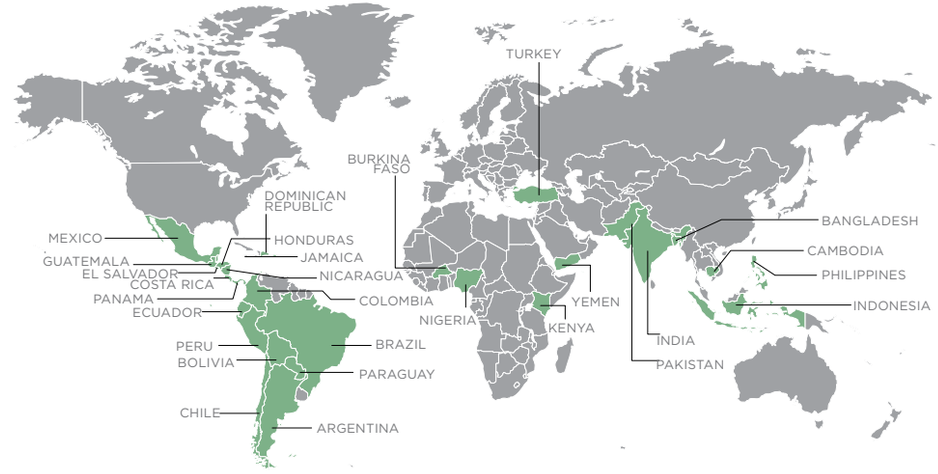
### SUCCESSFUL EXAMPLES OF CCT PROGRAMS

**Bolsa Familia Program**
Data from 2015 reveals that Bolsa Familia benefits around 54 million people or 14 million families (27% of Brazil's population) using a budget of around US$9 billion (ECLAC, 2016; Gazola Hellman, 2015). The program also contributes to reducing infant mortality caused by malnutrition and diarrhea by over 50%, and to raising the average school attendance rates from 75.7% to 79.7% (see more details in Gazola Hellman, 2015).

**Prospera Social Inclusion Program**
This program has been evaluated on multiple occasions using rigorous scientific methods (Cruz, De la Torre, and Velázquez, 2006; CONEVAL, 2016). One of the longest-running initiatives of its type in the world, Prospera has reduced poverty in Mexico by 8% at what is considered to be a low cost (The Economist, 2010). Studies have demonstrated different positive impacts on education, health, and nutrition, among other indicators. For example, the program has increased enrollment in educational establishments, particularly for girls and women. It also reduces school failure and dropout rates and increases educational achievements (e.g., grade level increases of 0.9 for 19–20-year-olds and 0.6 for 18–19-year-olds) (CONEVAL, 2016). Likewise, the program reduces mother-child mortality, morbidity, and disability rates and increases use of outpatient public health services.



FIGURE 3
**CCTS AROUND THE WORLD**

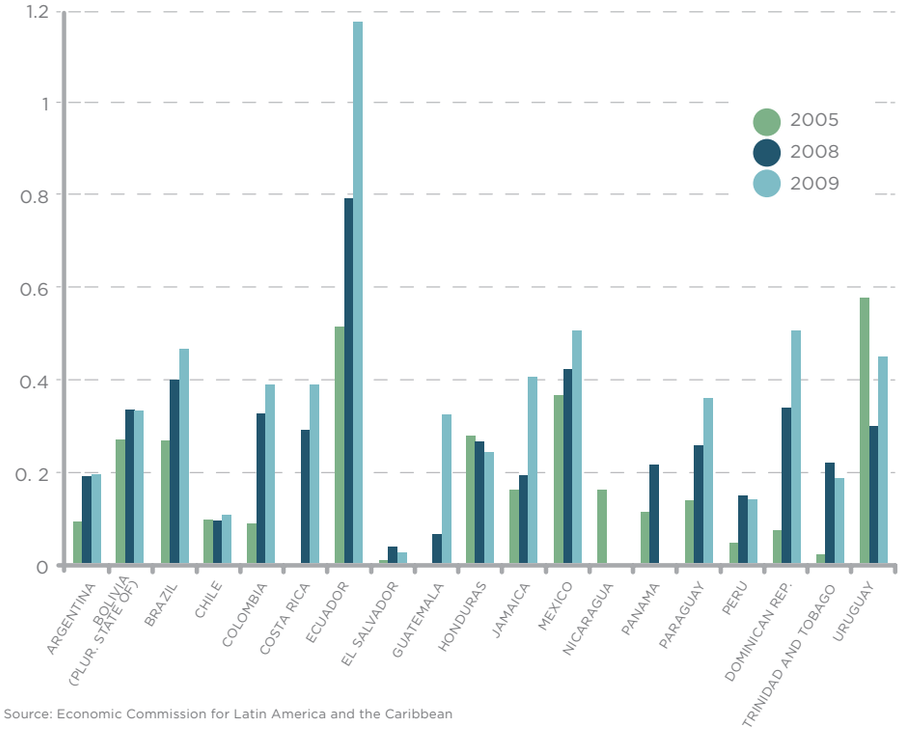



Source: Adapted from Fiszbein and Schady (2009).

these programs face is not only achieving greater demand for health and education services but also finding effective ways of doing so and strengthening the supply of these services (Cecchini, 2009). Likewise, various studies argue for the need to increase the scientific bases that justify these programs and to identify possibilities for achieving the goals set out in them in a wider variety of contexts (Filmer and Schady, 2009). In addition, two core factors in CCT design are the definition of rigorous beneficiary selection criteria to maximize the impact of transfers and the creation of predefined exit mechanisms (Stampini and Tornarolli, 2012).

One of the mechanisms that is most often used to evaluate the success of PES and CCT programs is additionality verification. This concerns results that would not have been achieved without the program. Although determining additionality tends to be a complicated technical exercise (Pattanayak et al., 2010), such findings serve to define the results that can be clearly attributed to these programs. Consequently, they serve to justify these initiatives from a political and social point of view and in terms of economic efficiency in the use of public funds. The evidence to date reveals that various CCTs show positive results when evaluated from this perspective (Fiszbein and Schady, 2009; Gazola Hellman, 2015; Stampini and Tornarolli, 2012; Molina-Millan et al., 2016). There is evidence that CCTs represent more than 20% of poor beneficiaries' incomes and that the incidence of poverty would be 13% greater on average if these programs had not been implemented (Stampini and Tornarolli, 2012). The largest of these programs (Brazil, Colombia, and Mexico) have reached coverage rates of around

FIGURE 4
**THE IMPORTANCE OF CCTS AS A PERCENTAGE OF GDP**




Source: Economic Commission for Latin America and the Caribbean

50%–55% of poor populations (Stampini and Tornarolli, 2012) (see Box 3). Although the empirical evidence is clear regarding the positive impact of several CCTs in the short term, the scientific results on long-term impacts are ambiguous (Molina-Millan et al., 2016). Achieving significant long-term goals is one of the major challenges to guaranteeing permanent relief from the problems of structural poverty in Latin America.

Although few similar evaluations have been carried out for PES programs, the scientific evidence on the impact is mixed, but there is a certain trend toward results that show low additionality (see table 2). The challenge of improving additionality largely implies that modifications be made to the selection criteria for suppliers taking part in the programs. However, this requires sufficiently robust information (e.g., information on areas at higher risk of deforestation), periodic evaluations that function as feedback, and the determination of possible undesired effects on the behavior of economic agents (behavioral spillovers) due to the implementation of these criteria (Persson and Alpízar, 2013; Alpízar et al., 2015). Finally, another of the major challenges that these public policy tools are facing concerns their financial sustainability, particularly in contexts where state budgets are limited. This problem is more evident in the case of PESs because combating poverty tends to be a priority issue in most countries in Latin America. As a consequence, governments and international cooperation organizations are more likely to allocate funds to finance CCT than PES programs, provided these are demonstrated to be effective. One alternative to PESs is the possibility of attracting the private sector as a mainstay for the financing structure of these programs. However, this would require increasing the scientific rationale for these programs by obtaining verifiable metrics on the benefits they bring. In other words, to provide incentives for the private sector (e.g., hydropower companies) to finance these programs, it would be necessary to clearly demonstrate how the money they invest in PESs will translate into quantifiable environmental benefits (e.g., improvements in cubic meters of water available) and tangible economic benefits (e.g., savings on the costs of transporting water from distant areas). Clearly, the government structure or agency implementing these investments must demonstrate such technical solvency. However, programs must also contain accountability mechanisms and efficient management schemes that create an atmosphere of trust and low transaction costs for private investors.

**18**

COUNTRIES IN LATIN AMERICA AND THE CARIBBEAN HAVE CONDITIONAL CASH TRANSFER PROGRAMS

### CAREFUL DESIGN

CCTs and PESs are promising public policy tools with the potential for achieving social and environmental benefits, on the one hand, and increasing the incomes and thus the well-being of the region's most vulnerable families, on the other. The recommendations in *Laudato Si'*, taken as public policy suggestions, are highly compatible with these programs. Pope Francis has called on us to reward behavior that benefits society or the environment for the common good, avoiding the excessive use of punishment mechanisms that could ultimately impose disproportionate costs on parts of the population that are already vulnerable.

It is important, however, to avoid using these tools indiscriminately, because they are not always the most suitable means for achieving the purposes described above. The impact of CCTs and PESs on well-being depends largely on careful design, attention to scientific evidence, the definition of the target population, and governments' capacity to administer investment flows and select the target population.

The encyclical is a rousing call for us to use limited resources efficiently, including public resources for financing CCT and PES schemes. It is the responsibility of governments and scientists to ensure that these tools are the best way of addressing each set of circumstances.

**NOTES**

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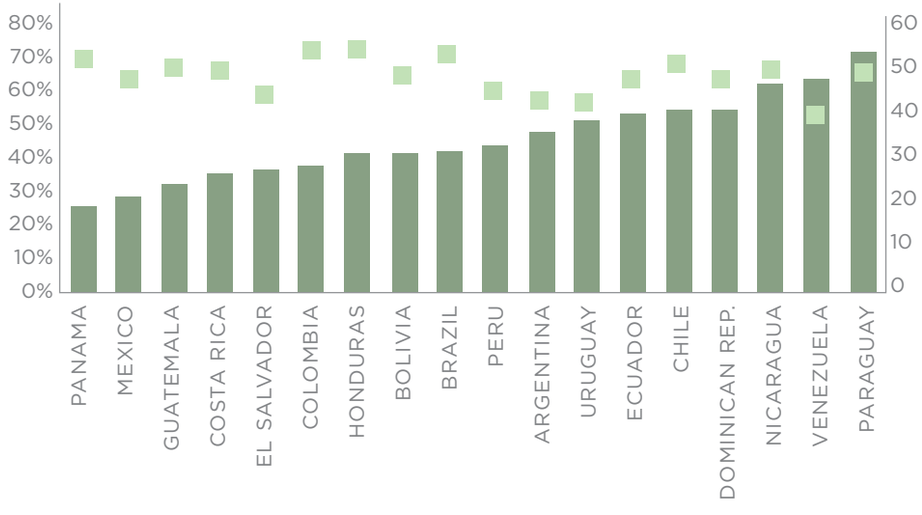
# THE HARD CORE OF INEQUALITY

Are societies where income inequality is greater more likely to undertake reforms to reduce this? There is a negative correlation (-0.36) between the classic measure of inequality, the Gini coefficient, and peoples' willingness to pay more for products that safeguard workers' rights. In other words, the most unequal countries are the least willing to pay more to improve equality.

This negative relationship therefore implies that social inequality goes hand-in-hand with less demand for labor rights, which makes reducing inequality even more challenging.

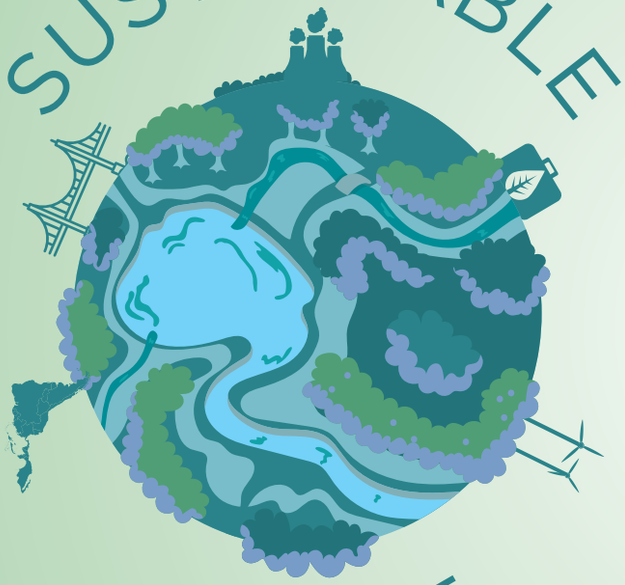
## WILLINGNESS TO PAY TO SAFEGUARD WORKERS' RIGHTS AND GINI COEFFICIENT

Question: Imagine that your country signs an integration agreement with other countries in the region (Latin America and the Caribbean). Would you strongly agree, agree, disagree or strongly disagree with the following statements? Responses for "strongly agree" and "agree."




Source: www.iadb.org/intal/alianzalb

SUSTAINABLE



TRADE

Efforts to promote a sustainable
use of natural resources are not a waste of money,
but rather an investment capable of providing
economic benefits in the medium term.

*Laudato Si'*

# BIG DATA, BIG INTEGRATION

**INTRADE, INTAL Interactive, and COSIPLAN/IIRSA are promoting transparency and access to information on integration and infrastructure**

9 renewable energy projects are to be developed in the action area for the Agua Negra Binational Tunnel (Chile/Argentina)

216

regional infrastructure projects in the COSIPLAN Project Portfolio have environmental permits

US$ 70 BILLION

is what multilateral organizations spend on infrastructure financing each year

60% of greenhouse gas emissions come from or are associated with infrastructure

Agricultural productivity must increase by 60% to feed the global population

10,000

companies in Latin America are ISO 14001 certified for environmental sustainability

80%

of global deforestation is caused by activities that are connected to agriculture

The environmental goods market will be worth US$1.9 trillion by 2020

The world has lost 2.3 million square kilometers of forest since the year 2000

Source: www.iirsa.org

Arancha González
International Trade Centre

# Sustainable global value chains

## Promoting Good Trade Practices

THE ENVIRONMENT IS ONE OF THOSE GOODS THAT CANNOT BE ADEQUATELY SAFEGUARDED OR PROMOTED BY MARKET FORCES

*Laudato Si'*

This article examines policies and Aid for Trade interventions that can foster the development of sustainable value chains. After briefly reviewing the broader relationship between trade and the environment, it looks at how tariffs and nontariff measures can help incentivize (or discourage) better environmental policies, from the adoption of green technology to the protection of fragile ecosystems. It pays particular attention to the consumer-propelled popularity of a plethora of voluntary sustainability standards. These standards present opportunities to encourage more sustainable modes of production but also risk excluding small and medium-sized enterprises (SMEs) in developing countries from such trade. The article offers suggestions and examples of interventions to maximize the former while minimizing the latter. The final section looks at the ongoing evolution of environmental concerns in multilateral and "megaregional" trade fora, from the World Trade Organization and the Trans-Pacific Partnership Agreement to the negotiations on a prospective Transatlantic Trade and Investment Partnership (TTIP). It closes by outlining an agenda.

By 2030, the world's population is estimated to reach 8.3 billion (FAO, 2003: 4). The United Nations (UN) 2030 Agenda for Sustainable Development,[1] adopted in September 2015,[2] builds a universal plan of action to ensure that all of these people, the majority of whom reside in the developing world, can live free from the scourge of extreme poverty. Ending poverty will be impossible if climate change continues unabated, and the Paris Agreement reached in December 2016 sets a framework for countries to take action on curbing greenhouse gas emissions.

Promoting sustainable and inclusive growth as a means to eradicate poverty is at the heart of the 2030 Agenda. Committing the world's governments and people to the ambitious goal of ending poverty by 2030 sends an important signal of zero tolerance.

Trade, as an engine for inclusive economic growth and sustainable development, is key to achieving this objective. Indeed, this is why it has been recognized as a key "means of implementation" for the 2030 Agenda. As we will see below, trade also can play a useful role in reducing emissions and creating economic incentives for environmental conservation.



# SUSTAINABLE GLOBAL VALUE CHAINS

History shows that the countries that have been able to sustain high growth rates over a generation or more—the kind of sustained rapid growth that outlasts commodity price cycles and substantially reduces poverty—all "fully exploited the global economy," using it as a source of demand, ideas, and technology (World Bank, 2008). The 2013 edition of the United Nations Human Development Report showed that virtually every country that had achieved strong gains in human development indicators between 1990 and 2012 had also registered relatively strong trade performances, measured by high or increasing shares of trade to output, and a large number of trading partners. Meanwhile, many of the worst laggards on the human development index actually saw their trade integration decline (UNDP, 2013).

It is therefore only right that trade is mentioned explicitly under Sustainable Development Goal (SDG) 17 (global partnership for sustainable development). In addition, expanding participation in global trade for value added goods and services will be a critical tool to achieve other SDGs, such as gender equality (Goal 5); economic growth and decent work (Goal 8); responsible consumption and production (Goal 12); and combating climate change (Goal 13), and to leverage synergies among these different objectives. In other words, trade is a lever to achieve wider economic and social goals.

THE WORLD WILL HAVE **8.3** BILLION INHABITANTS BY 2030

Trade agreements moved "behind the border" decades ago, establishing parameters designed to ensure that an array of traditionally domestic measures, ranging from health and safety standards to technical regulations for products, do not serve as pretexts for discriminatory protectionism.

Broader sustainability awareness in the trade sphere has grown steadily. Already in 1989, the Grand Anse Declaration in which Caribbean Community leaders pledged to build a regional common market recognized the economic threat posed by environmental fragility.[3] "Preserving the environment" figures among the overarching goals of Mercosur's 1991 founding Treaty of Asunción. The preamble to the 1994 Marrakesh Agreement Establishing the World Trade Organization placed sustainable development—rather than a narrow focus on imports and exports—at the

TOURISM
ACCOUNTS FOR
**8.9%**
OF REGIONAL
EXPORTS

heart of the new institution's objectives.[4]

The SDGs reflect calls for the promotion of a strong multilateral trading system and for meaningful trade opening. But more importantly, they create a space for a new generation of trade agreements that seek to more effectively entrench trade as a means to achieve inclusive, sustainable development, economic growth and job creation. In other words, to better build and connect international value chains, increase the participation of small and medium-sized enterprises (SMEs) in international trade, expand the diffusion of environmentally friendly technologies, foster women's economic empowerment, increase youth employment, and promote the protection of biodiversity.

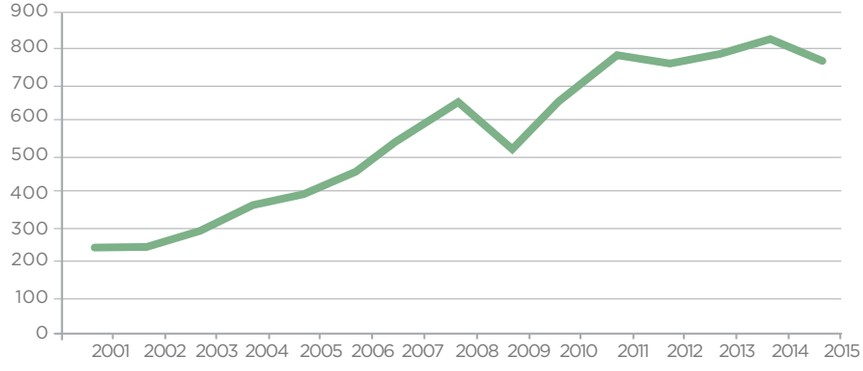
This article will discuss the policy choices that underpin these trade agreements, particularly with regard to the environment. Second, it will analyze how sustainable and inclusive strategies are reflected within some prominent trade agreements. Finally, it will look at how businesses from Latin America and the Caribbean (LAC) might be equipped better to participate in sustainable international value chains.

## SUPPLY-SIDE ACTION

The relationship between trade and environmental concerns is multifaceted. The standard framework for thinking about how trade opening impacts the environment breaks the effects down into three categories: scale, composition, and technique. "Scale" refers to the notion that other things being equal, if trade opening spurs greater growth it will lead to greater resource consumption and energy use. The other two categories address the fact that other things are rarely equal. "Composition" refers to the liberalization-induced reallocation of resources within a country's economy, towards sectors in which it has a comparative advantage. The implications here vary: for example, if the expanding sectors are less energy-intensive, the country's emissions could fall (though if they are more energy-intensive, emissions could rise, in the absence of countervailing domestic policies). Finally, "technique" effects refer to how market opening can reduce the cost of environmentally-efficient technologies, thus paving the way for more efficient resource use and lower levels of pollution.[5]

As we will see, trade policy has focused primarily on demand-side aspects of these "technique" effects, but supply-side action to improve sustainability practices across the value chain is growing in prominence.

FIGURE 1
**GLOBAL EXPORTS OF ENVIRONMENTAL GOODS ARE RISING (BILLIONS OF US$)**




Source: ITC Trade Map 2016, using the OECD classification for environmental goods

## TRADE IN ENVIRONMENTAL GOODS AND SERVICES

Environmental goods and services are broadly defined as those that "measure, prevent, limit, minimize or correct environmental damage to water, air, soil, as well as problems related to waste, noise, and ecosystems" (OECD, 2014: 88). Trade policy can help meet governmental and private commitments on environmental protection, such as countries' Paris Agreement pledges, by lowering the cost of environmental goods and services. For example, reducing tariffs and other trade barriers for solar panels would encourage their uptake.

The global market for environmental goods and services was estimated to have reached US$866 billion in 2011 and is expected to rise to US$1.9 trillion by 2020.[6] As the International Trade Centre (ITC) Trade Map shows below, global exports of environmental goods have risen in the past years—despite the short-lived 2008–09 decline during the global financial crisis (ITC, 2014). The market for such goods and services offers tremendous opportunities for developing countries as suppliers; as consumers, it makes it possible for them to leapfrog polluting technologies and move directly into more environmentally sensitive activities.

In Barbados, a small island developing state (SIDS), for example, disseminating solar water heaters has done more than just address the island's environmental concerns and heavy dependency on fossil fuels. It has also given rise to a flourishing new industry. Barbados has capitalized on its over 3,000 hours of sunshine per year and is now saving its inhabitants over 100,000 MWh of energy annually with over 50,000 solar water heater installations (Climate and Development Knowledge Network, 2012). As Barbados shows, trading in environmental goods and services can reduce the impact of climate change while creating economic growth opportunities.

## TACKLING NONTARIFF BARRIERS, TOO

The effect of pro-environment trade policies can be multiplied by amending unnecessary nontariff measures (NTMs) that may be obstructing trade in environmental goods and services. These

**17%**
OF GREENHOUSE GAS EMISSIONS COME FROM AGRICULTURE

include duplicative requirements on testing and product certification, unnecessary taxes, charges and quantity control measures (ITC, 2013b).

Evidence also shows that overcoming NTMs in export markets can have a substantial impact. For example, exporters in Peru expected sales to the United States of oil extracted from sacha inchi, a protein-rich traditional plant, to jump from US$500,000 annually to US$2.5 million in 2015, after it won a key US food safety approval known as Generally Recognized as Safe (GRAS), enabling its use as an ingredient in everything from granola bars to mayonnaise (ITC, 2013b: 51 et seq.). Increased sales of biodiversity-based products like sacha inchi, which is cultivated and harvested in Peru's Amazon region, give local communities both income gains and an incentive to conserve and protect fragile ecosystems.

Addressing NTMs often has a strong regional dimension. ITC's business surveys of exporters in Latin American and Caribbean countries reveal that the bulk of NTMs impeding their trade operations originate either at home, i.e., within the country itself, or from within the region (ITC, 2013c). ITC data confirms that exporting SMEs in LAC countries are particularly affected by widely varying buyers' demands on quality. Many of these SMEs lack information about the necessary standards and related compliance requirements, and lack access to certification processes (ITC, 2013a). ITC's Trade and Environment Programme has provided SMEs in Latin America with tailored technical assistance to overcome governmental NTMs like GRAS, access market information, and meet private voluntary standards like organic and fair trade.

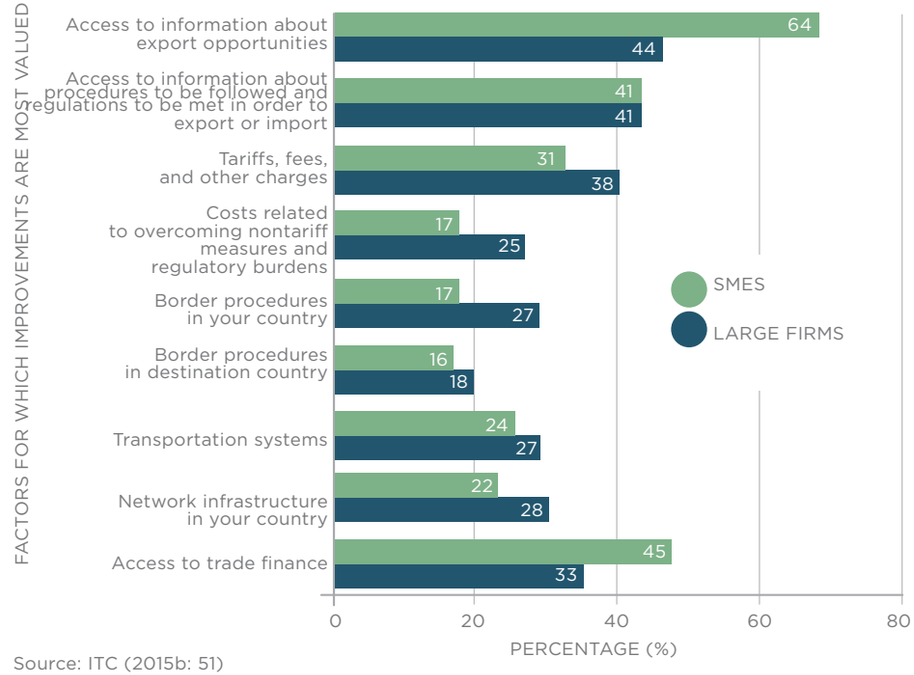
## CONSUMER PREFERENCES

Greater consumer awareness of environmental issues—and indeed of workers' rights—in value chains is driving a growing market for sustainably sourced products and services, highlighting the need for value chains to be more transparent. Markets for sustainable commodities, defined as "products that are demonstrably … compliant with internationally recognized standards for sustainable practice" (ITC, 2015c), are growing far faster than those for conventional commodities (ITC, 2015c). According to a survey conducted by Nielsen (2015: 8), 66% of global consumers are ready to pay extra for products and services from companies that are committed to positive social and environmental impact. This is up from just 38% in 2011. According to the Inter-American Development Bank, tourism represents 41% of exports in the Caribbean and 8.9% in Latin America and "tourist choices are increasingly influenced by sustainability considerations" (UNEP, 2012: 28). Responding smartly to these preferences benefits the bottom line: consumer surveys show that consumer goods from brands with a demonstrated commitment to sustainability register faster sales growth than those from brands without such a commitment (Nielsen, 2015: 2).

The increase in demand for sustainable trade has given rise to a growing array of voluntary sustainability standards. Such standards can play a valuable role in supporting greener supply chains. For example, land areas subject to sustainability standards compliance requirements sharply expanded: between 2008 and 2014, areas certified by the Roundtable on Sustainable Palm Oil expanded almost 30-fold and the Rainforest Alliance/Sustainable Agriculture Network's areas of coverage increased by more than nine times; meanwhile, between 2010 and 2014, the UTZ-certified area grew by 6.5 times (ITC, 2015c: xvi).

Yet these sustainability standards can be difficult to meet, especially for smaller players in developing countries. One key to overcoming these challenges is transparency. ITC's Standards Map database (www.standardsmap.org) contains information on over 200 standard systems, codes of conduct and audit protocols addressing sustainability hotspots in global supply chains. The database together with its self-assessment tools is a resource for small farmers and SMEs to navigate the complexities of private standards.

FIGURE 2
**IMPROVEMENTS VALUED: SMES VERSUS LARGE FIRMS**




Source: ITC (2015b: 51)


But understanding the requirements of different sustainability standards and certifications is only a first step. Looking to the future, ITC is extending its offering of online solutions under a new heading: the Sustainability Network which will provide transparent and verified information on voluntary sustainability standards and trends, as well as facilitate access to related global networks. In sum, the Sustainability Network helps make complex sustainability-related information intelligible. It will enable users to share "sustainability diagnostic reports" about their existing or envisaged sustainability commitments directly online with certification bodies and potential business partners. Not only will this give a digital presence to small and previously invisible businesses and enable them to link up with larger buyers, it will open doors to greater transparency across the supply chain. Information generated by the system will let procurement managers and policymakers make better-informed decisions and identify sustainability gaps.

Unique identification numbers obtained through Global Standard 1 (GS1) are an important feature of the Sustainability Network. Users of the system will have the option of obtaining a GS1 number, giving, international buyers on the Sustainability Network a glimpse into the geographic location and performance of existing or potential new suppliers as well as traceability tool. The Sustainability Network is, therefore, well placed to contribute to more supporting more sustainable value chains, a theme that is high on the global agenda.

Global public goods such as the Sustainability Network together with well-targeted Aid for Trade can play a useful role in helping smallholder farmers and SMEs meet private voluntary standards, including for lucrative niche markets such as those for organic products, giving rise to virtuous circles of compliance, increased export sales, higher rural incomes, and more sustainable food value chains. In Peru, for example, ITC's Trade and Environment Programme works to help smallholder producers of top-quality "fine or flavor" cocoa varieties—as distinct from "ordinary" or "bulk" varieties—boost both competitiveness and sustainability. Prized in international luxury chocolate markets for their unique taste, many of these fine or flavor varieties are native to the Amazon region. But to reap the rewards of higher prices and incomes, Peruvian smallholders and SMEs need to be able to differentiate and position their product in the highly competitive international market. By enabling them to do so and to meet international quality and sanitary standards, obtain sustainability certifications, and connect to international buyers, ITC helps them generates income opportunities linked to the preservation of local biodiversity.[8]

## PROMOTING SUSTAINABLE AGRICULTURE

Agriculture is both uniquely vulnerable to climate change and a large contributor to greenhouse gas emissions. Agriculture is responsible for 17% of global greenhouse gas emissions, and that rises to 24% to 34% once agriculture-related land clearance is taken into account (OECD, 2015). Nearly half of all greenhouse gas emissions in the LAC region result from land-use change, forestry, or agriculture, according to the World Resources Institute.[9] At the same time, climate change is damaging the competitiveness of exports in agricultural produce. An ITC survey of exporters in Peru and Uganda showed that most cooperatives producing coffee and cacao ranked climate change up with—or even above—price volatility and quality as a challenge they faced in connecting to international markets (ITC, 2015a).

Trade can help strengthen climate resilience by providing market incentives for more sustainable practices. For example, certified shade-grown coffee production has boomed in Peru, where forest tree canopies maintain coffee's agroforestry systems at adequate temperatures (ITC, 2015a).

And Aid for Trade can support this transition to more sustainable practices through training farm enterprise and cooperatives in climate resilient practices. For example, ITC has supported tea factories in Kenya sourcing from over 500,000 smallholders to reduce energy usage by up to 30% while training farmers in climate resilience practices like drip irrigation, planting tree canopies and increased composting. This change in practices helps the farmer build climate resilience. It helps reduce emissions while at the same time providing the farmer with better incomes linked to compliance with private standards that include climate considerations.[10]

**90%**

OF PRIVATE-SECTOR COMPANIES IN LATIN AMERICA AND THE CARIBBEAN ARE SMES

## REDUCING THE CARBON FOOTPRINT OF TRADE

As more goods are traded, the level of transport emissions rise. The International Energy Agency's 2007 study on $CO_2$ emissions from fuel combustion suggests that international marine transport generates about 8.6% of total transport-related emissions.[11]

Domestic and international policies can support more efficient, environmentally friendly trade. The setting up of a sustainable transportation ecosystem is one such initiative as leaner transport methods can help reduce the negative environmental impact of trade. For instance, the selection approach for carriers could be based on a carbon footprint scorecard that evaluates the environmental performance of transportation companies, based on criteria such as cooperation levels, carbon efficiency, information sharing transparency and engagement.

Cutting the environmental footprint of trade and transport can be helped by switching to paperless alternatives such as E-solutions. According to the United Nations Conference on Trade and Development (UNCTAD), the average international transaction involves 40 documents.[12] An Asia-Pacific Economic Cooperation (APEC) study found that in the case of sugar, paperless trading technology reduced trading costs by US$8 per ton, or 4.4% of total value (Commonwealth of Australia, 2001: 2).

SUSTAINABILITY CERTIFICATION CAN COST UP TO

**€4,000**

PER YEAR

Measures to facilitate trade would also reduce the time trucks spend idling at borders, thus contributing to cutting greenhouse gas emissions from transport. This is an often-overlooked benefit of implementing the WTO Agreement on Trade Facilitation.

Global disciplines on fossils fuel subsidies would also greatly advance the goal of significantly reducing the emissions they generate. So far reduction commitments have been largely voluntary and therefore anchoring them in a multilateral framework such as the WTO would contribute to transparency and predictability.

At the economy-wide level, fiscal measures like carbon taxes provide an effective means of incentivizing reductions in the carbon intensity of production and consumption.[13]

## THE NEW DEAL: ENVIRONMENTAL POLICY AND TRADE AGREEMENTS

Recent trade negotiations, particularly so-called "megaregional deals," have sought to incorporate "sustainability" into the text of agreements. The trend is positive, as it speaks to greater appreciation of the links between trade governance and sustainable development, though the concept of what sustainability entails varies considerably from one agreement to the next. Some prospective agreements view sustainability solely in terms of environmental protection. Others, such as the concluded-but-not-yet-ratified Trans-Pacific Partnership Agreement, expand the concept to encompass biodiversity and even inclusiveness dimensions such as promoting women's economic empowerment or supporting SMEs.[14]


## THE WTO ENVIRONMENTAL GOODS AGREEMENT

Since July 2014, a group of WTO members have been negotiating an Environmental Goods Agreement (EGA)[15] to remove trade barriers on environmental goods, to facilitate the spread of climate-friendly technologies. A list of 54 products agreed upon by APEC members has served as a basis for negotiations. The products on the list range from bamboo flooring panels to industrial pollution control devices and machinery components needed to generate energy from a variety of renewable energy sources.

As noted above, lowering tariffs on environmental goods would contribute to their wider dissemination, lowering the cost of green energy contributing to more efficient resource use. It would also generate new commercial opportunities for producers of environmental goods. Tariffs currently applied on products for renewable and clean energy generation, such as solar panels and wind turbines, can be as high as 35%.[16]

The EGA has the potential both to support countries' international objectives, such as climate targets under the Paris Agreement on Climate Change, as well as national energy policies, such as Costa Rica's aspiration to become a carbon neutral economy by 2021 (Government of Costa Rica, Ministry of Environment and Energy, 2015: 3). It might even provide an impetus to multilateral negotiations on green goods and services.[17]

## THE TRANS-PACIFIC PARTNERSHIP AGREEMENT

The Trans-Pacific Partnership Agreement (TPP) will eliminate tariffs on environmental goods and technologies such as solar panels, wind turbines, and air pollution control mechanisms among the 12[18] participating Pacific Rim countries.[19]

In the text of the TPP agreement, the Parties agreed to join efforts to develop cost-effective low-carbon technologies and to identify alternative, clean and renewable energy sources (TPP, Art. 20.15 [2]).

But the agreement goes beyond liberalizing trade in environmental goods and services. It would explicitly require parties to fulfill their obligations under the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the International Convention for the Prevention of Pollution from Ships (MARPOL) (Art. 20.17 [2] and Art. 20.6 [1], footnote 6). The TPP further features clauses on conservation of species (Art. 20.16 [4]), deforestation and forest degradation (Art. 20.15 [2]), as well as an innovative chapter on sustainable fisheries management, an issue which WTO members have been negotiating multilaterally, albeit inconclusively, under the Doha Round (Art. 20.16 [3]). In an evolution from earlier trade agreements, such as such as the North American Free Trade Agreement (NAFTA), these sustainability clauses will be fully enforceable through dispute settlement, with the threat of trade sanctions (Art. 20.17 [5]).

Other innovations in the TPP agreement include an e-commerce chapter that promotes paperless trade through electronic authentication and signatures for commercial transactions (Art. 14.6). The agreement also seeks specifically to promote SME participation in regional value chains, by encouraging each TPP Party to create a user-friendly website for SMEs, with easily accessible information on how SMEs can take advantage of the TPP (Art. 24.1).[20] In addition, the TPP's development chapter urges parties to provide women with opportunities to participate in the domestic and global economy (Art. 23.4).

## THE TRANSATLANTIC TRADE AND INVESTMENT PARTNERSHIP (TTIP)

The prospective TTIP agreement between the EU and the United States of America (USA) might be the next major trade agreement to feature a broad-based approach to environmentally sustainable development.

The proposed chapter on sustainable development refers to environmental commitments in Multilateral Environmental Agreements (MEAs) as well as to core labor standards regulated by the

International Labour Organisation (ILO).[21] It also includes an obligation not to soften domestic regulations on labor or environmental protection when seeking to foster trade or attract investment. [22]

Like the agreements discussed above, the TTIP negotiations include trade and investment promotion covering green goods and technologies. Commitments relating to biodiversity and ecosystem conservation, including the sustainable use and management of forests, fisheries, wildlife, and other natural resources, have also been discussed.[23]

One TTIP novelty is a potential cross-cutting provision on corporate social responsibility (CSR) and responsible business conduct standards, which promote multistakeholder interaction among governments, businesses and consumers on sustainability issues. [24]

## LATIN AMERICA AND GLOBAL VALUE CHAINS

Businesses will increasingly need to integrate sustainability requirements into their operations and strategies to remain profitable and remain attractive to consumers. Governments will need to support business with investments in both improving the business environment and strengthening hard and soft infrastructure to strengthen climate resilience.

As we have seen, voluntary and compulsory standards are market differentiation tools that can open doors to more lucrative value chains and consumers—so long as producers, especially SMEs, are equipped to walk through those doors. SMEs need to be able to adopt new production methods and adjust to changing market demands. They also have to make it through complex certification and audit processes, and continuously prove that they are meeting sustainability requirements. The SME focus is critical because they account for over 90% of private sector firms and close to 70% of employment in the LAC region (ITC, 2015b: 2). Thriving SMEs are essential for growth to be inclusive, which is why it is crucial for smaller businesses in the LAC region to tap into the export opportunities presented by sustainable value chains.

The ITC's SME Competitiveness Outlook (2015b: 51 et seq.) points to how governments, development partners, trade and investment support institutions (TISIs), and businesses can work to help SMEs become more competitive and connect to international value chains. Four types of interventions are particularly relevant for sustainable value chains:

1. Keeping SMEs Informed on Sustainability Requirements

As noted, SMEs tend to find it challenging—and expensive—to identify and understand relevant standards and technical requirements in potential destination markets.[25] The chart below shows that getting information about such standards and market-entry requirements is a major challenge for SMEs (and indeed larger firms).

Countries' national quality infrastructure—public institutions as well as chambers of commerce and other TISIs—can help SMEs by providing information and technical training to support the implementation of key sustainability standards (ITC, 2015b: 88).

2. Supporting SME Compliance As They Adapt Products and Processes

Even when relevant information on a standard is accessible, SMEs frequently lack the expertise and organizational absorptive capacity to implement it. Furthermore, compliance typically entails high fixed costs, which weigh on SMEs disproportionately compared to larger firms (ITC, 2015b: 56 et seq.).

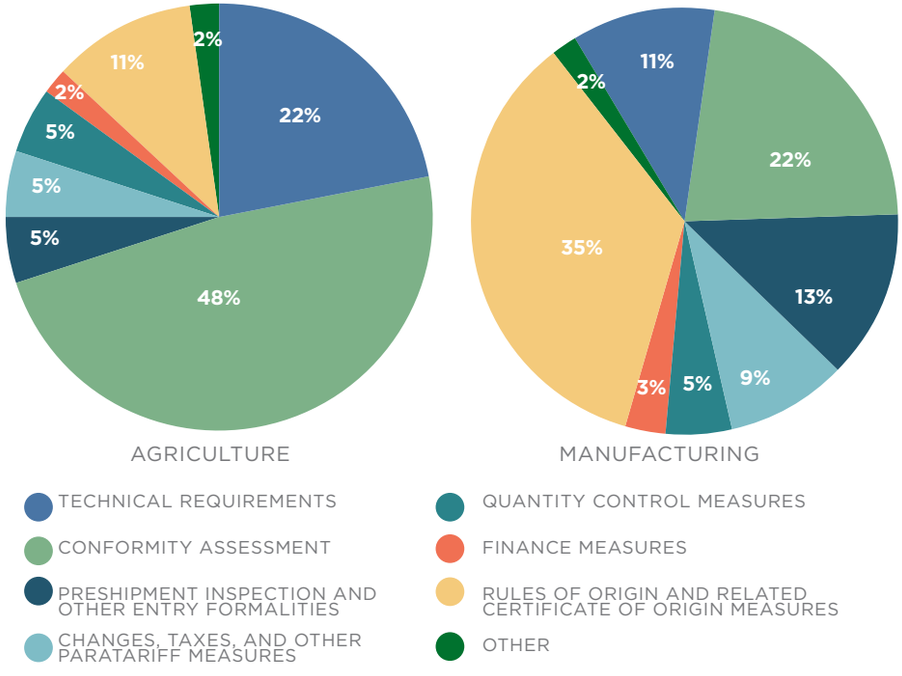
Within international value chains, buyers (lead firms) can act to reduce transaction costs and risks for SME suppliers, by transferring know-how and guaranteeing a certain level of sales if suppliers comply with relevant sustainability standards (ITC, 2015b).

The ITC's SME Competitiveness Outlook (2015b) references Mexican suppliers to Wal-Mart. The retailer requires its suppliers to comply with certain product and process standards, and in return guarantees competitive market prices. This way, Wal-Mart significantly decreases the transaction costs for its suppliers.

Linking up with large retailing firms in sustainable value chains can help SMEs "move from niche to mainstream markets" (ITC, 2015b: 41) while bolstering their own technological sophistication and productivity.[26]

Appropriately tailored and target-

FIGURE 3
**NTMS FOR AGRICULTURE AND MANUFACTURING EXPORTS**



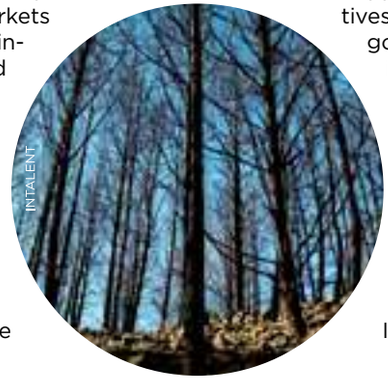

Source: ITC (2015b: 57)

ed tools can help enable sustainability compliance by SME suppliers. For example, ITC has developed an online supply chain management tool for the Sustainable Agriculture Initiative (SAI) Platform, a global food industry initiative to promote sustainable agriculture, through which SAI members can better understand and share information on the sustainability profiles of their upstream farmers. This both lightens the burden of sustainability reporting burdens and improves understanding of sustainability gains and gaps in the agricultural supply chains of over 80 international food, beverage, and retailing companies.

3. Demonstrating SME Compliance Through Conformity Assessments

Surveys show that demonstrating compliance with sustainability requirements is seen by firms as sometimes more difficult than meeting the underlying requirements themselves. ITC surveys show that 48% of agricultural exporters identified conformity assessment as their primary trade concern. Manufacturing exporters see conformity assessment as the second largest issue, identified as a trade barrier by 22% of respondents (ITC, 2015b: 57).

Certification entails significant costs, especially when exporting to destination markets with different sustainability standards and requirements. Certification and auditing for the Fair Trade International standard, for example, can amount to up to €4,000 annually (ITC, 2015b).




Especially if they are designed for large firms, sustainability standards can be costly and complicated for SMEs. Encouraging SME participation in the standard-setting process would ultimately make it easier for SMEs to join sustainable international value chains (ITC, 2015b: 88). Governments can further enhance SME participation in sustainable value chains by ensuring that national certification systems and related compliance procedures do not impose excessive burdens on firms (ITC, 2015b: 58).

It is with this in mind that ITC launched in 2014 the Trade for Sustainable Development (T4SD) Principles, which encourage companies and institutions to develop transparent, harmonized sustainability standards and practices. The first principle is sustainability: organizations should support and promote production, trade, management, and quality practices that are sustainable, encompassing social, environmental, economic and ethics issues. The second principle is transparency: organizations should demonstrate openness to sharing good practices at all levels. Harmonization is the third principle: all value chain actors need to build on existing methodologies in a collaborative way to avoid re-inventing the wheel by duplicating audits or creating overlapping codes and initiatives that serve the same goal. The final principle is about aligning work and activities to the SDGs. To date, over 70 public and private organizations have endorsed the T4SD Principles, including Nestlé, Cargill, Givaudan, the ISEAL Alliance, and McDonald's. ITC's work with SAI Platform, mentioned above, is an example of the T4SD Principles in action.

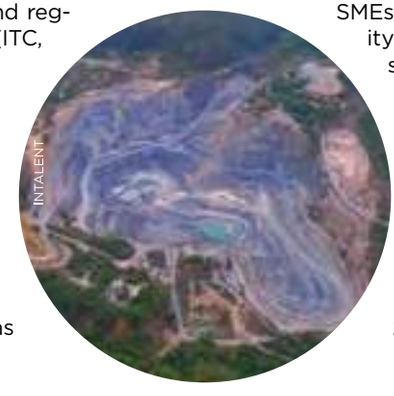
A separate approach to benchmarking, monitoring, impact measurement and transparency developed by ITC's Ethical Fashion Initiative is called Respect Invest Sustain Empower (RISE). Based on data gathered through means including assessments, focus group discussions, surveys, mapping, and tracking tools, the approach enables ITC to systematically examine the poverty reduction and other social impact effects and the initiative's orders from micro-scale fashion producers in developing countries. As part of ensuring an ethical and fully traceable supply chain, and the information gathered through it is made public, thus responding to consumer demands for supply chain transparency.

4. Recognizing SME Sustainability Commitments

While accreditation is sufficient for recognizing SME sustainability commitments at the national level, mutual recognition arrangements are often necessary in international trade, so that sustainability achievements recognized in one country are duly acknowledged in another. International collaboration on certification schemes and processes can facilitate trade by preventing SMEs from having to undergo multiple testing, certification and registration processes (ITC, 2015b).

## POWERFUL TOOLS

The open global economy, anchored in the WTO and a growing number of bilateral and regional trade agreements, has enabled the organization of production into multicountry value chains involving flows of goods, services, investment, and innovation. Together with shifting consumer preferences, environmental imperatives reflected in the SDGs and the Paris Agreement on Climate Change mean that it is more important than ever to view trade as a "means for implementation" for sustainable development.




Trade agreements are powerful tools to promote environmental sustainability, whether through the traditional channel of lowering trade barriers on environmental goods and services, or more novel provisions to actively encourage better environmental practices.

The growing number of sustainability standards offer new avenues to improve environmentally sustainable practices in international value chains. Yet such standards present both a challenge and an opportunity to businesses, especially SMEs in developing countries. If SMEs do not have the technical and financial means to meet and prove compliance with sustainability standards, they—and their employees, who collectively account for the bulk of the labor force—risk exclusion from lucrative value chains.

The challenge, in LAC as in Africa and Asia, is for policymakers, TISIs, and businesses to work to enable SMEs to meet sustainability standards and tap into sustainable international value chains. This would help ensure that the benefits of the growing array of trade agreements are shared more broadly, and contribute to achieving the ambitious goals of the 2030 Agenda.

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[2] "Sustainable Development Goals," United Nations, https://sustainabledevelopment.un.org/sdgs.

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[5] "The Impact of Trade Opening on Climate Change," World Trade Organization, https://www.wto.org/english/tratop_e/envir_e/climate_impact_e.htm

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[13] Kasterine, A. 2009. "Carbon Labels Present Taxing Problem." BBC News, March 31. http://news.bbc.co.uk/2/hi/7974972.stm. Cf. WTO (2013).

[14] See TPP chapters 20, 23, and 24, respectively.

[15] The current 17 EGA members are Australia; Canada; China; Costa Rica; the European Union (and its 28 member states); Hong Kong, China; Iceland; Israel; Japan; Korea; New Zealand; Norway; Singapore; Switzerland; Separate Customs Territory of Taiwan, Penghu, Kinmen, and Matsu; Turkey; and the United States.

[16] "Environmental Goods Agreement," Office of the United States Trade Representative, https://ustr.gov/trade-agreements/other-initiatives/environmental-goods-agreement.

[17] "The Environmental Goods Agreement (EGA): Liberalising Trade in Environmental Goods and Services," European Commission, last modified July 8, 2016, http://trade.ec.europa.eu/doclib/press/index.cfm?id=1116.

[18] The countries that are party to the TPP are: New Zealand, Australia, Brunei Darussalam, Canada, Chile, Japan, Malaysia, Mexico, Peru, Singapore, the United States, and Vietnam.
vMarket access in the TPP is regulated individually between members.

[19] For example, Art. 24.2 (4) sets forth: "The SME Committee may seek to collaborate with appropriate experts and international donor organisations in carrying out its programmes and activities."

[20] "About TTIP," European Commission, last modified April 1, 2015, http://ec.europa.eu/trade/policy/in-focus/ttip/about-ttip/

[21] "About TTIP," European Commission, last modified April 1, 2015, http://ec.europa.eu/trade/policy/in-focus/ttip/about-ttip/

[22] "About TTIP," European Commission, last modified April 1, 2015, http://ec.europa.eu/trade/policy/in-focus/ttip/about-ttip/

[23] "About TTIP," European Commission, last modified April 1, 2015, http://ec.europa.eu/trade/policy/in-focus/ttip/about-ttip/

[24] ITC (2015b) referring to European Commission (2012).

[25] ITC (2015b), referring to Iacovone et al. (2011) and Maertens, Colen, and Swinnen (2011).

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“We need to **design a climate** agreement mechanism **that all countries would agree to**”

**Eric Maskin**
Winner of the Nobel Prize in Economics

Mechanism design is a way of finding optimum solutions to problems that involve coordination among different people and interests. For example, if two children want to share a cake, one mechanism for doing this would be for one child to cut the cake and the other to choose which half they would like to have. The one cutting the cake thus has a strong incentive to do so equitably. Eric Maskin won the Nobel Prize in 2007 for laying the foundations of the modern theory of mechanism design in economics, which has very complex applications that are based on the signals that institutions send and the supposition that there is private information that not everyone is party to. In this exclusive interview with the Integration & Trade Journal, Maskin argues that many countries do not wish to reduce their emissions and are instead hoping that others will do so, which implies the need for mechanisms to overcome this problem. He also claimed that nuclear energy is, for now, the most realistic alternative to fossil fuels.

**How could mechanism design help to mitigate climate change?**

Reducing carbon dioxide and other greenhouse gas emissions is the best way we know to mitigate climate change. But although most countries would benefit from such mitigation, they have conflicting objectives: reducing emissions is expensive, and they would prefer not to make the reductions themselves—they would prefer other countries to do so. In other words, there is a "free rider" problem: each country would like other countries to make reductions but not do so itself. Mechanism design can help find the terms of a climate change accord that ALL countries would agree to.

> IF GLOBAL WARMING GETS WORSE, THE COST OF RELOCATING THE MANY MILLIONS OF PEOPLE WHO LIVE ON COASTS WOULD BE HUGE

**Could you give us some examples of good designs and the outcomes of these?**

Mechanism design was used to design the auctions that the Federal Communications Commission (FCC) uses in the US to allocate spectrum licenses to telecoms companies. Among many other successful applications, it has also been used to assign schoolchildren to public schools.

**Do you think the carbon credit system is working well or would you suggest an alternative system?**

The carbon credit system is working, but not enough countries are involved yet.

**What are the economic consequences of a hotter planet?**

The cost of relocating the many millions of people who live on coasts would be huge. Worsening droughts, floods, and storms also imply potentially high costs for the global economy.

**How can public policies try to mitigate climate change?**

Eric Maskin was born in New York City in 1950. After completing his PhD in Applied Mathematics at Harvard, he taught at Cambridge, MIT, and Princeton before returning to Harvard, where he currently works. In 2007, he won the Nobel Prize with fellow economists Leonid Hurwicz and Roger Myerson for their contribution to mechanism design theory. He has also contributed to game theory, contract theory, and social choice theory. His most recent publications include:

- "The Unity of Auction Theory." Journal of Economic Literature. 42 (4): 1102–1115. 2004.
- Environment and Regional Trade Agreements: Essays in Honour of Sir Partha Dasgupta. Oxford: Stanford University Press. 2014.
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- "Debreu's Social Equilibrium Existence Theorem." Proceedings of the National Academy of Sciences of the United States of America. 112 (52): 15769–15770. With P. Dasgupta. 2015.
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Introducing a carbon tax or a cap-and-trade system would be the most effective public policies.

**What are the global challenges we are facing following the COP21 and COP22 international summits?**

COP21 was very important because the US and China—the two biggest emitters—were involved and made significant pledges. I don't have such high expectations for COP22.

**What are the current perspectives for the clean energy market?**

There have been many technological advances in clean energy, but realistically the only way that fossil fuels can be replaced (at least in the foreseeable future) is by making much greater use of nuclear energy.

**How can new technologies help to create "green jobs"?**

I don't know whether "green" technology will create a large number of new jobs. But these technologies are so important that they should be pursued regardless of the job potential they may have.

> I AM VERY GLAD THAT THE POPE MADE SUCH A STRONG STATEMENT ABOUT CLIMATE CHANGE

**What is your general opinion on *Laudato Si'*, Pope Francis's encyclical on the environment?**

I am very glad that the Pope made such a strong statement about climate change. What was perhaps missing from the document was a consideration of the free rider problem that I mentioned above.

ANALYSIS

# Trade policy after the Paris Agreement

## Environmental goods and **clean energy**

Mahesh Sugathan
International Centre for Trade and Sustainable Development (ICTSD)

**WHAT IS NEEDED IS A POLITICS WHICH IS FAR-SIGHTED AND CAPABLE OF A NEW, INTEGRAL AND INTERDISCIPLINARY APPROACH TO HANDLING THE DIFFERENT ASPECTS OF THE CRISIS.**

*Laudato Si'*

EFFORTS AT COMBATING CLIMATE CHANGE WILL HAVE DECARBONIZATION AT THEIR CORE THROUGH A SHIFT AWAY FROM FOSSIL FUELS TO CLEAN ENERGY SOURCES SUCH AS SOLAR, WIND, HYDRO, AND BIOMASS. FREEING UP TRADE IN ENVIRONMENTAL GOODS AND SERVICES (EGS), WHICH INCLUDE CLEAN ENERGY GOODS AND SERVICES, COULD LOWER THEIR COSTS ALONG GLOBALLY DISPERSED CLEAN ENERGY VALUE CHAINS AND LOWER INPUT COSTS FOR CLEAN ELECTRICITY GENERATION. THIS ARTICLE DISCUSSES THE BENEFITS LATIN AMERICA STANDS TO GAIN FROM DEVELOPING CROSS-BORDER TRADE IN ELECTRICITY, WHICH GO FROM MINIMIZING TRADE DISPUTES TO MAKING THE MOST OF THE NEW OPPORTUNITIES THE ENERGY SECTOR OFFERS.

In a seminal speech on May 24, 2015, Pope Francis highlighted climate change as one of the principal challenges facing humanity today, echoing the consensus view of numerous governments, scientists, and experts the world over. He referred to the climate as a common good, belonging to all and meant for all, and pointed to the disastrous impacts, particularly on developing countries. He further underscored the urgent need to develop policies so that, in the next few years, the emission of carbon dioxide and other highly polluting gases can be drastically reduced, for example, by substituting fossil fuels, developing sources of renewable energy, and using energy more efficiently (Pope Francis, 2015). Clean energy scale-up will be critical in the fight against climate change.

What does all of this mean for the design of trade policy? Countries need to assess the impact of their trade policy measures and ensure that these are coherent with other domestic policies designed to achieve NDC goals. It is important that the domestic policies underlying and driving forward their NDCs are compatible with their existing obligations under the WTO. If they are not, they need to consider how such policies can be designed so as to make them more WTO-compatible.

Of course, several experts argue that WTO rules themselves may need to change to accommodate domestic climate policy measures, but delving into this debate is beyond the scope of the present article. This article will briefly explore definitional and classification aspects surrounding clean energy environmental goods and services (EGS), the political economy issues involved in the design of both trade and clean energy policies, and the trade-offs facing policymakers as they seek to balance multiple objectives. It will then lay out the state of play with regard to LAC's clean energy expansion, and demand and supply dimensions for clean energy goods. It will also examine the various considerations and priorities that policymakers will need to balance while simultaneously trying to achieve trade, development, and climate-related goals. It concludes with a checklist of options that will assist policymakers in this regard.





## DEFINITIONAL AND CLASSIFICATION CHALLENGES

### Clean Energy Environmental Goods

There is no universally accepted definition of what constitutes an environmental good. In terms of classification for trade purposes, categories and subcategories of goods are assigned a code within the Harmonized Commodity Description and Coding System (HS), allowing countries to track trade volumes and tariff levels. Lists of environmental goods were drawn up for both illustrative as well as trade negotiation purposes well before the launch of the WTO Doha Round of negotiations. Most WTO members did not choose to engage in a definitional debate on environmental goods but rather chose to submit lists of product subcategories or baskets at the HS 6-digit level of aggregation containing environmental goods, or specifying products at a more detailed level through "ex-outs" including national tariff lines (NTLs) at the 8-, 8.10-, or even 12-digit level.

In addition to the general lack of momentum in the Doha trade talks, progress on the Doha Round of negotiations on environmental goods stalled due to two factors: the challenges of defining and classifying environmental goods within the HS system, and the problem of "dual-use." The first issue arose due to the HS 6-digit subheadings being too broad to capture goods used for both environmental as well as nonenvironmental purposes. The second is that a specific good itself may have environmental and nonenvironmental applications. For example, ball bearings (HS 848210) are an important component in wind energy production but they can also be used in numerous other industrial applications. Similarly, pipes and tubes can be used in both geothermal energy generation as well as in oil and gas refining.

In some cases, countries may wish to liberalize the whole subheading, particularly if tariffs are very low already. In other cases, including for ensuring greater "environmental credibility,"

LAC'S SOLAR ENERGY CAPACITY HAS INCREASED BY

**370%**

TABLE 1
**GLOBAL AND LAC RENEWABLE ENERGY CAPACITY, 2010–2015 (GW) AND COMPOUND ANNUAL GROWTH RATE, 2013–2015**

| RENEWABLE ENERGY SECTOR | PERIOD (END-OF-YEAR) 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | CAGR 2013-2015 |
|---|---|---|---|---|---|---|---|
| **WORLD** | | | | | | | |
| TOTAL RENEWABLE ENERGY | 1,348 | 1,456.7 | 1,570.5 | 1,697.6 | 1,833.5 | 1,985.1 | 8.1% |
| WIND ENERGY | 196.3 | 236.6 | 282.7 | 318.3 | 369 | 431.9 | 16.5% |
| SOLAR PV | 38.8 | 69 | 97.3 | 136.8 | 175.4 | 222.4 | 27.5% |
| HYDROPOWER | 1,027.6 | 1,058 | 1,090.9 | 1,135.6 | 1,173.5 | 1,208.9 | 3.2% |
| ---- LARGE HYDROPOWER (>10MW) | 779.2 | 801.4 | 818.1 | 856 | 888.4 | 910.2 | 3.1% |
| ---- SMALL AND MEDIUM HYDRO | 248.4 | 256.6 | 272.8 | 279.6 | 285.1 | 298.7 | 3.4% |
| CONCENTRATED SOLAR POWER | 1.3 | 1.7 | 2.6 | 3.8 | 4.4 | 4.7 | 11.2% |
| BIOENERGY | 72.7 | 79.9 | 85.2 | 90.9 | 98.3 | 105.4 | 7.7% |
| --- TOTAL, EXCL. LARGE HYDROPOWER | 568.8 | 655.3 | 752.4 | 841.6 | 945.1 | 1.074.9 | 13.1% |
| **LATIN AMERICA AND THE CARIBBEAN** | | | | | | | |
| TOTAL RENEWABLE ENERGY | 169.3 | 174.2 | 180.1 | 185.8 | 197.8 | 209.4 | 6.2% |
| WIND ENERGY | 2.1 | 2.8 | 5 | 6,6 | 11.1 | 15.4 | 52.8% |
| SOLAR PV | 0.1 | 0.2 | 0.3 | 0.4 | 1 | 2.2 | 134.5% |
| HYDROPOWER | 154.2 | 157 | 159.3 | 161.7 | 167.3 | 172 | 3.1% |
| ---- LARGE HYDROPOWER (>10MW) | 148.4 | 150.7 | 152.5 | 154.4 | 159.7 | 164.1 | 3.1% |
| ---- SMALL AND MEDIUM HYDRO | 5.8 | 6.3 | 6.8 | 7.3 | 7.6 | 7.9 | 4% |
| CONCENTRATED SOLAR POWER | .. | .. | .. | .. | .. | .. | .. |
| BIOENERGY | 11.4 | 12.7 | 14 | 15.7 | 17 | 18.2 | 7.7% |
| --- TOTAL, EXCL. LARGE HYDROPOWER | 20.9 | 23.5 | 27.6 | 31.4 | 38.1 | 45.3 | 20.1% |
| **LATIN AMERICA AND THE CARIBBEAN: SHARE IN GLOBAL CAPACITY (%)** | | | | | | | |
| TOTAL RENEWABLE ENERGY | 12.6 | 12 | 11.5 | 10.9 | 10.8 | 10.5 | |
| WIND ENERGY | 1.1 | 1.2 | 1.8 | 2.1 | 3 | 3.6 | |
| SOLAR PV | 0.3 | 0.2 | 0.3 | 0.3 | 0.6 | 1 | |
| HYDROPOWER | 15 | 14.8 | 14.6 | 14.2 | 14.3 | 14.2 | |
| ---- LARGE HYDROPOWER(>10MW) | 19 | 18.8 | 18.6 | 18 | 18 | 18 | |
| ---- SMALL AND MEDIUM HYDRO | 2.3 | 2.5 | 2.5 | 2.6 | 2.7 | 2.6 | |
| CONCENTRATED SOLAR POWER | 0 | 0 | 0 | 0 | 0 | 0 | |
| BIOENERGY | 15.7 | 15.9 | 16.4 | 17.3 | 17.3 | 17.6 | |
| --- TOTAL, EXCL. LARGE HYDROPOWER | 3.7 | 3.6 | 3.7 | 3.7 | 4 | 4.2 | |
| **LATIN AMERICA AND THE CARIBBEAN: SHARE IN TOTAL REGIONAL RENEWABLE ENERGY CAPACITY (%)** | | | | | | | |
| ---- LARGE HYDROPOWER (10MW) | 87.7 | 86.5 | 84.7 | 83.1 | 80.7 | 78.4 | |
| ---- TOTAL EXCL. LARGE HYDROPOWER | 12.3 | 13.5 | 15.3 | 16.9 | 19.3 | 21.6 | |

Source: IRENA, *Renewable Capacity Statistics 2016* and Vossenaar (2016a).



members may wish to be more selective and liberalize only a specific national tariff line or even part of a national tariff line (for example, by indicating "ex" next to the NTL). Alternatively, they may wish to split an existing NTL and create a new NTL just to capture a particular environmental good more precisely. Both of these approaches have been adopted recently in the implementation by Asia-Pacific Economic Cooperation Forum (APEC) economies under the APEC voluntary liberalization initiative. For example, Mexico reduced applied tariffs for more narrowly-defined environmental goods by creating nine new TLs with a 5% rate, leaving the rates for existing TLs unchanged. Two of the new TLs created by Mexico under electric generating sets and rotary converters (HS 850239) and AC generators of an output exceeding 750 kVA relate to the end-use of this equipment "for electricity generation from renewable sources of energy." (Vossenaar, 2016b). However, such end use will need to be verified by customs at the time of import, perhaps through an importer's declaration, to apply the concessional duty rate.

For trade negotiations on environmental goods including climate-friendly ones, members will need to have a clear understanding of exactly which product their trading partner intends to liberalize, since NTL numbers (unlike HS 6-digit subheadings) are not harmonized. This could be achieved by describing exactly what the country intends to liberalize will make tariff concessions much clearer and enable greater transparency as well as "environmental credibility."

## Climate-Friendly Services

Services are an essential component of climate change mitigation. Clean energy generation requires both goods as well as a variety of services such as construction, engineering, maintenance, and consulting, and often such goods and services may be jointly provided as part of a package.

Given that there is no clear-cut classification of all services used for clean energy generation, it may be a chal-

TABLE 2
**LAC IMPORTS OF WIND-POWERED GENERATING SETS BY COUNTRY OF ORIGIN, 2009–2014**

| ORIGIN | ANNUAL IMPORTS (MILLIONS OF US$) 2009–2011 AVERAGE | 2012 | 2013 | 2014 | PARTICIPATION IN TOTAL IMPORTS (%) 2009–2011 AVERAGE | 2012–2014 AVERAGE |
|---|---|---|---|---|---|---|
| **WORLD** | 703 | 794 | 1346 | 1455 | 100 | 100 |
| **EU28** | 402 | 380 | 630 | 878 | 57.3 | 60.3 |
| **UNITED STATES** | 106 | 275 | 386 | 311 | 15 | 21.4 |
| **CHINA** | 36 | 99 | 321 | 193 | 15.1 | 13.3 |
| **INDIA** | 119 | 30 | 0 | 29 | 7 | 2 |
| **INTRAREGIONAL LAC** | 29 | 3 | 1 | 16 | 4.1 | 1.1 |
| **OTHER** | 11 | 7 | 8 | 28 | 1.6 | 1.9 |

Source: COMTRADE in Vossenaar (2016a).

LAC'S SHARE IN TOTAL GLOBAL CAPACITY ADDITIONS REACHED

**8.4%**

lenge to negotiate trade liberalization in a meaningful manner that captures all relevant services. Trade in clean energy services, as with other services, can happen through four principal modes of delivery, namely:

1. Cross-border delivery, such as providing consulting services over the Internet;
2. Movement of consumers abroad to consume a service, such as students from Peru receiving training at a university or technical institute in the US;
3. Commercial presence, which involves foreign direct investment such as an Indian wind-power company investing in Brazil; and
4. Temporary movement of service personnel abroad to deliver a service, such as Chinese technicians being sent to repair a solar photovoltaic (PV) plant in Chile.

The WTO Services Sectoral Classification list (W/120) is based on the UN Provisional Central Product Classification (CPC) and contains a classification of environmental services that many WTO members deem outdated as it does not reflect changes in the environment industry. WTO members are, however, free to use their own classification of environmental services so long as the sectors they commit for liberalization are mutually exclusive. The W/120 classification of energy services pertains only to transmission and distribution of energy, including not just clean but also fossil fuel energy as well. However, WTO members are free to specify their market access commitments on related services across different sectors—such as construction, engineering, and consulting—in their schedules, within the current structure of classification (Bernabe, 2014). Cossy (2011) argues that the absence of an appropriate classification should not prevent members from negotiating on climate change–related services and that what is more important is that each schedule be internally coherent and avoid overlapping with other sectors.

### Value Chains and Domestic Policy

These considerations will involve balancing multiple objectives and the interests of domestic stakeholders while designing clean energy policy and the relevant trade policy measures. As Cosbey (2013) emphasizes, while there are a number of cobenefits associated with encouraging green industries, the details of industrial policy design will matter and will need to be informed by sound analysis and sector-specific knowledge. Such policies are also subject to intense rent-seeking by supported firms, which may not be in the best interests of enabling clean energy expansion at the desired pace. It may be argued that overall expansion of clean energy through the lower input costs resulting from freer trade will encourage firms to create jobs along the value chain, whether in manufacturing facilities seeking to tap into clean energy demand or jobs associated with installation and construction, which will inevitably be largely locally sourced.



TABLE 3
**GLOBAL AND LAC TRADE IN HYDRAULIC TURBINES (HS 8410), 2012–2014**

| | IMPORTS (MILLIONS OF US$) | | | EXPORTS (MILLIONS OF US$) | | |
|---|---|---|---|---|---|---|
| | 2012 | 2013 | 2014 | 2012 | 2013 | 2014 |
| **GLOBAL TRADE (EXCL. INTRA-EU)** | 1381.4 | 1447.8 | 1440.2 | 1526.1 | 1353.3 | 1431.2 |
| **LAC TOTAL TRADE** | 259.1 | 212 | 273.3 | 152.9 | 129.9 | 105.8 |
| **LAC SHARE OF GLOBAL TRADE (%)** | 18.8% | 14.6% | 19% | 10% | 9.6% | 7.4% |
| **INTRAREGIONAL LAC TRADE** | 40.3 | 47.8 | 51.7 | 114.4 | 79.6 | 61.9 |
| **INTRAREGIONAL TRADE SHARE (%)** | 15.5% | 22.5% | 18.9% | 74.8% | 61.3% | 58.5% |

Source: COMTRADE in Vossenaar (2016a).

However, in such a case, it is inevitable that comparative advantage will dictate how these jobs are geographically distributed.

## BARRIERS TO TRADE AND ENVIRONMENTAL TARGETS

### LAC Countries on the Road to Clean Energy

LAC countries have invested significantly in renewable energy and are increasingly diversifying away from large hydro, which makes up half the total installed electricity generating capacity, to other renewable sources like solar, wind, and biomass. Cumulative windpower capacity in the region reached 15 GW by the end of 2015 (with more than half added in 2014–2015, mainly in Brazil, Mexico, Chile, and Uruguay). Annual capacity additions increased sharply from 1.6GW during 2011–2013 to 4.4 GW in 2014 and 2015. LAC's share in total global capacity additions reached 8.4% in 2014, up from 1.8% in 2010, before declining slightly to 6.9% in 2015. Growth in solar PV capacity addition was even more rapid, though starting from a low base.

Some 625 MW of solar PV capacity was added in 2014, an increase of 370% from 2013. This capacity more than doubled in 2015 when 1.2 GW was added. In Chile alone, installed PV capacity grew from almost nothing at the end of 2013 to 848 MW by the end of 2015. Central America installed 495 MW in 2015, of which 395 MW was in Honduras (Vossenaar, 2016a).

This process of diversification towards solar PV and wind, in particular, has been aided by falling technology prices, government policies (such as feed-in tariffs and renewable energy auctions), combined with private sector investment. Renewable energy targets were in place in more than 20 LAC countries by 2015. Several also submitted ambitious long-term targets in their climate NDCs, including countries like Brazil that did not have a target before.

## THE TRANS-PACIFIC PARTNERSHIP AND THE ENVIRONMENT

The Trans-Pacific Partnership (TPP) between 12 Asian and Pacific countries including Chile, Peru, and Mexico will eliminate all tariffs on manufactured goods once ratified, and will consequently free up trade in all products along the clean energy value chain among participating countries. These include major manufacturers and exporters of these products, such as the US, Japan, Korea, and Malaysia.

In addition, the TPP is considered a good example of a 21st-century supply-chain–oriented FTA as it develops additional provisions necessary for the development of supply chains which are not provided for in WTO agreements, such as those governing investment, competition, state-owned enterprises (SOEs), electronic commerce, cross-border mobility of business persons, and regulatory coherence. It also calls for establishing a uniform set of standards for intellectual property protection at the highest possible level and provides for expedited trade facilitation measures. However, it still falls short in other areas according to Kawase (2016), in that it does not fully eliminate regulatory impediments or apply binding dispute settlement procedures in these areas. Kawase points out that certain bilateral FTAs apply more ambitious provisions, such as the Australia–New Zealand FTA, which eliminates the application of antidumping measures.

However, by including extensive disciplines covering a vast region that is a hub of manufacturing activity, the TPP, once ratified, may further shift the choice and location of supply chains in various clean energy sectors including in the participating LAC countries—Mexico, Peru, and Chile.

Others such as Chile adopted targets that were more ambitious than previous ones and Argentina revised its Renewable Energy Law and set a target for 20% of all power consumed in the country by 2025 to come from renewable energy sources. The LAC region still represents only a small portion of global installed PV capacity: just 1% by the end of 2015, up from 0.3% by the end of 2013, which shows the enormous potential in a region with excellent conditions for solar energy. GTM research forecasts that solar installations will grow 28% annually from 2016–2020, compared to 9% for the global market (Vossenaar, 2016a).

### Trade in Clean Energy Goods

It is often difficult to identify trade in clean energy goods due to classification issues. For example, the HS classification of solar PV cells and modules (HS 854140) also includes LED lights, which are unrelated to clean energy generation. In the case of components, it is often difficult to identify end-use. For example, while ball bearings are a critical component in wind-power projects, only a very small part of the overall trade in ball bearings is driven by the deployment of wind technologies. Despite these challenges, some broad trends have been identified for the trade in clean energy goods for LAC by Vossenaar (2016a).

In spite of the growth of capacity additions, the participation of LAC in global trade flows is still very small, although imports appear to be picking up. Imports of wind-powered generating sets reached US$1.4 billion in 2013-14 (but fell in 2015). The region imported US$500 million of solar PV equipment in 2014, which was double the value of 2013. Most clean energy goods are imported, most notably from China, whose exports of PV cells and modules to the region almost doubled from US$435 million in 2014 to US$800 million in 2015. Intraregional trade flows in core renewable energy (wind and solar equipment) are still very small, and manufacturing capacity is limited to Brazil (for wind equipment catering largely to domestic markets) and Mexico (which exported wind equipment during 2014–2015 to Costa Rica but with exports largely serving the US market). LAC countries account for a relatively larger share of total global imports of hydropower equipment, accounting for nearly 20% in 2014 while contributing to 7.4% of global exports in 2014.

Brazil alone accounts for 5% of global exports during the period 2012–2014. Most Brazilian exports went to other LAC countries, notably Colombia, Ecuador, Venezuela, and Peru.

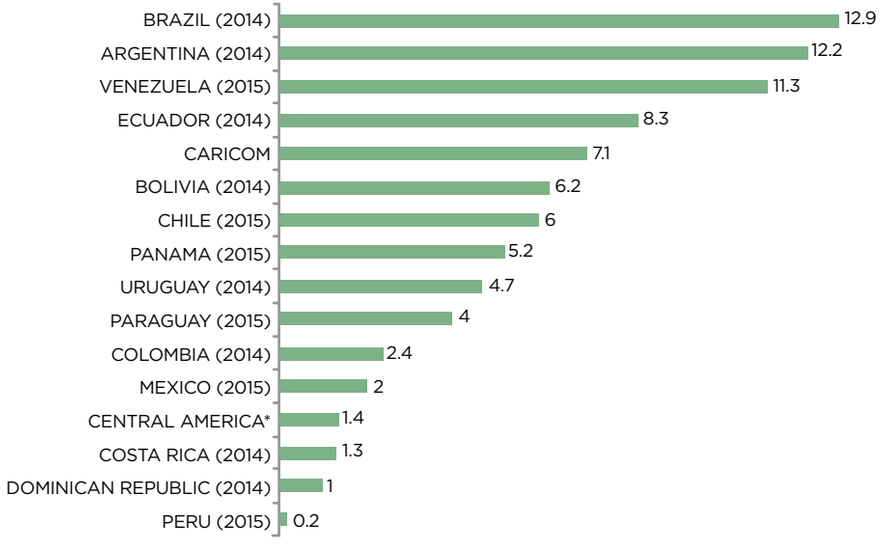
**20%**

OF ARGENTINA'S ENERGY MIX WILL COME FROM RENEWABLE SOURCES BY 2020

Parts and components of clean energy technologies are an interesting segment from the point of view of insertion of developing countries into global value chains, although the end-use of their trade flows is hard to track. Examining detailed national statistics for the US reveals that Brazil accounted for almost one-third of US imports of wind-turbine blades and hubs during 2012–2015. The US also imports wind towers from Mexico, although Mexico's share in US imports was only 7% in 2013–2014.

Tariffs and more importantly, non-tariff barriers, are the main trade-related obstacles affecting clean energy goods and components as they move across borders. Taking a sample of 35 HS subheadings that include a number of clean energy goods and components, Vossenaar (2016) finds that simple average import tariffs applied on a most-favored-nation (MFN) basis are lowest in Peru and highest in Brazil. MFN-applied rates in Colombia as well as a number of Central American countries are also low. While MERCOSUR generally applies a high common external tariff (CET) for many products, rates are usually lower for Paraguay and Uruguay (0 or 2%) for many clean energy products. Intraregional trade agreements such as the Pacific Alliance (Chile, Colombia, Mexico, and Peru with Costa Rica due to accede after parliamentary ratification) will bring down tariffs for renewable energy products within the region even further. While Chile applies a 6% uniform tariff, it has a broad range of FTAs within and outside the region, enabling practically

FIGURE 1
**AVERAGE IMPORT TARIFFS IN LAC COUNTRIES (SIMPLE AVERAGE MFN-APPLIED TARIFFS FOR 35 HS SUBHEADINGS THAT PROVIDE FOR TRADE IN RENEWABLE ENERGY GOODS)**




Source: COMTRADE in Vossenaar (2016a).
Note: * means selected countries.

all renewable energy products to enter Chile duty-free (Vossenaar, 2016a).

## Regional Trade Agreements

Regional trade initiatives within and outside the region will also give a downward push to tariffs facing clean energy goods.

LAC countries such as Mexico, Chile and Peru have already completed or are about to complete implementing voluntary tariff cuts to 5% on environmental goods under the APEC deal on environmental goods.

Mexico, for instance, has reduced tariffs on wind-powered generating sets and AC generators from the prevailing 15% to 5% under the APEC deal. Solar water heaters (SWHs), while not directly related to clean energy generation,

**20%**
OF GLOBAL IMPORTS FOR HYDROELECTRIC POWER STATIONS GO TO LATIN AMERICAN MARKETS

GTM RESEARCH FORECASTS THAT SOLAR INSTALLATIONS WILL GROW ANNUALLY BY
**28%**

are another climate-friendly good that faced high tariffs and will benefit from the APEC deal, with Mexico cutting its rates on SWHs from 10% in 2016 to 5% in 2016 and Peru completely eliminating tariffs in 2015.

## Environmental Goods and New Markets

So far, the only plurilateral liberalization initiative on environmental goods appears to be the EGA, with 17 participating members, of which Costa Rica the only LAC economy. While Costa Rica is not a major exporter of traditional environmental goods, there are some imports of wind-powered generating sets from Mexico. Costa Rica's MFN tariffs on a number of clean energy products are already quite low or even zero. For example, for wind energy, turbines and most parts already attract a zero duty rate and only reach 5% on towers (which are heavy and entail transportation costs). SWHs appear to be higher, reaching 9%. For solar panels and machines for cutting solar wafers, tariffs are permanently "bound" at zero. While any clean energy equipment industries, once established in Costa Rica, would benefit from market access to major producers and traders of clean energy goods such as the EU and China (Costa Rica already has duty-free access to the US market through CAFTA), so would all other WTO members, effectively leveling the competitive playing field. In this regard, joining the EGA could be important in terms of sending a positive signal on the predictability of low or zero tariffs to private investors.

## The Importance of Nontariff Measures

Nontariff measures on clean energy equipment are more important than tariffs as a barrier to trade and can include a diverse range of behind-the-border measures such as standards, conformity assessment measures, local content–related restrictions, and procurement-related barriers. For example, even if a product conforms to international standards, a number of countries may impose additional testing related requirements. Local content measures, while inconsistent with WTO rules, are still widely employed by several countries, both developing and developed. Many further restrict their government procurement markets for clean energy goods and services. In addition to these measures, trade remedy measures such as antidumping measures and countervailing duties have increasingly been used in the clean energy sector, particularly against China for solar PV panels. While such measures may be used in response to actual or perceived dumping or subsidization of clean energy products, they can also be misused for protectionist purposes, raising the price of clean energy equipment. In price-sensitive markets in developing economies, such measures could further constrain clean energy expansion.

### Market Access Opportunities

While the conclusion of the EGA, as well as numerous RTAs, will open up market access opportunities for LAC countries, countries will be able to tap into such opportunities meaningfully only if the right enabling environment is present both domestically as well as abroad. These include policies, regulations, and incentives aimed at deploying and creating a supportive environment for clean energy generation domestically and abroad on both the demand and supply sides. Policies supporting clean energy generation include feed-in tariffs, generation-linked tax incentives, renewable energy targets, and soft loans. On the demand side, policies include carbon and energy taxes, the reform of fossil fuel subsidies, the obligation for public and private entities to purchase clean energy, and soft loans to encourage clean energy equipment purchases such as roof-top solar panel kits. These policies will also be among the ones countries will pursue to achieve their NDC goals.

The combined effect of these policies would be to create demand for clean energy goods, including via trade. A good example is the growth of solar PV exports from China to Germany driven by the German feed-in-tariffs put in place to expand solar power generation in Germany (Jha, 2009). Many of these jobs will be in the downstream services sector such as installation, operations, and maintenance (where a number of jobs will inevitably be local). However, governments may view green manufacturing as being of strategic importance and desire to create manufacturing jobs including those geared towards exports. When they reach into their policy toolkit to do so, they will need to take existing WTO rules into account.

AT **13%,** BRAZIL'S ENVIRONMENTAL ENERGY GOODS TARIFF RATE IS THE HIGHEST IN THE REGION

### Compatibility with WTO Rules

To promote domestic manufacturing in the clean energy sector, several countries have resorted to local content requirements which require clean power producers to use a certain percentage of components that are manufactured domestically. Often feed-in tariffs and subsidies such as soft loans to these power producers may be made contingent on the use of locally manufactured equipment. In Brazil, for example, the national development bank (BNDES) has made access to cheap financing for companies winning clean energy auction bids subject to the use of domestically produced equipment. This has led to an expansion of local supply chains in the wind sector in Brazil. Measures that strengthen general manufacturing capacity and are not specific to a single sector would be consistent with the WTO's SCM Agreement.

In many countries, it has been found that the presence of complementary industries can help the development of the wind and solar industries. These include the steel, automotive, and aircraft industries for wind, the semiconductor industry for PV, and the glass industry for concentrated solar power. For example, Brazilian company Tecsis had gained considerable market prominence for the manufacture of blades and hubs. This gain in technological strength comes from Brazil's previously established technological capability in aircraft manufacture (Jha, forthcoming; Vilardaga, 2009). In addition, countries may also wish to explore possibilities of setting up training centers or institutes to build skills both with regard to manufacturing as well as the provision of services in specific areas of the clean energy value chain. India, for example, has created a national institute of solar energy and wind energy under its Ministry of New and Renewable Energy to assist the ministry in implementing the country's National Solar Mission and to coordinate research, technology, skill development, training, consultancy, incubation, and other related works.[1]

### The Future of Cross-Border Trade

Latin America is a continent blessed with a wide geographical area that is rich in renewable resources. In addition to developing competence in clean energy goods and services value chains, the cross-border export of clean electricity could open up new opportunities for investment, tapping into economies of scale created through bigger electricity markets. It will also enable countries in the region that are constrained in producing clean power to meet their NDCs to import clean power. Thus, trade could play a very direct role in enabling countries in the region to reach their NDC targets through electricity imports and also to earn foreign exchange through electricity exports, leading to associated economic and employment benefits. In addition, this could even help out supply disruptions and allow for a more stable and reliable electricity supply in the region, particularly given the difficulties associated with storage (although storage technologies are being developed, it may take some time before they become cost-competitive and mainstream). There is already cross-border trade within the region. Paraguay sells most of its electricity output to Brazil. Uruguay (with a share in electricity from renewables standing at 94% in 2014) exported electricity to Argentina during 2013–2014, and the state utility UTE and Brazil's Electrobras are presently testing a 500 MW transmission line (Vossenaar, 2016a). Chile, the first Latin American country to reach 1 GW of installed solar capacity, recently reactivated a transmission line from northern Chile to Argentina, paving the way for exports of solar electricity (Díaz López, 2016).

There are also several examples of binational power plants being operated by two or more LAC countries, such as the Itaipu power plant operated by Brazil and Paraguay. Latin American electricity markets are organized around three major blocs, with increasing cooperation within and among these blocs. These are: (i) Central American Electrical Interconnection System (SIEPAC), which includes Panama, Costa Rica, Honduras, Nicaragua, El Salvador, and Guatemala and is a genuine attempt at market integration; (ii) the Andean Community (CAN), made up of Bolivia, Colombia, Ecuador, and Peru, which is

moving towards a degree of integration through the Andean Electrical Interconnection System (SINEA); and (iii) the Southern Cone (Brazil, Argentina, Chile, Paraguay, and Uruguay), which is more loosely connected, but has several binational power agreements, effectively tying together power generation across borders (OECD, 2014). The Initiative for the Integration of Regional Infrastructure in South America (IIRSA), part of the South American Council of Infrastructure and Planning (COSIPLAN), aims to construct an interconnected network of power links throughout the South American continent, among other projects (Vossenaar, 2016a).

Further integration of electricity markets in LAC will require investments in infrastructure, including in transmission capacity, regulatory capacities, and frameworks to respond to the needs of an integrated market (such as in relation to pricing) and to ensure a sound level of competition (such as access of private-sector generators to the grid, among others) (OECD, 2014). In a number of these areas, multilateral development banks such as the World Bank and IDB could have an important role to play, along with private lending agencies and the UNFCCC's Green Fund.

**11**

DEVELOPED COUNTRY DONORS HAVE COMMITTED US$50 MILLION FOR ACCOUNTING EMISSIONS REDUCTIONS

## MAKING THE MOST OF OPPORTUNITIES

What elements might form part of a way forward to minimize risks and maximize opportunities for LAC countries while crafting a strategy for climate mitigation, trade, and development focusing on clean energy goods and services?

First, LAC countries could evaluate the main clean energy sectors that could play an important role in the attainment of their NDC goals and map the specific clean energy goods and services involved along the value chain.

Second, LAC countries could identify the HS codes as well as descriptions (in the case of goods) included in the detailed NTL levels in their national customs classification. This will also enable an assessment of whether any new domestic tariff lines may need to be created for trade purposes.

Third, the domestic policy measures in place for clean energy expansion could be mapped, including measures pursuant to NDCs. A similar mapping of trade measures such as tariffs on relevant clean energy goods or domestic restrictions on clean energy services affecting all aspects of the value chain could also be carried out.

Fourth, an "NDC-coherence" check could be carried out to evaluate whether a country's trade measures are supportive of or constrain the achievement of clean energy expansion, and whether its NDCs are coherent with the relevant domestic clean energy policy measures in place. For example, a country may find that having very high tariffs on solar inverters and balance-of-system components may not be helpful if it has other domestic policies aiming at a rapid expansion of solar energy to meet its NDCs. A similar coherence check may also be required if the country wishes to promote manufacturing of solar panels or wind turbines. In such cases, having high applied tariffs on inputs such as polysilicon for solar panel manufacture or bearings required for wind turbines may raise costs for domestic manufacturers. Such a coherence check could be jointly initiated by relevant ministries such as each country's ministry of the environment (which may oversee NDCs), ministry of commerce or trade (responsible for trade policy formulation), or ministry of industry (responsible for policies affecting manufacturing and industry).

Fifth, a "WTO-compatibility" check could be carried out in a similar fashion for a country's energy policy measures and for other policies aimed at achieving NDCs, such as sector-specific measures and "green growth" strategies. This would ascertain whether such measures could potentially violate WTO obligations. It may be the case that measures such as subsidies or other forms of industrial support may be introduced by one ministry without considering possible trade implications and coordinating with the trade ministry. A system of regular coordination between these ministries would be desirable if one is not already in place.

Sixth, with regard to bilateral or plurilateral trade agreements, countries may want to assess prevailing trade barriers and where trading partners negotiating the agreement stand in terms of clean energy goods and services and their importance as a source of both imports and exports of key examples of these. It would also be useful to take a dynamic perspective as to these negotiating partners.

## MUTUAL CONFORMITY

Seventh, emphasis should be placed on addressing nontariff measures in trade agreements. This could involve, for example, entering into mutual recognition agreements (MRAs) on conformity assessment measures for clean energy goods (Sugathan, 2016) or even concluding a moratorium on the use of trade remedy measures such as antidumping and countervailing duties and safeguards on clean energy goods (Horlick, 2014; Kasteng, 2014). There are already precedents for such moratoriums in a number of regional trade agreements such as the Australia–New Zealand FTA and the Canada–Chile FTA (Kommerscollegium, 2013).

Eighth, LAC countries may need to select which stage of the clean energy value chain to enter based on a number of considerations. These include existing levels of domestic manufacturing capacity, skill levels and training, access to natural resources, participation in bilateral or regional FTAs, and so forth. Generally, less industrially developed countries may wish to start out lower down the manufacturing value chain in products such as components and parts or in assembly related activity, then gradually move up the value chain as capacities develop. Creating a climate that is sound for manufacturing in general and specialization in manufacturing of basic components such as steel, glass, semiconductors, and so on could help establish clean energy equipment

## PROGRESS AT THE MARRAKECH SUMMIT

The 22nd meeting of the Conference of the Parties to the United Nations Framework Convention on Climate Change took place between November 7 and 18, 2016, in Morocco, just days after the Paris Agreement entered into force. The Marrakech Action Proclamation celebrates the current global impetus in the fight against climate change, which it frames as irreversible.

The Marrakech meeting achieved one of its major objectives: drafting a road map toward laying down the rules (the so-called Paris Rulebook) that will enable the the Paris Agreement to become fully functional by 2018. Countries need to "calibrate" their plans by then to bring them in line with the Paris Agreement, as they need to present new nationally determined contributions (NDCs) in 2020.

The summit underlined the need to provide climate change adaptation funds to the most vulnerable countries, one of the few headings of the first decision made at the first meeting of the parties to the Paris Agreement (CMA1). There was a call for mitigation efforts to be stepped up and for the funds that had been committed to be put in motion, especially those needed for the most vulnerable countries to face up to the impacts of climate change. Likewise, four European countries announced new contributions to the Adaptation Fund that was started in 2001.

The agreement is also seeking to improve the transparency of the process of measuring and accounting for emissions reductions through the Paris Committee on Capacity-building. This committee will help to build developing countries' capacity to undertake climate action. Eleven developed country donors have committed US$50 million for this purpose. Other countries agreed to allocate US$23 million to the Climate Technology Centre and Network (CTCN), which connects developing countries to climate technology solutions.

A five-year loss and damage plan was also agreed on to cover impacts that are not included as part of adaptation. For example, displacement, migration and movement of people, and integrated risk management.

Progress was certainly made at Marrakesh although there is still much work to be done if we are to bring national contributions down to net zero by the middle of this century and thus prevent the planet's average temperature from increasing more than 2°C above preindustrial levels by the end of the century.

more easily.

Ninth, services important for clean energy development must not be neglected and must be coherent with a strategy for trade in clean energy goods, as often both are jointly deployed in clean energy projects. Skills and training are essential, and setting up of specialized training institutes and flexible programs aimed at the clean energy sector would help in job creation and enable countries to benefit from trade opportunities that arise in both goods and services.

Last, a strategy for financing and capacity building—whether to develop institutions, regulations, or infrastructure—will be critical and can benefit climate, trade, and development goals in LAC countries.

**NOTE**

[1]Ministry of New and Renewable Energy (MNRE), National Institute for Solar Energy. http://mnre.gov.in/centers/about-sec-2/

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# The environmental **impact of free** trade agreements

RELATIONS BETWEEN STATES MUST BE RESPECTFUL OF EACH OTHER'S SOVEREIGNTY, BUT MUST ALSO LAY DOWN MUTUALLY AGREED MEANS OF AVERTING REGIONAL DISASTERS WHICH WOULD EVENTUALLY AFFECT EVERYONE.

*Laudato Si'*

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This study analyzes the environmental provisions (EPs) included in free trade agreements (FTAs), especially those signed by countries in the Americas over the last few decades. First, the text provides a general overview of the environmental content that is included in the legal texts of the latest generation of FTAs and lists examples of specific provisions. Second, it evaluates the possible effects of the inclusion of EPs on local greenhouse gas emissions. The main results indicate that FTAs with EPs seem to contribute to reducing pollution in signatory countries.

From the mid-1990s and early 2000s, a growing number of FTAs and economic integration agreements (EIAs) have included environmental considerations in the agreement text, or have been accompanied by a separate environmental agreement, as was the case for the North American Free Trade Agreement (NAFTA). The main objective for including EPs tends to be preventing the elimination of barriers to trade and the resulting increase in trade from having a negative effect on environmental quality in signatory countries. The aim of this article is to present a general overview of the environmental content of the legal texts of the latest generation of FTAs and evaluate the possible effects this content may have on a series of environmental indicators.

From the start of the 1990s, the interaction between global trade and environmental quality has been widely recognized within studies on international economics and international relations and has been taken into account in a broad sense during the negotiation of both FTAs and EIAs. As early as 1992, in the Rio+20 agreement, environmental protection was considered necessary to guarantee the sustainability of countries' economic growth. Likewise, there have been regional environmental cooperation agreements between the US and Central America since the mid-1990s that are not necessarily linked to trade.

At the same time, the number of trade agreements that have entered into force in the last two decades has grown considerably, reaching a total of over 250 by 2016, a growing number of which include devices that extend into other areas, such as the environment and labor protection. Figure 1 shows the cumulative number of FTAs that have been signed since the mid-1990s and the number of FTAs that include EPs or parallel environmental agreements. The cumulative figures for 2014 indicate that approximately 25% of agreements include EPs. Figure 1 also shows the number of agreements that include labor provisions, so as to compare the relative importance of environmental and labor-related content. Approximately 21% of FTAs touch on issues related to labor rights or social protection. The number of more inclusive agreements has grown, especially from 2005 onward. Since 2007, the Organisation for Economic Co-operation and Development (OECD) has periodically reviewed how environmental issues have been handled in FTAs (OECD, 2007) and has compiled an inventory of FTAs with EPs. In the studies it is currently carrying out, the OECD is encouraging econometric analyses to evaluate whether the inclusion of EPs in FTAs reduces emissions and improves environmental quality in signatory countries.

It is worth noting that, to date, very few quantitative studies have attempted an ex-post assessment of the effectiveness of these EPs. In the academic sphere, there have been two empirical studies based on econometric models (Ghosh and Yamarik, 2006; Baghdadi, Martínez-Zarzoso, and Zitouna, 2013), but only the latter distinguishes between FTAs with and without EPs, while the former evaluates the general effects of FTAs on the environment and uses emissions data from 1990. Ghosh and Yamarik's (2006) main findings show that accession to FTAs reduces pollution, but this effect is indirect and derives from the positive effect of increased trade on per-capita income, which in turn affects environmental quality. In contrast, they found no evidence of a direct effect between adherence to FTAs and emission reductions. Baghdadi et al. (2013) do distinguish between agreements with and without EPs between 1980 and 2008 and obtained evidence for the existence of a direct effect of adherence to FTAs on the reduction of $CO_2$ emissions, but only for FTAs with EPs and not for those that do not include environmental aspects. This study was based on a methodology that is widely accepted in economics to identify whether an effect is causal rather than merely indicating a positive correlation without pinpointing causality. This paper uses instrumental variables and a fixed effects estimator (panel data). At the initial stage, trade was estimated using a gravitational equation in which bilateral trade was explained using geographical determinants, while per capita income was estimated using a growth model, in line with Baghdadi et al. (2013). During the second stage, the equation for determinants of emissions was estimated using panel data and fixed effects, and the predictions obtained during the first stage for trade and per capita income were incorporated. This combined use of instrumental techniques and variables made it easier to identify causality.

This study updates the results obtained by Baghdadi et al. (2013) for $CO_2$ and extends these to include the effects on three other environmental indicators for the period between 1970 and 2011 for $CO_2$, 1970 to 2008 for $SO_2$ and NOx, and 1999 to 2011 for PM2.5.

Other ex-post studies on the effectiveness of EPs in FTAs include an assessment of the DR-CAFTA FTA carried out by the Organization of American States (OAS, 2011) and two period-

# FREE TRADE AGREEMENTS

**250+**

FREE TRADE AGREEMENTS HAVE BEEN SIGNED IN RECENT DECADES

ical assessments of the EU–Chile FTA commissioned by the European Commission (Ergon Associates, 2011; ITAQA Sarl, 2012). The main results of the first study point to the contribution of FTAs to improving institutional coordination, significant advances in the capacity to implement environmental impact assessment, and the building of links between suppliers of certified products and consumers. The main results of the study on the EU–Chile FTA indicate that this seems only to have had a marginal impact on the use of natural resources and environmental degradation, while the imposition of stricter environmental norms has meant that trade with the EU (and therefore with the United States, Canada, and Japan) has made a positive contribution to reducing the intensity of the pollution caused by production in some sectors.

Section 2 reviews the environmental content of specific agreements and emphasizes the differences between these depending on the country promoting the agreement. Section 3 presents the methodology used to assess the effects of EPs on pollutant gas emissions, and section 4 describes the main results of the environmental impact assessment. Finally, section 5 presents the main conclusions that can be drawn from the study and identifies areas of interest for future research.

**21%**

OF FTAS TOUCH ON ISSUES RELATED TO LABOR RIGHTS OR SOCIAL PROTECTION

## ENVIRONMENTAL PROTECTION, TRADE, AND INTEGRATION

This section provides a general review of FTAs with EPs, paying special attention to those which countries in the Americas are party to.

The aim of including environmental content in FTAs is to protect the environment and establish forms of cooperation on environmental issues. For example, article 3 of the Canada–Chile Agreement on Environmental Cooperation states that: "each Party shall ensure that its laws and regulations provide for high levels of environmental protection and shall strive to continue to improve those laws and regulations," while article 6 refers to the application of environmental laws and regulations, and article 8 contemplates the creation of the Canada–Chile Commission for Environmental Cooperation which is the governing body for the agreement. Furthermore, the EU's agreements with its partners tend to include a chapter on sustainable development. One example of this is the EU–CARICOM agreement, article 6 of which recognizes that the parties to the agreement are free to establish their own levels of environmental protection. Gallagher and Serret (2011) provide detailed examples of the EPs that are most frequently included in FTAs. The scope and binding nature of EPs vary considerably from one agreement to the next. In this context, "scope" refers to the number of different environmental aspects that are included in the legal text, and "binding nature" refers to the enforcement mechanisms included in the provisions, that is, whether they are binding or are just recommendations. At the very least, new RTAs tend to include environmental issues in the preamble or in certain articles that regulate investments or exceptions. Other FTAs include an entire chapter focusing exclusively on environmental matters.

As I will demonstrate below, EPs vary hugely from one FTA to another. I have divided the different types of EPs that tend to be included in FTAs into the following seven categories: preamble, chapter, collateral agreement, exceptions and dispute settlement, high level of protection (environmental law), cooperation, and environmental and multilateral agreements (EMAs).

Figure 2 shows the number of FTAs by category over time. It is worth highlighting that it was only when NAFTA came into force in 1994 that developed countries, led by the United States and the European Union, first started to take the interaction between the environment and trade into account and to regulate environmental issues at the regional level. This is especially true in the case of agreements signed between countries where local regulations or the local institutional context in general did not contain the elements necessary for them to effectively regulate the negative externalities associated with environmental degradation. It is worth pointing out that in figure 2, the most widespread provisions are the inclusion of EPs in the preamble and the exceptions chapter, along with aspects relating to environmental cooperation. There is a tendency in more recent agreements for a chapter on the environment to be included the main text, rather than for collateral agreements to be signed on the matter.

Table 1, below, lists the FTAs signed by countries in the Americas and distinguishes between those that include EPs and those that do not touch on environmental issues in any area.

Both Canada and the United States have advocated for the inclusion of EPs in FTAs, in some cases through parallel environmental agreements, and more recently through the inclusion of specific chapters on the environment in the general text of agreements. Although the EU has followed a similar line, the terms employed refer to "sustainable development," and the environmental content is mainly based on collaboration and technical and financial assistance, with little emphasis on penalizing noncompliance through sanctions, which is the case in the agreements put forward by the US. However, it is worth highlighting that, to date, there are no examples of actual implementation of the sanctions that are to apply to a signatory country should it violate the environmental regulations of an agreement. Furthermore, Mexico had 10 FTAs in force by 2014, and as a result of its involvement in NAFTA, it has also been a proponent of the inclusion of EPs in some of the FTAs which it is party to.

Since the mid-1990s, Chile has also begun to include EPs in its FTAs. However, in this case, the scope and depth of these provisions varies greatly from one agreement to the next. Its agreements with Canada, the United States, and the Trans-Pacific Partnership (TPP) include complete provisions on the environment and chapters or parallel agreements on environmental cooperation. Among the key EPs in the agreements that Chile has recently signed are those in the preambles and those on environmental cooperation. For example, the Chile–China FTA establishes that the two parties agree to improve communication and cooperation on matters of labor and social and environmental security through the Memorandum of Understanding on Labor and Social Security Cooperation and the Environ-

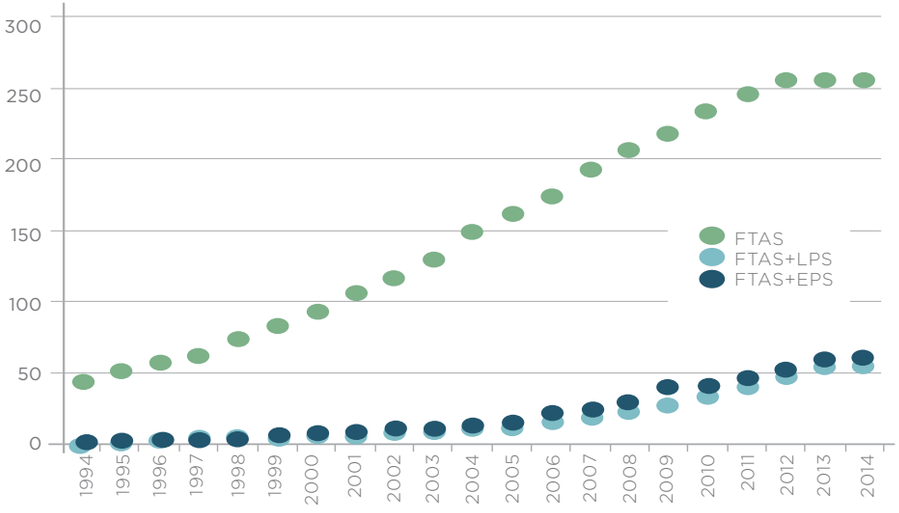
mental Cooperation Agreement. Furthermore, the TPP between Chile, New Zealand, Singapore, and Brunei Darussalam refers to the environment in its preamble, and the parallel Environmental Cooperation Agreement aims to foster suitable environmental policies and improve the countries' capacities for tackling environmental issues through cooperation and dialog. The parties restated their intention to guarantee a high level of environmental protection and meet their respective multilateral environmental commitments while also recognizing that it is not appropriate to use environmental legislation for protectionist ends.

Chile has recently signed FTAs with Panama, Colombia, Peru, Guatemala, Malaysia, Nicaragua, Hong Kong, and Vietnam. For example, its FTA with Peru refers to the environment in the preamble and in chapters 10 (Technical Barriers to Trade), 11 (Investment), and 17 (Exceptions). Its FTA with Panama includes EPs as part of a complimentary agreement which is comparable to that of the TPP, while the Chile–Colombia FTA includes a specific chapter on the environment containing similar provisions.

As examples of agreements between Latin American countries, the first box below details the EPs that are included in the Panama–El Salvador FTA, and the second box shows those in the Chile–Colombia FTA.

A **10%** INCREASE IN TRADE OPENNESS INCREASES EMISSION CONCENTRATIONS BY 0.01%

FIGURE 1
**CUMULATIVE NUMBER OF FTAS BY DATE OF ENTRY INTO FORCE**




Note: LPs=labor provisions; EPs=environmental provisions.
Source: Compiled by the author, based on WTO data (RTA Gateway).

## METHODOLOGY FOR EVALUATING THE EFFECTIVENESS OF FTAS

This section presents the methodology used to analyze the effects on a series of environmental quality indicators by comparing agreements with and without EPs. The environmental indicators include local greenhouse gas emissions.

To be able to separate the specific effect of trade from the effect of trade policy, a gravity equation was estimated which included geographical and cultural components. Bilateral trade flows per income unit were determined by the population size of trading countries, using transportation costs (the distance between countries) and a series of factors that facilitate or hamper trade, including whether countries shared a border, had a common language or colonial ties, are landlocked, etc.

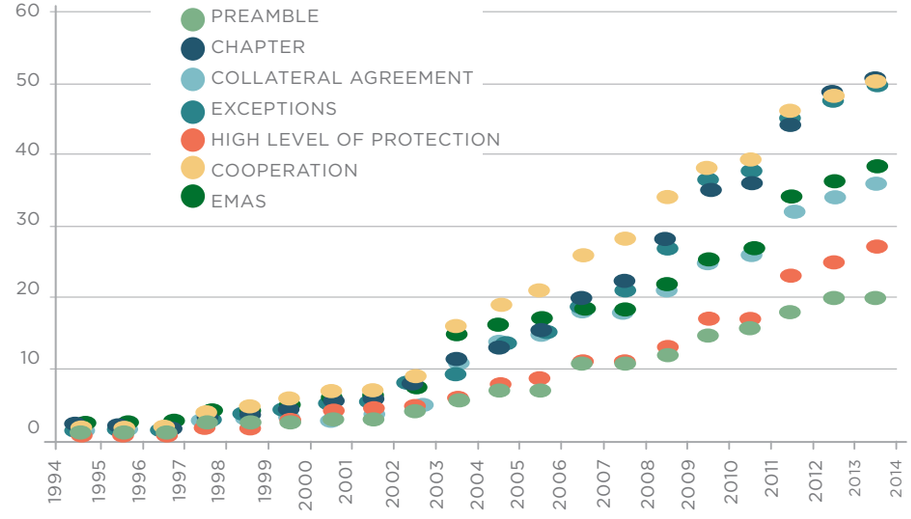
The predictions obtained from this model were later incorporated into the model that explains the determinants of emissions, which is described in detail below. The gravity model was estimated using the latest panel data techniques.

The model explains gas emissions in terms of a series of variables that seek to reflect the scale, technique, and composition effects, which have been used since Grossman and Krueger (1991) coined them in their assessment of the environmental impacts of NAFTA. In line with Baghdadi et al. (2013),

$$\ln(IM_{it}) = \gamma_0 + \gamma_1 \ln(Pob_{it}) + \gamma_2 \ln\left(\frac{Area}{Pob}\right)_i + \gamma_3 \ln(PIB/Pob)_{it} + \gamma_4 \ln(PIB/Pob)_{it}^2 + \gamma_5 \ln(AE_{it}) + \gamma_6 \sum_i TLC\_BM_{it} + \gamma_7 \sum_j TLC\_BDM_{jt} + \theta_i + \alpha_t \quad (1)$$

where: IM stands for the corresponding environmental indica-

FIGURE 2
**NUMBER OF FTAS WITH EPS**




Source: Compiled by the author based on the contents of the legal texts of 67 FTAs.

TABLE 1
**FTAS WITH COUNTRIES IN THE AMERICAS WITH AND WITHOUT ENVIRONMENTAL CONTENT**

| FTA | TYPE | ENTRY INTO FORCE |
|---|---|---|
| ANDEAN COMMUNITY (CAN: BOLIVIA, COLOMBIA, ECUADOR, PERU) | CU | 25-MAY-88 |
| CHILE–AUSTRALIA | FTA AND EIA | 06-MAR-09 |
| **CANADA–CHILE** | FTA AND EIA | 05-JUL-97 |
| CANADA–ISRAEL | FTA | 01-JAN-97 |
| **CANADA–COSTA RICA** | FTA | 01-NOV-02 |
| **CANADA–PERU** | FTA AND EIA | 01-AUG-09 |
| **CANADA–COLOMBIA** | FTA AND EIA | 15-AUG-11 |
| **CANADA–JORDAN** | FTA | 01-OCT-12 |
| **CANADA–PANAMA** | FTA AND EIA | 01-APR-13 |
| **CANADA–KOREA** | FTA AND EIA | 01-JAN-15 |
| **CANADA–HONDURAS** | FTA AND EIA | 01-OCT-14 |
| CARIBBEAN COMMUNITY (CARICOM): | CU AND EIA | 01-AUG-1973 (G) |
| **CHILE–MEXICO** | FTA AND EIA | 01-AUG-99 |
| CHILE–COSTA RICA (CHILE–CENTRAL AMERICA) | FTA AND EIA | 15-FEB-02 |
| CHILE–EL SALVADOR (CHILE–CENTRAL AMERICA) | FTA AND EIA | 01-JUN-02 |
| **CHILE–CHINA** | FTA AND EIA | 01-OCT-2006 (G) |
| **CHILE–JAPAN** | FTA AND EIA | 03-SEP-07 |
| CHILE–HONDURAS (CHILE–CENTRAL AMERICA) | FTA AND EIA | 19-JUL-08 |
| **CHILE–PANAMA** | FTA AND EIA | 7-MAR-2008 |
| **CHILE–COLOMBIA** | FTA AND EIA | 08-MAY-09 |
| CHILE–GUATEMALA (CHILE–CENTRAL AMERICA) | FTA AND EIA | 23-MAR-10 |
| **CHINA–COSTA RICA** | FTA AND EIA | 01-AUG-11 |
| **CHILE–MALAYSIA** | FTA | 25-FEB-12 |
| CHILE–NICARAGUA (CHILE–CENTRAL AMERICA) | FTA AND EIA | 19-OCT-12 |
| HONG KONG, CHINA–CHILE | FTA AND EIA | 09-OCT-14 |
| CHILE–VIETNAM | FTA | 01-JAN-14 |
| COSTA RICA–PERU | FTA AND EIA | 01-JUN-13 |
| **COSTA RICA–SINGAPORE** | FTA AND EIA | 01-JUL-13 |
| **COLOMBIA–MEXICO** | FTA AND EIA | 01-JAN-95 |
| **COLOMBIA–NORTHERN TRIANGLE (EL SALVADOR, GUATEMALA, HONDURAS)** | FTA AND EIA | 12-NOV-09 |
| DOMINICAN REPUBLIC–CENTRAL AMERICA | FTA AND EIA | 04-OCT-01 |
| DOMINICAN REPUBLIC–CENTRAL AMERICA–UNITED STATES (CAFTA-DR) | FTA AND EIA | 01-MAR-06 |
| EFTA–MEXICO | | |
| **EFTA–CHILE** | FTA AND EIA | 01-JUL-01 |
| **EFTA–CANADA** | FTA AND EIA | 01-DEC-04 |
| EFTA–COLOMBIA | FTA | 01-JUL-09 |
| EFTA–PERU | FTA AND EIA | 01-JUL-11 |
| EU–MEXICO | FTA | 01-JUL-11 |
| EU–CHILE | FTA AND EIA | 01-JUL-2000 (G) |
| **EU–COLOMBIA-PERU** | FTA AND EIA | 01-FEB-2003 (G) |
| **EU–CARIFORUM** | FTA AND EIA | 01-MAR-13 |
| **EU–CENTRAL AMERICA** | FTA AND EIA | 01-NOV-08 |
| ISRAEL–MEXICO | FTA AND EIA | 01-AUG-13 |
| **JAPAN–MEXICO** | FTA | 01-JUL-00 |
| JAPAN–PERU | FTA AND EIA | 01-APR-05 |
| **KOREA–CHILE** | FTA AND EIA | 01-MAR-12 |
| MEXICO–URUGUAY | FTA AND EIA | 01-APR-04 |
| MEXICO–CENTRAL AMERICA (COSTA RICA, EL SALVADOR, GUATEMALA, | FTA AND EIA | 15-JUL-04 |
| HONDURAS, AND NICARAGUA) | FTA AND EIA | 01-SEP-12 |
| **NORTH AMERICAN FREE TRADE AGREEMENT (NAFTA)** | FTA AND EIA | 01-JAN-94 |
| PANAMA–EL SALVADOR (PANAMA–CENTRAL AMERICA) | FTA AND EIA | 11-APR-03 |
| PANAMA–SINGAPORE | FTA AND EIA | 24-JUL-06 |
| **PANAMA–CHILE** | FTA AND EIA | 07-MAR-08 |
| **PANAMA–EL SALVADOR (PANAMA–CENTRAL AMERICA)** | FTA AND EIA | 23-NOV-08 |
| **PANAMA–HONDURAS (PANAMA–CENTRAL AMERICA)** | FTA AND EIA | 09-JAN-09 |
| **PANAMA–GUATEMALA (PANAMA–CENTRAL AMERICA)** | FTA AND EIA | 20-JUN-09 |
| **PANAMA–NICARAGUA (PANAMA–CENTRAL AMERICA)** | FTA AND EIA | 21-NOV-09 |
| **PANAMA–PERU** | FTA AND EIA | 01-MAY-12 |
| **PERU–CHILE** | FTA AND EIA | 01-MAR-09 |
| **PERU–SINGAPORE** | FTA AND EIA | 01-AUG-09 |
| **PERU–CHINA** | FTA AND EIA | 01-MAR-10 |
| PERU–KOREA | FTA AND EIA | 01-AUG-11 |
| **PERU–MEXICO** | FTA AND EIA | 01-FEB-12 |
| SOUTHERN COMMON MARKET (MERCOSUR) | CU AND EIA | 29-NOV-1991 (G) |
| TRANS-PACIFIC PARTNERSHIP (TPP) | FTA AND EIA | 28-MAY-06 |
| TURKEY–CHILE | FTA | 01-MAR-11 |
| U S–ISRAEL | FTA | 19-AUG-85 |
| **U S–JORDAN** | FTA AND EIA | 17-DEC-01 |
| **U S–CHILE** | FTA AND EIA | 01-JAN-04 |
| **U S–SINGAPORE** | FTA AND EIA | 01-JAN-04 |
| **U S–AUSTRALIA** | FTA AND EIA | 01-JAN-05 |
| **U S–MOROCCO** | FTA AND EIA | 01-JAN-06 |
| **U S–BAHRAIN** | FTA AND EIA | 01-AUG-06 |
| **U S–OMAN** | FTA AND EIA | 01-JAN-09 |
| **U S–PERU** | FTA AND EIA | 01-FEB-09 |
| **U S–COLOMBIA** | FTA AND EIA | 15-MAY-12 |
| **U S–PANAMA** | FTA AND EIA | 31-OCT-12 |

Note: FTAs with EPs are in bold type. (G) indicates an agreement on goods in cases in which an agreement on services came at a later date.
Source: compiled by the author using information from the WTO web page.

tor (PM2.5, $SO_2$, NOx, and $CO_2$)[3], *Pob* stands for population, *Area*[4] stands for the surface area of the country in $km^2$, *PIB* stands for the country's income, AE stands for trade openness, and *TLC_DM* and *TLC_NDM* stand for the number of trade agreements with and without EPs, respectively, that each country *i* has signed with its trade partners *j* each year.

The estimation technique used was a panel data estimator with fixed effects by country (intragroup estimator), which explains the variation in each country's emissions over time in relation to the average levels of these.[5] This eliminates factors that vary from country to country and are constant over time (unobservable heterogeneity), which avoids endogeneity problems. In fact, the endogeneity of the target variable *(TLC_DM)*, which was tested by adding the variable in the period (*t*+1) as a regressor in the model, indicates that the corresponding coefficient was not statistically different to zero.

The results in table 2 indicate that the coefficient for the *TLC_DM* variable is negative and significant (at the 1% and 5% level) for the four pollutants included here. For PM2.5, the magnitude of the coefficient indicates that for each additional FTA with environmental content, the average concentration of PM2.5 weighted by population size decreases by about 0.3%, while for $SO_2$, NOx, and $CO_2$, emissions per capita

TABLE 2
**RESULTS OF THE ESTIMATION OF THE DETERMINANTS OF EMISSIONS**

| VARIABLE | (1) PM2.5 | (2) $SO_2$ | (3) NOx | (4) $CO_2$ |
|---|---|---|---|---|
| TLC_DM | -0.00306*** [0.00088] | -0.0217*** [0.00709] | -0.011** [0.0047] | -0.00676*** [0.00103] |
| TLC_NDM | 0.0013 [0.0013] | -0.00378 [0.00303] | -0.00326 [0.00293] | -0.000219 [0.000843] |
| LN_POB | -0.531*** [0.239] | 1.051*** [0.258] | 0.0247 [0.193] | 0.112*** [0.0414] |
| LN_PIB PER INHABITANT | 1.935*** [0.529] | 0.709** [0.342] | 0.305 [0.278] | 1.693*** [0.0825] |
| (LN_PIB PER INHABITANT)$^2$ | -0.120*** [0.0298] | -0.009 [0.0236] | 0.012 [0.0203] | -0.0573*** [0.00562] |
| LN_APERTURA COMERCIAL (PREDICTION) | 0.00171*** [0.0004] | 0.0264 [0.019] | 0.00523 [0.0176] | 0.0192 [0.0117] |
| $R^2$-INTRAGROUPS | 0.174 | 0.237 | 0.147 | 0.321 |
| NUMBER OF OBSERVATIONS | 570 | 5,290 | 5,318 | 5,729 |
| NUMBER OF COUNTRIES | 48 | 176 | 177 | 177 |

Note: *** and ** indicate significance at 1% and 5%, respectively. The period in (1) is from 1999 to 2011, in (2) and (3) from 1970 to 2008, and in (4) from 1970 to 2011, depending on data availability. Source: OECD for PM2.5, World Bank Development Indicators for $SO_2$, NOx, and $CO_2$, trade openness, income per capita, population, and area. Bilateral trade data was obtained from UN_COMTRADE. The other variables in the gravity model are from CEPPI.

are reduced by 2%, 0.1%, and 0.6%, respectively. The negative and significant coefficient for TLC_DM indicates that FTAs with EPs or parallel environmental agreements reduce pollutant gas emissions. However, the coefficient for TLC_NDM is not statistically different to zero in any of the regressions, which indicates that, in the case of agreements with no environmental content, there is no direct relationship between their ratification and a reduction in emissions.

With regard to the other variables included in the model, an increase in trade (trade openness) raises PM2.5 emissions, although the effect is marginal. A 10% increase in trade openness increases emission concentrations by 0.01%, and there is no statistical relationship between trade and the other indicators. As a result, an increase in trade was not observed to increase gas emissions.

With regard to the coefficients for GDP per capita and GDP per capita squared, the latter was included so as to analyze whether there is a nonlinear relationship between emissions per inhabitant and income, that is, whether emissions increase with income up to a certain level and then decrease due to greater demand for environmental quality when a country develops economically. The results indicate that only in the cases of PM2.5 and $CO_2$ is there an inverted-U relationship between emissions and income. In contrast, emissions of $SO_2$ increase with income per capita and those of NOx are not affected.

**ENVIRONMENTAL BENEFITS**
ARE INDEPENDENT OF RESULTS RELATED TO TRADE OR ECONOMIC ACTIVITY

**ENVIRONMENTAL CONTENT OF THE PANAMA–EL SALVADOR FTA**

This FTA was signed in 2002 and entered into force in 2003. It only refers to the environment in the preamble and in the chapters on sanitary and phytosanitary measures and investment.

PREAMBLE:
The paragraph on the environment indicates that one of the FTA's objectives is to "promote economic development in a manner consistent with environmental protection and conservation and with sustainable development."

CHAPTER 8:
SANITARY AND PHYTOSANITARY MEASURES
Article 8.07. Risk Assessment and Determination of the Appropriate Level of Sanitary and Phytosanitary Protection
c) in assessing the risk posed by a good and establishing the appropriate level of protection, the Parties shall take account of factors such as [...] pertinent ecological and environmental conditions.

CHAPTER 10:
INVESTMENT
Article 10.15. Environmental Measures
1. Nothing in this Chapter shall be construed to prevent a Party from adopting, maintaining or enforcing any measure consistent with this Chapter that it considers appropriate to ensure that investment activity in its territory complies with the ecological and environmental legislation of that Party.
2. The Parties recognize that it is inappropriate to encourage investment by relaxing domestic health, safety, ecological or environmental measures. Accordingly, no Party shall exempt or undertake to exempt the investment of an investor from the application of such measures as an encouragement for the establishment, acquisition, expansion or retention in its territory of an investment of an investor. If a Party considers that the other Party has offered such an encouragement, it may request consultations with the other Party.
In contrast to the FTAs promoted by the US or Canada, this is an example of an FTA with basic EPs that do not imply legal cooperation or commitments or the development of environmental institutions, and is thus similar to the Panama–Peru FTA (2012).

Source: Legal text of the agreement. Available at: http://www.worldtradelaw.net/databases/ftas.php

## LEVELS OF ENVIRONMENTAL PROTECTION IN THE CHILE–COLOMBIA FTA

The Chile–Colombia FTA entered into force in 2009 and refers to the environment in the preamble and also contains an entire chapter that focuses exclusively on the environment (chapter 18). This chapter contains five articles, which describe, over the course of a four-page text, the objectives (1), principles and commitments (2), cooperation (3), institutional arrangements (4), and consultations (5) implied by the agreement.

CHAPTER 18: ENVIRONMENT

The most relevant aspects of each article are summarized below.

Article 18.1. Commercial and environmental policies shall be mutually complimentary, and the parties commit to working together to promote the conservation and sustainable use of natural resources and to protect the ecosystem so as to guarantee sustainable development.

Article 18.2. The Parties have the sovereign right over their natural resources and will strive for their laws and policies to promote and establish high levels of environmental protection and natural resource conservation. They also commit to fulfilling the environmental commitments they took on as part of multilateral agreements and recognize that it is inappropriate to promote trade or investment by reducing levels of environmental protection.

Article 18.3. The Parties agree to cooperate on matters of trade and the environment and list a series of 14 activities that are of mutual interest: forestry and natural resource development, management of hydrobiological resources, desertification, green markets, ecotourism, biodiversity, institutional strengthening, control and monitoring, water quality, conservation of marine areas, watershed management, environmental education, environmental liabilities, environmental assessments, and other matters agreed on by the Parties. Possible forms of cooperation are also indicated, as are the competent authorities in this regard and their specific functions. Finally, the article refers to Chapter 19 (Cooperation), in the framework of which the Parties can also carry out environmental activities.

Article 18.4. This article establishes national contact points for handling queries and requests from the other Party so as to promote the exchange of information and evaluate cooperation initiatives.

Article 18.5. Any matter that affects the application of the measures included in this chapter may be subject to consultation. The Parties shall go to the national contact point, which shall identify the institution or official responsible for the matter and shall help to resolve it.

This agreement contains more specific provisions that cover matters relating to cooperation and consultation and dispute settlement but it does not include sanctions and places the responsibility for implementing the agreement on each country's ministry of the environment. With regard to environmental legislation, it is worth highlighting the creation of Chile's Ministry of the Environment in 2010, whose primary objective is environmental protection and the efficient use of natural resources. Likewise, in 2012, Chile's Support Program for the Development of Nonconventional Renewable Energy was approved.

Source: Legal text of the agreement. Available (in Spanish) at http://www.sice.oas.org.



## INCENTIVES FOR REDUCING CONTAMINATION

The main empirical results show that FTAs with EPs seem to contribute to reducing pollution in signatory countries. The results are based on a series of environmental indicators which are representative of air quality (local pollutants) and global warming ($CO_2$).

The main implications of these results for economic policymaking are as follows. First, FTAs with EPs seem to have a direct positive effect on reducing environmental damage. Second, this effect possibly operates by providing members with incentives to apply and comply with stricter environmental regulations and reduce environmental damage. Third, the relationship with regulations to reduce such damage is independent of the effect caused by trade and that of the increased economic activity that derives from FTAs.

These findings seem to have significant implications for the FTAs that are currently being negotiated. In fact, the establishment of a causal relationship between regional trade agreements containing EPs and a reduction in emissions suggests that future negotiations should pay more attention to designing EPs (including cooperation) so as to better meet the commitments countries have made regarding specific environmental results.

**NOTES**

[1] An early version of this paper titled "Is the Road to Regional Integration Paved with Pollution Convergence?" was presented at the 10th Tenth Annual Conference of the Euro-Latin Study Network on Integration and Trade (ELSNIT), which was sponsored by the IDB http://events.iadb.org/calendar/eventDetail.aspx?lang=en&id=3735. This study focuses exclusively on the effects of FTAs with EPs on the convergence of $CO_2$ emissions (and not the effect on emissions levels by country) between 1980 and 2008 and does not consider other pollutants.

[2] The methodological use of these techniques is explained in detail in Baghdadi et al. (2013).

[3] PM2.5 are particles suspended in the air that are less than 2.5 micrometers in diameter. $SO_2$, NOx, and $CO_2$ are emissions of sulfur dioxide, nitrogen oxides, and carbon dioxide. Per-capita values for $SO_2$, NOx, and $CO_2$ emissions were included in the model and those for PM2.5 were weighted by population size.

[4] Given that the Area variable does not change over time, the inclusion of country fixed effects implies that it is not possible to estimate a per-capita coefficient for the Area variable as its effect is already included in the fixed effects and the population variable.

[5] Baghdadi et al. (2013) use matching and difference-in-differences techniques to identify the effect of agreements, which is why the country sample was reduced from 182 to 154 countries in this instance. In the case of $CO_2$, this study used panel data techniques and included 177 countries. The results for $CO_2$ confirm those obtained by Baghdadi et al. (2013): in their study, the estimated coefficient for the TLC_DM variable was 0.0036 and significant at 5%, while in this study it was 0.0067 and significant at 1%.

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INTERVIEW

Christiana Figueres
Costa Rica
Former Executive Secretary, UNFCCC

Patricia Espinosa
Mexico
Executive Secretary, UNFCCC

# Protecting the planet: a tough mission

THERE ARE CERTAIN ENVIRONMENTAL ISSUES WHERE IT IS NOT EASY TO ACHIEVE A BROAD CONSENSUS.

*Laudato Si'*

Two Latin American women have been leading the multilateral negotiations to save the planet from the natural disasters caused by climate change. Christiana Figueres of Costa Rica was executive secretary of the United Nations Framework Convention on Climate Change (UNFCCC) when the historic Paris Agreement was reached in 2015. In 2016, Patricia Espinosa of Mexico took the helm, steering the organization through the recent Marrakech Conference. In an exclusive interview, Integration & Trade asked the two global leaders for their opinions on the difficulties in reaching consensus, the impact of new technologies, and how *Laudato Si'* has contributed to defending the environment.

**What was the significance of the Paris Agreement?**

**PE:** For the first time ever, the Paris Agreement on climate change managed to bring the entire community of nations together as equals to tackle a global problem that will require urgent concrete cooperation initiatives, based on national action plans. Through this agreement, countries have committed to reducing their greenhouse gas emissions and have recognized the urgency of fulfilling this commitment, which is of paramount importance if all nations are to aspire to a truly sustainable future for their citizens. In Paris, two roads for responding efficiently to climate change were mapped out. First, the transformation toward a low-carbon global economy, in other words, decoupling economic growth from emissions. At the same time, climate neutrality in the second half of the 21st century was clearly established as our intended destination—in other words, keeping emissions levels so low that they can be safely and easily absorbed by the earth's natural infrastructure, such as forests and soils. The Paris Agreement also encourages economies and societies to strengthen their capacity to withstand the increasing numbers of adverse climate impacts to prevent them from causing economic damage and human suffering.

**CF:** The milestones of the Paris Agreement were, first, to have established a baseline for the contributions that each country can make toward the global mitigation effort, as the agreement entailed each country submitting its own baseline in keeping with its economy. Second, that baseline was acknowledged to be a starting point in the discussion rather than a conclusion. It marks the beginning of an ongoing process toward decarbonizing the economy over the coming years.

**How far has the Marrakesh Conference reinforced the commitments that were made in Paris in 2015?**

**PE:** Through their work at COP22 and into the future, the different governments that are party to the UNFCCC are on the right path to ensuring that the objectives of the Paris Agreement are applied quickly and efficiently. There are many details that we still need to address, but I would point to three key areas: transparency; support; and the



**CHRISTIANA FIGUERES**
**COSTA RICA**

The daughter of former president José Figueres Ferrer, she studied anthropology and economics. She took part in the negotiations for the Kyoto Protocol in 1995. Between 2010 and 2016, she led the UNFCCC. TIME magazine has included her among the 100 most influential people in the world and she ran to follow Ban Ki-moon as UN secretary-general.

**PATRICIA ESPINOSA**
**MEXICO**

She studied international relations at El Colegio de México. She was Mexico's minister of foreign relations between 2006 and 2012 and has been the country's ambassador to Germany since 2012. She has also represented Mexico at multilateral organizations in Vienna, Geneva, and New York. She was appointed executive secretary of the UNFCCC in 2016.

relevance of all involved. The transparency of each country's cooperation efforts is essential in all spheres so that all players, both state and nonstate, can help maintain the mutual political and economic trust needed to take climate action to the next level. The regulations for this new climate regime within the UNFCCC will provide a solid basis for transparency.

**CF:** The Paris Agreement had already entered into force by the start of the Marrakesh Conference. It was made official on November 4, 2016, a very important date for all of us. Morocco is the starting point on a difficult road: countries need to agree on the regulations that will govern the implementation of the Paris Agreement. Some of the specific features of Latin America make it very important in comparison with other regions, particularly the fact that it has a cleaner energy mix due to its use of hydropower and wind and solar energy. We are all responsible for caring for nature in countries like Brazil, which contains one of the most biodiverse areas in the world.

**In terms of multilateral negotiations, what was the secret to success at the conferences?**

**PE:** I wouldn't dare to put forward a single, all-embracing answer on why some negotiation processes fail and others are successful. A lot has been written about multiple negotiation models. I believe understanding, cooperation, and transparency to be core issues. However, in the case of climate change, I could point to three main reasons why the world's nations were able to reach this historic agreement. First, the enormous, committed efforts from the global scientific community rooted the negotiations in grim reality by revealing the existence, scale, and consequences of uncontrolled climate change. We can delay our response to this, but there is no getting away from

the consequences of such a delay. Second, the UNFCCC's guiding principle has been that each country can act in accordance with its particular circumstances and the support it may need. This has been an essential part of the success of the negotiations. It was also one of the most complex aspects due to how varied these circumstances are throughout the world, but this principle has helped maintain the necessary levels of trust between nations over the years. It recognizes that countries have different needs and seeks to advance the main aim of the UNFCCC—emissions reduction—while guaranteeing sustainable development for all. Last but not least, it was recognized that although governments must take the lead on climate change through more ambitious national and international initiatives that are underpinned by appropriate incentives and policies, they do not have the economic or social reach to act on their own.

**CF:** Over the last year, we have witnessed a series of successful climate change agreements: as well as the Paris Agreement there is the civil aviation industry agreement and the latest amendment to the Montreal Protocol. Why were these negotiation processes successful? Every country has experienced the negative impacts of climate change, and there is a lot of evidence which suggests that if we don't tackle the problem, the impacts will be increasingly harmful and far-reaching. Countries understand both the risks and the opportunities that this entails. The Paris Agreement is an opportunity for countries to modernize their economies and make gains in energy security, food security, and improvements to healthcare systems and transportation—indeed, all the benefits that come with tackling climate change.

THE GUIDING PRINCIPLE IS THAT EACH COUNTRY CAN ACT ACCORDING TO ITS SPECIFIC CIRCUMSTANCES

THE PARIS AGREEMENT ESTABLISHED A BASELINE WHICH IS THE STARTING POINT IN THIS DISCUSSION, NOT THE END

**What role are new technologies playing in the fight against climate change?**

**PE:** In order to rapidly reduce emissions and help societies successfully adapt to climate change, we need accessible, appropriate technological and financial support so that developing countries can build a sustainable future based on clean energies. All aspects of the Paris Agreement need to be urgently implemented and need to be relevant to all players, from the global investment institutions that wish to mobilize thousands of people to take climate action to the poorest farmer needing to access micro-insurance against floods and droughts.



**CF:** All emissions-reducing technologies are important. There are countless useful technologies for generating, using, and distributing energy and others for transportation, agriculture, and telecommunications. Indeed, there are very few sectors where emissions cannot be reduced. We need to encourage emissions-reducing technologies in absolutely every sector so that they can operate with greater energy efficiency.

**How do you think *Laudato Si'* has contributed to this process?**

**PE:** The encyclical *Laudato Si'*, which Pope Francis presented in June 2015, is a crucial contribution to the global discussion on climate change. Not all climate action is or should be motivated by economic incentives. *Laudato Si'* highlights the moral imperative for taking action against climate change and links climate action to an ecological growth model whose main objective is to protect the most vulnerable, bring people out of poverty, and create a safer, sustainable world for our children and grandchildren. The encyclical's message has echoed through other faith communities, which together influence the actions and attitudes of billions of people. The signing of the Paris Agreement has sparked a movement that invites others to care for our common home as part of our everyday life. If you search for the hashtag #LiveLaudatoSi on Twitter or Instagram, you can see countless examples of people who are trying to make their lifestyles more environmentally responsible. Of course, this invitation is not just for those who use social networks. It is an invitation for each and every one of us to choose one of the many different ways of acting respectfully toward the earth's climate. The encyclical has helped to raise awareness around the need to take action to stop climate change and work on the basis of our shared humanity. This is the contribution that *Laudato Si'* has made.

THE POPE IS CALLING ON US TO ACT ON OUR MORAL RESPONSIBILITY TO PROTECT THE MOST VULNERABLE

*LAUDATO SI'* TEACHES US THAT NOT ALL CLIMATE ACTION SHOULD BE MOTIVATED BY ECONOMIC INCENTIVES

**CF:** All of us working in the field of climate change have read *Laudato Si'* and we are grateful to the Pope for having written this text for the Catholic Church and the world. His words are a call for us to act on the moral responsibility that we all have to protect the most vulnerable and open up opportunities in a world that seems to be moving in the opposite direction, creating ever wider gaps between those that have the most and those that have the least. Climate change is making the vulnerable even more vulnerable. The moral responsibility to face up to this phenomenon has been a powerful call to action on the Pope's part.

# A new perspective on the carbon market

> THE STRATEGY OF BUYING AND SELLING "CARBON CREDITS" CAN LEAD TO A NEW FORM OF SPECULATION WHICH WOULD NOT HELP REDUCE THE EMISSION OF POLLUTING GASES WORLDWIDE. THIS SYSTEM SEEMS TO PROVIDE A QUICK AND EASY SOLUTION UNDER THE GUISE OF A CERTAIN COMMITMENT TO THE ENVIRONMENT, BUT IN NO WAY DOES IT ALLOW FOR THE RADICAL CHANGE WHICH PRESENT CIRCUMSTANCES REQUIRE.
>
> *Laudato Si'*

Axel Michaelowa
University of Zurich and
Perspectives Climate Research[1]

*Laudato Si'* is a landmark piece of environmental writing, based essentially on transcendental ethical and moral issues. In parallel to these dimensions, market mechanisms to address climate change have emerged in recent years, although these may still need to be perfected. This article reviews the progress on these mechanisms and explores how they need to contribute to the development and spread of emissions-reducing technology. It points to the importance of correcting one of the main flaws in market mechanisms: their inability to maintain an appropriate price for emissions permits.

Pope Francis's encyclical *Laudato Si'* (2015) is the first high-level document of the Catholic Church entirely dedicated to environmental issues. It has garnered worldwide recognition and has been credited as one of the key elements that led to a successful outcome of the Paris Conference of the Parties to the UN Framework Convention on Climate Change (UNFCCC) in December 2015 in form of the Paris Agreement (Bodansky, 2015). Even observers from NGOs that have traditionally been critical of the Catholic Church's stance on environmental and social issues have acclaimed *Laudato Si'* in glowing terms, like arguing that it serves as a "Magna Carta of integral ecology" (Bals, 2016).

Pope Francis stresses the common good that an intact environment and climate represent and calls for cooperative action that acknowledges the inherent value of every creature, human and nonhuman. Its recommendations on climate policy are essentially grounded in basic ethical and moral considerations.

In the last 15 years of international and national level climate policies, a number of market mechanisms have emerged. Their aim is to achieve greenhouse gas mitigation at the lowest possible cost. Two principal forms stand out. The first is a "cap-and-trade" system where a regulator specifies a maximal emissions level for emitting entities and then allows trade in emissions allowances. Entities that have reduced emissions below their cap can sell allowances while emissions in excess of the cap can be covered through the acquisition of a sufficient quantity of such units. The second form is a "baseline-and-credit" mechanism where activities that reduce emissions below a predefined baseline generate emission credits that can be sold to entities that require mitigation units. The Kyoto Protocol operates as a cap-and-trade system for the group of industrialized countries with emissions commitments, while projects in countries without commitments can generate credits under the Clean Development Mechanism (CDM). On the national and subnational levels, various cap-and-trade schemes have been set up, most notably in the EU, California, and various Chinese provinces.



# A NEW PERSPECTIVE ON THE CARBON MARKET

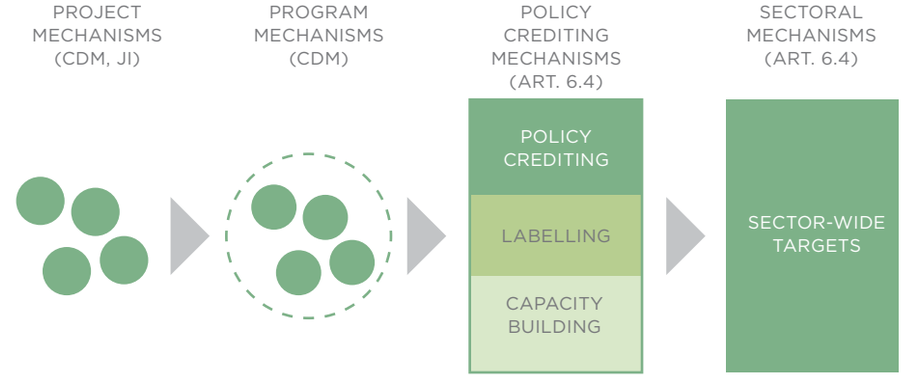
The Paris Agreement introduces an array of new market mechanisms in Article 6 (UN, 2016: 24–25) with "baseline and offset" (Art. 6.4) as well as cap-and-trade characteristics (Art. 6.2).

The mechanism under Art. 6.4 envisages upscaling to policy and sectoral approaches. The rules of the Paris mechanisms will be defined in the coming years.

Most comments on *Laudato Si'* have stated that it condemns market mechanisms in climate policy. The famous environmental economist William Nordhaus (2015) explicitly uses this term. Harvard University's Robert Stavins (2015) says "the encyclical rejects outright 'carbon credits'." The eminent environmental law expert Dan Bodansky (2015: 129) talks about the "encyclical's dismissal of emissions trading." Sileccia et al. (2016) stress the moral aspect of the critique.

However, the Pope's statement on market mechanisms is much more nuanced than is commonly acknowledged. Para. 171 of the encyclical (Pope Francis, 2015: 126) reads: "The strategy of buying and selling 'carbon credits' can lead to a new form of speculation which would not help reduce the emission of polluting gases worldwide. This system seems to provide a quick and easy solution under the guise of a certain commitment to the environment, but in no way does it allow for the

FIGURE 1
**THE UPSCALING OF BASELINE AND CREDIT MECHANISMS**




Source: Perspectives Climate Research.

radical change which present circumstances require. Rather, it may simply become a ploy which permits maintaining the excessive consumption of some countries and sectors" (my italics to highlight "can," "would," and "may").

I therefore want to assess the performance of the market mechanisms with regards to the principles set up in *Laudato Si'*.

## WHAT PRINCIPLES SHOULD GUIDE MARKET MECHANISMS?


Dissecting the Pope's statement on market mechanisms allows us to understand his principles for the implementation of such mechanisms. He calls for the mechanisms to be designed in a way

- that achieves greenhouse gas emission reductions;
- that does not stall the radical change needed for climate change mitigation; and
- that does not lead to a persistence of "excessive consumption."

The first two principles[1] have been widely discussed by climate policy researchers and practitioners. The first principle, in particular, has led to wide-ranging reforms in market mechanisms over the last decade, and the second principle is currently gaining ground in international discussion. Several important international climate finance vehicles set up in the last five years—notably the Green Climate Fund and the NAMA Facility—require that project proponents describe "transformational impacts" or "paradigm shifts." The third principle is less frequently invoked but its supporters are quite vocal.

## SUPPORTING THE PRINCIPLES OF *LAUDATO SI'*

The first of the Pope's principles—achieving greenhouse gas emissions reductions—can be unequivocally supported. Forms of market mechanisms that have low levels of integrity have no reason to exist. Otherwise, they would dilute the mitigation action achieved by an international or national climate policy instrument. It is akin to bad money driving out the good money and leading to inflation. This is fully acknowledged in the Paris Agreement with Art. 6.2 calling for governments to "ensure environmental integrity," and any mechanism thus needs to fulfill the principle of additionality. Emissions credits from baseline-and-credit schemes must only accrue through activities that go beyond business-as-usual (Greiner and Michaelowa, 2003). Cap-and-trade systems require caps that are set below the "business-as-usual" level; otherwise "hot air" is created. A strong system of monitoring, reporting, and verification (MRV) needs to underpin any mechanism, and fraud or noncompliance need to be severely punished.

The second principle—not stalling the radical change needed for climate change mitigation—is also crucial for a successful long-term climate policy. Mechanisms need to contribute to the development and diffusion of emission reduction technologies. They also should induce policymakers to adopt more stringent emission reduction targets than they would normally be willing to do. By mobilizing the most efficient mitigation initiatives first, mechanisms would allow a political backlash against climate change mitigation to be prevented by overcoming the perceived "impossibility" of reaching stringent emission reduction commitments. A radical change can also be promoted by spreading the message that mitigation is actually manageable and can be achieved under very different circumstances. Nowhere should mechanisms "ossify" emission-intensive structures.

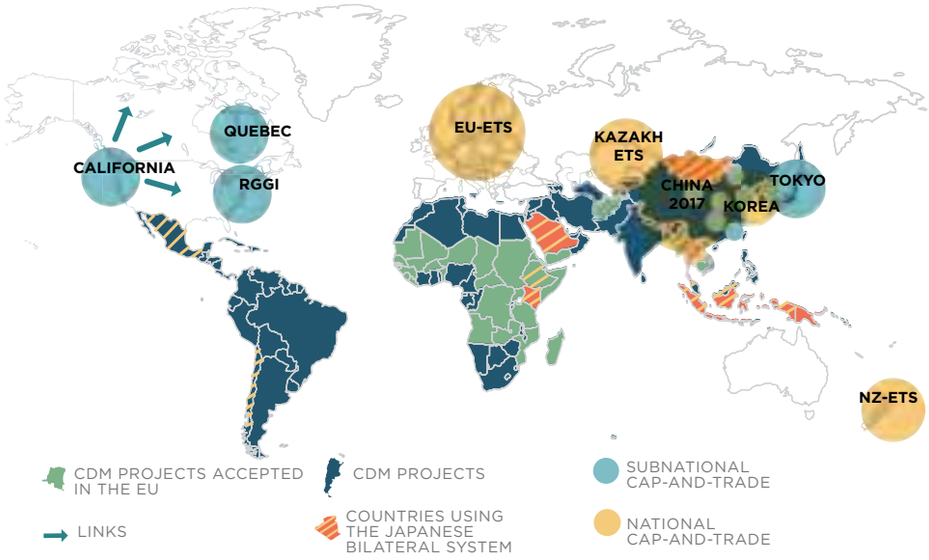
The third principle is probably the most difficult to accept and has been criticized by economists, legal and political scientists alike (see, for example, Bodansky, 2015: 130). High consumption per se is not a bad. It becomes a bad if it deprives other people of resources of basic necessity and creates public bads like climate change. It also is a bad if it incentivizes unethical behavior like crime, corruption, and exploitation. But these problems can be prevented by appropriate policy instruments—and well-designed market mechanisms are one of these instruments. Eventually, the world's policymakers should strive to allow sustainable consumption for as many people as possible. This is acknowledged in the preamble of the Paris Agreement that reads "sustainable lifestyles and sustainable patterns of consumption [...] play an important role in addressing climate change" (UN, 2016: 22). Voluntary restraint makes sense and may be on the upswing as people realize that frantic consumption reduces their overall quality of life. But rationing goods and services through government action has never worked in human history for a prolonged time and will not work in the future.

**CAP-AND-TRADE**
SYSTEMS SET UPPER LIMITS ON GREENHOUSE GAS EMISSIONS

## ALTERNATIVE POLICY INSTRUMENTS

We now have over a decade of experience with international and national carbon market mechanisms. The Kyoto Mechanisms CDM and Joint Implementation (JI), covering mitigation projects in industrialized countries, have been used widely. The CDM has mobilized projects in over 90 countries and generated over 1.7 billion emissions credits. Over 850 million JI credits have been issued. National emissions trading systems have proliferated. However, the Kyoto Mechanism, which was initially thought to be highly promising—International Emissions Trading between governments of countries with commitments—languished due to high-profile cases of corruption in countries in transition[2] and the existence of national emissions budget surpluses in countries in transition, the so-called "hot air." Western European governments were unwilling to buy emission units which did not really reflect emis-

FIGURE 2
**STATUS OF MARKET MECHANISMS 2016**




Source: Perspectives Climate Research.

sion reductions and involved doubtful governance structures.

I will now assess how the CDM, JI, and national emissions trading mechanisms fared with regard to the three principles set out in *Laudato Si'*.

The first principle has been partially achieved, but serious failures have occurred. In its first years, many nonadditional projects were registered under the CDM (Schneider, 2009). For example, highly profitable waste heat recovery projects in Indian steel mills led to arguments about unspecified barriers to investments. The reasons for this failure were mainly an overburdened regulatory structure at the level of the UNFCCC Secretariat, which had not expected such a large number of project submissions, and the failure of the CDM auditors to implement stringent audits. The latter shows that it is imperative to strictly control auditors. Subsequently, rules and regulatory practices improved significantly. For example, several auditors were suspended and subsequently carried out much more serious audits. Also, qualitative arguments about barriers were replaced by checking economic indicators for the projects (Michaelowa, 2009). However, there remains a "gray zone" in which it is difficult to judge whether a project is additional. For example, a risk-averse company that enters a new country will require higher profitability of a project than a company that knows the country very well—for example, the former's annual profit rate may be 20%, the latter's 10%. At which of these two levels should the regulator now fix the profitability threshold at which a CDM project is no longer seen as additional?

Cap-and-trade systems have suffered from a lax emissions cap[3] due to the pressure of emitter interest groups, as shown by Branger, Lecuyer, and Quirion (2015) for the EU and Jotzo and Löschel (2014) for China. If the cap is not stringent, the system does not generate emission reductions. This problem has increased since the eruption of the economic and financial crisis in 2008, which led to significant decreases in industrial activity and emissions that were not reflected in the emissions baseline used for setting the cap. Currently, only a small share of cap-and-trade systems around the world have an emissions cap that is significantly lower than the business-as-usual emissions level, and those systems face strong industry pressure to loosen the cap. Tellingly, the South Korean emission trading system, which had one of the most stringent caps, was recently subject to such strong industry pressure that regulatory responsibility for it was taken away from the environment ministry and given to the industry-friendly presidential administration. The latter promptly loosened the cap. In the EU, while some regulatory improvements regarding cap setting have been achieved over the years, they were immediately overwhelmed by the effects of the economic crisis described above. The consequence has been that in almost all emission trading schemes, prices have started at a relatively high level but subsequently fallen as market participants realized that the cap was above business-as-usual emissions levels. Prices only have not fallen to zero because allowances can be banked for future use. This banking, however, is a heavy burden for future policymakers because it requires them to set more stringent mitigation targets than they would normally have done in order to squeeze the accumulated surplus out of the system.

## BASELINE-AND-CREDIT

THOSE WHO REDUCE THEIR EMISSIONS CAN SELL CREDITS TO EMITTERS

JI was used to launder "hot air" in Ukraine and Russia due to the absence of an international oversight for its "Track 1." Essentially, the governments of those two countries invented "Potemkin village"-style projects or submitted projects that were blatantly nonadditional, and thereby were able to convert the surplus of their national emissions budget that nobody wanted to buy into valuable, project-specific credits for which significant demand existed. In the last weeks of 2012, over 400 million credits were created in that manner (Koll-

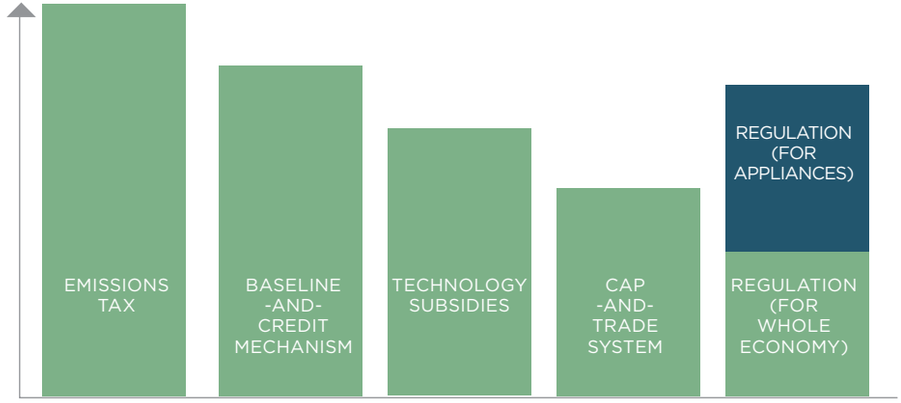
muss, Schneider, and Zhezherin, 2015). This shows how important it is to have international rules preventing unscrupulous governments from trying to exploit the system.

On the success side, compliance with cap-and-trade systems has generally been high due to significant penalties slapped on emitters that did not have sufficient emission allowances. MRV systems have become highly differentiated. Over 200 methodologies for baseline and monitoring have been specified under the CDM; they cover all key greenhouse gas mitigation technologies. Due to the CDM, for the first time, transparency about performance parameters for renewable energy projects in key countries like China and India has been achieved. Previously, such information was notoriously unreliable. This transparency has led to significant pressure to improve technology performance, and may partially explain the strong success of Chinese and Indian wind turbine manufacturers in the recent years.

Regarding the second principle, the CDM has achieved an unprecedented diffusion of technologies. Abatement of industrial gases that was unknown outside a very small circle of technical specialists was implemented within three years around the world leading to $CO_2$ reductions of several hundred million tonnes (Michaelowa and Buen, 2012). Wind power technologies were rapidly scaled up in many countries through the CDM, as has been the case in China (Lewis, 2010) and India (Benecke, 2009). Awareness of entrepreneurs that mitigation is not a crazy idea but a business opportunity was mobilized in an astonishing manner—during the mid-2000s, Indian business newspapers ran daily stories about the CDM. By 2006, any respectable Indian entrepreneur would have known that CDM credits were an important new commodity for export and would have checked his or her company operations for mitigation opportunities. Moreover, a whole ecosystem of consultants and mitigation specialists sprang up around the world which has become very useful in the context of the development of national mitigation policies in developing countries. With regards to the development of new technologies, however, the prices achieved on emissions markets were too low to really mobilize such technologies (Grubb, 2014). Evidence of an increased willingness among policymakers to adopt stringent emission targets is less clear. However, industry pressure for a weak climate policy has been less in countries with access to market mechanisms; this could be seen in Switzerland, Norway, and the EU. Interestingly, since the EU limited imports of CDM credits, EU industry pressure against stringent EU emission targets has increased.

FIGURE 3
**THE PERFORMANCE OF MITIGATION POLICIES TO DATE**

PERFORMANCE ON EMISSIONS MITIGATION AND INNOVATION




Source: Perspectives Climate Research.

## VOLUNTARY RESTRICTIONS

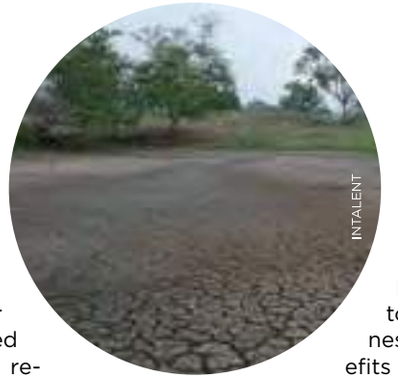
PEOPLE ARE REALIZING THAT RELENTLESS CONSUMPTION REDUCES THEIR QUALITY OF LIFE

With respect to the principle of excessive consumption, market mechanisms have probably reduced consumption by increasing the price of consumer goods by transferring the price of emissions allowances and credits to them, as compared to a "do nothing" situation. This increase was higher in places that have an above-average consumption level. Overconsumption of greenhouse gas–intensive goods has certainly been curbed, but it would have probably been reduced more had regulation prohibited certain goods or had other costlier instruments been introduced that thus lead to a stronger increase in goods and service prices.

How have alternatives to market mechanisms performed with regards to the Pope's principles? Alternative policy approaches can be broadly classified into regulatory and fiscal instruments. The former prescribe or prohibit specific technologies, or require minimum performance of a technology. The latter provide subsidies (in various forms, ranging from direct transfers to tax credits) for low-emissions technologies or tax greenhouse gas emissions.

Generally speaking, regulatory instruments are better than market mechanisms at achieving emissions reductions in situations where emissions are widely spread and emitters lack information or suffer from split incentives. This is the case for consumer appliances or vehicles (Grubb, 2014). However, due to the political economy of regulation, where emitters have an informational advantage and thus can prevent overly strict regulation, a radical change through regulation is relatively unlikely. For the same reasons, regulations cannot address overconsumption.

Subsidies for low carbon technologies, such as through feed-in tariffs for renewable energy, suffer from the problem that their level needs to be carefully chosen. A subsidy which is too low will not generate any mitigation benefit, whereas an overly high subsidy will lead to windfall profits




and an unnecessary pressure on public budgets. The latter has been experienced with feed-in tariffs for renewable electricity in Spain and Germany. Carbon taxes seem to be quite good in mobilizing mitigation (see Brännlund, Lundgren, and Marklund, 2014, for the Swedish case) as well as innovation. Both OECD (2010) and Martin, de Preux, and Wagner (2014) find a clear innovation effect for the English climate change levy. If set high enough, carbon taxes can clearly contribute to curbing excessive consumption. However, the levels applied to date have not been sufficient to achieve this aim, even though they are still significantly higher than the prices achieved by market mechanisms.

Comparing all mechanisms, a carbon tax would probably perform best with regard to Pope Francis's criteria for the design of policy instruments. Well-designed baseline-and-credit mechanisms would rank second. The assessment of mitigation technology subsidies depends on their design; empirically they rank between baseline-and-credit and cap-and-trade systems. The latter suffer from too lenient cap setting. Pure regulation fares well for consumer appliances but scores lowest with regards to mitigation effectiveness and innovation benefits for other sectors.

**90**
COUNTRIES ARE CARRYING OUT MITIGATION PROJECTS LIKE THOSE PROPOSED IN KYOTO

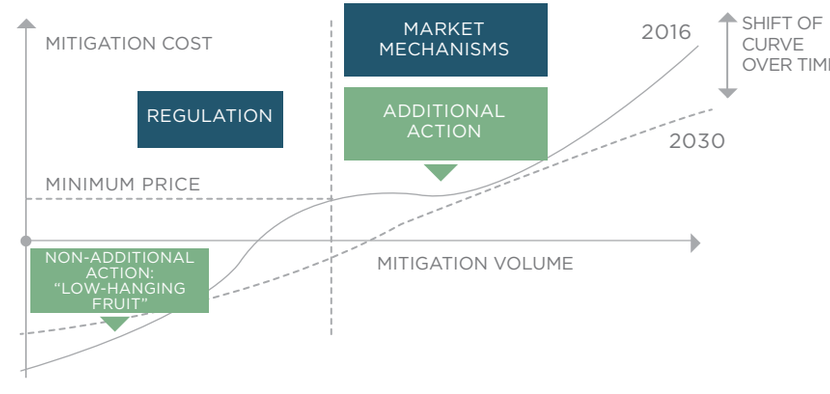
## HOW TO DESIGN MARKET MECHANISMS IN THE FUTURE

The Paris Agreement provides the opportunity to develop rules for an array of new market mechanisms that respect the first two principles on market mechanisms specified in *Laudato Si'*. Stringent additionality rules and a minimum price for transactions, as well as strong international oversight of the principal rules and MRV systems are crucial to making market mechanisms a long-term success. To determine the additionality of projects, clear thresholds for internal rate of return need to be set that reflect the business decisions of risk-taking companies. The mechanisms cannot be tasked to cater for the risk aversion of certain businesses. Projects that entail efficiency improvement need to be judged according to their payback period; a threshold of four years seems appropriate. One key weakness of market mechanisms needs to be rectified—their inability to sustain a relevant price for emission credits/allowances. The crash of prices for CDM credits from 2011 onwards tarnished the reputation of the market mechanisms in developing countries. This was compounded by the widespread failure of credit buyers to honor the terms of the credit purchase agreements. Thus in the future, minimum prices should be introduced in all national and subnational cap-and-trade schemes (see Wood and Jotzo, 2011). To rebuild trust, a minimum price of at least 10 €/t $CO_2$ needs to be set on the international level for all the market mechanisms under the Paris Agreement.

Methodologically, a lot of work remains to be done. As market mechanisms are expanded to cover policy instruments and entire sectors, a careful specification of the baseline emissions is required. The definition of national and sectoral "business-as-usual" policy paths needs to be made through internationally agreed, transparent methodologies. This entails a clear understanding about the non-climate-related benefits of policy instruments. Principally, a policy instrument should only be deemed additional if the costs that it causes exceed the nonclimate benefits. In the context of a feed-in tariff for renewable energy, for example, the cost differential between conventional and renewable energy provision would have to exceed the health benefits from the reduction of local air pollutants to classify the policy as additional. The challenge here is that many policymakers actually do not believe in the cobenefits of the policy or their valuation. So a shortcut solution may be to define a policy as additional if it generates a carbon price exceeding a certain threshold, for example, the minimum price discussed above. Regulation could be deemed additional if it induces activities whose payback period exceeds the value at which individuals and entities would cease to invest.

At the same time, governments need to become serious regarding their mitigation action. The ambitious long-term mitigation target of the Paris Agreement—reaching a balance of emissions and sinks in the second half of this century—can only be reached if national mitigation contributions are scaled up significantly, including through the acquisition of credits from market mechanisms. Countries and country groups that portray themselves as champions of mitigation policy, such as the EU, especially need to

FIGURE 4
**ADDITIONALITY OF POLICY INSTRUMENTS AND MINIMUM PRICE**




Source: Perspectives Climate Research.

## ECONOMIC CRISIS

RISING UNEMPLOYMENT PREVENTED IMPROVEMENTS FROM BEING MADE TO REGULATIONS

move quickly in this direction. All countries that joined the "High Ambition Coalition" at the Paris Conference need to show that they are serious and do not just make nice statements on momentous occasions.

So there is a full workload for policymakers, economists, lawyers, and political scientists alike to improve the operation of market mechanisms. *Laudato Si'* has been a wake-up call for policymakers that reinforces many messages sent by researchers in the last years, but that were ignored on the political level. If they policymakers do not engage in the reforms outlined above, the Pope's uneasiness would rightly transform into rejection and condemnation of market mechanisms.

**NOTES**

[1] It should be noted that the Pope does not criticize the mechanisms for not contributing to sustainable development, as has many NGOs have. I will therefore not discuss this aspect in this article.

[2] For example, in Slovakia, three ministers of the environment had to resign in a short period due to a sale of emission units which clearly had been underpriced compared to the prevailing market price.

[3] This is also called "overallocation" of emissions allowances.

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CASE STUDY

SERGIO CAMPOS
**INTER-AMERICAN DEVELOPMENT BANK**

# SANITATION AND QUALITY OF LIFE


Latin America and the Caribbean contains over 30% of the planet's fresh water, from the glaciers of the Andes to the forested volcanoes of Central America. However, climate change has caused through floods and droughts, increasing people's risk not having access to water in both villages and cities. Providing water and sanitation services will be no simple task in the years ahead.

Between 1990 and 2015, more than 220 million people of a total 600 million in Latin America gained access to water and sanitation services. The percentage of people with access to better water services thus went from 85% to 95% and those with sanitation services from 67% 83%. However, this means that there are still 34 million people without access to fresh water and 106 million without access to adequate sanitation.

These statistics are alarmingly high for the continent's most vulnerable inhabitants and remoter areas. There is a huge disparity between urban and rural areas: the coverage of water and sanitation services in the latter was 84% and 64%, respectively, in 2015—levels that are similar to those in the urban sector 25 years ago.

The Sustainable Development Goals (SDGs) adopted by the United Nations General Assembly establish an ambitious sustainable development agenda for 2030. SDG 6 focuses on ensuring the availability and sustainable management of water and sanitation for all. Not only do governments need to work toward guaranteeing the high-quality provision of these services, they must also reduce wastewater contamination, strengthen water governance, increase the efficiency of the use of water resources, and protect natural capital.

In recent years, Latin America has invested less than half a percentage point of its GDP in new water and sanitation infrastructure. Of the total fresh water produced in the region, almost half is lost in distribution networks due to physical leakages that are caused by a lack of maintenance.

How much financing is needed to guarantee access to water over the next 15 years? To achieve universal access to fresh water, the region needs to invest at least US$28 billion. An even greater investment is needed in sanitation: US$49 billion. This would imply investments of around US$5.1 billion per year.

Improvements also need to be made to the quality of the service received by those who are already connected to the water network. Around 200 million people in the region are estimated to have only intermittent water provision (that is, less than 24 hours per day of guaranteed supply). Other issues include the widespread lack of data on water quality in Latin America and the lag in wastewater treatment: only 18% of the region's sewage is treated, in contrast to the 60% average for high-income countries. By 2030, the percentage of untreated wastewater must be cut by half, which implies an investment in large urban areas of another US$30 billion.

Some successful experiences developed by the Inter-American Development Bank (IDB) point the way to guaranteeing sustainable, high-quality access to water for all citizens.

One example of this is the Latin American Water Funds Partnership, which was started in 2011 on the initiative of the IDB, the FEMSA Foundation, the GEF, and the Nature Conservancy to create and strengthen water funds in the region. Water funds function as institutional and financial mechanisms that promote water security in a metropolitan area or region through public-private partnerships. One of their main advantages is that they help to bridge the gap between water supply and demand by offering innovative opportunities for implementing green infrastructure and conservation projects. Each fund is presided over by an independent committee and has a technical secretariat that implements conservation projects such as reforestation, the creation of protected areas or payments for environmental services, and promotes good practices in the different activities taking place in each catchment area.

Another example is being developed in Lima through the creation of AquaFondo, which the main users of the city's three largest catchment areas are involved in. This fund has supported rates-based changes to public policy changes. Next year, a percentage of the rates paid to SEDAPAL, the water company, will be used for green infrastructure and conservation projects.

Another interesting experience is AquaRating, a widespread, voluntary system that offers comprehensive ratings of water or sanitation services based on reliable information that is audited by an independent body. This tool fills a gap in the market as an international standard of excellence for the provision of water or sanitation services based on criteria for accessibility, quality, efficiency, sustainability, and transparency. As well as measuring performance indicators, AquaRating evaluates organizational management practices.

These are simply benchmarks that point us in the right direction to achieving concrete results. Success will depend largely on countries providing appropriate frameworks that include infrastructure, access to financing, and an effective business environment.

ANALYSIS

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# Big Data

## Predicting and preventing climate-related shocks

THE DIGITAL REVOLUTION, ROBOTICS, BIOTECHNOLOGIES AND NANOTECHNOLOGIES. IT IS RIGHT TO REJOICE IN THESE ADVANCES AND TO BE EXCITED BY THE IMMENSE POSSIBILITIES WHICH THEY CONTINUE TO OPEN UP BEFORE US.

*Laudato Si'*

Big Data as a socio-technological phenomenon has the potential to generate new insights on the functioning and interaction of human and natural ecosystems. In particular, Big Data can improve our understanding of how societies deal with shocks related to climate change, and inform policies and actions to foster adaptive mechanisms. However, such positive effects will not occur automatically and investments to address the technological, human, and ethical barriers of Big Data will be necessary. This article analyzes these factors and makes a series of recommendations on the potential for leveraging Big Data for climate change resilience in LAC, impediments to doing so, and requirements if this is to be effective.

Latin America and the Caribbean (LAC) is vulnerable to a wide range of climate-related shocks and processes. These include rising sea levels and temperatures, changes in rainfall patterns, the melting of Andean glaciers, and extreme climate phenomena such as tropical cyclones and El Niño Southern Oscillation. According to the World Bank (2014) "by 2100, summer temperatures over the region will increase by approximately 1.5°C under the low-emissions scenario and by about 5.5°C under the high-emissions scenario compared to the 1951–1980 baseline".

The region is highly heterogeneous in terms of its natural ecosystems—which include mountain glaciers, rainforests, savannas, wetlands, islands, deserts, and coastline—and its socio-economic development—despite progress it remains the region with the highest level of income inequality worldwide. This means that climate change impacts will continue to be unevenly distributed within and among countries. Climate models for the region show that impacts will be more severe for poor populations, both in rural and urban contexts and more in some areas of LAC than in others (IPCC, 2014a; Stern, 2007, 2013).

Climate change impacts have various implications for the LAC's development, including water and food security, health, migration, biodiversity, forests, and energy. In terms of economics, climate change will set the region's GDP back by between 1% and 5% by 2050 (ECLAC, 2015). To mitigate stronger effects in the next decades, urgent action needs to be taken now. Building resilience to empower communities and countries as complex systems that can endure uncertainty and adversity and adapt in response to them is essential and requires innovative approaches.

Climate science has long relied on large amounts of fine-grained and comprehensive spatial data and computational power. But over the past decade, there has been significant growth in various kinds of high-frequency data and associated analytical capacities resulting from the sophistication and spread of the digital technology lumped under the term "Big Data." Big Data constitutes a sea change for climate resilience: with the rise of Big Data, opportunities for better understanding hazards, vulnerabilities, and resilience factors have vastly expanded.



# BIG DATA

LAC has relatively strong official statistical and academic systems that could serve as a backbone for the so-called "data revolution," along with wide penetration of mobile and internet technology and a solid open data movement. More broadly speaking, its civil societies are active and vibrant. However, Big Data's potential to help us better understand climate resilience does not mechanistically bridge the gap between information and action. How to best unlock the potential of Big Data for resilience remains an important yet largely unaddressed question. Technical barriers include access to data "crumbs," global coordination for climate data sharing, data reliability, and representativeness, and other factors. In addition, Big Data introduces new ethical and political risks that warrant careful consideration. A key message is that Big Data must involve many stakeholders. Approaches should focus on not only ingesting data from people but more importantly on getting data to the people.

## ECOSYSTEM

Over the past two decades, humanity has experienced a significant rise in the amounts of data produced and stored, which has brought changes in the way we approach data. First, it is critical to draw attention to the use of capitalization in our terms and differentiate "big data" from "Big Data". Whereas the former refers simply to big sets and streams of data, Big Data is an ecosystem and socio-technological phenomenon made up of the "3 Cs" of Big Data: (1) digital "crumbs"—that is, digital traces of human actions and interactions captured by digital services and devices, such as exhaust data, web-based data, and sensing data; (2) "capacities," that is, tools, methods, and skills used to store, explore, analyze, and make sense of the data, which may be computational, methodological, or human; and (3) "communities," which are the individuals, institutions, and corporations that produce, collect, and/or use data—potentially all of us. If we do not conceptualize Big Data on these terms, that is, including political elements that go beyond simply the "big data" itself, we are overlooking much of the field's potential and requirements for working with it.

Several regional stakeholders are already taking advantage of the opportunities Big Data offers: government and international agencies; national statistics offices such as INEGI in Mexico or DANE in Colombia; the private sector; and academia and civil society. Big

Data has the potential to offer new insights on economic factors, such as the use of internet-based data to monitor inflation in real time or satellite images to estimate GDP growth. To this day, most Big Data investments have been made by the private sector, responding to commercial interests. For example, banks are investing heavily in Big Data to identify money laundering and fraud.

## POST-2015 DEVELOPMENT

Within the international community, significant attention is being paid to Big Data's potential contribution to the post-2015 development agenda. In fact, collecting data and measuring how far targets have been achieved are cross-cutting concerns that appear throughout the Sustainable Development Goals (SDGs). The development and use of Big Data could be considered an objective in itself, as is exemplified by target 17.8, which calls to "enhance capacity-building support to developing countries (…) to increase significantly the availability of high-quality, timely and reliable data (…)". Indeed, Big Data could play a key role in better understanding climate change resilience and sustainable development, since it brings new data sources, tools, techniques, and communities that need to be leveraged to achieve the post-2015 development agenda. Not only is Big Data an opportunity for policy makers, governments, and civil society to obtain new and better insights into the collective behavior of communities, it is also a new socio-technological phenomenon capable of leveraging established processes and tools when measuring SDGs.

Big Data as an ecosystem affects societies through one or more of its four functions:

- Its descriptive function involves narrative or early detection such as using data from satellite imagery to identify flooded areas or identifying areas in need within crisis maps;
- Its predictive function includes what has been called "now-casting"—to infer real-time population distribution based on cell-phone activity before, during or after a shock, for example—as well as forecasting sudden and slow-onset hazards;
- Its prescriptive (or diagnostic) function goes beyond description and inferences to establish and make recommendations based on causal relations, for instance, by identifying the effects of agricultural diversification on resilience;
- Its discursive (or engagement) function concerns spurring on and shaping dialogue within and between communities and with key stakeholders about the needs and resources of vulnerable populations, such as crowdsourcing maps to assist disaster relief efforts.

## RESILIENCE

The SDGs also call for action to protect, empower, and enhance the resilience of vulnerable communities (e.g., SDG 11, "Make cities and human settlements inclusive, safe, resilient, and sustainable" and SDG 13, "take urgent action to combat climate change and its impact"). Critically, we need to make clear what is being defined as resilience in this context: the capacity of a system (or community ecosystem) to absorb disturbance, reorganize, and then retain essential functions, structures, and feedbacks. "Resilience" implies that individuals, communities, and ecosystems can adapt to climate change-related disasters, but also to evolve and transform themselves accordingly.

Climate science typically involves massive amounts of computational power and data from various sources. In the context of climate resilience, sensor data such as satellite remote sensing (SRS) helps monitor indicators that are key to anticipating precipitation extremes such as terrestrial and sea-sur-

TABLE 1
**FIVE WAYS IN WHICH BIG DATA CAN ENHANCE CLIMATE CHANGE RESILIENCE EFFORTS**

| |
|---|
| **Monitoring hazards:** Seismographs, satellites, and drones offer ever-improving remote sensing capabilities. Adding vibration data from citizens' smartphones or information from their Twitter feeds offers tremendous potential for monitoring such hazards as earthquakes and floods. |
| **Assessing exposure and vulnerability to hazards:** Satellite images enable experts to identify geographical and infrastructure risks. Crowdsourcing initiatives like the OpenStreetMap project empower volunteers to add ground-level data that are useful notably for verification purposes. CDRs—phone metadata that tracks numbers and times of calls—have been used to estimate population distribution and socioeconomic status in very diverse places. |
| **Guiding disaster response:** Social media can be monitored to provide early warning of threats ranging from disease outbreaks to food insecurity. Remote sensing has been used to provide early assessment of damage caused by hurricanes and earthquakes. Mobile phone data can provide precious information on population movements and behavioral response after a disaster. |
| **Assessing the resilience of natural systems:** Satellite images revealing changes in, for example, soil quality or water availability have been used to inform agricultural interventions in developing countries. Citizen science reporting via social media and other platforms can radically expand scientists' observations of ecological systems. |
| **Engaging communities:** Building long-term resilience takes more than enhancing the ability of both external and local actors to react to single events. Resilient communities manage their natural systems, strengthen their infrastructure, and maintain the social ties and networks that make communities strong. The longer-term potential of Big Data lies in its capacity to raise citizens' awareness and empower them to act. Decisions that facilitate or hinder this capacity are fundamentally political ones. |

RICE CROP YIELDS INCREASE

**3**

TONS PER HECTARE WITH DATA TECHNOLOGY

TABLE 2
**SPECIFIC AREAS OF CONCERN IN LAC**

| | KEYS RISKS | WHAT IS AT STAKE |
|---|---|---|
| **MAIN AREAS OF CONCERN** | Reductions in the income of vulnerable groups, especially in the agricultural sector, increased income inequality. | |
| **AGRICULTURAL ACTIVITIES** | Intensification of desertification and soil degradation processes, decreases in food production and quality, lower revenues, rising prices | In 2010, the rural poverty rate was twice as high as that of urban areas, and the extreme poverty rate was four times as high. Due to dependency on small-holdings, rainwater irrigation, and other environmental resources that are particularly susceptible to the effects of climate change, the rural poor are more likely to feel the impacts of climate change and variability. |
| **WATER RESOURCES** | Water supply in semi-arid and glacier melt-dependent regions, flooding in urban areas associated with extreme precipitation | The region has abundant water supply, although this is unequally distributed among countries. Changes in hydrological conditions are already happening (e.g., Argentina) and there is increasing risk for people in water-stressed conditions. |
| **URBAN AND HEALTH** | Infrastructure problems (especially for the urban poor), deterioration in air quality, increasing pollution | Settlements in hazardous areas (floodplains, mountain slopes, etc.) already facing infrastructure problems (water supplies, sanitation, solid waste management) are at greater risk of flooding, being affected by extreme weather, seasonal storms, sea surges and other disasters. Urban transportation is increasingly private, associated with high levels of gasoline consumption generating negative health externalities (e.g., increases in respiratory diseases). |
| **COASTLINES** | Rising sea levels, loss of infrastructure, extreme events | 348 million people live within 200km of the coastline, thus being particularly exposed to natural hazards (storms, cyclones) and sea-level rise and coastal flooding. Communities that rely on natural resources for a living (e.g., tourism or fishery) are at greater risk. |
| **EXTREME WEATHER EVENTS** | Evidence of a correlation between climate change and extreme weather events, especially those triggered by increases in mean temperatures. | Extreme weather events include droughts, floods, earthquakes, storms, tropical cyclones, and El Niño Southern Oscillation. Consequences of natural disasters include increases in public spending and adverse impacts on ecosystems and natural stocks. A large portion of LAC's population is still highly vulnerable to the impacts of extreme weather events. |
| **BIODIVERSITY & FORESTS** | Changes in land use, disappearance of forests, coral reef bleaching, loss of biodiversity and of ecosystem services | LAC is the most biodiverse region in the world, contains the largest freshwater reserves, and is home to the Amazon, the world's largest carbon sink. One-quarter of the countries with the highest number of threatened animal species (Brazil, Colombia, Ecuador, Mexico, and Peru) and 7 out of 20 countries with the most threatened plant species (Brazil, Peru, Mexico, Colombia, Jamaica, Panama, and Cuba) are in LAC. |

face temperatures, atmospheric temperatures, sea-level rise, ice melt and glacier retreat, and changes in precipitation regimes. SRS data is also fundamental to assessing numerous environmental variables, including detecting trends in growing season parameters and their impacts on crops, soil degradation, or key water cycle variables (see the box on Big Data and Agricultural Output).

Imagery is also used to assess settlement patterns in countries or regions facing the most critical vulnerability challenges, particularly the presence of slums, informal settlements, and highly variable sizes and densities of built-up structures and sparse and scattered rural-urban areas. Not all important resilience variables can be remotely sensed using satellites. Physical sensors on the ground provide a rapidly growing source of Big Data, such as by enabling better monitoring of carbon emissions or electricity consumption patterns, which can in turn be used to make power supply systems more resilient and efficient. For example, as part of a smart city initiative in Guadalajara (Mexico), the city and Cisco Systems are analyzing sensor data to improve energy efficiency.

Beyond data about the physical environment, Big Data also yields insights into the social, demographic, behavioral, and psychological dimensions of resilience and climate change. Big Data on social ties and social networks at the neighborhood or community level were found to be strong factors determining immediate loss and long-term recovery from disaster. Knowing where people are is arguably the simplest and most crucial statistic for any stage of climate analysis, adaptation, and mitigation, and certainly for social vulnerability assessment and response. Call detail records (CDRs) and GPS locations have been compiled and analyzed for descriptive purposes such as real-time information on patterns of movement and migrations. CDRs also provide insight on potential vulnerabilities and behaviors during and after disasters, including social cohesion, an important component of resilience.

**60%**
OF THE POPULATION
WILL HAVE A CELL PHONE
BY 2020

These examples show that Big Data has the potential to improve humanitarian efforts and make them operational by developing an understanding of resilience and social vulnerability to climate change impact. New data sources and new techniques to garner insights enable researchers and practitioners to move beyond census data and other official statistics that are difficult and time consuming to collect to more dynamic, responsive, and effective information for resilience at all scales.

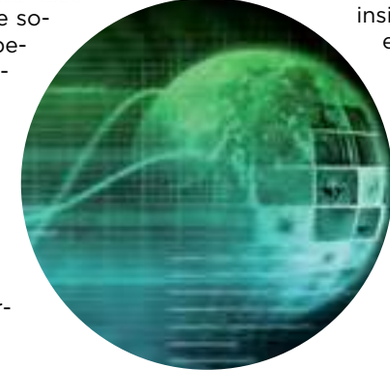


TABLE 3
**ADDED VALUE OF BIG DATA ACROSS LAC CLIMATE HOTSPOTS**

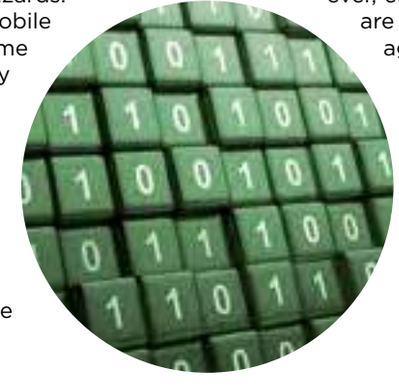
| CLIMATE HOTSPOT | ASSOCIATED VULNERABILITIES | USE CASES OF ADDED VALUE OF BIG DATA |
|---|---|---|
| **CENTRAL AMERICA AND THE CARIBBEAN** | Extreme events threatening human livelihood and damaging infrastructure | • Situational awareness, e.g., identifying populations and critical infrastructure at risk.<br>• Early warning, e.g., using tweets, check-ins (Foursquare), Facebook content, and YouTube videos to provide early warning of threats ranging from disease outbreaks to food insecurity.<br>• Immediate impacts, e.g., providing early assessment of damage caused by hurricanes and earthquakes.<br>• Situational awareness, e.g. providing individuals in disaster situations critical information in real time.<br>• Postdisaster response, e.g. providing information on population movements and behavioral response after a disaster, define optimal positioning of levees and shelters, design robust evacuation routes. |
| **ANDES** | Changes in water resource availability challenge the rural and urban poor | • Satellite imagery can provide dynamic and high-resolution data on soil quality and water availability.<br>• Big Data can be used to promote community engagement, e.g., to raise awareness about risks in water scarcity and provide real-time feedback to enhance response and community-led preparedness. |
| **AMAZON** | Risks of tipping point, forest degradation, and biodiversity loss threaten local communities | • Early detection of tipping point situation. Big Data methods have been applied, e.g., to the sustainability of harvested fish stocks. |
| **SOUTHERN CONE** | Hydrological changes that may affect the wider region | • Satellite imagery can provide dynamic and high-resolution data on soil quality and water availability.<br>• Big Data, notably social media (e.g., Twitter hashtags) for early detection of and response to floods. |
| **MEXICAN DRY SUBTROPICAL REGIONS AND NORTHEASTERN BRAZIL** | Increasing drought stress threatening rural livelihoods and health | • Monitor desertification. |

## BIG DATA IN LATIN AMERICA AND THE CARIBBEAN

Although Big Data should not be taken as the ultimate solution for all problems, it does hold the potential to bring new insights to climate resilience efforts by combining data crumbs and enhanced capacities to created more adaptive communities. Countries in LAC are high value-add contexts in which to explore Big Data technologies. The region shows rapid growth in cell phone use and social media consumption, and is the fourth-largest mobile market in the world. While technology penetration is still far from being comprehensive—there is a gender gap in cell phone ownership of 5% in the region (Santosham and Lindsey, 2015)—more than half of its population now owns and uses a cell phone.

Estimates indicate that by 2020, mobile penetration will reach 60%, almost the global average. Moreover, the region is becoming one of the largest producers and consumers of social media, most notably Facebook and Twitter, which produce large amounts of data that could become relevant for the development field, since it improves the ability of humanitarian and disaster risk reduction organizations to monitor and respond to hazards.

In Brazil, mobile phones have become the number one way of accessing the internet (IBGE, 2016). This is especially true in the northern region, one of the two poorest regions in Brazil, where three-quarters of homes access the internet through a mobile phone (IBGE, 2016). Mobile-based social media and crowdsourced content could be used to build resilience in the region. Local communities living in the Northern region, particularly the Amazon, are especially vulnerable to climate change impacts and could benefit from investments in data literacy, for example.



## VULNERABILITIES AND CLIMATE CHANGE

In 2011, LAC greenhouse gas emissions accounted for 9% of the global share, far behind Asia and the Pacific (37%), Europe and Central Asia (18%), and Canada and the United States (15%) (ECLAC, 2015). The region's patterns of greenhouse gas emissions differ from the world's, in which the energy sector accounts for almost three-quarters of the total. LAC has a cleaner energy mix than other world regions, with the energy sector accounting for 42% of the region's total emissions. Activities such as electricity and heating, manufacturing, construction, and transportation are the largest consumers of energy. Agriculture (28%) and changes in soil use and forestry activities (21%) represent a much higher proportion of emissions in LAC than in the world average. However, energy-related emissions are increasing whereas agriculture and forestry-related emissions are declining. Evidence suggests that mitigation processes aiming to control and reduce greenhouse gas emissions are not yet in place. Climate models indicate that temperatures will

rise by 2°C if current emission trends prevail. Even if the region's historical contribution to greenhouse gas emissions is limited, it is now particularly vulnerable to the consequences of this.

LAC's current development model needs to shift towards a more sustainable path if countries hope to limit temperature increase. This means rethinking the region's current consumption patterns, fueled by the rise of a middle-income class migrating towards private healthcare, education, and transportation. According to ECLAC "these consumption patterns [...] are associated with significant negative externalities, such as the generation of waste, air pollution, environmental deterioration or destruction, increased use of renewable and nonrenewable resources, and emissions of the greenhouse gases that are driving climate change" (ECLAC, 2015).

In the last decade, LAC achieved historic levels of development in socio-economic terms: extreme poverty has been halved since 2003 and for the first time there are more people in the middle class than there are living in poverty. However, income inequalities persist and are central to the discussion around building resilience to climate change in the region. People living in coastal areas and slums and marginalized groups are particularly vulnerable to the effects of climate change. Female-headed households, which have less access to resources and fewer opportunities for participating in policymaking, are more exposed to shocks and future climate change risks. Indigenous people living in the Amazon, the Andes, the Caribbean, and Central America are directly affected by changes in the seasonal cycle, in that "river flooding affects fish and turtle reproduction, thereby impacting the food security of indigenous populations; changes in periods during which important local fruits ripen and the succession of dry and rainy seasons affect the harvests of wild fruits; and changes in the length of the dry season affects agriculture productivity, particularly in alluvial plateau gardens" (World Bank, 2014).

So far, LAC's sustainable development strategies have preserved its forests more than any other region has. However, due to the confluence of risk factors and the possibility of increased disasters, the international community has stressed the need to make risk reduction a core development concern, making a more aggressive call to address climate change, which not only affects the environment but also economic and sustainable development, especially for impoverished communities.

**24%**

OF THE WORLD'S ARABLE LAND IS IN LAC

### BIG DATA AND AGRICULTURAL OUTPUT

LAC countries represent 24% of the world's arable land and 11% of the world food production (value wise): the agricultural sector is a key economic strength in LAC and will be particularly affected by climate change. Related impacts will compound existing development challenges, such as poverty levels in rural population (two-thirds still live below the poverty line), access to water, and food security. Both crop and livestock productivity will decline, putting the region at risk of hunger. However, LAC has a competitive advantage in terms of land resources as well as the highest share of renewable water resources in the world.

Accurately assessing potential threats to agriculture would allow policy makers, governments, and communities to be better prepared to design and implement adaptation and mitigation strategies. In this sense, the added value of Big Data for facing climate change-related risks for agriculture comes in the form of data-driven analytical tools (data crumbs), that could be used to assess existing risks and/or vulnerabilities that may be accentuated due to rising temperatures, increasing natural hazards, changes in precipitation regimes, sea-level rise, etc.

So-called climate-smart agricultural practices, for example, which have been put forward to alleviate the region's risk in terms of agricultural productivity and food security, could be further enhanced by Big Data in the form of new and more data sources, tools, and capacities and communities that are able to engage through and with data. For example, in Colombia, the International Center for Tropical Agriculture has developed models of agricultural productivity for small-scale farmers using Big Data analytics to reveal how climate variations impact rice yields. By identifying the most productive rice varieties and planting times according to location and weather spells, they are contributing to boosting crops by 1 to 3 tons per hectare. The model is being scaled out in the region, including in Argentina, Nicaragua, Peru, and Uruguay (CGIAR, CCAFS, 2015).

## RISKS IN LATIN AMERICA AND THE CARIBBEAN

According to the UN Office for Disaster Risk Reduction, climate-related disasters have doubled and currently account for 90% of disasters worldwide. In LAC, clear evidence of this can be seen in the massive 2005 and 2010 Amazon droughts, the increased frequency of Atlantic hurricanes, and the 90% loss of tropical glaciers in the region. Heat extremes and changing precipitation patterns will affect agricultural productivity, hydrological regimes, and biodiversity.

The specific areas of concern in LAC are detailed in the table

## VALUE ADDED

Big Data has the potential to bring new insights for climate resilience efforts by combining data crumbs and enhanced capacities. As described above, there are four main types of Big Data analytics for resilience: descriptive analytics, predictive analytics, prescriptive analytics, and discursive analytics. By relying on these functions, we have

## RECOMMENDATIONS FOR LEVERAGING BIG DATA FOR CLIMATE CHANGE RESILIENCE IN LAC

### INVESTMENTS IN TECHNOLOGIES

- Tap mobile phone data more fully and rapidly. Mobile phones are a key technology entry point in LAC and can be tools for data collection and action. However, investing in human and technological capacity building is needed to gather, process, and analyze this data.
- Invest in forms of existing applications that have high returns, e.g. social media, mobile record data, and crowdsourcing approaches that combine machine and human computing.
- Promote wide access and use of early warning systems and risk maps, notably by developing human-centered designs for the existing models and techniques.

### INVESTMENTS IN COMMUNITIES

- Tap mobile phone data more fully and rapidly. Mobile phones are a key technology entry point in LAC and can be tools for data collection and action. However, investing in human and technological capacity building is needed to gather, process, and analyze this data.
- Invest in forms of existing applications that have high returns, e.g. social media, mobile record data, and crowdsourcing approaches that combine machine and human computing.
- Promote wide access and use of early warning systems and risk maps, notably by developing human-centered designs for the existing models and techniques. • Invest in capacity building and data literacy to enhance people's willingness and ability to engage with and via Big Data. • Promote and incentivize data sharing and private sector involvement, notably the telecommunications sector, via the organization of data challenges and promotion of financial and in-kind support. In LAC countries, lack of public access to data sources is one of the main barriers to a Big Data revolution that could benefit all. • Facilitate coordination among stakeholders by fostering the regional data ecosystem around key actors and activities, e.g. developing data-sharing guidelines and common standards, synchronizing big data sources.

Spurring dialogue on ethics and privacy. The potential for unethical or even dangerous use of Big Data is growing exponentially in developing countries and there is an urgent need for developing ethical guidelines addressing privacy and other political and legal risks.

**SPURRING DIALOGUE ON ETHICS AND PRIVACY.** The potential for unethical or even dangerous use of Big Data is growing exponentially in developing countries and there is an urgent need for developing ethical guidelines addressing privacy and other political and legal risks.



identified examples showing the added value that Big Data can bring to address climate vulnerabilities across the different climate hotspots in LAC.

## REQUIREMENTS FOR LEVERAGING BIG DATA

The region has shown signs of leadership when it comes to combating climate change. Major investments in green transportation systems, clean energy, as well as payments for environmental services and forest conservation programs that combine advanced technology with the knowledge of local communities have been made. Appropriate investments in Big Data to overcome the barriers, gaps, and risks associated with the application and use of Big Data could further enhance climate change resilience in LAC. As mentioned before, LAC is a high value-add context for Big Data development, especially due to the extent of cell phone penetration and internet access. But leveraging Big Data is often highly complex, and volatile environments add to the need to be especially mindful of technological, human, logistical, and ethical factors when attempting to build resilience.

Big Data has the potential to become a central tool for better understanding and reacting to climate change. Through proper investments in technologies, communities, and in the field, Big Data will inform efforts towards sustainable development and resilience to climate change in LAC. However, as projected risks in LAC affect several sectors, regions, and populations, urgent multisector coordination will be essential among regional policy makers, civil society, and vulnerable communities if they are to engage and exploit Big Data effectively. The core of any development of Big Data–related technologies must be a comprehensive and human-centered approach, involving all stakeholders, including people living in coastal areas, slums, and marginalized population groups, and informed by dialogue on ethics and privacy.

**NOTES**

[1] The authors wish to thank Fernanda Villaseñor for her assistance with their research. This article builds on past research produced by the Data-Pop Alliance.

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CASE STUDY


# DISRUPTIVE TECHNOLOGIES

## FIVE INVENTIONS THAT COULD HELP TO SAVE THE WORLD

The encyclical *Laudato Si'* warns that when technology attempts to be the silver bullet for all our problems, the technocratic paradigm begins to threaten ecosystems. However, the text also invites us to celebrate technological progress and be excited by all the possibilities this opens up. "Technoscience, when well directed, can produce important means of improving the quality of human life."

The key is for this "immense technological development" to go hand-in-hand with "a development in human responsibility, values and conscience." These innovations could bring about a qualitative leap in the struggle against climate change by reducing the use of polluting forms of energy or improving recycling techniques if they are used responsibly and with the aim of promoting sustainable development. What are the cutting-edge technologies that will help us address climate change?

### 1. BIG DATA APPLIED TO ENERGY

Solar and wind power have become key sources of clean energy but they also pose challenges. One such difficulty is intermittency since sun and wind energy are not always available. However, the use of artificial intelligence and big data can help mitigate intermittency. New software developments are making it possible to predict usage peaks and availability periods more effectively so as to use these natural resources more efficiently.

### 2. PHOTOVOLTAIC PANELS

Placing photovoltaic panels on satellites in geostationary earth orbits can capture the sun's energy and transmit it wirelessly back to earth. Technology could thus help overcome the main problem of solar energy, which is intermittency, caused by cloud formation in the atmosphere or the absence of sun at nighttime. Advocates of this technology argue that space-based solar power is literally billions of times more powerful than the solar power that we use on earth and is undoubtedly the largest source of energy available to us. However, there are various obstacles that are holding this technology back or preventing it from being implemented, most of which are to do with its extremely high cost, the difficulty in manufacturing photovoltaic panels that can withstand the intensity of solar radiation in space, and efficient wireless transmission of the energy back to earth.

### 3. CLEAN ENERGY BATTERIES

An organic redox flow battery would be able to store electric energy at a low cost and for longer periods of time than other technologies. If this were to be effectively developed, it would play a significant role in supporting the increased development of renewable energies and the electric vehicle industry.

### 4. $CO_2$ CAPTURE AND STORAGE

Some factories can use heat to capture carbon dioxide ($CO_2$) that is then reused for industrial purposes. The advantage of these factories is that they can be designed and built anywhere in the world to meet whatever needs the client has.

### 5. GEO-ENGINEERING

NASA has been looking at the idea of installing a giant space sunshield. This would provide shade for certain regions of the earth and thus prevent the warming caused by climate change. One design entails countless thin, light disks that would be placed 1.5 million kilometers from earth. Another option could be autonomous ships that roam the oceans spraying clouds to fill them with saltwater, which would help to reflect sunlight and prevent the planet's temperature from increasing.

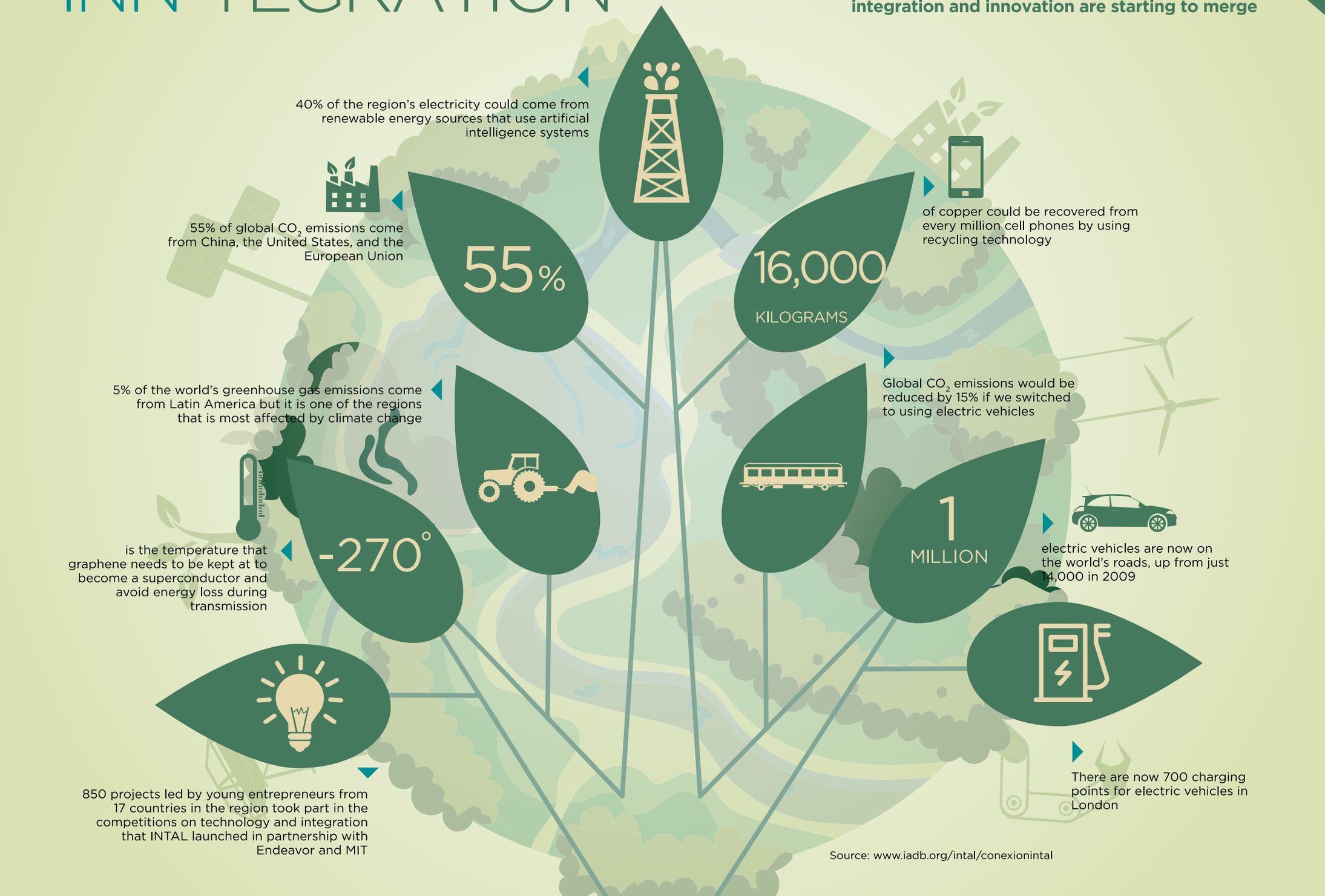
# INTEGRAL ECOLOGY

Since everything is closely interrelated,
I suggest that we now consider
some elements of an integral ecology,
one which clearly respects its
human and social dimensions.

*Laudato Si'*

# INN-TEGRATION

**In a world in which technology is pushing geographic boundaries and blurring borders, integration and innovation are starting to merge**




Source: www.iadb.org/intal/conexionintal

ANALYSIS

Ottmar Edenhofer and
Anselm Schultes
Potsdam Institute for Climate Impact Studies

# Energy policy for sustainable development

UNTIL GREATER PROGRESS IS MADE IN DEVELOPING WIDELY ACCESSIBLE SOURCES OF RENEWABLE ENERGY, IT IS LEGITIMATE TO CHOOSE THE LESS HARMFUL ALTERNATIVE OR TO FIND SHORT-TERM SOLUTIONS

*Laudato Si'*

Last year in Paris, most nations of the world agreed upon an ambitious international climate agreement to limit the global temperature increase to well below 2°C. National contributions to emissions reductions, however, are radically insufficient for reaching the climate targets. In this article, we review the Paris Agreement and show that further action on climate and energy policies across the globe is urgently needed. We highlight several aspects from a global perspective, but with a focus on Latin America: the long-term prospects of clean energy technologies, the market potential of renewable energy and associated market failures, and the role of climate policies for trade in energy resources. We discuss the current state of climate and energy policies and argue that strengthening carbon pricing is crucial for effective emissions reductions.

In 2015, Pope Francis sounded a moral appeal in his encyclical *Laudato Si'* to recognize the climate system as a common good, meant to belong to everyone on the planet. Fighting climate change in order to leave the environment in a better shape for generations to come is thus a moral imperative. A few months after the publication of the encyclical, in December 2015, representatives of most nations of the world agreed upon the most comprehensive climate accord to date. The agreement came after more than two decades of international negotiations under the United Nations Framework Convention on Climate Change (UNFCCC). In the Paris Agreement, nations agreed to restrict global temperature rises from climate change to well below 2°C, and to pursue efforts to limit it to no more than 1.5°C.

The Paris Agreement also lays the foundations for the ways in which the greenhouse gas emissions reductions necessary to meet the global targets should be achieved. In the run-up to the negotiations, each nation pledged some emissions reductions as part of their Intended Nationally Determined Contributions (INDCs), known simply as Nationally Determined Contributions (NDCs) following COP21. The agreement specifies how to regularly compare national contributions to emissions reductions with the global climate targets in a global emissions stocktake and envisions rising national climate policy ambitions over time. It also lays out a number of multilateral instruments to facilitate sharing the costs of emissions reductions, arguably the most important being the Green Climate Fund.

We believe that strengthening carbon pricing is crucial for effective emissions reductions. Beyond that, a price on carbon does have many additional benefits, for example those related to public finance and synergies with the Sustainable Development Goals. We propose that international climate policy based on carbon taxation and strategic transfers could help to build effective global mitigation action, which is urgently needed to make the Paris Agreement successful in saving the climate as a common good for generations to come.

As of this writing, the global emissions reductions implied by the INDCs fall drastically short of the climate targets that are aspired to (Rogelj et al., 2016) (see figure 1). To reach the 2°C target, cumulative greenhouse gas emissions between 2011 and the end of the century cannot exceed a budget of around 900 gigatonnes $CO_2$—the 1.5°C target only allows for a budget of around 300 gigatonnes $CO_2$. The emissions that would be released if countries adhere to their current INDCs are estimated at more than 700 gigatonnes $CO_2$ until 2030 alone, close to what the 2°C target would allow as an emissions budget for the whole 21st century (figure 1). The emissions budget for the 1.5°C target would be long overshot in the year 2030. By 2030, under the current INDCs, any attempt to still reach the 1.5°C target would require the deployment of negative emission technologies on a massive scale, but these technologies are risky and their deployment is subject to large uncertainties.

Arguably, the biggest obstacle to reaching the aspired climate targets is coal: the lifetime emissions from coal-fired power plants existing around the globe today alone will use up much of the emissions budget for the 1.5°C target. Additionally, coal-fired power plants currently planned and under construction around the world will double the emissions from coal power (see figure 1). In fact, many poor and fast-growing nations increasingly rely on coal power to satisfy their demand for energy, in part driven by low prices of coal in the last decades (Steckel et al., 2015). This renaissance of coal is incompatible with the global climate targets of the Paris Agreement. The effectiveness and success of the Paris Agreement will largely depend on whether all nations turn away quickly enough from fossil fuel–based development (in particular from coal power) and toward low-carbon development pathways.

The remainder of this article discusses the global perspectives for clean energy, the market potential of renewables, implications for resource trade, and the state of energy and climate policy, with a particular focus on countries in Latin America.

## LONG-TERM PERSPECTIVES FOR CLEAN ENERGY

Deep emissions cuts across sectors are necessary to achieve the climate targets set forth in the Paris Agreement. Pathways to the 2°C target require reducing global emissions to net zero by the end of the century. Reaching the 1.5°C target requires net zero emissions

THE POTENTIAL FOR RENEWABLE ENERGY PRODUCTION IN LATIN AMERICA IS

**20 TIMES**

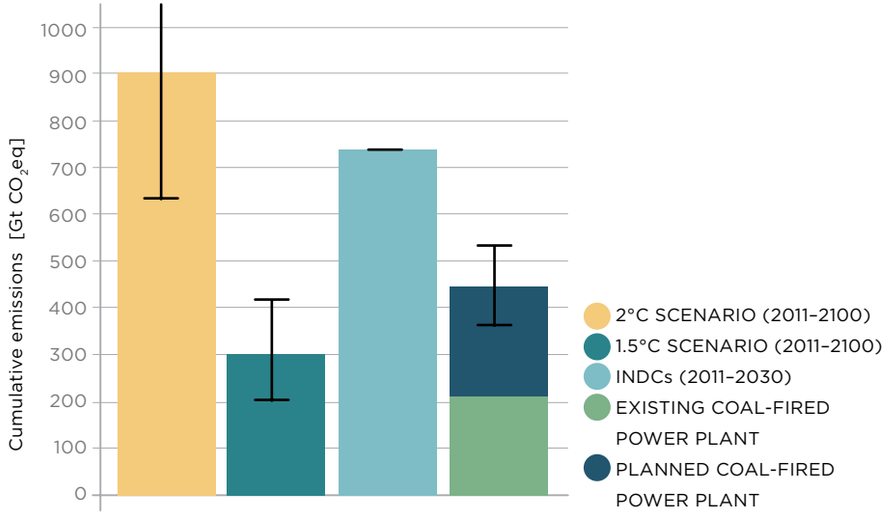
GREATER THAN CURRENT DEMAND FOR ENERGY

around midcentury, followed by negative emissions in the second half of the century (Rogelj et al., 2016).

Clean energy technologies are key to achieving emissions reductions. Improving energy efficiency, that is, reducing the energy demand of producing a given economic output, has great potential to contribute to emissions reductions. Clean energy on the supply side includes renewable energy sources such as wind and solar power, hydropower, and bioenergy. Nuclear power can be considered a clean energy source to some extent, but may come at the expense of significant additional environmental concerns and risks: nuclear power is by and large $CO_2$ neutral, but its deployment has stagnated globally in the last decades, often amid concerns about high costs. The problem of nuclear waste disposal and risks due to the proliferation of nuclear technology limit its prospects as a clean energy technology.

Fossil-fueled power plants may be complemented by technologies that render them cleaner, such as fossil fuel combustion using carbon capture and storage technologies, which results in the separation of $CO_2$ that may then be permanently stored in geological formations. These technologies would enable the use of fossil fuels with much reduced greenhouse gas emissions. To date, they have not been deployed on a large scale. Risks related to the long-term safety and viability of $CO_2$ storage are substantial, and the many other detrimental environmental side effects of fossil fuel extraction remain unsolved. Carbon capture and storage technologies may also be used in combination with bioenergy, in sum delivering negative greenhouse gas emissions. The large-scale production of bioenergy may have many risks and potential negative side effects, compounding the risks already presented by carbon capture and storage technologies (Creutzig et al., 2015).

FIGURE 1
**IPCC EMISSIONS BUDGETS FOR THE 2°C TARGET AND THE 1.5°C TARGET FOR 2011–2100**




Note: Emissions budgets for the 2°C target (IPCC, 2014) and the 1.5°C target (Rogelj et al., 2015) for the period 2011-2100, compared to the cumulative emissions implied by the INDCs (United Nations, 2016) and lifetime emissions by coal-fired power plants existing in 2012 (Davis et al., 2014) and those planned and under construction as of 2016 (Coal Tracker, 2016). Many thanks to Ulrike Kornek for advice in creating this figure.



REACHING THE GOAL OF ONLY

**2°C**

OF WARMING BY 2100 IMPLIES BRINGING NET EMISSIONS DOWN TO ZERO

As electricity production makes up a large share of current emissions, and many clean energy technologies are available as alternatives, this sector is key to the mitigation of greenhouse gases. Renewable energy sources are arguably the most important clean energy technologies, and certainly have a large technical potential—defined here as the energy output obtainable through the full implementation of demonstrated technologies (Edenhofer et al., 2013). The technical potential of renewable energy does not to limit its growth prospects in any world region (Arvizu et al., 2011) (see figure 2).

Latin America is blessed with a particularly large technical potential for renewable energy that is estimated at around 20 times today's primary energy demand (see figure 2). Solar power makes up the lion's share of total technical potential globally, but Latin America's potential is quite diverse: solar and geothermal potential make up three-quarters of the total renewable potential. Compared to other world regions, Latin America also has relatively large technical potential for hydro and bioenergy power.

Naturally, it is not economical to make use of the full technical potential of renewable energy. The economic potential of renewable energy is a subset of the technical potential, and considers technical feasibility as well as cost considerations and potentially diverse public policy objectives. To determine the economic potential of renewable energy, a particular weighting of public policy objectives (e.g., climate change mitigation, green growth, energy security, and poverty reduction) is used. To reach the respective objectives in an effective manner, the deployment of clean energy technologies may be justified as a means, and the resulting level of deployment is called the economic potential (Edenhofer et al., 2013).

As climate change is a global challenge, the economic potential of clean energy has to be determined globally. This is commonly done using Integrated Assessment Models of Climate Change that describe the economy, energy, land use, and the climate system in a coherent way to find optimal mitigation pathways. The resulting mitigation pathways—for example, those compatible with the 2°C target—then specify the economically optimal contributions to emissions reductions across regions and sectors (see figure 3).

Mitigation pathways stratify the economic potential of emissions reductions by sector and clean energy technologies. In figure 3, the global economic potential of emissions reductions compatible with the 2°C target is stratified by sector. All sectors contribute to $CO_2$

LATIN AMERICA WOULD NEED TO INVEST

**US$ 20 BILLION**

PER YEAR IN ELECTRICITY TO REACH THE TARGET OF 2°C

emissions reductions. Buildings and industry sectors undergo a nearly full decarbonization during the 21st century. Emissions in the transport sector are reduced more slowly, as decarbonization is more expensive in this sector. The agriculture, forestry, and other land use (AFOLU) sector has net negative $CO_2$ emissions toward the end of the century. Non-$CO_2$ emissions from all sectors are only slightly reduced. Electricity stands out, as emissions reductions start very early on, and turn deeply negative by midcentury through the use of bioenergy in combination with carbon capture and storage. If this negative emissions technology should not become available, other land-based mitigation options in the AFOLU sector (e.g., afforestation) could possibly provide similar potential for negative emissions. This is shown in the right panel of figure 3.

The economic potential of specific clean energy technologies is presented in figure 4, in which economic potential is stratified by technology. Without climate policy, emissions are shown to rise strongly until around midcentury, at which time a mitigation pathway toward 2°C reduces emissions strongly, bringing them into the negative near the end of the century. The contributions of clean energy technologies fill the gap between the two emissions scenarios, sometimes known as technology wedges. Demand-side reductions begin early in the century, and nuclear power and fossil fuels in combination with carbon capture and storage provide some midcentury emissions reductions. In the long run, renewable energy and bioenergy in combination with carbon capture and storage have the largest economic potential of all technologies by far in this scenario.

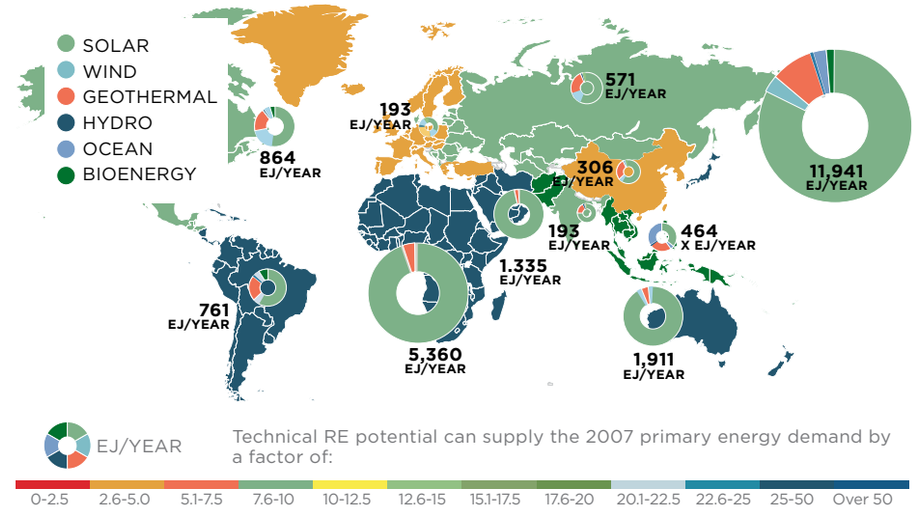
To deliver on the large economic potential of clean energy technologies, investments have to undergo drastic changes in the coming decades. Necessary changes in annual investments flows to reach a 2°C target (see figure 5) include a global shift away from fossil fuel infrastructure toward all forms of clean energy technologies by 2030. Investments in energy efficiency and renewable energy make up the bulk of such clean investments.

For Latin American countries, climate policies in line with the 2°C target require an additional 5% of cumulative investment in the energy sector by 2050 (Kober et al., 2016). This number hides a drastic shift in the structure of investments: While investment in fossil fuel production and refining decline massively, cumulative investment in the electricity sector increases by close to 50% by 2050. Consequently, additional investments of around US$20 billion annually in the electricity sector in Latin America are anticipated to be required in order to reach the 2°C target (Kober et al., 2016).

## MARKET POTENTIAL OF RENEWABLE ENERGY

Investments in energy technologies are, to a great extent, made by private actors. If the clean energy investment necessary to achieve ambitious climate targets are made in a timely way and clean technologies are deployed at their

FIGURE 2
**TECHNICAL POTENTIAL OF RENEWABLE ENERGY BY 2050**

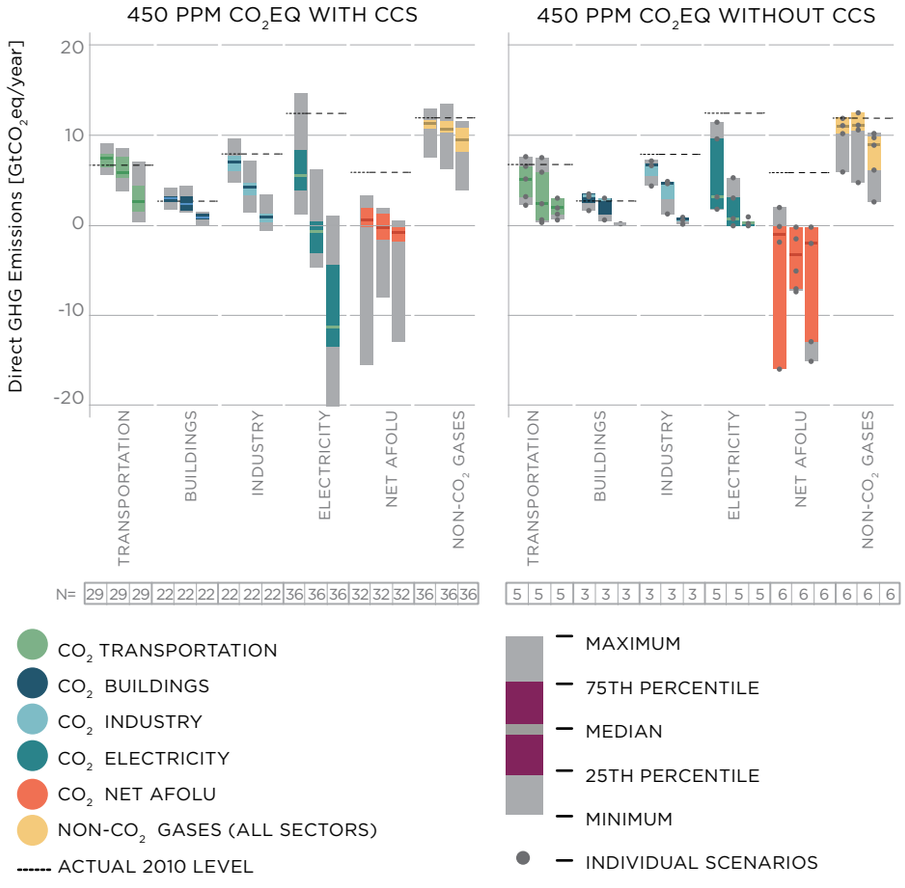



Note: reproduced from figure TS.10.9 in Arvizu et al. (2011). The global potential is above 11,000 EJ/year. In every world region, the potential is much larger than the current primary energy demand.

full economic potential, the market potential of a clean energy is said to be equal to its economic potential. Market potential is determined by the incentives of firms and investors, and greatly influenced by public policies. With regard to climate change, the most important public policies are those aimed directly at reducing greenhouse gas emissions, such as carbon pricing. There may be additional market failures that, if not targeted by appropriate policy instruments, cause the market potential of clean energy to stay below its full economic potential. Two of the arguably most relevant additional market failures in the context of climate change are in the innovation and adoption of clean energy technologies and in relation to the variability of renewable energy supply.

Market failures in innovation and adoption of clean energy occur when private actors are unable to appropriate the full returns to their R&D or deployment efforts, which hinders clean energy deployment. Market failures exist in both areas: 1) in innovation, such as in research and development; and 2) in the adoption and diffusion of technologies (Jaffe et al., 2005). The scientific literature finds many cases of such external effects caused by imperfect property rights or spillover effects, but their exact magnitude is hard to determine empirically. Technology policy targets such market failures, for example through the public funding of research or by addressing external effects in adoption and diffusion by investment cost subsidies or feed-in tariffs (Fischer et al., 2012). Though it is generally acknowledged that carbon pricing is, by a large margin, the single most important

FIGURE 3
**ECONOMICALLY OPTIMAL GLOBAL SECTORAL EMISSIONS REDUCTIONS FOR A SCENARIO COMPATIBLE WITH THE 2°C TARGET.**




Notes: reproduced from figure TS.17 in Edenhofer et al. (2014). Direct emissions of $CO_2$ are shown across sectors, and non-$CO_2$ greenhouse gases for all sectors are combined. The left panel assumes carbon capture and storage is available, while the right panel assumes it is unavailable. The white boxes indicate the whole range of scenarios (the number of scenarios in each category is indicated at the bottom of each bar), the colorful boxes indicate the 25th to 75th percentiles, and the black solid lines indicate the median. Dotted lines show 2010 emission levels.

climate policy instrument, there is often disagreement about the optimal degree of technology policy instruments that may be included as part of climate policy (Aldy et al., 2010).

Many renewable energy sources such as solar and wind power are not dispatchable, an issue also known as the intermittency or variability of supply. This can create challenges for existing electricity infrastructure because the supply of and demand for electricity have to be balanced at each instant in time. Technically, the integration of a high share of variable power supplies can be facilitated by technologies that help smooth electricity supply and demand over time and space. Increasing the demand-side elasticity by smart metering, for example, is one such measure. Building electricity storage capacities and grid interconnections or increasing the flexibility of thermal power plants can also raise the elasticity of the supply side (Hirth, 2015).

High shares of variable renewable

## CLEAN ENERGY AND TRADE

Trade in energy resources is important for many countries in Latin America, and the continent as a whole is a net exporter of fossil fuels (International Energy Agency, 2014). Stringent climate policies around the world could put revenues from fossil fuel export at risk: in order to reach the aspired climate targets, the use of fossil fuels will eventually have to decline. There are, however, large discrepancies in the market prospects of different types of fossil fuels. The use of coal, the dirtiest of all fossil fuels, will have to decline quickly to meet the global climate targets set forth in the Paris Agreement. It follows that export opportunities for this fuel will diminish in the coming decades. Export markets for oil and gas are expected to wane less quickly. Some studies estimate that the scarcity value of oil (in particular) and natural gas will not decline as dramatically on the global scale under stringent climate policy, hinting at sizable remaining export opportunities (Bauer et al., 2013).

Increasing export opportunities for biomass are expected to arise under stringent climate policies. Bioenergy, especially in combination with carbon capture and storage, is very valuable for ambitious climate change mitigation targets. Most of the potential to grow bioenergy feedstocks is concentrated in specific world regions, Latin America being one of them (Arvizu et al., 2011). Many countries in Latin America already have a track record of producing and using bioenergy, which could give them an edge in upcoming trade opportunities.

Bioenergy production on large scales is not without risks, as it could lead to adverse effects on ecosystems and societies if not properly managed. Purpose-grown bioenergy crops could, for example, increase deforestation, displace local farmers, or endanger food security. Consequently, for bioenergy to deliver a net benefit for climate change mitigation without negative side effects, policy design has to take into account emissions related to changes in land use, displacement of other water and land uses, biodiversity, and social aspects such as employment and access to land (Creutzig et al., 2015).

energy also challenge the current design of electricity markets. While many naive arguments about problems caused by the variability of supply neglect the dynamic response of the market, potential problems can occur. For example, existing electricity market imperfections may be exacerbated by increasing variability of supply. Such existing market failures include low demand response, coordination failures, or suboptimal price formation due to market power or regulatory intervention (Edenhofer et al., 2013; Cramton et al., 2012). It is hotly debated in the scientific literature just how significant these market failures are in the respective national or regional energy markets. Though some argue for complementing electricity markets with markets for generation capacity, there is no general agreement on the necessity of this measure (Edenhofer et al., 2013).

## REGIONAL CLIMATE AND ENERGY POLICIES

The current energy and climate policy landscape in Latin American countries is diverse. Countries in the region have been experimenting with renewable energy policies since the 1970s, and as of the time of writing, more than 300 distinct renewable energy support schemes exist at the national level across the continent (IRENA, 2015). Virtually all countries in Latin America have established renewable energy targets. Policy instruments enacted to deliver on these renewable energy targets are diverse, but consist mostly of auctions and fiscal incentives in the electricity sector, and of policies supporting biofuels in the transport sector (IRENA, 2015). In sharp contrast to the prevalence of renewable energy policies, only two countries in Latin America, Chile and Mexico, have established a price on greenhouse gas emissions (World Bank, 2015).

As mentioned above, there is wide agreement among economists that putting a price on carbon is the single most important climate policy instrument (Aldy et al., 2010). The current state of climate and energy policies in most countries of the world is far from being an effective package according to this thinking. While the plethora of technology policies supporting renewable energy will no doubt accelerate the transition to a low-carbon energy supply, technology policy without carbon pricing will not necessarily reduce carbon emissions. Pulling renewable energy into the energy mix via technology policy alone will not push out carbon-intensive energy sources quickly enough to achieve ambitious climate change mitigation targets (Kalkuhl et al., 2013). Technology policies without carbon pricing may also lead to low electricity prices that can trigger a rebound effect and increase energy demand, making it very costly or even impossible to achieve deep emissions reductions without comprehensive carbon pricing (Bertram et al., 2015).

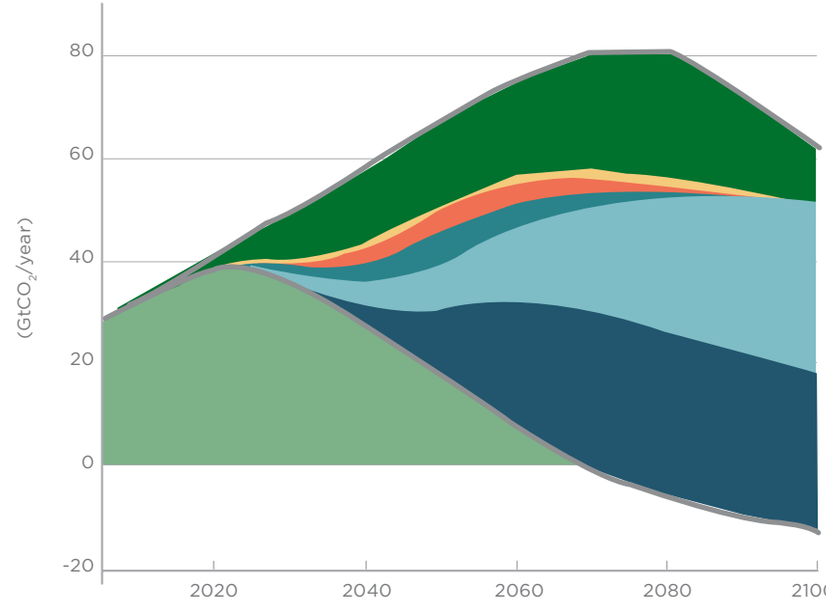
Germany provides a striking example. While feed-in-tariffs increased renewable energy to around one-third of the electricity supply, total greenhouse gas emissions did not decline drastically. In fact, emissions in the power sector actually increased since 2009, driven mostly by coal-fired power plants (Graichen et al., 2014). Even though the German power sector is covered by the European Union's emissions trading system, the emissions price signal was too weak to push coal power out of the power mix, preventing significant emissions reductions.

Pricing carbon is essential for effective emissions reductions, but also has additional benefits. First, revenue from carbon pricing may increase the effectiveness of public finance on the revenue raising and spending side. Carbon pricing may also help finance some of the Sustainable Development Goals. Finally, carbon pricing may be an essential component of the international climate policy landscape defined by the Paris Agreement.

Climate policy is often assessed separately from fiscal policy both by academic researchers, and policy makers. Siegmeier et al. (2015) argue that integrating carbon pricing and fiscal policy reveals several benefits: On the revenue-raising side of fiscal policy, pricing carbon may help national governments escape international tax competition by means of increasing private investment as some of the scarcity rents created by climate policy may be captured. Revenue from carbon pricing is thus an effective source of public funds, and could be invested in underfinanced public infrastructure or used to reduce public debt.

Revenues from carbon pricing can generate significant public funds. Annual revenues from a carbon tax of US$30 per tonne of $CO_2$ are estimated to be

FIGURE 4
**EMISSIONS REDUCTIONS FROM A BASELINE SCENARIO TO A 2°C SCENARIO**




Notes: Emissions reductions from a baseline scenario (upper solid black line) to a 2°C scenario (lower solid black line) broken down into contributions of various clean energy technologies or "technology wedges." Demand-side efficiency gains in are presented in gray, fuel switch in brown, fossil with carbon capture and storage in blue, nuclear power in red, renewables in yellow, and bioenergy with carbon capture and storage in green. Figure courtesy of Gunner Luderer, based on the method in Luderer et al. (2012) and the data in Luderer et al. (2013).

above US$150 per capita in Latin America (see figure 6). These public funds could go a long way to finance some of the basic public infrastructure that is necessary for achieving the Sustainable Development Goals. In many countries, carbon pricing could provide significant funding for access to clean water, sanitation, electricity, telecommunication, and paved roads (Jakob et al., 2016).

The distributional effects of carbon pricing can be significant, and careful policy design must address inequality concerns. While there are often concerns about the potentially regressive impacts of carbon taxation, recent research argues that the regressivity of a carbon tax can be avoided if the revenue recycling is designed in such a way that it counters the regressive incidence of the tax (Klenert et al., 2016): lump-sum returns to households, as already introduced by some countries, can even render carbon taxation progressive.

Implementing climate policy compatible with the 2°C target comes with significant cobenefits for other policy goals. The most important examples include a reduction in local air pollution, reduced congestion, and increased energy access from the shift to low-carbon energy supply (Edenhofer et al., 2015). Estimated monetary benefits from a reduction in local air pollution—a significant incentive to enact climate policy in many countries—are indicated in figure 6.

For comprehensive climate policy, carbon pricing must be complemented by low-carbon public investments and infrastructure policies. This is all the more important considering the rapid urbanization taking place in many Latin American countries, as policies defining investments in transport infrastructure and the building stock shape those urban areas for decades to come. Integrating low-carbon infrastructure investments (such as public transport) enables deep emissions reductions.

## INTERNATIONAL CLIMATE POLICY

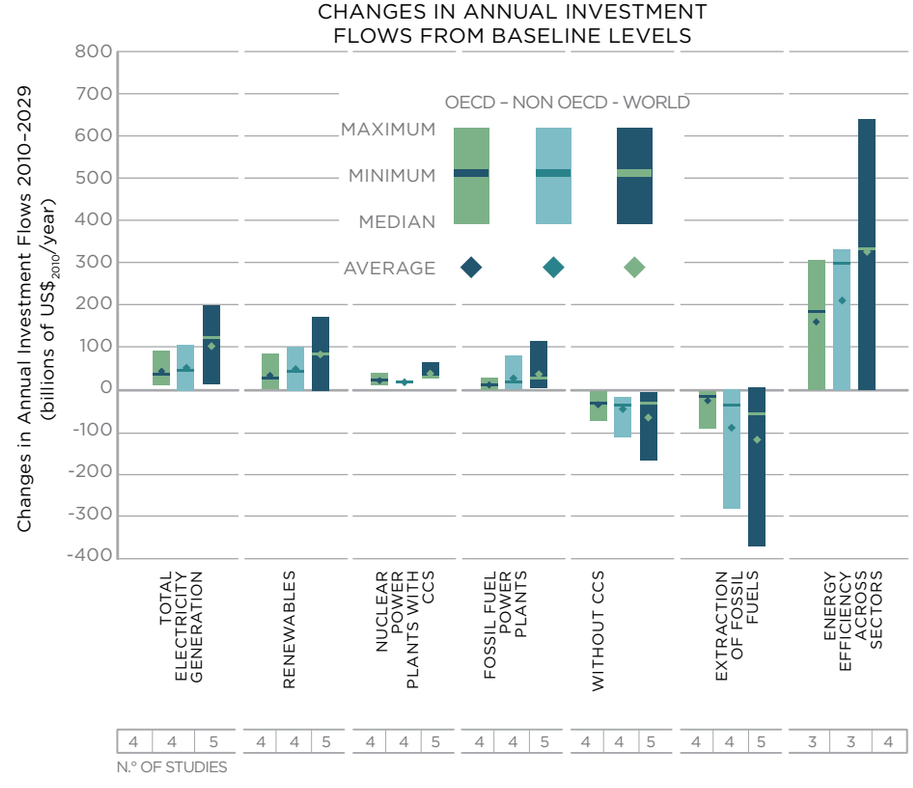
Most importantly, carbon pricing may turn out to be a key instrument in the international climate policy landscape. While the Paris Agreement was a feat of diplomacy in establishing the global long-term temperature targets, the nations' individual contributions to the global target are not yet sufficient to reach these targets—a major obstacle is the renaissance of coal power. Whether the climate targets set forth in the Paris Agreement will be reached depends on whether nations' climate policy ambitions can be strengthened in the coming years and decades. How such a process would work is not yet apparent in full detail. Edenhofer et al. (2016) suggest that making national climate policy ambitions more transparent is an important prerequisite, upon which a mechanism to raise ambitions over time could be based. They argue that multilateral instruments to increase cooperation and burden sharing are essential.

As of today, the ambitions of the NDCs to global emissions reductions are difficult to compare, as they are defined through many different measures, for example as intensity-based emissions reductions or absolute reductions with regard to a given baseline. Putting a price on carbon makes it easier to compare mitigation ambitions across nations as the price approximately reflects the marginal costs of abating emissions. Making other nations' ambitions transparent is a prerequisite for a successive ratcheting up of ambitions through international negotiations over time. The Paris Agreement does not establish effective sanctioning mechanisms to enforce nations' contributions to emissions reductions. The establishment of a minimum carbon price could be conditional and dependent upon other nations' participation. Formulated this way, concerns that pricing carbon could lead to decreasing international competitiveness could be countered, which can also help in negotiating increasingly ambitious climate policies (Edenhofer et al., 2016).

Developing and emerging economies may not be able to meet the costs of reducing greenhouse gas emissions, or be less willing to do so, given the responsibility of rich countries for most historic greenhouse gas emissions. Con-

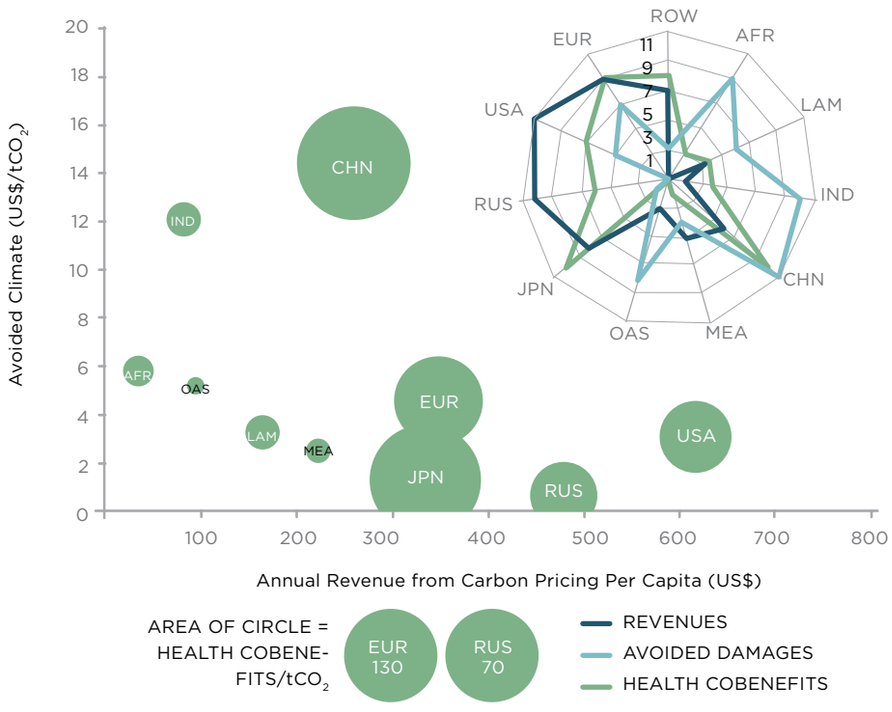


FIGURE 5
**CHANGES IN ANNUAL INVESTMENT FLOWS 2010–2029 FOR 2°C SCENARIOS, STRATIFIED BY CLEAN ENERGY TECHNOLOGY**




Note: Reproduced from figure SPM.9 (IPCC, 2014).

FIGURE 6
**INCENTIVES FOR CARBON PRICING BY WORLD REGIONS**




Notes: Annual revenues from a US$30 per tonne $CO_2$ carbon tax, avoided damages, and cobenefits from reduced air pollution. Latin America is marked as LAM. Figure courtesy of Michael Jakob, based on Edenhofer et al. (2015).

sequently, multilateral instruments are crucial for incentivizing the strengthening of climate policies. One proposal is to strategically use international transfers to incentivize the establishment of carbon pricing in developing and emerging economies (Kornek et al., 2016). Following this approach, transfers, originating for example in the Green Climate Fund, would be used to compensate countries for their costs incurred by transitioning to low-carbon development pathways. Parts of these transfers could be used to help build the capacities necessary to establish and administer carbon pricing instruments in developing nations (Edenhofer et al., 2016). Building up carbon pricing around the world is a promising way to follow up on the diplomatic success of the Paris Agreement with effective mitigation action—averting the worst of climate change impacts for generations to come.



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Photo: Carsten Costard

# “New materials are an essential part of protecting the environment”

**Paul Crutzen**
Winner of the Nobel Prize in Chemistry

Dutch chemist Paul Crutzen shot to fame in 1995 when he won the Nobel Prize in Chemistry for his research on the ozone layer. His pioneering studies began in the 1970s and revealed what types of substances pollute the atmosphere, thus laying the foundations for understanding the causes of climate change. Professor Crutzen is a member of the Max Planck Institute for Chemistry and the Pontifical Academy of Sciences. In this exclusive interview with the Integration & Trade Journal, the Nobel laureate argues that new materials such as superconductors will play a part in creating more sustainable forms of production while asserting that greater global commitment is needed to stabilize the climate.

**How can global governance promote a type of innovation that will help mitigate climate change?**

Global governance is necessary to limit the excessive exploitation of natural resources, while science and knowledge are needed to develop technologies that will help us make better, more efficient use of these resources. The important thing is to coordinate efforts to prevent the exploitation of the environment.

**How can new materials contribute to making production more sustainable?**

New materials are part of the solution, in particular for the storage and transportation of electrical energy, which is an extremely important factor in the protection of the environment.

> WE NEED A FORM OF GLOBAL GOVERNANCE THAT WILL PUT LIMITS ON THE EXPLOITATION OF NATURAL RESOURCES

**Could you give an example of an innovation or new materials that are helping to reduce pollution?**

Mikhail Eremets and other colleagues at our research institute and around the world are searching for superconductor materials that will enable electricity to be transported without resistance at room temperature. These materials will enable us to use energy much more efficiently. There are many other examples.

## WHAT IS SUPERCONDUCTIVITY?

Paul Crutzen, winner of the Nobel Prize for Chemistry, believes that superconductivity could play a key part in protecting the environment. When an electric current passes through a conductor, some energy is lost because the electrons that form the current collide into things and their flow is restricted. This phenomenon is called resistance. If science could manage to prevent these losses, there would be such large energy savings at the global level that it would have an extremely positive impact on the environment.



Photo: Carsten Costard

Paul Crutzen was born in Amsterdam in 1933 and was educated in Germany, Sweden, and England. He was one of 22 Nobel laureates to sign the Humanist Manifesto in 2003, which highlights the social nature of human beings and the importance of rational analysis and experimentation in science. His most significant publications include:


• "The Influence of Nitrogen Oxides on the Atmospheric Ozone Content." Quarterly Journal of the Royal Meteorological Society. 96 (408): 320–325. 1970.

• "Ozone Production Rates in an Oxygen-Hydrogen-Nitrogen Oxide Atmosphere." Journal of Geophysical Research. 76: 7311–7327. 1971.

• "Nitric Acid Cloud Formation in the Cold Antarctic Stratosphere: A Major Cause for the Springtime 'Ozone Hole'." Nature. 324: 651–655. With F. Arnold. 1986.

• "The ''Anthropocene'." Global Change Newsletter. 41: 17–18. With E.F. Stoermer. 2000.


**What are the global challenges we are facing following the international summits on the environment in Paris and Marrakesh?**

The main challenge now is implementing and extending the agreements and commitments of COP21. I hope that COP22 will advance this process, leading to further engagement and action by all parties involved so as to stabilize the climate, protect our environment, and ensure the sustainable, peaceful, and prosperous future development of humanity.

**Can you explain the meaning of the term "Anthropocene," which you coined in the year 2000 and which is becoming more and more relevant in discussions on climate change?**

The Anthropocene is a new geological era that began with the Industrial Revolution, when human activities began to have a significant global impact on the climate and the earth's ecosystems. Maybe the concept of the Anthropocene can help us to overcome political and societal hurdles of the past by highlighting the risks and opportunities that humanity's shaping of planet Earth entails.

> THE ENCYCLICAL IS AN IMPORTANT AND RESOUNDING CALL AGAINST ENVIRONMENTAL DESTRUCTION, CLIMATE CHANGE, INJUSTICE, AND SOCIAL ILLS

**What is your general opinion on *Laudato Si'*, Pope Francis's encyclical on the environment?**

The encyclical is an important and resounding call against environmental destruction, climate change, injustice, and social ills—and in favor of a more social and equitable life. I am glad that I was able to contribute to it through the work of the Pontifical Academy of Sciences.

ANALYSIS

Ariel Yépez-García
Inter-American Development Bank

# Renewable energy in Latin America and the Caribbean

THERE IS AN URGENT NEED TO DEVELOP POLICIES SO THAT, IN THE NEXT FEW YEARS, THE EMISSION OF CARBON DIOXIDE AND OTHER HIGHLY POLLUTING GASES CAN BE DRASTICALLY REDUCED, FOR EXAMPLE, SUBSTITUTING FOR FOSSIL FUELS AND DEVELOPING SOURCES OF RENEWABLE ENERGY

*Laudato Si'*

# RENEWABLE ENERGY

How much renewable energy is produced in Latin America and the Caribbean and how much investment would be needed to modify the energy matrix? Based on a comparison with other global regions, this article provides a precise appraisal of this issue and anticipates the changes in energy consumption that the coming decades may bring. It also details the levels of investment necessary to address global warming.

The growth of the economy and the population has been proven to have negative effects on the environment; the most evident of these is global warming as a consequence of greenhouse gas emissions (Zhang and Cheng, 2009).[1] Global warming is also causing a series of changes to the availability of food[2] and safe drinking water. According to calculations from the IPCC (2015), it is estimated that global temperatures will exceed the limit of 2°C above preindustrial levels if human activity and greenhouse gas emissions continue on their current paths. Furthermore, the World Health Organization (2014) has stated that early deaths in connection with air pollution reached seven million in 2014. This situation has highlighted the need for energy sources that reduce pollution and facilitate a path of sustainable economic growth.

The determining factors for renewable energy consumption include countries' per-capita GDP, the mitigation of CO2 emissions, the volatility of oil and fossil fuel prices, and the commercial availability of energy resources (Omri and Nguyen, 2014). Economic growth and the incremental demand for energy create an opportunity for renewables, especially in emerging economies where their use would help to reduce dependence on the importation of resources such as oil and gas. It is also expected that countries with greater renewable energy potential will be the ones to develop more technological innovations to make more efficient use of these resources (Aguirre and Ibikunle, 2014; Sadorsky, 2009).

This article discusses the share of renewable energy sources for electricity production in Latin America and the Caribbean (LAC) and is organized as follows. The next section presents an overview of renewable sources within the regional electricity production mix, their current status, and their behavior over the last four decades. Section 3 contains a comparison of electricity production in the region in comparison with the rest of the world in order to demonstrate that LAC has the least polluting electricity mix at the global level. In section 4, I analyze the instruments that have been used to mitigate investment risks and expand renewable-based electricity production. Section 5 explores the barriers these sources of energy face to increasing their share in overall electricity production. Finally, section 6 contains policy recommendations to achieve a more diversified and environmentally sustainable electricity production mix.



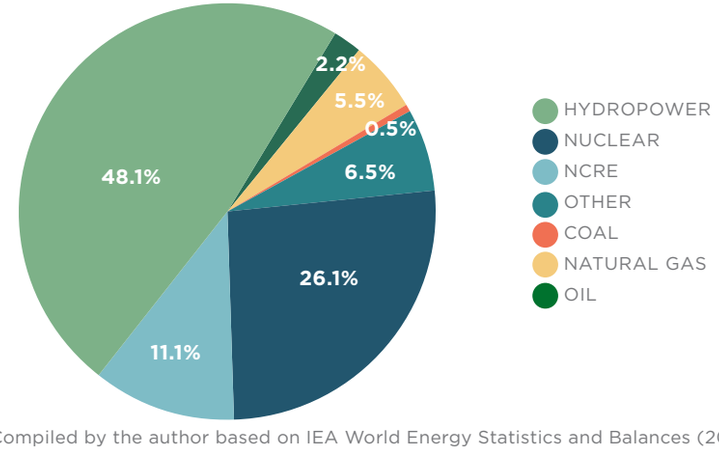
## THE EVOLUTION OF THE ELECTRICITY SECTOR AND ITS CURRENT STATUS

Renewables have a solid presence in electricity generation. In 2013, LAC generated 54% of its electricity from renewable energy sources, including conventional forms such as hydropower (48%) and nonconventional renewable energy (NCRE) (6%). The NCRE sources with the largest market shares are biofuels (71%), geothermal energy (12%), and wind and solar (17%) (see figure 1).

The region's electricity requirements have increased significantly in recent decades. Electricity consumption went from 144 terawatt hours (TWh) in 1971 to 1,297 TWh in 2013. This has implied a 5.24% average annual growth, 2 percentage points of which are due to the increase in Brazil's electricity consumption, followed by Mexico, Argentina, and Venezuela. Paraguay's electricity consumption has grown at an average annual rate of 9.28%, which makes it the country with the highest growth rates during this period, although its contribution to the growth in regional consumption is lower.[3] During this period, Brazil accounted for around 36.4% of total electricity production. These high growth rates pose major long-term challenges to ensuring a secure and environmentally sustainable supply of electricity.

Historically, hydropower has been the most significant form of renewable energy in LAC, as is shown in figure 2. Its growth over the last three decades has contributed substantially to meeting the growing demand for electricity in the region. Brazil was one of the first countries to use its water resources to generate electricity. Indeed, it was the world's largest hydropower producer for over a century due to the availability

FIGURE 1
**REGIONAL ELECTRICITY PRODUCTION MIX (2013)**




Source: Compiled by the author based on IEA World Energy Statistics and Balances (2016).

of natural resources within its borders (Rubio and Tafunell, 2014). According to estimates for Latin America, hydropower capacity in 2009 was nine times greater than in 1928.[4]

LAC continues to be above the global hydropower production average (16.3% of total electricity production). NCRE sources are an alternative for clean electricity production with great potential, and wind and geothermal energy are the renewable technologies that have shown the greatest dynamism. Mexico was the first country in LAC to exploit these resources. In 2013, 52.6% of its NCRE-base electricity production came from geothermal energy. In the case of wind energy, Brazil and Mexico account for 80% of electricity production using this resource.

In recent years, the region has seen a marked increase in the share of renewable energies in its electricity production mix. Table 1 shows the share of NCRE within the energy production mix for 12 LAC countries between 2005 and 2015. Increases in wind and geothermal capacity explain the growth in the use of NCRE sources and reinforce trends in the composition of LAC's electricity production mix.

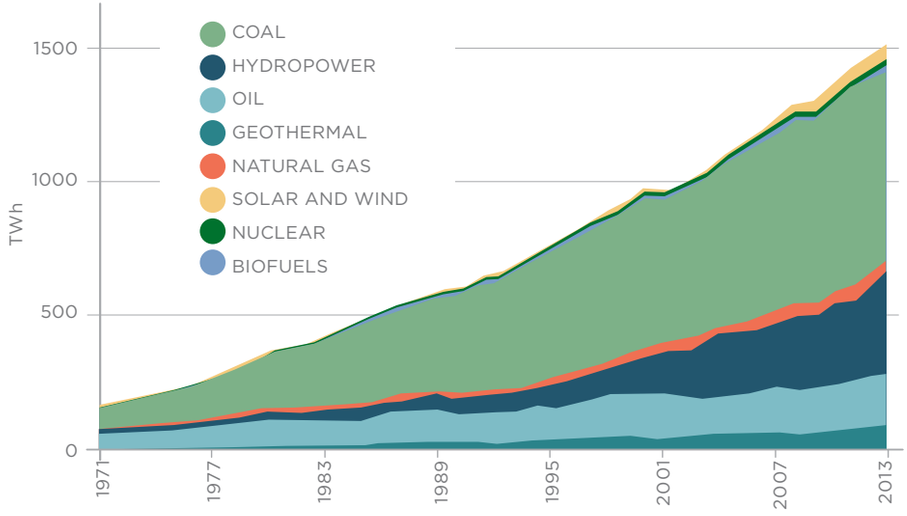
ENERGY CONSUMPTION IN THE REGION HAS INCREASED BY **800%** SINCE 1971

The development of these technologies coincided with periods of high oil prices. Examples of this include the ProÁlcool biofuels program, which Brazil established in 1975, and the laws on geothermal energy that were passed in Costa Rica in 1976 and Nicaragua in 1977. In recent years, despite the slump in oil prices, numerous NCRE projects have continued to emerge, especially ones using wind energy. These have had positive results on the region's installed capacity. For example, in 2015, Brazil added 2,708 MW; Mexico, 659 MW; Chile, 147 MW, and Argentina, 53 MW. Uruguay has a total installed capacity of 865 MW of power in different wind farms, 513.2 MW of which came online in 2015.[5]

It is worth emphasizing that NCRE sources improve access to electricity and contribute to maintaining competitive prices. For example, photovoltaic solar energy, which is generally used in off-grid rural areas, has been scaled up in many countries. One example of this is the Don Alejo solar farm in Mexico. With a capacity of 21 MW, this is part of a project to build the largest photovoltaic power station in Latin America, one that will have a capacity of 400MW and be capable of supplying 1.5 million homes.[6]

In general, renewable energies have shown greater dynamism due to improvements in competitiveness resulting from reductions in their leveled costs (see figure 4). There have been significant reductions in the costs of both photovoltaic and concentrated solar power. It is expected that this trend

FIGURE 2
**ELECTRICITY PRODUCTION BY SOURCE TYPE**




Source: Compiled by the author based on IEA World Energy Statistics and Balances (2016).

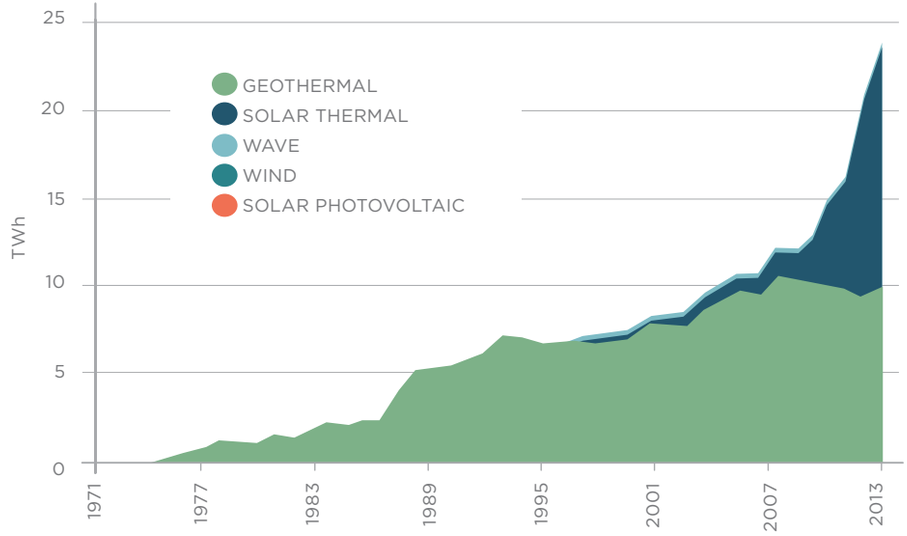
**ITAIPÚ BINACIONAL: AN EXAMPLE OF REGIONAL INTEGRATION THROUGH RENEWABLE ENERGY**

During the 1970s, rising international oil prices and the continual increase in demand for electricity prompted policy makers to seek out substitutes for petroleum as a source of electricity production and thus to promote hydropower projects in the region. In this context, in 1973, Paraguay and Brazil signed the Treaty of Itaipú in order to jointly harness the hydroelectric potential of the Paraná River, which led to the construction of the largest hydroelectric power station of its time.

The Itaipú Power Station has an installed capacity of 14,000 MW and is the second-largest hydropower station in the world after the Three Gorges Dam in China (22,000 MW). Since it began operations, Itaipú's electricity output has increased annually by an average 20.5% and reached its highest production levels in 2013 with 98,630 GWh. The station supplies around 15% of the energy consumed in Brazil and 75% of the energy used in Paraguay. Its technical and operational set-up makes it the largest renewables-based electricity production project in the world, one that integrates the two countries' energy matrices.

Itaipú has also contributed to reducing $CO_2$ emissions. If all the electricity produced each year by the power station was generated by coal-fired stations, it would emit approximately 79 million tonnes of $CO_2$. Itaipú is also renowned worldwide for its other environmental initiatives, as it is surrounded by a reserve of approximately 100,000 ha, through which it also contributes to environmental sustainability.

FIGURE 3
**REGIONAL NCRE-BASED ELECTRICITY PRODUCTION**




Note: the NCRE category does not include biofuels.
Source: Compiled by the author based on IEA World Energy Statistics and Balances (2016) and countries' own energy balance reports.

will continue and that the share of solar energy within the electricity mix will increase.

## COMPARISON OF LAC'S ELECTRICITY PRODUCTION MIX WITH THE REST OF THE WORLD'S

LAC has one of the cleanest electricity production mixes in the world due to the large share of hydropower in comparison with other energy sources. In 1971, LAC was producing 54.2% of its electricity output using renewable sources, while most of the world was still relying on fossil fuels (see figure 4). In 2013, renewables continued to represent a major share: 52.4%. During this period (1971–2013), the share of natural gas increased by 26.1% and that of other fossil fuels, such as oil, decreased.

However, several economies in the region still largely depend on fossil fuels. For example, in Brazil and Mexico, fossil fuels explain around 20% and 80% of electricity production, respectively. Given the size of these two economies, this represents a substantial demand for fossil fuels from the region's electricity sector. Likewise, in Caribbean countries, approximately 90% of electricity is generated using fossil fuels.[7] However, in LAC the electricity sector pollutes less than in other parts of the world. Some 35% of total CO2 emissions in Latin America come from electricity and heat production, in contrast to countries such as the United States, China, and India, where the electricity sector emits 47%, 52.9%, and 52.8% of CO2, respectively. In the cases of China and India, $CO_2$ emissions levels are due to the high share of fossil fuels—especially coal—in the electricity mix. Some 79% of India's electricity output is coal-based, while in China this figure is as high as 86%.[8]

## CONSUMPTION FORECASTS AND INSTRUMENTS FOR THE EXPANSION OF RENEWABLE ENERGY

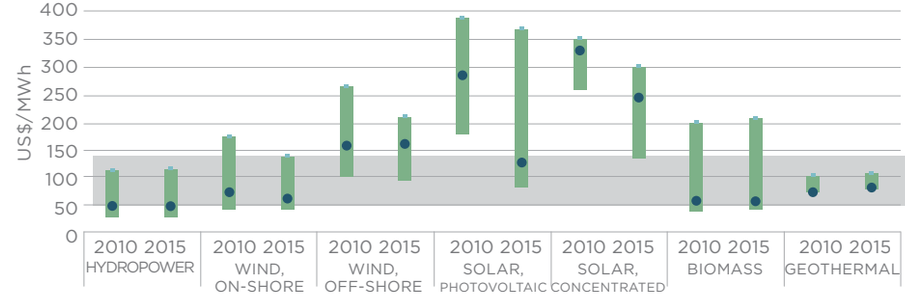
According to a report from the EIA (2010), it is estimated that renewable energy consumption to generate electricity will grow at an average annual rate of 3% between 2007 and 2035. As a result of this growth, the share of renewable energy in the global electricity production mix will go from 18% in 2007 to 23% in 2035.

Latin American countries are establishing goals and implementing policy mechanisms to develop renewable energy. In 2015, 325 support mechanisms were identified, such as the creation of national objectives and laws in relation to renewable energy in most LAC countries (IRENA, 2015). However, scaling up renewable energy and reducing dependence on fossil fuels still poses significant challenges.

Energy auctions and tax incentives are among the most commonly used mechanisms in the region. Tax incentives include exemptions, accelerated depreciation, and stability agreements. One clear example is Nicaragua, where tax incentives for investment in renewables have been applied since 2005 (and are expected to remain in force until 2020). In contrast, Argentina and Peru offer tax stability incentives to protect certain renewable energy technologies against future changes in the tax regime and additional levies, among other mechanisms (IRENA, 2015).

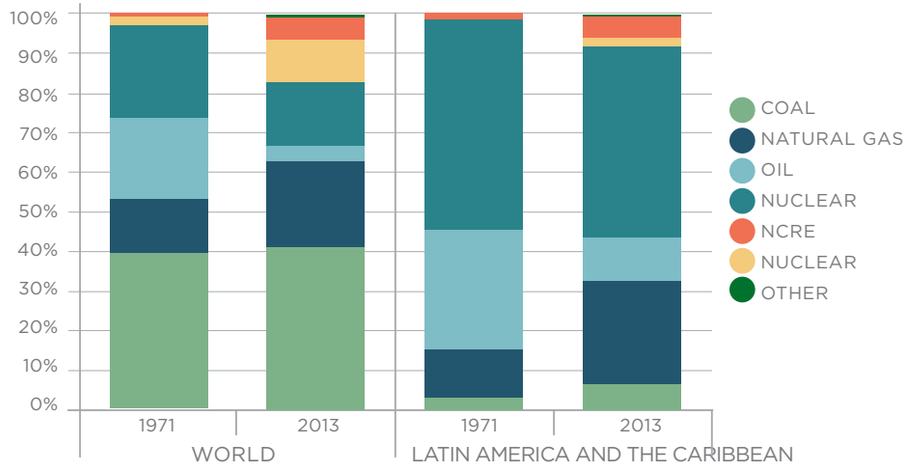
In relation to auction mechanisms, between 2013 and 2015 more than 20 auctions were held for electricity production (MWh) and building wind, biomass, solar, and hydropower capacity (MW) through long-term contracts lasting between 10 and 30 years. These auctions have shown a downward trend in the cost of generating electricity based on renewables. For example, the average weighted price at the first wind auction in Peru was US$80.38/MWh, but this has decreased by 53% in just five years. Similar cases have been reported in Brazil, where the auction price for wind energy has dropped by 40% in

FIGURE 4
**LEVELED COSTS BY TECHNOLOGY (WEIGHTED GLOBAL AVERAGE AND RANGES)**



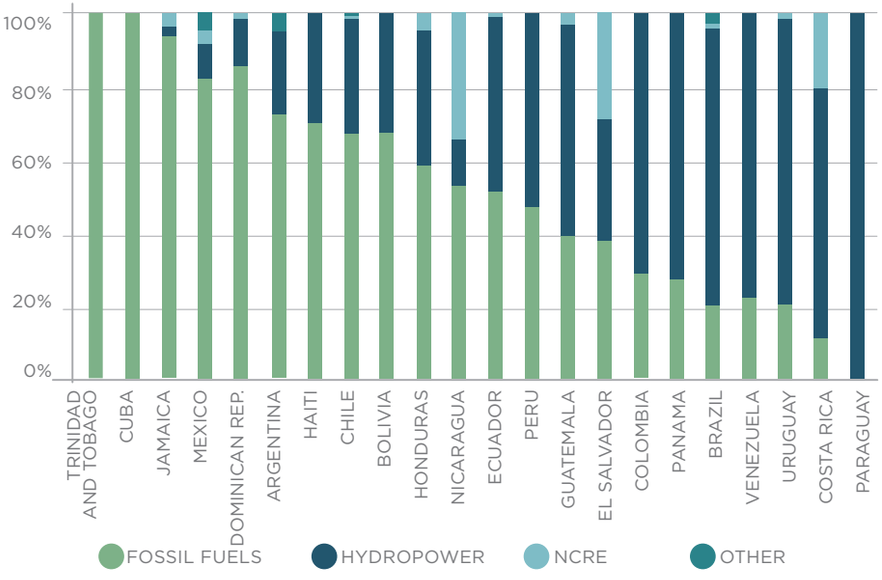

Source: Compiled by the author using data from the International Renewable Energy Agency (IRENA).

FIGURE 5
**ENERGY PRODUCTION MIX**
**PANEL A. COMPARISON OF LAC'S ELECTRICITY MIX WITH THE REST OF THE WORLD (1971–2013).**




Source: Compiled by the author based on IEA World Energy Statistics and Balances (2016).

**PANEL B. COMPOSITION OF ELECTRICITY MIX BY COUNTRY (2013).**




Source: Compiled by the author based on IEA World Energy Statistics and Balances (2016).



TABLE 1
**SHARE OF NCRE SOURCES IN ELECTRICITY PRODUCTION IN SELECTED COUNTRIES**

| COUNTRY | 2005 % | 2015 % |
|---|---|---|
| BRAZIL | 0.02 | 13.3 |
| CHILE | 1 | 8 |
| COSTA RICA | 16.37 | 24 |
| DOMINICAN REPUBLIC | 0.51 | 2 |
| EL SALVADOR | 21.79 | 32 |
| GUATEMALA | 2.06 | 31 |
| HONDURAS | 0 | 17 |
| MEXICO | 3.01 | 5 |
| NICARAGUA | 8.88 | 34 |
| PANAMA | 0 | 2 |
| PERU | 0 | 2 |
| URUGUAY | 0 | 22 |

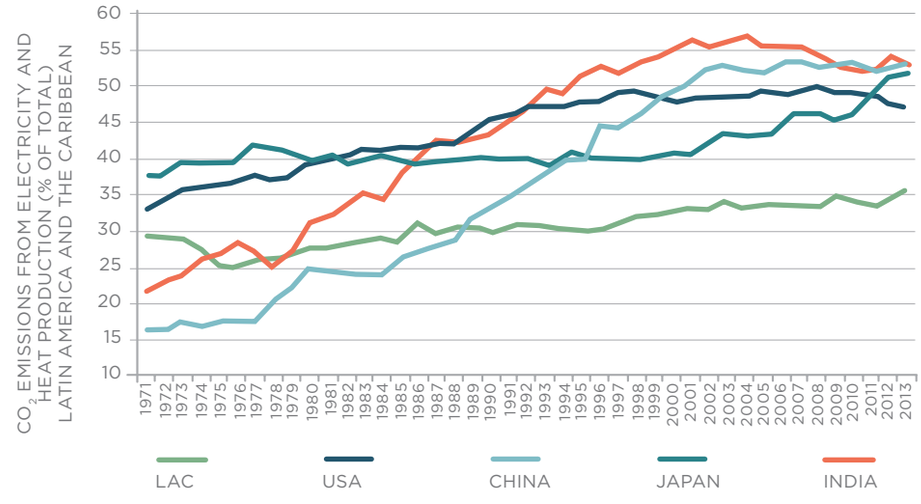
three years.[9]

Other LAC countries have implemented a range of schemes to reduce investment risks and provide incentives for developing geothermal electricity production based on geothermal energy. At the global level, it is estimated that there is potential for 70–80 GW of geothermal energy, of which approximately 12 GW is currently being exploited (ESMAP, 2016). This form of energy is not being developed extensively due to the high costs and risks that developing steam fields and building geothermal power stations entail.

## THE CHALLENGES FACING THE EXPANSION OF RENEWABLE ENERGY

At the global level, fossil fuels continue to be the most commonly used energy source for electricity production, especially coal. In 2012, coal-fired power stations generated around 9,614.6 TWh of electricity, which is equal to 41.3% of total electricity production. In Latin America, coal-based electricity production grew 7.04% per year between 1971 and 2013 until reaching 98.852 TWh, 6.5% of the total.[10] In relative terms, countries such as Trini-

FIGURE 6
**PERCENTAGE OF $CO_2$ EMISSIONS ATTRIBUTED TO THE ELECTRICITY SECTOR**




Source: Compiled by the author using data from World Development Indicators.

TABLE 2
**RISK MITIGATION SCHEMES FOR ELECTRICITY PRODUCTION BASED ON GEOTHERMAL ENERGY**

| | GOVERNMENT AS DEVELOPER | DRILLING WITH SHARED COSTS | TAX INCENTIVES FOR THE SET-UP PHASE |
|---|---|---|---|
| CHARACTERISTICS | Government or publicly supported bodies explore and develop geothermal resources at all stages. | The government takes part in the drilling stage to reduce risk. The following mechanisms are used to attract private capital:<br>1. Drilling with shared costs<br>2. Government carries out exploratory drilling; the project is then developed by private enterprises. | Tax and tariff exemptions for importing equipment and machinery related to the exploratory phase of the project. This reduces the total amount of capital required. |
| COUNTRIES | Costa Rica, El Salvador, Nicaragua, and Mexico. | Costa Rica, El Salvador, Guatemala, and Nicaragua. | Mexico. |
| DEVELOPED CAPACITY | Costa Rica: 177 MW (2 fields)<br>El Salvador: 149 MW (2 fields)<br>Nicaragua: 70 MW (1 field)<br>Mexico: 980 MW (4 fields) | Costa Rica: 3 MW (1 field)<br>El Salvador: 44 MW (1 field)<br>Guatemala: 52 MW (2 fields)<br>Nicaragua: 70 MW (1 field) | This scheme has been used in several geothermal fields and cannot be analyzed as a single factor. |

Source: Compiled by the author using information from ESMAP (2016).

dad and Tobago, Cuba, and Jamaica generate 100%, 95%, and 89% of their electricity, respectively, using fossil fuels. In absolute terms, in 2013, Mexico, Brazil, and Argentina produced the majority of their electricity using fossil fuels: together they generate 461.84 TWh, in other words, these three economies produced approximately 68% of the electricity generated using fossil fuels in Latin America. Although countries in the region are making efforts to increase the share of renewable energy in the electricity production mix, there are several challenges to be overcome.

One of these is financial. According to estimates from IEA (2012), at the global level, an investment of approximately US$24 billion is needed to tackle global warming; part of this investment would be used to develop and implement clean energy sources in electricity production.

Despite recent progress in the regulation of renewables, much remains to be done. For example, the legal and regulatory frameworks for some renewable energies in the region—notably biofuels—are recent and have been modified as the countries in question have accrued experience using them (CAF, 2013). These modifications and any alterations to their implementation imply a challenge when the time comes to attract capital to make secure investments in the sector.

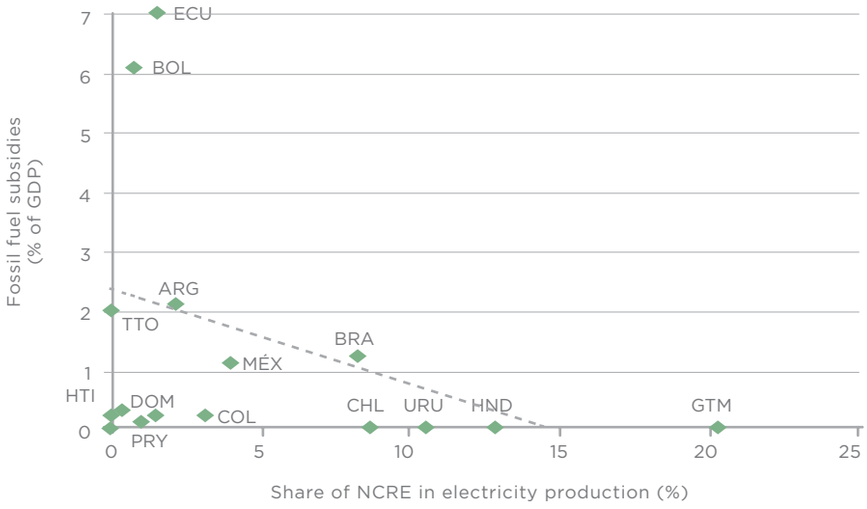
According to Zyadin et al. (2014), there are four barriers to the expansion of renewable energy: technical, economic, environmental, and institutional. These barriers are different for each type of renewable energy and are summarized in table 3. For example, the very nature of solar and wind power implies problems of intermittency and the technology these sources use often requires large investments in transmission. This is due to the fact that the places where these forms of energy are available are

TABLE 3
**BARRIERS TO THE EXPANSION OF RENEWABLE ENERGY**

| TECHNOLOGICAL | TECHNICAL | ECONOMICAL | ENVIRONMENTAL | INSTITUTIONAL |
|---|---|---|---|---|
| SOLAR PHOTOVOLTAIC | Intermittency, land availability, experience lag, build-up of sand and dust, storage capacity, low efficiency. | Access to financing, marketability, link between supply and demand, volatility of gas and oil prices. | Impact on biodiversity, effects on land availability. | Distortion caused by subsidies, regulation-related barriers. |
| SOLAR THERMAL | Durability, maintenance, build-up of dust and steam. | Affordability for the poorest sectors of the population. | Displacement effect. | Incentives and regulations. |
| WIND | Intermittency, 25 m/s limit, technical experience lag. | High capital and investment costs, electricity market prices. | Bird deaths, effects on land availability. | Support policies, fossil fuel subsidies. |
| GEOTHERMAL | Risks in relation to exploration and drilling. | High costs in the early stages of the project, investment security. | Leakage of injection fluid, lack of resources. | Sanctions and public support. |
| BIOMASS | Technological maturity, experience lag in the use of materials. | Sensitive to the use of fossil fuel subsidies. | Effects on food supply and impact on biodiversity. | Expansion in transportation and public support. |

Source: Compiled by the author using information from Zyadin et al. (2014).

FIGURE 7
**SUBSIDIES TO FOSSIL FUELS AND NCRE**




Source: Compiled by the author using information from Di Bella et al. (2015) and IEA.

often far from the grid (Stram, 2016). The main economic barriers include access to financing and high capital and investment costs, as well as the use of fossil fuel subsidies, which hamper fair competition among different technology types. In environmental terms, the expansion of renewable energy can have an impact on biodiversity and land availability. At the institutional level, there is a lack of government support through policies that provide incentives for implementing these types of technology and only limited use of regulatory frameworks to promote their use.

## RECOMMENDATIONS

The experience of LAC and other regions indicates that the transition to clean energy sources will take place on the basis of concrete advantages in these technologies, such as cost competitiveness, environmental sustainability, and security of supply, but political commitment to develop them also plays a part.

In emerging economies, the main energy policy objective should be uncoupling economic growth from fossil fuel consumption (Stram, 2016). Any attempts to level the playing field between fossil and clean energy resources should strive to internalize the benefits of renewables and the externalities of fossil fuels (Aguirre and Ibikunle, 2014). For this reason, removing subsidies from fossil fuels and including externalities in the price of electricity would be two useful ways of leveling the playing field. Evidence of this is the fact that countries with lower fossil fuel subsidies have higher shares of renewables in their electricity production mix (see figure 7).[11]

The following policy recommendations aim to ensure a diversified and environmentally sustainable energy matrix: 1) promote research and development into renewable energies, especially in relation to intermittency and storage; 2) eliminate fossil fuel subsidies to promote fair competition; 3) promote energy integration, as it allows countries to fill gaps in their supply and leverage their comparative advantages in terms of their natural resource endowments; 4) support the expansion of renewable energy and energy efficiency by adapting appropriate regulatory frameworks that promote the use of these technologies; 5) in addition to the above points, improve the collection and subsequent analysis of information on the sector so as to design policies that make the most of the region's energy potential.[12]

Renewable energy sources have shown marked dynamism in recent years. However, it is important to remember that the transition to a cleaner and more affordable energy mix will depend on the political will of governments and the active involvement of the private sector.

**NOTES**

[1]According to recent projections from the Population Reference Bureau (PRB), in 2050 the global population will reach 9.9 billion people. The continent with the highest number of inhabitants will continue to be Asia (5.3 billion people). It is estimated that approximately 1.2 billion people will live in the Americas and that Brazil will be the seventh-largest global economy in terms of population size (226 million). This would imply, among other things, increased demand for services and the need for sustainable resources to meet these needs.

[2]Lobell, Schlenker, and Costa-Roberts (2011) have studied the global effects of increased environmental temperatures on the four major crops (maize, wheat, rice, and soybeans) that constitute approximately 75% of the calories that humans consume daily. Their results show losses of 3.8% and 5.5% in maize and wheat production, respectively. Although there is no significant net effect on rice and soybeans, the gains in some countries offset losses in others.

[3]According to data from the International Energy Agency. Note that these figures are for electricity consumption. During the same period, electricity production has grown at a similar annual rate of 5.3%.

[4]According to estimates in Rubio and Tafunell (2014).

[5]According to official figures from Uruguay's Ministry of Industry, Energy, and Mining: http://www.energiaeolica.gub.uy/index.php?page=parques-en-uruguay.

[6]García (January 17, 2016).

[7]Countries for which information is available include Trinidad and Tobago, Jamaica, the Dominican Republic, Haiti, and Cuba.

[8]According to data from the International Energy Agency.

[9]Vergara, Alatorre, and Alves (2013).

[10]According to data from IEA World Energy Statistics and Balances (2016).

[11]According to a study by Di Bella et al. (2015), energy subsidies as a percentage of the GDP are much higher in oil-producing countries and lower in oil-importing countries. Quality is a crucial factor when defining the size of subsidies.

[12]Yépez-García, Johnson, and Andrés (2011).

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ANALYSIS

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# The impact of climate change on agriculture

## Evidence for Latin America

SUCH A CONSENSUS COULD LEAD, FOR EXAMPLE, TO PLANNING A SUSTAINABLE AND DIVERSIFIED AGRICULTURE.

*Laudato Si'*

This paper reviews the econometric methods used to determine the effect of climate change on agricultural output and value. The intended application is to Latin America, thus a review of the literature examining Latin America is also included. It concludes that climate change would appear to have a significant negative effect on the region, though more research on specific countries is warranted.

*Laudato Si'* (Pope Francis, 2015) is a landmark document. Although parts of this papal encyclical are not entirely supportive of using economic tools to manage the environment, the basic message of the importance of environmental protection is completely consistent with economic work on the economic implications of environmental change, particularly climate change.

In terms of empirical analysis of the effects of changes in the climate on economic activity, no sector has received more attention than agriculture. There are at least three reasons for this. One of the most straightforward is that data on economic activity in agriculture is widely available—not in all countries, but in many. A second reason is that, intuitively, weather and climate have an obvious and understandable effect of agricultural output. Almost everyone has had a vegetable garden of some sort in their life and knows what makes a garden grow. It is less intuitive how weather and climate affect other sectors, such as manufacturing. A third reason, which is somewhat ambiguous, is that agriculture is a very important economic sector, though that varies considerably from country to country. In the US, for instance, agriculture constitutes only 1% of the GDP, yet this underestimates the importance of agriculture to the society. A similar pattern exists in Latin America—agriculture only accounts for a small share of the economy in wealthier countries (3% of Chile's GDP) and a larger share in less well-off countries (13% of Bolivia's GDP).[1] However, agriculture plays a more important role in many societies than these GDP figures suggests. It touches a large number of people and also permeates the social fabric of many countries. Preserving agriculture is often seen as a way of preserving cultural history and a traditional way of life.

In this brief survey, I will review the empirical literature on the effect of weather and climate on agriculture, globally. I will also consider analysis carried out in the Latin American context. One of the key challenges in the literature is disentangling the effect of weather from the effect of climate. Climate is the long-run average weather (or, more accurately, the distribution of weather), whereas weather is what we experience from day to day and hour to hour, and which fluctuates widely. We observe weather, not climate. For the most part climate is used to make agricultural decisions—what crops to plant and when—whereas weather physically affects how crops develop.

In the next section I review the empirical literature on the effect of climate and weather on agriculture. In the subsequent section I discuss the challenges in extending this work further. In the concluding section I discuss the implications for Latin America.



# IMPACT OF CLIMATE CHANGE ON AGRICULTURE

AGRICULTURE REPRESENTS **13%** OF THE ECONOMY IN SOME COUNTRIES IN LAC

## THE LITERATURE ON EMPIRICAL METHODS

In the context of climate change impacts, no sector of the economy has received more research attention than agriculture. Early work focused on agricultural process models which could project how specific crops would respond to weather and climate changes, holding all decision and other exogenous variables constant (for example, see Rosenberg, 1992, and Rosenzweig and Parry, 1994; for a review, see Smith and Tirpak, 1989). The virtue of this approach is that the data requirements for parameterizing a process model of an individual crop are manageable. Laboratory and field experiments can be conducted to determine how crops respond to different weather environments. The downside of this "process model" approach is that decision variables are fixed and not endogenous. Farmers are assumed to not change behavior as the climate and weather change, thus adaptation is presumed to not exist. Hence, this has been dubbed the "dumb farmer" approach to estimating the damage to agriculture from a change in climate.

A major step forward in this literature was to use econometric methods to infer how weather and climate affect agricultural output. Although this had been done earlier in the context of weather modification (Johnson and Haigh, 1970), the first modern application to climate change was Mendelsohn, Nordhaus, and Shaw (1994). Recognizing that agricultural land values reflected the endowment of soil characteristics, speculative rents (future land use for nonagricultural purposes) and climate, the authors dubbed their approach the "Ricardian method," reflecting David Ricardo's focus on the value of land. The Ricardian method, sometimes referred to as cross-sectional analysis of climate impacts, involves econometrically estimating the effect of climate, soil characteristics, and proximity to urban areas on the price of agricultural land. This allows the analyst to infer the effect of climate on land value. Intuitively, if one is comparing two plots of land, which differ only in climate (average weather), then the difference in the price of land (or the rent) can be inferred to be the economic value of the difference in climate.

There are many advantages to the Ricardian method over the process model method. The two obvious ones are (1) that value is inferred from actual behavior and (2) that decision variables are endogenous. Because behavioral

changes are included (farmer behavior in Argentina is different from farmer behavior in Costa Rica), it is possible to obtain a more accurate representation of the impact of a change in climate. The downside of the approach is primarily that agriculture is assumed to be in long-run equilibrium. Farmers in Argentina have had a very long time to adjust to their climate, and the same is true of farmers in Costa Rica. Another downside is that observing land values or rents requires the existence of a land market. These are often either absent or highly distorted. In such as case, it is possible to construct a proxy, such as the difference between income and nonland expenses (as a proxy for rent), though those variables are both hard to observe (e.g., working owners may not receive a wage) and subject to market distortions (for an application to Brazil, see Sanghi and Mendelsohn, 2008).

The typical approach in these and other Ricardian models is to first econometrically estimate the effect of climate on economic activity (land value) and then to use that estimated relationship to examine a counterfactual of a particular change in the climate (such as a 2.5°C increase in average temperature and an 8% increase in precipitation, the assumption used by Mendelsohn et al., 1994). Much of the path-breaking work on this issue is done in the United States, which has the advantage of having over 3,000 political jurisdictions (counties) with economic and weather data disaggregated to that level. Furthermore, decades of data exist at the county level—fertile ground for econometric analysis.

Using a profit function instead of land values has many advantages. One of these is that profits can be inferred even if land markets are distorted or absent. Another major advantage is that time series data can be used, which is not the case with the pure Ricardian approach (since land values are not subject to change due to weather fluctuations). A time series allows the researcher to infer the effect of weather as well as climate on agricultural production. One of the first applications of the agricultural profit function to climate and weather impacts is Kelly, Kolstad, and Mitchell (2005). Another important paper focusing only on the effects of weather (not climate) is Deschênes and Greenstone (2007). Both of these papers deserve additional discussion since they implied a significant expansion of the tool kit for measuring the impacts of climate on agriculture. It should be noted that the application is to the US but the methods can be applied in many other parts of the world, and have been.

Kelly et al. (2005) recognized that how climate change affects agriculture is more complicated than previous work had suggested. In particular, weather is unpredictable but impacts crop yields in the standard sort of way; however, agricultural decisions are generally made before the weather is realized, based on expectations about the weather. With perfect knowledge, expectations about the weather and climate are the same thing. But we do not observe climate so there may be a divergence between the actual climate (from which weather realizations are drawn) and expected climate.

## PRODUCTION AND WEATHER CONDITIONS

At the simplest level, assume the value of agricultural output (Y) is determined by production choices (X) and weather (locational and temporal subscripts are suppressed):

$$Y = f(X,W) \quad (1)$$

The farmer assumes weather is drawn from a distribution (for convenience here, assumed to be normal): $W \sim N(\omega,\sigma)$, where the mean ($\omega$) and variance ($\sigma$) may be imperfectly known by the farmer. We denote the farmer's estimate of these parameters as w and s.

The authors distinguish between ex ante profits ($\Pi A$)—expected profits prior to the realization of the weather—and ex post profits ($\Pi P$)—actual profits which are determined by the weather realization. Clearly ex ante profits need not be the same as the expected value of ex post profits, unless the farmer is perfectly knowledgeable about the climate:

$$\Pi^{A}(w,s) = \max_{X} EW\{q_y f(X,W) - qX\} \quad (2a)$$

and

$$\Pi^{P}(w,s,W) = q_y f[X(w,s),W] - q_x X(w,s) \quad (2b)$$

Where X(w,s) is the optimal X from solving equation 2a and E is the expectation operator. For instance, an X might be the type of crop planted, based on expectations about weather.

Kelly et al. (2005) estimate equation 2b econometrically over a panel of mid-western counties in the US over a 30-year period. They then simulate a counterfactual of a change in climate but assume the farmer only becomes aware of the change by observing abnormal weather, slowly updating his prior assumptions about the climate by observing actual weather over many years.

A TEMPERATURE INCREASE OF 2.5°C WOULD CAUSE AN **8%** INCREASE IN RAINFALL

Deschênes and Greenstone (2007) take a fundamentally different approach, noting correctly that climate changes very little, even over 30 years. As a consequence, identifying the effect of climate in a setup such as equation 2 is extremely difficult. They take an approach of focusing on the effect of weather on economic activity, using extensive fixed effects to better identify the effect of weather on agricultural profits (the same dependent variable as used by Kelly et al., 2005). The fixed effects include climate since that is basically fixed at specific locations over their sample. As with Kelly et al. (2005), they use a panel of county data and agricultural profits net of the cost of land as the dependent variable. Because climate changes little at a location over their sample, they cannot simultaneously identify the effect of climate and other fixed effects. The advantage is that they obtain a better estimate of the effect of weather but are unable to determine the effect of climate. Clearly the two effects are related, though researchers have not been able to derive the effects of climate from an estimate of the effects of weather.

Many papers have grown out of these initial efforts. Wolfram Schlenker and colleagues, in a series of papers (starting with Schlenker, Hanemann, and Fisher, 2005) refined the Ricardian method of Mendelsohn et al. (1994). A large number of papers have focused

on weather rather than climate, in the spirit of Deschênes and Greenstone (2007), though in many other contexts (see detailed review by Dell, Jones, and Olken, 2014). A number of papers have applied methods initially developed for the US to other countries of the world. In fact, Robert Mendelsohn of Yale has produced many assessments of the effect of climate change on agriculture in diverse areas of the developing world. Additionally, much of the recent progress has been in applying methods initially used for agriculture to a broader context, such as the effect of weather and/or climate on aggregate economic activity (GDP), health and mortality, and violence (for example, see Dell, Jones, and Olken, 2012; Barreca et al., 2016; Burke, Hsiang, and Miguel, 2015; and Hsiang, Burke, and Miguel, 2013).

## APPLICATIONS TO LATIN AMERICA

Although a decade or so ago the World Bank commissioned a number of analyses of the impacts of climate change on agriculture in Latin America (Confalonieri et al., 2012), the literature base is relatively sparse.

One apparently comprehensive book on regional impacts on agriculture is that of William Cline (2007). He starts with estimates of impacts on agriculture from climate change, based on US data and using both Ricardian analysis and agricultural process models (Mendelsohn and Schlesinger, 1999). Where local analyses have also been done, those are used instead. Cline (2007) evaluates the impacts in 2080 based on IPCC forecasts of climate change. Results for Latin America are reproduced in table 1. It is important to recognize that these numbers are generated from a very simple quadratic function of temperature and precipitation at the national level, based largely on experience with US farms. Thus the uncertainty is significant.

There are several other studies of the effect of climate change on agriculture in Latin America. S. Niggol Seo has published a number of analyses of the effect of climate change on agriculture in different parts of the world (e.g., Seo, 2012, examines adaptation in South America). The primary approach he has used in a number of applications to South America is a multinomial logit approach to crop and animal choice as a function of climate. Using World Bank survey data, he is able to determine how climate change might influence these choices. Using a sample of 2,300 households, he examines several cropping and livestock regimes: livestock only, crops only, forest only, crops and livestock, crops and forests, and crops-livestock-forest. Climate is one of the exogenous variables explaining the choice farmers make. Unfortunately, the work is not sufficiently general to be able to infer the profit loss or gain that might result from climate change.

One of the most comprehensive applications to Latin America is the study of Mexican farms carried out by Mendelsohn, Arellano-Gonzalez, and Christensen (2009). This is a straightforward application of the Ricardian method to Mexico, using a database of over 600 farms from the Mexico National Rural Household Survey, which provides detailed data on assets, production, and income from 2002. Similar to Mendelsohn et al.'s (1994) analysis of the US, the authors estimate the Ricardian model and then use it to examine the damage from climate change.

The basic equation estimated for Mexico is

$$\Pi = \sum P_i Q_i(X,F,Z) - \sum P_x X \quad (3)$$

where $\Pi$ is net revenue per hectare, $P_i$ is the market price of crop i, $Q_i$ is output of crop i, X is a vector of purchased inputs (other than land), F is a vector of climate variables, Z is a vector of other control variables such as soil and market access, and $P_x$ is a vector of input prices. Farmland value is proportional to net revenue ($V=\varpi/r$, where r is the interest rate). The authors adopt a loglinear function form for the model with log of V depending on a quadratic in F and linearly in Z. The authors estimate the model with 24 climate variables and 22 other variables. With 621 variables, they achieve an R2 of 0.60, with about a quarter of the coefficients significant at the 95% level or greater. At the margin, winter and summer temperature increases farmland value, whereas spring, autumn, and annual temperature decreases value. Spring and summer precipitation increases land value, whereas winter, autumn, and annual precipitation decreases value. Except for the annual relationship, it is unclear if this is intuitive or not.

## PRACTICAL IMPLICATIONS

Most of the evidence on the consequences for Latin American agriculture of climate change which may occur over the coming century is derived from US experience and US estimation of the effect of temperature and precipitation

TABLE 1
**ESTIMATES OF IMPACTS OF OUTPUT FROM IPCC 2080 CLIMATE CHANGE FORECAST**

| | FARM AREA (1,000 HECTARES) | OUTPUT CHANGE BY 2080 (%) | IPCC TEMPERATURE CHANGE BY 2080 (°C) | IPCC PRECIPITATION CHANGE BY 2080 (MM/DAY) |
|---|---|---|---|---|
| ARGENTINA | 172,106 | -14.7 | 3.24 | 0.03 |
| BRAZIL | 353,611 | -4.4 | 4.03 | -0.01 |
| CENTRAL AMERICA | 7,624 | -12.3 | 3.53 | -0.33 |
| CHILE | 26,502 | -13.1 | 2.9 | -0.09 |
| COLOMBIA | 50,706 | -11.7 | 3.5 | 0.19 |
| ECUADOR | 12,356 | -18.1 | 3.21 | 0.49 |
| MEXICO | 183,839 | -25.7 | 4.05 | -0.25 |
| PERU | 35,382 | -20.2 | 3.82 | 0.2 |
| VENEZUELA | 30,071 | -22 | 3.73 | -0.14 |
| WORLD | 30,097,935 | -3.2 | 4.95 | 0.13 |

Source: Cline (2007), tables 4.2, 4.3, and 5.8.

## CLIMATE AND MEXICAN AGRICULTURE

After estimating the Ricardian model, as described in the text, the next step for Mendelsohn et al. (2009) is to examine the effect of a hypothetical change in the future climate. To conduct this thought experiment, one has to first determine a possible future climate and then use this future climate characterization to compute the value of agricultural land. Comparing that with current land values from the Ricardian equation gives an estimate of the damage to agriculture from the change in climate.

Projected climate change is taken from three atmospheric models, which differ somewhat in their forecasts. One predicts a 2.3°C temperature rise and a 1.7 mm/month precipitation decrease by 2100; the other two models predict a 5.1°C temperature increase and either a precipitation decrease (one model) or a precipitation increase (the other model). The results for the three models are shown in table 2.

TABLE 2
**WELFARE IMPACTS ON MEXICAN FARMLANDS (PER HECTARE) IN 2100 FROM ALTERNATIVE CLIMATE SCENARIOS.**

| | ALL | IRRIGATED | RAINFED | LARGE | SMALL |
|---|---|---|---|---|---|
| **CURRENT MEAN LAND VALUE PER HECTARE** | 27,112 | 41,457 | 21,792 | 15,639 | 38,696 |
| | | | **LOGLINEAR MODEL** | | |
| **PCM** | -11,554 (-42.6%) | -19,851 (-47.9%) | -9,606 (-44.1%) | -6,221 (-39.8%) | -18,269 (-47.2%) |
| **MIMR** | -14,417 (-53.2%) | -23,347 (-56.3%) | -11,314 (-51.9%) | -9,063 (-57.9%) | -20,870 (-53.9%) |
| **HAD** | -14,680 (-54.1%) | -25,839 (-62.3%) | -11,077 (-50.8%) | -9,381 (-60%) | -20,512 (-53%) |

Note: Impacts are changes in land value in pesos per hectare averaged over total farms. Percentage changes are in parentheses. Harmful impacts have been truncated to be no larger than the value of the land itself. All effects are statistically significant.

Source: Table 7 in Mendelsohn et al. (2009).

As can be seen, the analysis applying these forecasts to the Ricardian model predicts losses of 40%–50% of land value over the three models, which is somewhat surprising since they forecast such different climate changes. Leaving aside the three atmospheric model forecasts, the authors conclude that the marginal effect of temperature change is to drop land value by MXN6,500–7,700 per hectare per degree Celsius increase. This is a substantial effect from climate change.

on farm value, as a function of climate variables. This is a reasonable first approximation but does not account for the very significant technological differences between the US and Latin America. For one thing, US agriculture is likely significantly more capital intensive than that of much of Latin America. Secondly, the crops are significantly different. Thirdly, adaptation may be quite different, considering these crop differences.

Nevertheless, the few studies which have been conducted using Latin American data do tend to qualitatively support the results of extrapolation of US experience. Climate change would seem to have a significantly negative impact on agriculture in Latin America by the end of this century.

The lesson here is not only that Latin America will feel the consequences of climate change. Another lesson is that considerably more microresearch is needed on agriculture in the region, in order to increase the reliability of estimates of the consequences of climate change.

**NOTA**

[1] Data from the World Bank World Development Indicators for 2010–2015. See also Magrin et al. (2014).

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ANALYSIS

# Sustainable cities

## **Care** for our **common home**

IT IS IMPORTANT THAT THE DIFFERENT PARTS OF A CITY BE WELL INTEGRATED AND THAT THOSE WHO LIVE THERE HAVE A SENSE OF THE WHOLE.

*Laudato Si'*

Horacio Terraza
Inter-American Development Bank

Cities have a singular intra- and intergenerational responsibility for taking on the socio-environmental challenges that the papal encyclical *Laudato Si'* alludes to. A little over half the global population lives in cities, 80% of global GDP is generated there, and between 60% and 80% of the world's energy is consumed there, which implies that urban areas emit around 70% of the planet's greenhouse gases (GHG). The aim of this article is to contribute to defining the development challenges that cities in Latin America and the Caribbean are currently facing in relation to the key sustainability issues mentioned in the papal encyclical: water, pollution, soil, mobility, equality, security, and transparency. To do so, I will show quantitative indicators and the results of public opinion polls that the IDB's Emerging and Sustainable Cities (ESC) Initiative has systematized over the course of five years of work with 37 medium-sized cities in the region. The data presented here invites us not to lose sight of the fact that the notion of responsibility is an essential part of the city of the future. Likewise, responsible cities demand a comprehensive understanding of the idea of "our common home" and the interdependence between human beings and natural and urban ecosystems.

In February 2015, the city of São Paulo was facing a moment of great political and social conflict—undoubtedly one of the greatest crises in its history. The tensions that reigned that summer sparked hostility between communities and threatened the ways of life of at least 9 million of the more than 20 million people that live in this metropolis. The cause of the crisis was chronic water shortages, as the city was experiencing its third year of minimal rainfall and its water reserves had dropped below 15%. The responses to the rationing imposed by the authorities were street protests, neighborhood feuds, and even the digging of clandestine wells and boreholes. These scenes smacked of a social revolution, but they were missing the tyrant who it could all be blamed on. Instead, it was a clear example of the tragedy of the commons: the build-up of individual habits, short-term thinking, and disconnection from the ecosystem had put São Paulo on the brink of a humanitarian crisis.

The situation in São Paulo is an example of the type of environmental warnings that *Laudato Si'* refers to, as it is the outcome of a complex tangle of interdependent issues: watershed conservation, wastewater treatment, equal access to water, and climate change. In the northeast of Brazil, the frequency and intensity of droughts will continue to increase over the course of this century, meaning that traditional water infrastructure solutions will fall short of solving water shortages (Marengo, 2008). This absence of integral sustainability solutions is threatening the health, food, and ways of life of the more than 40 million people that live in this subregion.

At the same time, São Paulo is cause for reflection on the strategic potential of cities in answering Pope Francis's call. This metropolis takes up just 0.1% of Brazil's land mass but houses 10% of its population and 11% of its GDP. This pattern is repeated throughout Latin America, a region that is not only the most urbanized in the world—80% of the population live in cities—but that also has one of the most pronounced concentrations of wealth in urban areas: 60% of the region's GDP is generated in just 198 urban centers are (Cadena et al., 2011). Cities are thus the main market for production and consumption, but also for ideas. Likewise, city governments and communication within cities are what are closest to people's daily lives. For all these reasons, cities need to be our starting point for reversing the patterns of inequality, degradation, and waste that *Laudato Si'* discusses.

In the next section, I will demonstrate that although the scale of the challenge of urban sustainability is significant, there is much to gain from taking it on. It is easier to carry out transformative interventions in cities than anywhere else, and these are the best way of moving towards a responsible development model that is consistent with the call to care for our common home.



# SUSTAINABLE CITIES

## THE SCALE OF THE URBAN CHALLENGE: IMPACTS AND OPPORTUNITIES

The Inter-American Development Bank has systematically collected key data on the LAC region by implementing the methodology of the Emerging and Sustainable Cities (ESC) program in 37 medium-sized cities (see table 2). To a certain extent, this data illustrates the problems that are the deciding factors in our cities' development. Since its creation as a pilot program in 2011, the ESC program has systematized indicators, measured public opinion, and consulted with local and international experts to prioritize policy and infrastructure projects that will contribute to the sustainable development of cities. Although around 120 indicators contemplated by the methodology were collected in each case, in the following section I analyze a subset of indicators related to seven key issues which *Laudato Si'* clearly states as being key to cities: access to water; water, air, and soil pollution; land-use planning; mobility; public safety; transparency; and equality. I begin by presenting a categorization of the state of these

**80%**

OF ILLNESSES IN DEVELOPING COUNTRIES ARE LINKED TO BAD WATER AND SANITATION CONDITIONS

indicators in the cities analyzed (table 2) before looking in more detail at specific values and case studies.

### Access to Water

The implications of limited access to water are varied and significant. It is estimated that in developing countries up to 80% of illnesses are linked to bad water and sanitation conditions (UNESCO, 2006). The World Health Organization calculates that US$1 invested in access to water brings almost US$8 of benefits in terms of health, economic productivity, education, and human life, among other factors (WHO, 2008).

On average, in the cities in which the ESC program operates, water networks cover 90% of the population and guarantee more than 20 hours a day of access to the service, which reflects a relatively high level of development without reaching the universal coverage required if we are to guarantee the human right to water. The list includes exemplary cities such as Pereira, which has 100% coverage rates and full continuity of service; but also others such as Tegucigalpa and Cochabamba which are lagging seriously behind. The drinking water network in the latter only reaches 60% of homes and supply is only guaranteed 11 hours per day, which translates into countless interruptions that affect not just families but also businesses and industries that depend on water to operate. As we will see later, there is a strong correlation between access to water and equality, because it is precisely the more marginal areas of cities that lack home water connections and thus are those that pay most for this resource. In Tegucigalpa, for example, households in the highest parts of the city, which the water supply network does not reach, depend on water tankers and pay up to 50 times more than the subsidized rates for households that are connected to the network.

Investing in access to water is even more urgent today given climate change: reductions in rainfall are expected in many cities in the region and consumption per capita increases with temperature, which exacerbates the water deficit. One example of best practices is Port of Spain in Trinidad and Tobago, which is implementing a comprehensive solution to this issue with support from the IDB.

### Water, air, and soil pollution

Table 2 clearly shows how poorly medium-sized cities in the region perform in terms of waste and pollutant handling. The implications of this are extremely significant. A recent World Health Organization study indicates that nearly one in every four deaths in 2012 was due to exposure to environmental risks such as water, air, and soil pollution, the presence of chemicals in the environment, climate change, and UV radiation, among others (Prüss-Ustün et al., 2015).

At the ESC program, we have found that an average 10% of the water samples for the cities we analyzed do not comply with national quality standards; concentrations of particulate matter in the air tend to be above 50 µg/m3; on average, only half of solid waste is deposited in landfills with leachate treatment and less than 40% of wastewater is treated; and even though there are noise pollution standards in many cities, monitoring of these is inconsistent and compliance with them, limited.

Although it is important for there to be instruments for enforcing regulations on these matters, the connections between pollution, effective watershed management, and the availability of green spaces suggests that cities need to approach these issues through integrated land-use planning, exploring combinations of gray and green infrastructure to tackle these problems comprehensively, as Port of Spain is doing today (see table 2).

In Colombia, it is estimated that airborne pollutants generate health costs of approximately 0.8% of GDP (US$698 million). In Europe, noise pollution causes economic health costs of approximately 0.5% of GDP (Embarq-CTS, 2011).

*Laudato Si'* repeatedly mentions the importance of quantifying pollution costs. In response to this, we might ask how we can put a price on a clean and healthy environment. One of the cities that have managed to measure the benefits of environmental quality is Barcelona. After reducing exposure to particulate matter from 50 to 20 µg/m³, the city estimated that it was able to prevent 3,500 deaths, 1,800 hospitalizations due to cardiorespiratory illness, 5,100 cases of chronic bronchitis in adults, and 54 asthma attacks. It is estimated that the above improve-

TABLE 1
**KEY FACTORS, IMPACTS, AND ISSUES IN THE WATER CRISIS IN SÃO PAULO**

| TRIGGERING FACTORS | IMPACTS | KEY ISSUES |
|---|---|---|
| Changes in climate patterns, El Niño. | More intense but more sporadic rainfall. | Climate change. |
| Pollution of the Tieté and Pinheiros rivers. | Water from alternative sources is unsafe, unsuitable for making up for the shortfall. | Unsustainable production and wastewater treatment patterns. |
| Deforestation and destruction of wetlands high in the watershed. | High levels of surface rainwater run-off on eroded soils, which prevents the aquifer from recharging and causes underground wells to dry up. | Sectoral or isolated understandings of ecosystems. |
| Centralization of water infrastructure: the Cantareira reservoir system holds 45% of all water consumed in the city. | High dependence on water infrastructure, little diversification of risk. | Lack of a view to resilience in planning water solutions. |
| Reluctance among the population to accept increases in water rates. | Gaps in budgets for strengthening integrated water management. | Fiscal pressures, changes in human behavior. |
| Lack of environmental education and social communication; inequality in access to water in different parts of the city; lack of trust in local government. | Lack of response or skepticism in the face of warnings and water conservation measures. Low levels of willingness to change consumption patterns. | Environmental education, resource governance, and public administration. |

Source: Compiled by the author.

TABLE 2:
**SELECT INDICATORS FOR 37 CITIES IN THE ESC PROGRAM**

| INDICATOR | DESCRIPTION | SUSTAINABILITY LEVELS ACCORDING TO ESC METHODOLOGY* | CITIES WITH AVAILABLE DATA FOR THE INDICATOR | CATEGORY (NUMBER OF EMERGING CITIES CATEGORIZED AS RED, YELLOW, OR GREEN) |
|---|---|---|---|---|
| CONNECTION TO WATER NETWORK | Percentage of households that are connected to the water network | 90-100 (%)<br>75-90<br><75 | 36 | 26<br>6<br>4 |
| CONTINUITY OF WATER SERVICE | Hours per day of continuous service | >20 (hours)<br>20-12<br><12 | 37 | 25<br>7<br>5 |
| WATER QUALITY | Percentage of water samples in a year that comply with national drinking water quality standards | >97 (%)<br>90-97<br><90 | 29 | 18<br>4<br>7 |
| WASTEWATER TREATMENT | Percentage of wastewater that is treated according to applicable national standards | >60 (%)<br>40-60<br><40 | 35 | 10<br>7<br>18 |
| SOLID WASTE MANAGEMENT | Percentage of solid waste disposed of in sanitary landfills with leachate and landfill gas collection and treatment systems | 90-100 (%)<br>80-90<br><80 | 35 | 15<br>2<br>18 |
| NOISE CONTROL | Existence, monitoring, and enforcement of regulations on noise pollution. | Approved regulations, frequent monitoring, adequate enforcement<br>Approved regulations, inconsistent monitoring, limited enforcement<br>Regulations not approved, no monitoring or enforcement | 37 | 13<br>19<br>5 |
| PER CAPITA GREENHOUSE GAS EMISSIONS | Measure of the intensity of GHG emissions per person based on censuses and GHG inventories. | <5 ($CO_2$e/hab.)<br>5-10<br>>10 | 25 | 22<br>1<br>2 |
| PM10 CONCENTRATION | Suspended particulate matter with a diameter lower than 10 µm, 24-hour average | <50 (µg/m$^3$)<br>50-150<br>>150 | 22 | 15<br>6<br>1 |
| GROWTH OF THE URBAN FOOTPRINT | Average annual growth rate of the urban footprint within the city's official limits (minimum last five years or last time period available). | < 3 (%)<br>3-5<br>>5 | 32 | 13<br>11<br>8 |
| GREEN AREAS | Permanent green space in the city. | >50 (ha/100,000 inhab.)<br>20-50<br><20 | 35 | 16<br>7<br>12 |
| INFORMAL SETTLEMENTS | Percentage of housing located in informal settlements. | <20 (%)<br>20-30<br>>30 | 19 | 24<br>6<br>3 |
| AT-RISK HOUSEHOLDS | Percentage of households at risk due to inadequate walls, roofs, or floors as a percentage of total households. | <10 (%)<br>10-20<br>>20 | | 9<br>4<br>6 |
| USE OF PUBLIC TRANSPORTATION | Percentage of total trips taken in the city using public transportation | >65 (%)<br>50-65<br><50 | 27 | 2<br>3<br>22 |
| GINI COEFFICIENT | Measure of inequality in which 0 corresponds to perfect equality in income and 1 corresponds to perfect inequality in income | <0.35 (coefficient)<br>0,35-0,45<br>>0.45 | 34 | 0<br>15<br>19 |
| INFORMAL EMPLOYMENT | The percentage of the population engaged in informal employment as defined by the International Labour Organization | <20 (%)<br>20-35<br>>35 | 30 | 1<br>11<br>18 |
| ROBBERIES | Annual number of robberies (theft with violence or threat of violence). | <300 (robberies/100,000 inhab.)<br>300-1,000<br>>1,000 | 32 | 13<br>11<br>8 |
| HOMICIDES | Homicide rate per 100,000 inhabitants | <10 (homicides/100,000 inhab.)<br>10-25<br>>25 | 35 | 8<br>13<br>14 |
| PUBLIC REPORTING. | Number of sessions per year in which the municipal government publicly shares information about its management practices. | More than one public reporting session per year.<br>One annual public reporting session.<br>No annual public reporting session. | 34 | 19<br>10<br>5 |
| PUBLIC SPACE | Publicly accessible, open-air recreational space in the city. | >10 (ha/100,000 inhab.)<br>7-10<br><7 | 31 | 22<br>3<br>6 |
| TRANSPARENCY | Countries' scores from Transparency International. | >6 (index)<br>3-6<br><3 | 17 | 4<br>6<br>7 |
| AUDITING OF ACCOUNTS BY THIRD PARTIES | Percentage of municipal companies' accounts audited by an external, independent third party. | 100 (%)<br>75-100<br><75 | 15 | 10<br>1<br>4 |

* Sustainability levels are classified green, yellow, or red according to the reference values in the ESC Methodologies Annex.
This analysis was carried out using the first round of indicators collected by the program in each city. Some of these have subsequently been modified as they are updated as part of the citizen monitoring system that the ESC program supports. However, this table reflects the baseline situation for these cities at the point the methodology was first applied.
Source: ESC Initiative database, available at urbandashboard.org.

ments represent a monetary total of €6.4 billion (Pérez et al., 2009).

San Francisco is another city that has demonstrated how innovation and regulation can work together to achieve rapid transformations in the waste and pollution patterns mentioned in the encyclical. Since 2013, the city has reduced the waste sent to landfills to just 20% of the total. This is the outcome of: i) regulations that oblige citizens and companies to compost and recycle waste, and

**SUCCESS STORY:**
**CLIMATE CHANGE ADAPTATION THROUGH GREEN INFRASTRUCTURE**

For decades, cities have responded to the challenges of urban pollution on a sector-by-sector basis: by expanding the wastewater drainage network, but without handling the solid waste that pollutes water courses and without realizing that if no action is taken to slow the unplanned expansion of the city, it will become increasingly unfeasible to achieve full sanitation coverage. In response to this, projects have been developed that seek to provide integral, creative solutions to problems of environmental quality and access to natural resources. One such example is Port of Spain, a coastal city where 30% of the drinking water supply depends on underground water sources, which are highly vulnerable to saline intrusion during tidal surges. Aquifer recharge is another problem the city is facing, because as the urban footprint has grown, the hills to the north of the city have been deforested. These not only helped to retain and filter rainwater but also provided protection from storms. Port of Spain's drain network is also limited, which has caused river pollution and makes flooding hard to handle, resulting in annual economic losses of approximately US$11.6 million. Finally, there is very little public green space in this capital city, which impacts the quality of the urban area as a whole.

With the support of the ESC program, Port of Spain's authorities have started to understand the importance of taking on these diverse challenges in an integrated fashion and to make climate change adaptation and intrinsic part of their strategy for handling them. The ESC program's climate change studies have revealed that risk and pressure on underground wells will increase more than expected, due to the combination of an increase in evapotranspiration levels and a predicted average rise in sea levels of 1.25 m toward the end of the century. If no action is taken to prevent this, it will cause major coastal erosion (Jeppesen et al., 2015). In this context, the city government understood that piecemeal repairs to the drainage network or solutions designed to comply with current efficiency standards would be of little use, as any progress made would rapidly be offset by rising sea levels and increased demand for water.

With IDB financing, Port of Spain has begun a comprehensive program that will combine forest conservation initiatives with drainage infrastructure and institutional strengthening so that an independent authority in the country can manage these factors from a long-term perspective, based on climate change science. The culmination of these initiatives will be the creation of a 1.4-kilometer linear park that will be adaptable to flooding, help water reabsorption, and provide the city's inhabitants with a major space for recreation and environmental awareness-raising.

See the video "Flood Prevention and Creation of a Linear Park. Port of Spain, Trinidad & Tobago" on the IDB Sustainable Cities Vimeo channel.



MAP 1
**NUMBER OF PUBLIC BICYCLES AVAILABLE PER 10,000 INHABITANTS IN LATIN AMERICAN CITIES**

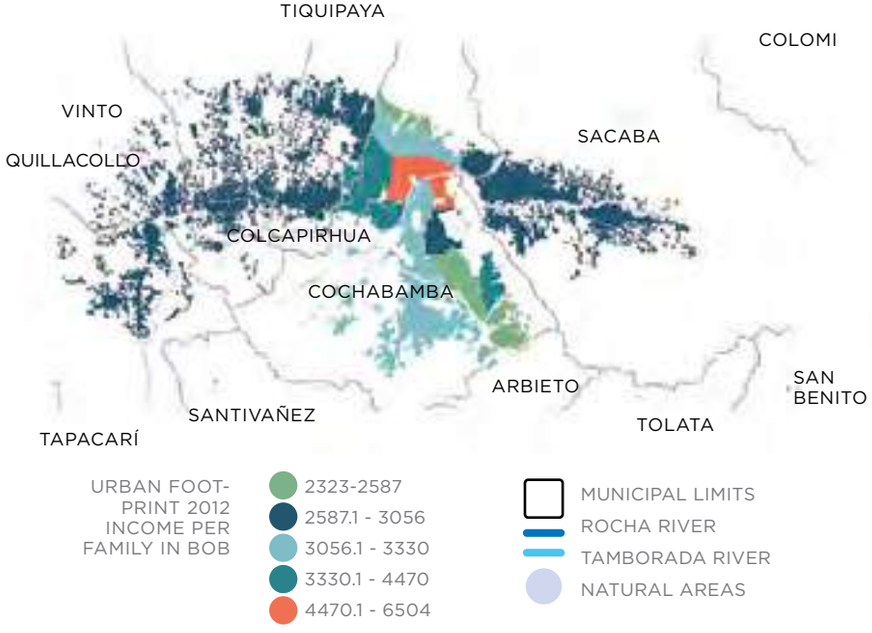

Source: Taddia et al. (2015)

ii) a partnership between the local government and a private company with the necessary technology for recycling a wide variety of materials without this implying higher collection and handling rates than in other cities in the United States. Thanks to this waste management strategy, the city's greenhouse gas emissions are 12% lower than they were in 1990. San Francisco's example is also proof that the recycling industry can be a dynamic driver for the economy: it is estimated that if every city in the United States instigated similar recycling and composting programs, some 2.3 million jobs would be created (PM, 2013).

## Land-Use Planning

*Laudato Si'* refers at several points to the importance of reducing the chaos of cities, making these respectful of natural systems and organized in such a way that access to beautiful, green spaces is not

MAP 2
**SOCIOSPATIAL SEGREGATION IN CITIES: INCOME PER FAMILY IN METROPOLITAN COCHABAMBA, BOLIVIA**




Source: Action Plan. Sustainable Cochabamba Metropolitan Area (2013) and CEPLAG.

limited to a select few. In other words, it is calling for better land-use planning from a perspective of social and spatial equality. To analyze these patterns, we will focus on four of the indicators used in the ESC methodology: (i) how fast the urban footprint is growing, (ii) how much permanent green space there is per person, (iii) what percentage of housing is contained in informal settlements, and (iv) what percentage of households are at risk.

## Mobility

Mobility is another sector that citizens are keenly aware of when they think of typical city problems. Indeed, the public opinion surveys on the quality of urban life that were collected by the ESC program revealed that in practically every city, transportation is one of the four main problems that citizens see as having the greatest impact on their quality of life.

Like other issues, mobility is strongly affected by land-use planning decisions and is another factor that reinforces patterns of inequality. In LAC cities, the lowest socio-economic classes live in remote areas and depend on public transportation systems that are at a great disadvantage to cars. It comes as no surprise that public opinion surveys indicate that in medium-sized cities, lower income populations spend 78 minutes getting to their destination, compared with 53 minutes for higher social classes (Juan et al., 2016). Although 43% of these cities' populations frequently use public transportation, only one in three people find this comfortable.

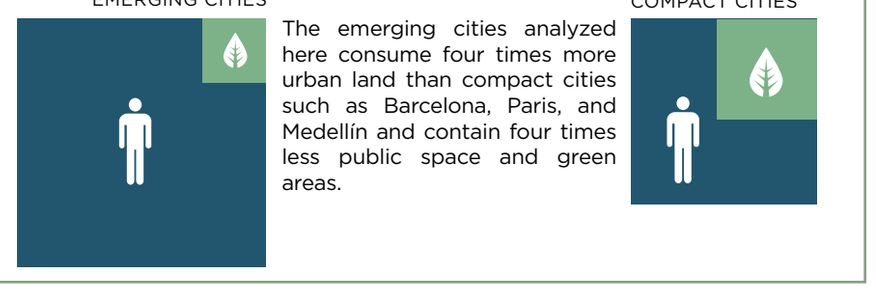
The implications that mobility has for equality are precisely why the social and economic benefits of improving it are so substantial. For example, in Mexico City, doing so would save the 3.3 million person-hours eaten up by each day of heavy traffic (IMCO, 2011) and free up time for people to spend with their family and look after themselves and their community. Reducing traffic congestion would strengthen cities' competitiveness, as the time spent transporting goods within their limits could be cut to a third of current levels, as a recent IDB study in the cities of São Paulo, Barranquilla, and Santiago de Chile has revealed (Guerrero, 2016).

There are many examples of transformative interventions to these ends. One of these is the changes that Copenhagen went through during the second half of the 20th century. It may seem hard to believe, but the initial attempts at pedestrianization in 1960, which envisioned open-air cafés and car-free streets, met with great social resistance that was encapsulated by the argument that "Danes are not Italians" (Beatley, 2011). The first such intervention in Copenhagen was the pedestrianization of just 15,800 $m^2$ of the Strøget area. By 2005, the pedestrian area covered 99,770 $m^2$, and it currently also includes a road system whose 454 km of bike lanes favor sustainable mobility, so much so that 45% of trips to work or school are made by bike (SCED, 2016). In Latin America, cities like Bogotá and Rosario are following in Copenhagen's footsteps in that more than 5% of trips are now made by bike (Taddia et al., 2015).

These and other examples demonstrate that changes in mobility paradigms are not only possible but are also economically profitable. In New York City, when bike lanes were established on Eighth and Ninth avenues, sales in local businesses went up by 49%, according to revenue analysis based on sales taxes (NYCDOT, 2012).

## Equality and Security

La Equality is at the heart of the message contained in the papal encyclical and cuts through all the issues presented above. Inequality is a particularly severe problem in LAC. It corrodes the social fabric and is closely related to citizen security, an issue which the inhabitants of medium-sized cities in the region rank



SALES ON NEW YORK AVENUES INCREASED BY

**49%**

WHEN BIKE LANES WERE BUILT

highest among their concerns.

Table 2 shows that inequality as measured by the Gini coefficient is the only indicator for which no cities have reached a sustainable level (<0.35). The average value for medium-sized ESC cities is 0.5, which could be interpreted as meaning that half of total households account for practically all income in urban economies, leaving the other half dispossessed. This is the case in Cochabamba, whose coefficient of 0.51 is the third highest of all cities in Bolivia, a country which in turn is one of the most unequal in Latin America (see map 2).

We need to take into account that there is a close relationship between the financial insolvency that characterizes inequality and job insecurity. After analyzing the results of public opinion polls, we discovered that an average 29% of the families surveyed lacked sufficient income to cover their basic needs. In terms of informal employment, we found that an average 45% of the urban populations that we analyzed worked in the informal sector, which implies not only low income but also high levels of job insecurity, a lack of social security, and, in many cases, abuse and mistreatment.

Inequality permeates the social construction of cities. This reinforces the need to introduce a multisectoral vision into development projects. This is evident in relation to environmental issues such as solid waste management: in LAC, most workers in these sectors are informal and do not have suitable clothing or equipment in a context in which homes neither separate their trash nor pay appropriate rates for handling it. These thousands of informal garbage collectors or scavengers are exposed to great risks, which are made even worse by the fact that they have no job benefits or health coverage. A study in Mexico City revealed that although the average life expectancy for inhabitants in the year 2000 was 67, the average expectancy of scavengers in open-air dumps was just 39 (Medina, 2000).

Inequality is also closely related to violence. Latin America and the Caribbean has been known for many years as the most unequal region in the world, and at present, 43 of the world's 50 most violent cities are in the region (CCSPJP, 2014). At the ESC program, we see these issues as being closely linked to access to education and the existence of public space. Many studies suggest that improvements to transportation and buildings, better lighting, the density of green spaces, and police access are key factors in reducing violence among young people (Welsh and Farrington, 2008; Cassidy et al., 2014; Prüss-Ustün et al., 2015). This is why we are emphasizing the importance of building cities on a human scale, avoiding road infrastructure whose design disincentivates pedestrian movement and cuts off entire areas of the city.

Instead, we are celebrating projects that seek to recover and renew public space, which is where inhabitants become citizens, because it is where they play, live together, and carry out political demonstrations.

The quintessential public space is the street. However, opinion polls in medium-sized cities indicate that only 28% of inhabitants feel safe walking the streets of their city at night. With regard to public squares and other such spaces, the average ESC city has about 40 hectares of public space for every 100,000 inhabitants, however, there are extreme cases such as Cumaná or Tegucigalpa which do not even have as much 2 hectares for every 100,000 inhabitants.

Whether or not these public spaces exist, it is clear that insecurity is one of the major obstacles preventing them from performing their function. Given the above, the experience at the ESC program suggests that the only way to impact this issue is to work together on strengthening institutions and the situational prevention of violent crime. One example of this is the work that the IDB has carried out in the Villa Cristina and Villa Franca settlements in Tegucigalpa, where neighborhood improvement projects such as the construction of storm drains, paving, and drainage was made possible through training days which empowered the community and strengthened social cohesion. This at least partly explains the 60% reduction in homicide rates in these areas. Other initiatives involved access to water, housing and flood and landslide mitigation (IDB, 2013).

### Transparency

Transparency is an inescapable and crosscutting aspect of governance in cities. As was discussed at the start of this article in relation to São Paulo, local governments need credibility if citizens are to be willing to change their habits and adopt new norms. Many basic services in cities are financially unsustainable without increases to rates and revenues, but inhabitants are wary of these when they perceive that the government does not handle public finances transparently.

The World Bank's Social Development Department indicates that transparency is one of the greatest disincentives for the misappropriation of funds, thus reducing corruption. However, transparency also enables citizens to give feedback on the use of resources so as to make municipal operations more efficient (Patel and Agarwal, 2014).

One of the indicators reviewed as part of the ESC program is the transparency index, for which there were varied performances among the region's medium-sized cities. The highest scores were for Vitória and Montevideo (7.6 and 6.9, respectively), while the lowest were for Cochabamba (1) and Managua (2.5). The median for the 37 cities fell within the yellow category with 4.2. The program has gathered nominal information on public accountability sessions and whether government agencies are audited to share critical information on government programs. This is extremely important as this sort of information is the only way that the course the local administration is on can be assessed and corrected.

## CITIES THAT ARE RESPONSIBLE FOR OUR COMMON HOME

The data and experiences that we have reviewed here prove that it is feasible to revert the unsustainable development patterns that have caused so much damage to the ecosystems that support cities, but they also show the close ties between access to the benefits of cities and inequality.

The first step in this direction is quantifying the problems and the benefits that will derive from solving them.

**29%**

OF THE WORLD'S POPULATION LIVE IN INFORMAL SETTLEMENTS

Measuring is an act of understanding but is not enough on its own. Cities also need to describe and prioritize these challenges and to seek out the interdependencies between them so as to identify critical areas where virtuous improvement cycles could be set off. A multisectoral understanding of urban challenges is what will enable these processes to take place.

The second step is to design interventions that are human in every sense. They need to be on a human scale so that the city is seen as a space for interacting with other people, a space for enjoyment and not just for production. They also need to be human in their processes, as without citizen engagement it will be hard for interventions to improve cities to really take hold. Only rarely do we find transformative initiatives that have been achieved through top-down government leadership. It is said that you can't love what you don't know and, in this sense, it is essential to strengthen mechanisms to feed urban populations' sense of surprise at the value of environmental assets, to educate them about the implications of their daily habits, and to make them partially responsible for the changes that cities need to improve everyone's quality of life.

The common denominator for any transformative action is that it should be comprehensive. This is so because change is not achieved by a single social sector or a single infrastructure sector, and also because the hallmark of urban development, at least in LAC over the last five decades, has been fragmentation. Dealing with the problems of pollution, inequality, and governance implies re-articulating communities with services and economic opportunities in compact cities; reconciling the false dichotomy between asphalt and natural spaces by seeking to create biophilic cities; and demanding the restoration of urban interfaces that allow residents to spend their free afternoons together in inclusive cities. The density of ideas in cities and their economies and social capital make them a unique opportunity for attacking poverty and environmental degradation at the root. More than ever before, the time has come to face up to that responsibility.

**NOTES**

[1]According to estimates from Mexico's National Water Commission (2012), for each 1°C increase in current maximum temperatures, we can expect a rise in per capita water consumption of 5.4 liters per day.

[2]Some estimates suggest that each 33 m2 of green space reduces noise levels by 7 decibels (Coder, 1996).

[3]The World Bank uses the Cost of Environmental Damage to measure pollution costs, which is based on estimates of deaths caused by particulate matter (PM). Other methods contemplate morbidity, cognitive impairments, and even impacts that are unrelated to health issues, such as affects on infrastructure and crop harvests.

[4]The median is used to measure key trends because cities like Florianopolis and Joao Pessoa skew the average as they have 2,894 and 450 hectares of green space per hundred thousand inhabitants, respectively.

[5]These public opinion polls were carried out between 2011 and 2014 as part of the ESC methodology. They have a 95% reliability rate and a margin of error of +/-3.1% (Juan et al., 2016). Results for these polls were analyzed for the following 25 cities in 12 countries: Argentina: Añelo, Las Heras, Mar del Plata, Paraná, and Salta; Bolivia: Cochabamba; Brazil: Florianopolis, João Pessoa, and Vitória; Chile: Valdivia; Colombia: Barranquilla, Bucaramanga, Manizales, Montería, Pasto, and Pereira; Ecuador: Cuenca; Guatemala: Quetzaltenango; Jamaica: Montego Bay; Mexico: Campeche, La Paz, and Xalapa; Nicaragua: Managua; Paraguay: Asunción; and Uruguay: Montevideo.

[6]Security ranked top of the intersectoral index with a score of 10 out of a possible 10 according to public opinion polls in these cities in which respondents were asked rank the 21 issues that make up the ESCI methodology in order of priority. Equality ranked second, with a score of 6.5 out of a possible 10.

[7]This coefficient is based on a calculation in which zero implies absolute equality, that is, in economy in which resources are equitably distributed among all households. A value of one, in contrast, signifies absolute inequality, with a single household receiving all income and none available to other households.

[8]Based on a method that compares the perceptions of those who are in a position to evaluate corruption in the public sector in a given country.

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CASE STUDY

# ACCESS TO DRINKING WATER


With over a hundred years of experience in higher education, Sophia University in Tokyo has become one of the best-known universities in Asia. Its Graduate School of Global Environmental Studies keeps a close watch on the health of the planet and seeks to expand the knowledge frontier in the areas of conservation and environmental protection.

The school's director, Guangwei Huang, is one of the leading global authorities on access to water and protecting the world's oceans.

**Can you describe the current state of affairs regarding access to water in the world?**

Some 663 million people (one person in every ten) does not have access to drinking water. Some 2.4 billion people (one person in every three) do not have toilets. In other words, more people have cell phones than access to a bathroom. Pollution and contamination is another important aspect of the water problem. Numerous human activities impact water quality, including agriculture, industry, mining, disposal of human waste, population growth, and urbanization. Pollution further affects access to safe water. The impact of climate change on water resources is yet another challenge.

**What are the consequences of the lack of access to water?**

Women are forced to travel long distances to reach safe water. The poor are often unable to afford clean water and thus are forced to live with totally untreated water. Unsafe or inadequate quantities of water, sanitation, and hygiene together cause more than 1.7 million deaths annually.

**How can public policy can help to improve access to water and water quality?**

WOMEN ARE FORCED TO TRAVEL LONG DISTANCES TO REACH SAFE WATER

The Millennium Development Goals halved the number of people without safe drinking water. However, improved access to safe water has generated more wastewater, and the construction of wastewater treatment facilities often lags behind the development of water supplies. This lag is one of the major causes of water pollution. There are many national and regional policies on water quality management, however, the implementation of effective policies and regulations is often very poor in developing countries. In addition to policy, education and awareness-building are needed to solve water problems.

**What is the role of innovation to help pollution control?**

**33%**
OF THE WORLD'S POPULATION DOES NOT HAVE ACCESS TO A TOILET

We need to innovate in both technology development and societal reform in order to control pollution. For example, innovation in environmental monitoring could play a big role in controlling pollution and raising awareness. Using wetlands wisely may help control water pollution and also promote local economies. Good environmental monitoring and environmental law enforcement are the keys to the wise use of natural resources in Latin American countries.

**In Laudato Si´, Pope Francis talks at length about the oceans and their importance for life on earth. How can we better protect them?**

It is absolutely true that oceans are indispensable for life on the earth. They provide human beings with many ecosystems services including food and cultural services. Without oceans, the water cycle will stop and no one will be able to survive. However, overfishing, pollution, and habitat fragmentation are degrading the health of our oceans. In my opinion, the water crisis is the most serious global risk that we are facing, given its impact on our societies.

# Green Transportation

THE QUALITY OF LIFE IN CITIES HAS MUCH TO DO WITH SYSTEMS OF TRANSPORT, WHICH ARE OFTEN A SOURCE OF MUCH SUFFERING FOR THOSE WHO USE THEM.

*Laudato Si'*

José A. Barbero[1]
Institute of Transportation at the National University of San Martín

The global movement of goods and people has grown at an unprecedented rate in recent decades on both the urban scale and the national and international scales. The main causes for this phenomenon are population growth, increased production and consumption, urbanization and the expansion of cities, the motorization of society, and globalization. Transportation systems have met these tremendous demands but at the cost of significant direct and indirect negative impacts on the natural and social environment. Some of these impacts are local and regional, while others are global, the most noticeable example of which is the generation of greenhouse gases (GHGs), which cause global warming. This article examines the challenges ahead of us in the medium term.

It is not easy to comprehend the enormous growth in movements of goods and people in recent decades. Observations are often made regarding the technological changes that the transportation system has undergone (such as containers, high-speed trains, or hybrid vehicles), but comments pertaining to the sheer scale of the movements that the system must handle on every geographical level, from the global to the local, are rather more infrequent. A range of factors have contributed to driving increased physical flows of goods and people: population growth, increased production and consumption, the globalization of the economy and trade, urbanization, the territorial expansion of cities, motorization, and the increased international movement of people, among others. In terms of freight, global trade in 1980 stood at US$1.8 trillion per year (equivalent to 18.6% of global GDP), while by 2014 it had grown to US$19 trillion (24.6% of global GDP), a sign of the growing role of emergent economies and South-South trade (McKinsey Global Institute, 2016). In air transportation, revenue passenger kilometers practically doubled between 2003 and 2015 (ICAO). In terms of urban mobility, as of a few months ago, 50% of the global population now live in cities, with rates of mobility per person that increase progressively as income and motorization grow, and with cities that are expanding territorially, leading to longer commutes and travel times.

Transportation systems have responded to this tremendous growth in mobility by increasing their capacities, speed, and the quality of their services within the different segments of demand. They have also facilitated this growth: it's hard to imagine current



# GREEN TRANSPORTATION

trade levels without containers and the ships and terminals that move them, or big cities without the development of the infrastructure and public and private vehicles that take their inhabitants from place to place each day.

## IMPLICATIONS FOR TRANSPORTATION

There are multiple economic and social benefits to these unprecedented mobility levels, but the negative impacts they generate are also highly significant, as are the resources they require. Examples of negative impacts include the effects on the environment in both natural and social terms: pollutant gas emissions, the accidents caused by road transportation (over a million deaths per year), and the waste generated by the more than 1.2 billion vehicles in the world.

Transportation also consumes massive resources which—from a life-cycle perspective—include the different materials needed to build infrastructure and vehicles and the energy resources needed to run them, as well as the physical space required by transportation systems in terms of traffic and parking (which ranges from 10% to 50% of land use in urban areas). The energy used by transportation is particularly significant, as it represents approximately a quarter of the energy delivered at the global level (a fifth, if energy loss is taken into account). The sector maintains a strong link with fossil fuels: over 60% of the barrels of oil that are extracted worldwide each day are used for transportation. Within the sector, fossil fuels account for 96% of the energy consumed (IEA, 2016). As a result of these high levels of consumption of hydrocarbon derivatives, the transportation sector ranks second in terms of greenhouse gas (GHG) emissions (after the generation of electricity and heat). The sector is growing at an alarming rate: between 1990 and 2008, it grew 29% in OECD countries and 89% in the rest of the world. Light vehicles, which use gasoline and diesel, are the main energy consumers (52%). Trucks account for 17% of global energy consumption, while air and sea transportation each represents 10% (2010 values, World Economic Forum, 2011).

One of the peculiar features of these negative effects is that they are often not reflected in prices; the sector's total costs exceed revenue from users, the value of their time using transportation, and government subsidies. The environmental externalities (and other nonenvironmental ones) that the sector generates are considerable and they pose a challenge for public policy: who should try to reduce them and how should they go about doing so? It is worth pointing out that transportation also generates highly significant positive externalities, fundamentally by improving access to economic development and quality of life.

## ENVIRONMENTAL IMPACTS

Transportation impacts the environment in multiple, diverse ways. First, a distinction should be made between

the impacts that are generated during the construction phase and those that arise during operations. Infrastructure construction can bring about a wide range of impacts: for example, roads and highways may affect the water network, biodiversity, or populations that have to relocate; ports and dredging affect coastal ecosystems; and urban mass transit affects traffic and noise levels. During the operations stage, transportation can affect the environment by emitting pollutant gases (such as carbon monoxide) and particulate matter, both of which affect people's health and can alter the ozone layer; generating noise (for example, airplanes, freeways, or shipping terminals); creating urban barriers; and emitting GHGs. A complete list of the impacts that may arise as a result of establishing and operating different transportation systems throughout their life cycle would be extremely lengthy. Indeed, assessment techniques use predetermined tables of the most probable impacts, which vary considerably from one form of transportation to the next.

In terms of their geographical reach, these impacts may be local (for example, pollutant emissions in cities), regional (for example, acid rain or the pollution of water sources due to waste from ships), or, on occasion, global, as is the case with GHG emissions. Impacts tend to be classified as either direct, which reflects the immediate consequences they have for the sector (for example gas and particle emissions), or indirect, which refer to those caused by the former (in this example, the damage that those gases and particles can cause to people's health). The latter is usually harder to measure. These impacts are cumulative and hard to predict, as a result of the well-known complexity of environmental systems (Bennett and Chorley, 1978).

Effects can also be classified as first order and second order (Potter and Bailey, 2008). First-order effects are the direct physical impacts produced by transportation systems, such as vehicle emissions, noise, the urban or rural space required for road and rail networks and airports, the waste created by dredging ports, waterways, and shipping lanes, or the waste generated when ships and vehicles are dismantled and scrapped. Second-order effects are related to the ways in which societies and the economy adapt to growing mobility and changes in the transportation system. For example, the territorial expansion of cities driven by motorization and the spatial dispersion of economic activities. Or the relocation of productive activities, facilitated by technological improvements in logistics, which has led to the production and sale of goods entailing increasingly long trips, a change which has implied the continual inclusion of transportation in the goods value chain.

The last two decades have seen significant progress in the identification, measurement, and assessment of the environmental impacts of transportation projects. These practices have been gradually included in countries' regulatory frameworks, which require formal assessments and licenses as necessary conditions for implementing investment projects. Several factors have played a part in this process. One of these has been the imposition of environmental safeguards by multilateral credit entities as an essential requirement for financing projects, a practice which has also been adopted by the private banking sector. Another is growing environmental awareness on the part of the population and large-scale NGOs, which have led to the environment being taken into account within decision-making processes.

Environmental assessments are generally carried out at the project level, so there are specific guides for the different stages of each form of transportation (design, construction, operation).[2] In recent years, assessments of projects that have already been defined, which aim to mitigate their impacts, have been complemented by more strategic analyses (strategic environmental assessments) at the policy or program level. These tend to be more proactive than reactive and are more inclined to consider the cumulative nature of environmental impacts and how these interact.

## THE CHALLENGES OF CLIMATE CHANGE

Of the multiple impacts that transportation generates and that are summarized in the previous section, the emission of gases that contribute to global warming is probably the factor that is currently the greatest cause for concern in the international community. Mitigating climate change is an urgent issue both because of the well-documented impacts it is expected to have and because Latin America and the Caribbean are particularly vulnerable to it. In recent decades, changes in the earth's climate have affected natural and human systems on all continents and in all oceans. The most notable of these consequences include the distribution of usable species, crop yields, water availability, and the increase of extreme weather phenomena (IPCC, 2014). In Central and South America, the IPCC is predicting, with a high degree of confidence, a high to very high risk of increased landslides in rural and urban areas and increased spread of vector-borne diseases at higher altitudes and latitudes, among others (IPCC, 2014). Sir Nicholas Stern's "Review on the Economics of Climate Change" argued that it is more profitable to take measures to stop climate change than to face the cost of not doing so. The review thus urged that measures be taken to mitigate GHG emissions and to adapt the transportation sector to the effects of climate change immediately.

TRADE FLOWS ACCOUNT FOR

**24.6%**

OF GLOBAL GDP

An analysis of the sectors that contribute most to GHG emissions show that transportation plays a significant part in this process: in addition to being responsible for a large share of global emissions, the dynamic of these reveals it to be the sector where these have grown the most. In terms of GHG emissions at the global level, transportation is responsible for 13.1% of the total and 22% of those originating in energy consumption and is outperformed only by the generation of electric energy and heating (EIA, 2016). Between 1990 and 2010, global emissions from the transportation sector increased by 88%, fundamentally in emerging countries (non-OECD members), which is where the sector is experiencing the greatest growth (IDB and Office of Evaluation and Oversight, 2014)

Climate change poses several challenges to transportation systems, which are incorporating the following priority objectives into their agenda:

i. collaborating on reducing emissions in line with the targets established in the agreements countries have signed (the mitigation agenda);

ii. adapting facilities to changes in the climate that are already taking place (the adaptation agenda); and

iii. preparing to manage systems (infrastructure, services) to ensure they recover rapidly in the event of a catastrophe and return to normal service provision (resilience).

## MITIGATION STRATEGIES

There are numerous alternative strategies to effectively reduce emissions, which have been summarized in an approach known as Avoid-Shift-Improve (ASI), which establishes guiding principles to achieve this efficiently through low-cost systems that are easy to implement (Dalkmann and Brannigan, 2007).

Avoid refers to unnecessary travel, reducing distances or the need to move around, or taking better advantage of vehicle capacity. It implies better integrating transportation and land-use planning and promoting local production and consumption. It also includes replacing motorized trips with nonmotorized ones (on foot, by bicycle).

Shift targets changes in transportation modes, favoring forms with the lowest carbon emissions. In urban transportation, for example, this implies promoting greater use of public transportation and discouraging individual transportation or advocating the use of nonmotorized transportation. In relation to freight transportation, it implies fostering the shift from road to rail, sea, and river transportation, which favors greater intermodal connections.

Improve seeks greater efficiency in each form of transportation, which implies upping vehicles' energy efficiency through the introduction of new vehicle technologies (see box 1) and fuels (more efficient engines, hybrid vehicles, cleaner fuels, etc.), and also by operators adopting better practices (speed limits, improvements in truck aerodynamics, etc.).

The impact of these actions is reflected in the relationship between the emissions generated and traffic activity levels (tonne kilometers, passenger kilometers). Policy objectives normally seek to decouple increased travel by goods and people (which is part and parcel of economic development) from increased emissions. This can be achieved through supply-side measures (better technology, better operational practices), but also through measures that modify the demand profile. For example, in urban areas, demand management initiatives can be implemented on the basis of market mechanisms, such as parking or congestion charges, or even absolute limitations on vehicle traffic at certain times or in certain areas. There may also be attempts at longer-term actions by promoting changes in land use so as to generate urban spaces that lead to shorter trips through measures that foster mixed uses, favor the viability of public transportation, or limit the territorial expansion of cities. This latter type of measure requires coordination between public policy areas that have traditionally operated independently from one another, such as urban development, housing (including subsidized or public housing), the environment, energy, and mobility, which is a serious institutional organization challenge for cities. Box 1 shows, by way of example, a typical portfolio of initiatives that aim to mitigate GHG emissions in the urban context, and reveals how broad this agenda is (adapted from IEA, 2016).

Over the last 15 years, Latin America has made progress on this mitigation agenda, with its most notable advances probably being in urban passenger transportation. This has been related to the development of integrated mass transit systems, including both rubber-tyred systems (such as bus rapid transit or BRT, which Latin America has pioneered) and guided systems (subways or metros, light rail, and streetcars or trams), and the promotion of nonmotorized transportation, such as pedestrian precincts and bike paths. There have not been any major advances in freight transportation, despite the current and future importance of this (as figure 2 shows). Trucking accounts for approximately 75% of freight transportation in the region, and there are weaknesses in terms of both the management model for this (which is largely organized by vehicle, not by fleet, leading to low cargo space occupancy rates and low usage rates) and aging fleets, which have high emissions levels. Although these improvements are positive and noteworthy, they still have not been enough to compensate for the increase in emissions that has resulted from the enormous growth in passenger and freight traffic in the region.

## STRATEGIES FOR ADAPTATION AND RESILIENCE

Adaptation implies adjusting not only to the effects of climate change that have already been observed but

### PUBLIC POLICIES TO HALT POLLUTION

**National/Supranational Policies**

- Taxes on fuels.
- Elimination of fuel subsidies.
- Introduction of taxes on the $CO_2$ content of fuels (carbon taxes).
- Fuel economy standards.
- Taxes on vehicles, including on dirty technologies (feebates) and punishment and reward schemes.
- Support for research and development.

**Local Measures**

- Compact cities, that is: urban densification integrating land-use and transportation planning, promoting the redevelopment of derelict industrial zones, transit-oriented development (TOD).
- Price measures: congestion charges, parking surcharges.
- Regulatory measures: access and parking restrictions, low emission zones.
- Support for public transportation: development of networks, subsidies.

also to future effects, which are expected to include a range of high-risk situations. Adaptation relates to vulnerability, which in the case of transportation means reducing the effects of extreme natural phenomena on infrastructure and services. There are methodological differences for adaptation that are applicable to the transportation sector, including:

- Ecosystem-based adaptation, which implies making sustainable use of natural ecosystem services to reduce vulnerability. For example, slope revegetation to increase water regulation, and soil water retention so as to avoid floods and landslides onto roads or tracks.
- Infrastructure-based adaptation, which consists of building infrastructure that takes into account variations in extreme weather events and the long-term effects of climate change in order to reduce vulnerability in areas where potential impacts outstrip ecosystem capacity. For example, infrastructure for handling rainwater in areas where soils and ecosystems are at an advanced stage of deterioration.
- Knowledge-based adaptation in communities, which is especially important in places where there are no hydrometeorological records, for example, to design drainage systems for roads and transport links.
- Technology-based adaptation, such as the use of new materials to improve drainage or replenish aquifers.

Best practices recommend that adaptation strategies be robust and contain components of all these methodologies. They should be systematically included in infrastructure planning to ensure that this can service the community under future climate conditions (Rodríguez Tornquist and Cruz, 2016).

Resilience needs to be strengthened in parallel to adaptation, because climate change is associated with a high degree of uncertainty, which can lead to what is known in risk management as residual risk. Given this, it is important to strengthen emergency response organizations to ensure they act quickly, to design risk transfer mechanisms in strategic infrastructure to protect state investment, to ensure infrastructure redundancy around ports and communities so as to guarantee continued service provision in the event of natural disasters, and to strengthen transportation authorities to favor the prompt return to normal transportation service provision and the recovery of affected infrastructure.

## HOW TO MEET AGREEMENT OBJECTIVES

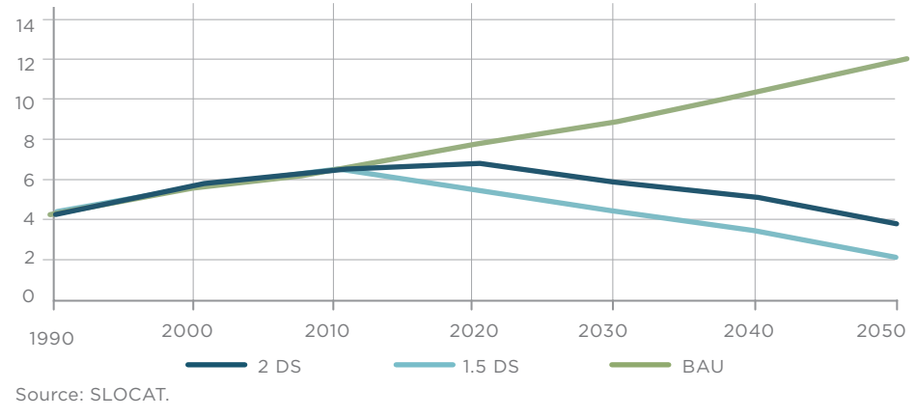
The United Nations (UN), through its Framework Convention on Climate Change (UNFCCC), has been trying to advance a global agreement to tackle the causes and effects of this phenomenon for over 20 years. At its 21st Conference of the Parties (COP21), which took place in Paris at the end of 2015, the UN managed to reach a universal and legally binding agreement on climate action for the first time. The agreement contains emissions reduction commitments on the part of 187 countries from 2020 onwards, with the main objective being to keep the increase in the earth's temperature associated with global warming below 2°C (or, eventually, 1.5°C). These goals are a sign of substantial progress in the so-called decarbonization of the transportation sector, which would radically change the path the sector has been on in recent decades. Figure 1 shows this historical trend and reflects the millions of tonnes of carbon emitted each year by the sector and how this would continue in a business-as-usual (BAU) scenario. It also establishes the levels these emissions must come down to to meet the goal of limiting global warming to 2°C (Transport 2DS) or 1.5°C (Transport 1.5DS).

The goals set out in COP21 imply substantial changes to a trend that is firmly entrenched, which represents an unprecedented challenge for transportation. A pioneering organization in the field (SLOCAT[3]) puts it in these terms: "Accelerating the decarbonization of multi-modal mobility/transport requires an integrated strategy across transport modes, integrating both system efficiency and modal improvements. It also calls for integration of the 'energy + land use + transport' landscape." In the UNFCCC, countries submitted their own proposals for reducing global warming, known as intended nationally determined contributions (INDCs), which set out the contribution they aim to make and their commitments towards reducing emissions and increasing resilience. Several of these INDCs contain explicit mitigation commitments for the transportation sector.

However, the gap between expected emissions and these goals is very wide. Figure 2 shows the growth prospects for the mobility of goods and people according to projections from the International Energy Agency (IEA) for up to 2050 that contain two growth hypotheses (IEA, 2009). The main increase in activity (expressed in units of traffic activity) is in developing countries (labeled non-OECD countries in the figure), fundamentally for freight[4], which is a necessary condition if these countries' economies are to grow and quality of life in them increase.

Moving from emissions forecasts to realities prompts many questions, particularly in developing countries. One

FIGURE 1
**POSSIBLE CARBON EMISSIONS PROJECTIONS FOR THE TRANSPORTATION SECTOR**




Source: SLOCAT.

of these is whether the gap in technological innovations can be closed. Great progress is being made, such as more efficient engines, cleaner fuels, hybrid and electric vehicles, automatic and intelligent transportation systems (such as autonomous vehicles), or even alternative forms of transportation. Many of these innovations may have revolutionary effects on the sector (see box 2), but they would be hard-pressed to revert the trends suggested in figure 1 on their own.

Another issue is how developing countries can take on an integrated agenda (one involving mitigation, adaptation, and resilience), due to the costs this implies.[5] Various factors may play part in responding to this, most notably:

- How realistic countries' pledges are. INDC proposals need to balance the diverse components of the transportation system, which is currently not the case, as there is a strong bias towards the urban environment to the detriment of potential emissions reductions through improvements to freight transportation.

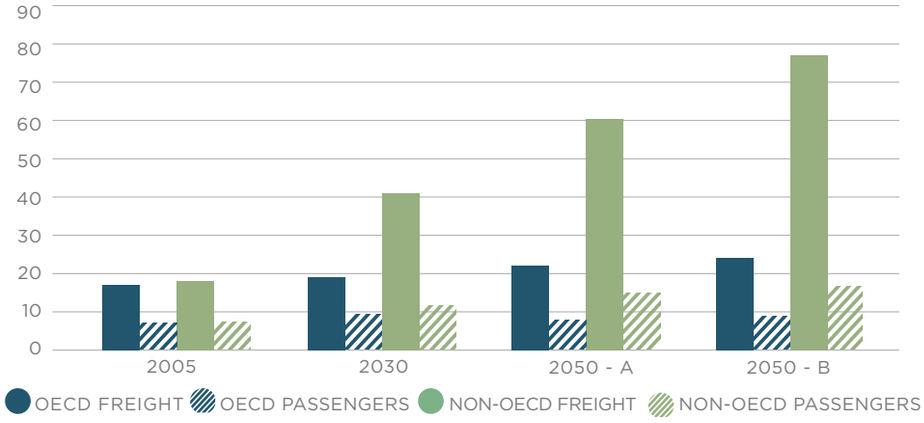
- Countries' capacities to develop and implement complex, cross-cutting agendas that are applicable to numerous areas of government. National governments are not the only ones that need to have appropriate institutional structures: this is also true at the subnational level, as many measures fall under these jurisdictions (for example, changes in urban mobility or land-use planning).

- The technological and financial assistance mechanisms available at the global level. At previous COPs, financial support mechanisms were foreseen on the part of more developed countries and multilateral bodies, as was the mobilization of around US$100 billion in resources per year, which represents a fifth of what the UNEP currently estimates is needed, in addition to the will to support and incorporate new technologies. However, recent international meetings suggest there is a reluctance to provide financial and technological support that contrasts with the results of estimations of the so-called adaptation finance gap, which has grown substantially in recent years (UNEP, 2016). A lack of financial support and technology transfer would considerably hamper progress on these agendas.

- The measuring, reporting, and checking mechanisms used to audit countries so as to guarantee genuine reductions, avoid double counting, and ensure that measurements are made using methodologies approved by the UNFCCC.

The international framework for assistance will undoubtedly be a crucial factor in making headway towards the goals set out at COP21. International discussions will revolve around the ethical aspects of climate change: even though this is a global phenomenon, some populations are disproportionately affected by it, and it is mainly the countries of the global South are that are facing these challenges despite not being major GHG producers.

FIGURE 2
**GROWTH PROSPECTS FOR MOBILITY**
In trillions of tonne kilometers and passenger kilometers.



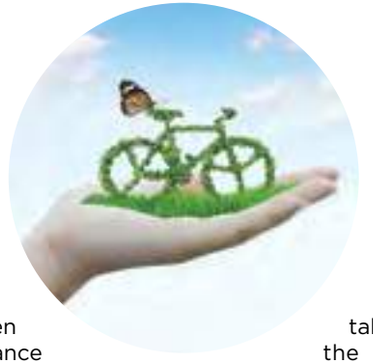

Source: IEA (2009).

### THE POTENTIAL OF HYBRID AND ELECTRIC VEHICLES

There are approximately 1 billion vehicles in the world, of which 80 million are hybrid and 1.5 million are electric. Numbers of the latter have been growing rapidly: one-third of the total were added in 2015.
Hybrid vehicles generate around 30% less GHG emissions than conventional ones. They currently account for approximately 5% of sales in developed countries (20% in Japan) but there are only minimal numbers of them in developing countries. Electric vehicles do not generate GHG emissions; their contribution to reducing such emissions depends on multiple factors, such as the carbon intensity of the type of electricity used to charge them, the time of day at which they are charged, and vehicle type.
In any case, their emissions are lower than those of conventional vehicles. Time of day is a key factor, as the mix of power sources (renewable and nonrenewable) tends to vary significantly between peak and off-peak times. For electricity grids, these vehicles are a major challenge due to the geographical distribution of demand and the operating reserve needed to cope with fluctuations in consumption.

## LATIN AMERICA UP AGAINST SHARED CHALLENGES

Returning to a more general outlook on transportation and the environment, it could be concluded that environmental policies for transportation are increasingly complex, as is the case for infrastructure in other sectors that affect both the local and global levels, such as energy or water management, which have come to occupy a leading role in the climate change agenda. Recent decades have seen significant advances: from virtually ignoring the environmental impacts of projects to establishing standards and compulsory environmental impact assessment mechanisms and licenses, establishing safeguards and



strategic assessments, and moving forward with cooperation between multiple players. Resistance and obstacles continue, but there has also been notable progress, above all in the management of projects throughout their life cycle (and not just during the drafting of national policies).

Transportation policies are facing a paradigm shift. Their objective is no longer to provide mobility-related solutions but to design transportation systems that ensure that the mobility of goods and people is compatible with sustainable development. Environmental issues are one of the pillars of the sustainable development paradigm (although not the only one), and the vast range of reductions in environmental impacts described above must be included permanently in national transportation policies.

The environmental agenda is broad, but the challenge of climate change is one of the most critical aspects that will undoubtedly influence the sector's agenda in the coming years. International negotiations over the financial and technological support needed to tackle mitigation, adaptation, and resilience could be one of the keys to achieving the targets that have been agreed upon. In this context, it is worth asking whether the countries of Latin America will benefit from advancing such policies jointly, in terms of both exchanging experiences regarding INDC proposals and tackling potentially onerous international negotiations together in order to obtain better financial and technological support.

**NOTES**

[1] The author would like to thank Rodrigo Rodríguez Tornquist (IT-UNSAM) and Laura Camila Cruz (IT-UNSAM) for their valuable comments.

[2] One such example, for roads, is Quintero, J. 2016. A Guide to Good Practices for Environmentally Friendly Roads. The Nature Conservancy/Latin America Conservation Council.

[3] "Global Road Map," Paris Process On Mobility and Climate (PPMC) website, http://www.ppmc-transport.org/macro-road-map/

[4] Only land transportation was included in this exercise.

[5] Projections from the McKinsey Global Institute on global infrastructure financing needs increase by 15% when the need to respond to the climate change agenda is taken into account(McKinsey Global Institute, 2013).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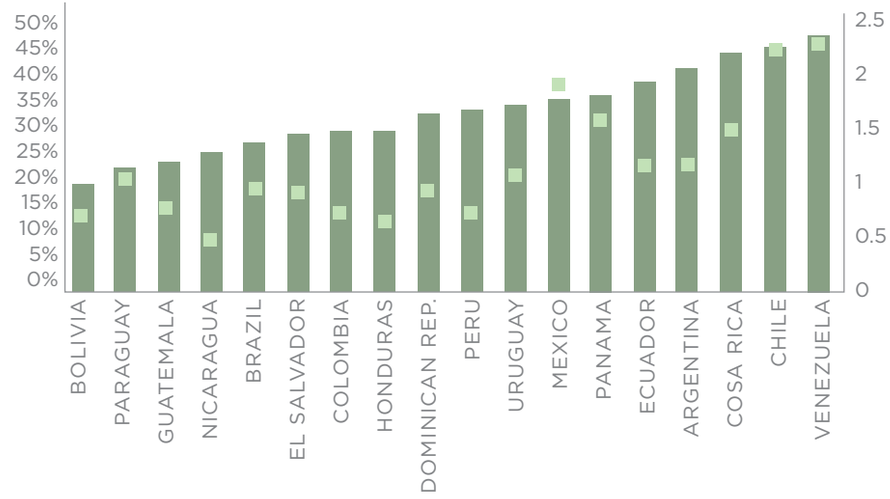
# POLLUTION AND CARBON FOOTPRINTS

Carbon footprints are a measure of the quantity of greenhouse gases that a country emits and their impact on climate change due to pollution from manufacturing activities or transportation. A comparison between countries with the largest carbon footprints and the importance people place on energy-related innovation reveals a correlation of 0.78.

In other words, the countries in LAC where production and manufacturing are causing a larger carbon footprint are also those whose inhabitants are demanding solutions and where energy is an innovation priority.

**IMPORTANCE OF POLLUTION AND CARBON FOOTPRINTS**

Question: Which areas do you think that scientific and technological innovations will have a positive impact on in 15 years' time? Responses for energy supply.




Percentage of the population that believes that scientific and technological innovations will have a positive impact on energy supply

Right axis: carbon footprint (hectares per person)

Source: www.iadb.org/intal/alianzalb

# Resilient Infra**structure**

## **Lessons** from **Chile**

WE NEED ONLY TAKE A FRANK LOOK AT THE FACTS TO SEE THAT OUR COMMON HOME IS FALLING INTO SERIOUS DISREPAIR.

*Laudato Si'*

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# RESILIENT INFRASTRUCTURE

This article looks at the key factors in building infrastructure that is resilient to natural disasters. It examines Chile's experience in this matter, particularly in relation to the 2010 Maule earthquake, which affected the center and south of the country, and then puts forward more general recommendations for the rest of the region. Seismic phenomena may intensify as a consequence of climate change. This article describes the specific technical requirements that new infrastructure should meet to lessen the damage caused by earthquakes, floods, tsunamis, volcano eruptions, and other natural disasters.

We are living through a time of great exposure to natural phenomena in which hydroclimatic events seem to be intensifying because of climate change. In Chile and other countries in Latin America and the Caribbean, the challenge consists of combining and balancing the efforts needed to better understand and define natural phenomena with designing new strategies to mitigate risk and increase infrastructure resilience. These include promoting sustainable development and reducing social inequality as crosscutting objectives.[1]

Throughout its history, Chile has been exposed to extreme natural events, both tectonic (earthquakes, tsunamis, volcanic eruptions) and hydroclimatic (river, pluvial, and coastal floods and droughts). In a single year, 2015, the country was hit by two volcanic eruptions (Villarrica and Calbuco), rare flooding in the world's driest desert (Wilcox et al., 2016), a large earthquake and a tsunami (Aránguiz et al., 2016), and coastal storm surges that caused serious damage to the Valparaíso region.

According to the *World Risk Report 2016* (Garschagen et al., 2016), Chile ranks eleventh on the global list of exposure to natural disasters and fourth among the countries of Latin American and the Caribbean (after Costa Rica, Guatemala, and El Salvador). Using the risk indicator that we put forward in this study—which includes, as well as exposure, factors related to vulnerability and installed preparation and adaptation capacity–Chile ranks twenty-second in the world and seventh in Latin America and the Caribbean. This relative shift in Chile's position in terms of exposure and risk is no coincidence. Instead, it is the result of a major recent effort to implement certain key mitigation measures, driven by the challenge of responding to destructive earthquakes on a regular basis.

The Maule earthquake of February 27, 2010, reached 8.8 Mw on the moment magnitude scale (which measures the energy released by earthquakes), making it the sixth-largest recorded earthquake in the world and one of the major catastrophes in Chilean history. International agencies such as the US Geological Survey, the International Red Cross, and UNIDSDRAM later drew attention to the country's resilience and emphasized how crucial its earthquake-resistant construction codes were in explaining the low recorded loss of human lives. In 2012, the specialist journal *Earthquake Spectra* published a special issue on the 2010 Chile earthquake containing observations and lessons learned (Earthquake Spectra, 2012). This devastating natural event provided evidence that is still being used today to advance knowledge and generate valuable new lessons for Chile and the rest of the world. Despite how well the country's infrastructure performed, the earthquake caused material damage of nearly US$30 billion or 17% of the country's GDP for 2010. This breaks down as follows: US$5.3 billion in costs to industry, fishing, and tourism; US$4 billion in damage to housing; US$3 billion in education infrastructure; US$2.7 billion in health; US$1.6 billion in energy; and US$1.5 billion in public infrastructure and roads (SVS, 2012). This figure confirms the trend that shows earthquakes to have cost Chile 1% of its annual GDP over the last 50 years, which places it at the top of the list of OECD countries in terms of this rate as a percentage of GDP (OECD, 2012).

Our aim in this article is to review Chile's earthquake experience, which may provide lessons for other similar earthquake-prone areas. However, it would be impossible to understand the 2010 earthquake without looking at historical factors, which have greatly influenced how successfully the country handled this disaster. We will then examine the impact that the earthquake had on the country's infrastructure, analyzing which factors played a key role in the reconstruction process and how Chile and other countries can better prepare for natural disasters.

## AN EARTHQUAKE-PRONE COUNTRY

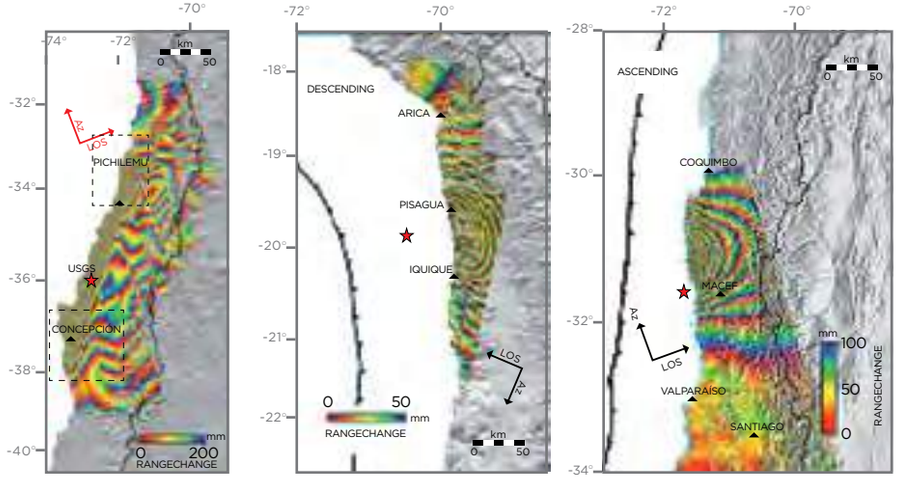
Chile's resilience to earthquakes has historic roots that stretch back fifty or a hundred years, during which time the most significant resilience-related decisions were made by the state. These established a general framework that has affected the country's development through public policies that have defined where, what, and how to build. The resulting institutional and regulatory choices have had an enormous impact on both the exposure of Chile's infrastructure to earthquakes and its current resilience. In this sense, Chile's historical experience of earthquakes has left a positive legacy: following each event, far from collapsing, the state has developed new institutional capacities which have become enduring resources and experience that have then helped the country to tackle the next disaster (Gil, 2016). The greatest lessons learned have related to emergency response and prevention.

The oldest legacy of the modern age is the Production Development Corporation (CORFO), a government organization that promotes the economic development of the country's different

CHILE RANKS
**11TH**
ON THE GLOBAL LIST OF EXPOSURE TO NATURAL DISASTERS

productive areas but that was created to rebuild the economy following the 1939 Chillán earthquake. That same year also saw the founding of the Relief and Reconstruction Corporation, a provisional agency in charge of rebuilding the worst-hit cities and towns. Over the years, this organization became the permanent Housing Corporation, which is now part of the Ministry of Housing. In 1943, the country also created the Economic and Social Stabilization Fund, a financing mechanism that enables the president to issue economic emergency decrees to spend up to 2% of annual GDP on emergency-related matters. This regulation has been used after every major catastrophe to have hit the country since it was created and allows the state to respond rapidly to highly destructive events. The enormous 1960 Valdivia earthquake also gave rise to some major institutional legacies. In 1965, the first national emergency management office, OEMI, was created. It became a permanent institution in 1970, when its name was changed to ONEMI. This office allows the government to respond immediately to emergencies by providing relief and aid to victims. The so-called Earthquake Law was also passed in 1965, which authorized the president to define the territorial limits of a disaster area and to govern the emergency-related aspects of these areas using exceptional decrees. It also allows the president to deploy the army as part of the emergency response effort.

FIGURE 1
**COMPARISON OF CHILE'S THREE MOST RECENT EARTHQUAKES**




Note: Satellite interferograms of the last three earthquakes to hit Chile. Each of the colored bars represents movements in the Earth's crust toward the satellite once the earthquake had finished. These movements occurred from the center of the country toward the coast, where the image is lost because it is impossible to see the seabed.
Source: Compiled by the author.





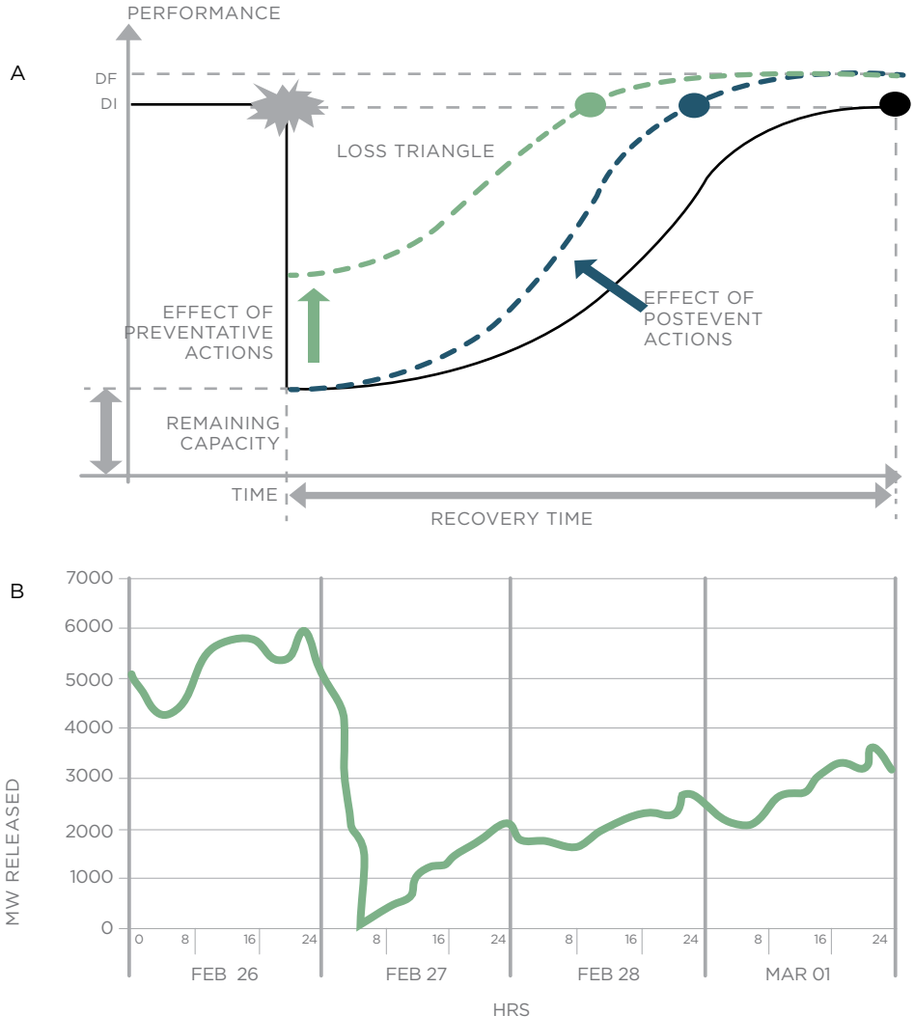
In matters of prevention, Chile's earthquake regulations are some of the most technically complete in the world and all construction work in the country complies with them rigorously. The history of these regulations began in the aftermath of the 1906 Valparaíso earthquake, when the National Seismological Institute was established. This organization carried out the first seismic surveys of the entire country and lobbied for the first regulations on earthquake-resistant construction. These regulations emerged following the 1928 Talca earthquake, when the General Ordinance on Construction was established. These new regulations defined nine building types and earthquake-resistant ways of building them. This law changed construction in the country forever and saw adobe replaced with materials such as concrete. Following each earthquake, these building codes have been thoroughly reviewed, although their success has been proven by the events themselves. For example, only 20% of new buildings suffered irreparable damage after the 1939 earthquake, in comparison with 67% of adobe buildings (Gil, 2016). Even so, it was clear that these regulations did not include urban planning provisions for the general protection of the population, so a new law following the 1939 earthquake contemplated the creation of regulatory plans for Chile's cities, particularly those that had been razed by the earthquake and that could be entirely redesigned. This is why in 1960, the highest magnitude earthquake ever recorded (Mw 9.5) caused significantly less damage and had a lower death toll than that of 1939. History repeated itself following the earthquakes of 1965, 1972, and 1985, when earthquake building codes were once again reviewed and improved, resulting in the regulations that were in force when the 2010 earthquake struck.

Over the last six years, Chile has experienced three major seismic events (figure 1): the Maule earthquake of February 27, 2010; the Pisagua earthquake on April 1, 2014 (Mw 8.2); and the Illapel earthquake on September 16, 2015 ($M_w$ 8.3). All three of these earthquakes are the consequence of the subduction of the Nazca Plate beneath the South American plate at an approximate average convergence rate of 7 cm/year to the east-northeast. Although the magnitudes of all three of these earthquakes were enormous, it was the 2010 earthquake that really put the country's regulations and infrastructure to the test, along with the entire National Civil Protection System, its emergency response capacities, emergency management, recovery and reconstruction capacities, and the resilience of individuals and communities. The 2010 Chile earthquake thus constitutes a unique opportunity for researchers to study, describe, and try to understand a country's response and systemic resilience to large-scale disaster.

## THE IMPORTANCE OF BEING PREPARED

Before describing Chile's resilience to the 2010 earthquake, we need to define what we understand by resilience. The current Committee for Natural Disaster Resilience (CREDEN), formed by Chile's National Council of Innovation for Development (CNID) at the request of President Bachelet, uses the following definition: "We understand resilience to be the capacities of a system, person, community, or country exposed to a natural threat to be able to anticipate,

FIGURE 2
**CONCEPTUAL DIAGRAM OF INFRASTRUCTURE RESILIENCE**




Note: System resilience: (a) conceptual diagram of the meaning of resilience, and (b) electricity transmission system after the 2010 earthquake.
Source: Compiled by the author.

resist, absorb, adapt to, and recover from its effects in a timely and efficient fashion so as to preserve, restore, and improve their structures, basic functioning, and identity."

Figure 2 represents the resilience of a system schematically as a function of performance versus time. Two main strategies allow us to increase resilience, that is, to reduce the "loss triangle" through: (1) specific postevent actions that accelerate the recovery process, shortening the time needed to return to the system's original performance levels; and (2) preventative preparation and risk mitigation actions that reduce the drop in the system's performance following a disturbance such as an earthquake. Naturally, any of these measures could also introduce modifications into the system that could lead to it performing even better than it originally did. This is typically the case with earthquake-resistant design standards. For example, figure 2b provides a real example of resilience for an electricity transmission system following the 2010 earthquake. It shows the initial performance of the system, the drop in this during the earthquake, and the recovery of functionality over the following days.

The provision of most services collapsed following the 2010 earthquake (de la Llera et al., 2012): electricity, water, fuel, telephones and telecommunications, and so on. The earthquake hit the area covered by Chile's Central Interconnected System (SIC), which supplies more than 90% of the country's population with electricity. There was damage to the SIC's components for the generation, transmission, and distribution of electricity, which led to a power outage that reduced the grid's electricity generating capacity by approximately 4,522 MW, 74% of its maximum demand and 15% of which was due to a power station having to close to carry out major repairs. The earthquake also affected several parts of the electricity transmission system, including damage to 12 of the 46 transmission substations (26%) and to 1.6 km of the total 7,280 km of electricity transmission lines (0.02%). Despite this damage, the grid was able to continue operating and supply resumed a few hours after the quake. The main consequences of the earthquake were serious damage to the distribution network, repairs to which took several days—and in some cases, weeks—to complete. In general, the electricity system responded as expected and service to most clients was re-established within 48 hours.

One of the first consequences of the power outage following the earthquake was the collapse of most media outlets (radio and television). Telecommunications systems suffered an almost total loss of functionality, even though only a small number of radio masts and towers suffered structural damage. The huge number of personal phone calls made during the emergency caused the mobile telephone network to collapse and severe congestion on the fixed-line network shortly after the earthquake, which led to a drop in the level of service and to very few calls actually getting through. The power outage affected the functioning of some vital parts of the mobile telephone network, including base transceiver stations (BTSs). Of all the BTSs that failed following the earthquake, only 2% were damaged by the quake itself, while 34% failed at least 20 minutes later due to the power outage, mainly because their electricity backup systems did not work. The remainder (64%) continued to function for between two and eight hours before collapsing. Antenna misalignment, loose batteries, electricity distribution failures, and congestion were common problems for

THE COST OF THE 2010 CHILE EARTHQUAKE WAS

**17%**

OF THE COUNTRY'S GDP

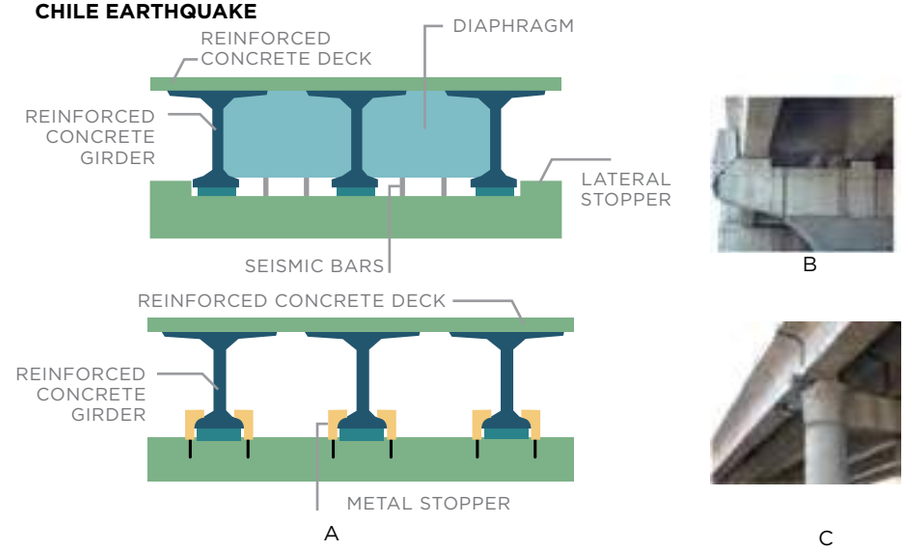
the country's telecommunication systems. Most mobile phone systems only recovered functionality two days after the earthquake. The 2010 earthquake also revealed the fragility of the emergency communications system, which collapsed mainly because of its dependence on public utilities which themselves collapsed due to lack of energy or congestion.

The country's public infrastructure was also seriously affected. The Ministry of Public Works's final survey identified 1,701 points of damage to the infrastructure network, 748 of which affected the rural drinking water supply network and 717, the road network. The damage to the road network was particularly significant because, in addition to damage to the infrastructure itself, it had serious negative social effects as several rural towns and villages were cut off from the rest of the country, which slowed work to restore services to them and hindered access to external humanitarian relief during the emergency stage immediately following the disaster.

The 2010 earthquake also revealed the importance of structural details in bridges and how these may determine the resilience of the entire road network. Damage to bridges, underpasses, and overpasses had a serious impact on the highways around Santiago and on Route 5 South, the country's main north-south axis, as traffic was interrupted due to superstructure failure and the collapse of bridges and pedestrian bridges over highways (Toro et al., 2010). The transfer of Chile's road infrastructure to private concessions from the mid-1990s onwards modified the traditional design that had been historically used for bridges. This consisted of a reinforced concrete slab resting on prestressed concrete girders that were joined using transverse diaphragms. These bridges had lateral concrete stoppers to restrict the transverse displacement of the superstructure and seismic bars to control the vertical movement of the girders. These components were eliminated from most of the new designs (figure 3).

Following the 2010 earthquake, the healthcare network played a key role in managing the emergency by providing medical and psychological care. The earthquake affected 130 public hospitals, 4 of which were shut down altogether while 12 suffered functionality losses of over 75%, and 62% required repairs or replacements, which together implied an 18% decrease in the numbers of available hospital beds for up to a month after the earthquake. One study carried out a comprehensive evaluation of the performance of healthcare infrastructure in Biobío Province, including the seven public hospitals in the zone, taking into account both structural and nonstructural damage to infrastructure as well as damage to mechanical and electrical systems and facilities (Mitrani-Reiser et al., 2012). Nonstructural damage (collapse of suspended ceilings, partitions, fallen equipment, damage to elevators) was widespread and was observed in almost all hospitals. There were serious problems with vital services as nearly all hospitals lost their electricity supply for several days, and five of the seven lost access to the drinking water supply network, which demonstrates the fragility and low capacity of their emergency systems. This was even more critical in the case of telecommunications, for which there was no back-up system and which were affected by the widespread collapse of these networks throughout the earthquake zone, hindering coordination and requests for assistance to outside institutions (Mitrani-Reiser et al., 2012). Similar situations were observed in the healthcare networks of the Tarapacá and Coquimbo regions following the 2014 and 2015 earthquakes, respectively.

FIGURE 3
**STRUCTURAL MODIFICATIONS TO THE DESIGN OF BRIDGES BEFORE THE 2010 CHILE EARTHQUAKE**




Note: (a) Structural details typically used in the bridge superstructure abutment areas: above, the pre-2000 design; below, the post-2000 design with no diaphragm or lateral stoppers. (b) Independencia North overpass, where it can be observed that despite the failure of the lateral stopper, the superstructure of the bridge did not collapse. (c) Independencia South overpass on the point of collapse due to the lack of lateral stoppers in the girder abutments.
Source: Prepared by the author using CIGIDEN archive photos.

Some 10% of Chile's industrial ports are in the Talcahuano-Concepción area, 95 km south of the epicenter of the 2010 earthquake. This area experienced large tremors which caused structural damage and brought port infrastructure services to a standstill. The total direct cost of damage to the ports in the areas reached US$285 million and was mainly attributed to a wide variety of soil problems, such as liquefaction and lateral spreading; structural damage to the connections between piles and decks; damages to pile coverings; and nonstructural damage, including crane derailments and the damage to mooring systems and fenders (Brunet et al., 2012). Much of the detailed information on how ports were affected by the earthquake was not made publicly available due to confidentiality in insurance negotiations and other commercial factors. On-the-ground observations were complemented by analytical models of

the infrastructure's expected performance. The 2010 experience and the lessons learned from it through this study enabled the authors to provide empirical recommendations for the design of future ports in Chile (Brunet et al., 2012).

The earthquake and the tsunami also had a huge impact on the housing sector. Official government statistics estimated that 370,051 residences were damaged, of which 22% collapsed, 29% suffered serious damage, and 49% minor damage. Of this total, 37% were adobe houses whose design did not meet earthquake-resistant standards, while 9% were located on the coast and were seriously affected by the tsunami. The damage observed in some reinforced concrete residential buildings was particularly surprising, especially in comparison with how well this type of building withstood the earthquake that struck Chile on March 3, 1985. The damage pattern was repetitive and affected around 2% of reinforced concrete buildings that were five or more stories high. The cause was fragile behavior in the bending compression of walls, especially in the lower stories of buildings. This caused at least one building to collapse, severe structural failures in around 50 more, and prompted a large number of international studies to attempt to understand these buildings' earthquake behavior in more detail. This data has already been incorporated into new earthquake-resistant building and design codes for concrete structures, which signifies major progress toward the future resilience of these structures.

When the 2010 Maule earthquake struck, there were 14 structures in the affected area with seismic protection systems (SPSs), that is, seismic isolation and energy dissipation systems, all designed using Chilean technology (de la Llera et al., 2015). The performance of these structures and systems was so positive that there has been explosive growth in their use not only in Chile but throughout Latin America. The increased use of SPSs in Peru is a good example of this. Three emblematic cases of the successful use of these technologies are the new Military Hospital (seismic isolation), the 54-story Titanium Tower (metallic dissipation), and Muelle Coronel, the only port in the Talcahuano area that remained operational.

Based on how well the projects that used SPS performed during the 2010 earthquake, Chile's Ministry of Health added the obligation to use seismic isolation in the construction of 12 new hospitals, and the same is true in Peru in all hospitals built in the most earthquake-prone areas. By 2014, over 80 projects in Chile had incorporated SPS (de la Llera et al., 2015). Seismic isolation is by far the most widely used system in Chile and is present in nearly 75% of all structures with SPS. Tuned mass dampers are the second-most widely used system (found in 18% of buildings), and the remaining 7% is split between different energy dissipation systems, including metallic dampers, viscous fluid dampers, viscoelastic dampers, and friction dampers. Only one example of a magnetorheological damper was installed for concept testing in a single building.

## RECOVERY AND RECONSTRUCTION

As with the major earthquakes of the 20th century, the 2010 Maule earthquake taught the country many lessons which have left major institutional legacies. One of the most significant reports to identify areas for improvement was a UN assessment of how Chile's institutions responded to the event, which established the existence of a series of shortcomings that needed to be addressed. Following this diagnostic exercise, a document containing 75 recommendations was delivered, the first of which was the creation of a National Policy for Disaster Risk Management. In 2012, the National Platform for Disaster Risk Reduction was established, a multisectoral and interdisciplinary body coordinated by ONEMI which functions as an umbrella organization for more than 75 other organizations. Its purpose is to ensure that disaster risk management is fully contemplated by the country's policies, planning, and development programs. The platform's first mission was to draft the National Policy for Disaster Risk Management, the goal of which is to "provide the Chilean state with an instrument or framework guidelines that allow it to develop a comprehensive disaster risk management system in which general policies are articulated with crosscutting policies and sectoral policies, through which disaster prevention, response, and recovery initiatives are carried out, within the framework of sustainable development." This policy was the basis for the Strategic National Plan for Disaster Risk Management and the equivalent plans at the regional, provincial, and township levels, along with sectoral plans for each government organization. One of the main initiatives within this national plan is to create a new National Disaster Risk Management System. This is currently being debated in congress and contemplates the strengthening and modernization of ONEMI, the creation of an expert advisory council, and the ongoing work of the aforementioned platform, among other factors.

**2%**

OF CHILE'S ANNUAL BUDGET CAN BE SPENT BY THE EXECUTIVE IN THE EVENT OF A DISASTER

The 2010 Chile earthquake allowed experts to review and improve the standards that regulate the design and construction of infrastructure. Assessments of the structural performance of buildings during the earthquake clearly revealed the need to modify these regulations. In 2011, two related decrees were issued: one that complements earthquake-resistant design standards and the design of reinforced concrete structures, and another that increases restrictions and improves foundation soil classifications in building design. On the basis of positive performances during the earthquake, a new version of the design standards for structures with seismic isolation was published in 2013, which acknowledges these performances and relaxes some ductility-related design conditions. The 2010 experience was especially useful in revealing the need to establish standards for aspects of construction that were not correctly regulated, which culminated in the publication of a set of new standards for the design of nonstructural elements, reinforcement projects for adobe structures, and recommendations for infrastructure design in tsunami risk zones (de la Llera et al., 2016). Similar lessons were learned

for bridge design: the end of 2010 saw the publication of an update to earthquake-resistant design criteria and the National Technical Bridge Committee has recently been established, which brings together representatives from academia and the public and private sectors.

Like the authorities in charge of responding to the emergency, Chile's communities have also built on the lessons of 2010. One of the most important of these concerns the handling of evacuation processes in tsunami risk zones. Although ONEMI has made efforts to increase the number of regional drills and improve infrastructure and the quality and availability of information on emergency prevention and action, the Chile's population has also demonstrated the importance of self-care during evacuations following high-magnitude earthquakes. Some examples of evidence of this include the successful mass evacuation processes following the 2014 and 2015 earthquakes in the north of Chile, in which the coastal area was evacuated in a safe and orderly fashion, which substantially reduced the number of deaths caused by flooding. It should be mentioned that these populations were not affected by the 2010 earthquake.

**75**

INSTITUTIONS AND PUBLIC ORGANIZATIONS ARE WORKING TOGETHER TO REDUCE THE IMPACT OF DISASTERS

## FUTURE PROSPECTS

From the experience gained in the course of Chile's recent earthquake history, certain factors stand out as being critical to achieving a society that is more resilient in the face of extreme nature phenomena. The first of these is ensuring the availability of reliable data that allows different stakeholders to make appropriate decisions, not only during the emergency but also as part of medium- and long-term evidence-based research projects that allow relevant new information to be incorporated into the different public policies for risk reduction and management, including building standards. This is why it is imperative to capture the information that is generated during these large-scale disruptions, which function as full-scale experiments which the best research, development, and innovation capacities can then be applied to, thus improving society's ability to handle future events. This is essentially what resilience is about—it evolves over time and can only really be put to the test during crisis situations.

Second, it is as important to learn from damage and failure as from elements that function correctly. An emblematic example of this during the 2010 Chile earthquake was the behavior of structures with SPSs. These systems not only prevented the buildings in question from being damaged, they also guaranteed their operational continuity. Several other examples support this openness to understand resilience from the perspectives of both failure and success. Examples of the latter must also be included in all exercises and drills, both formal and informal. These conclusions regarding the importance of resilient infrastructure also hold true for large regional infrastructure works such as the Agua Negra Tunnel between Chile and Argentina. Financing resilient infrastructure is another major challenge for the region.

Finally, the recent earthquakes of 2014 and 2015 are proof that Chile has learned a lot from the lessons of 2010 at different levels, which is itself probably the most important lesson of all. Even more importantly, and partly due to the recent occurrence of other major natural events, the country has made resilience to major natural threats a national strategic priority for the first time in its history. As a consequence, Chile is taking firm steps toward facing up to the challenge of making sustainable development compatible with the reduction of inequality in a context of large-scale social transformations and the intensification of the effects of climate change. It is doing so from both the political and institutional arena, through ONEMI and the work of the National Platform for Disaster Risk Reduction, and from the world of academia, through the presidential commission that will establish the country's future national strategy for research, development, and innovation to improve resilience. Although Chile has responded well to these earthquakes, we must not forget that science still knows very little about the origins and development of these and other natural phenomena. Understanding how these events affect the functioning of our societies will require interdisciplinary research and spaces where academic different disciplines can come together, including the social sciences, architecture and urban planning, the different branches of engineering, and geosciences. Only then will we be able to guarantee the design of sustainable strategies to reduce risk and increase resilience which can then gradually incorporate the new information and experiences that we acquire every time that nature reminds us that imagining we can control it is little more than an illusion.

**NOTE**

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We urgently need a humanism capable of bringing together the different fields of knowledge, including economics, in the service of a more integral and integrating vision."

*Laudato Si'*

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**Regional Integration + Social Inclusion**
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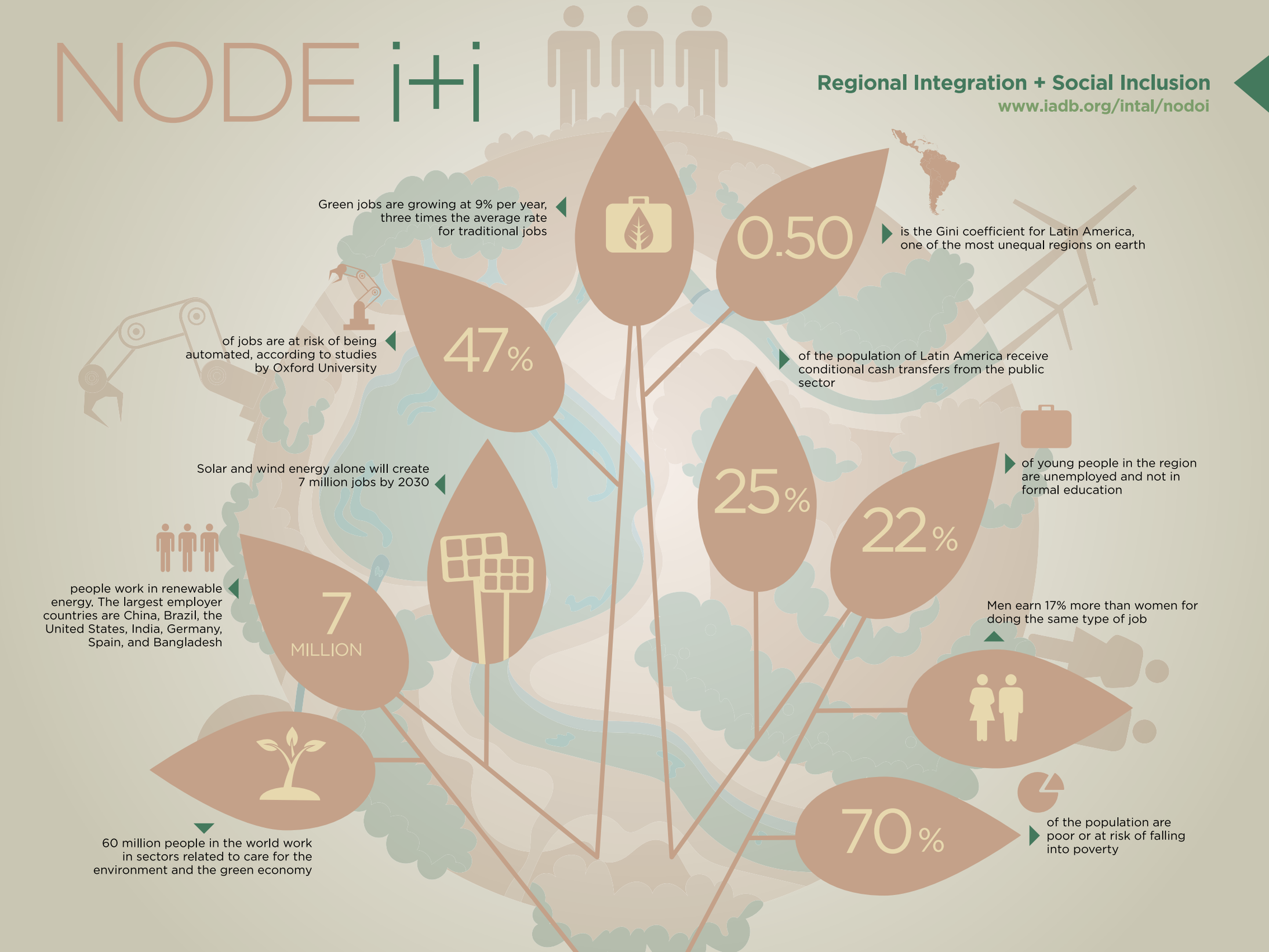


ANALYSIS

Mariano Rabassa
Pontifical Catholic University of Argentina

# Climate change and its impact on poverty

WINNING PHOTO FROM THE 2016 INTALENT COMPETITION

BOTH EVERYDAY EXPERIENCE AND SCIENTIFIC RESEARCH SHOW THAT THE GRAVEST EFFECTS OF ALL ATTACKS ON THE ENVIRONMENT ARE SUFFERED BY THE POOREST.

*Laudato Si'*

*Laudato Si'* argues that the environmental crisis is particularly harmful to the most vulnerable members of society. This article examines the relationship between climate change and poverty in detail, analyzing the impact of global warming on subsistence agriculture, labor markets, migratory movements, international trade flows, disease vectors, and public policies for adaptation and mitigation.

Pope Francis begins *Laudato Si'* with a detailed diagnosis of the scale of the current ecological crisis, based on scientific consensus. In it, he points to climate change as being the main threat to the welfare of humanity and all the species that inhabit the planet. He also draws attention to a wide variety of environmental topics, such as access to drinking water, the extinction of species, the excessive generation of waste, urban air pollution, indiscriminate deforestation, the risks of mining, and many more. So astute were Pope Francis's words on the need to care for our planet that *Laudato Si'* quickly transcended the usual readership for papal encyclicals and has acquired universal significance.

The encyclical is equally specific when pinpointing the causes of the environmental degradation we are experiencing. In the Pope's opinion, our current ecological crisis is mirrored by a crisis of values characterized by excessive consumerism, individualism, and the central role that humans have given to technology and the market in today's society. In this sense, the encyclical is seeking to do more than just raise awareness. It is also an invitation for us to take urgent action to recover the social values and norms that will allow us to reverse—even if only partially—the ecological damage to our planet before it is too late.

One of the main concerns of both the encyclical and related discussions in the relevant international arenas is how this ecological crisis is affecting, and will affect, the least fortunate. Pope Francis reminds us that "the gravest effects of all attacks on the environment are suffered by the poorest" (*Laudato Si'*,§48).

You do not need to be keenly interested in environmental issues to realize that those who depend on agriculture as their main means of subsistence are more vulnerable to the potential impacts of climate change, or that these people tend to be among the world's poorest. The current climate in the world's poorest countries is warm enough to tolerate additional increases in temperature without significantly affecting agricultural productivity. It is perhaps due to such observations that people tend to argue that climate change will exacerbate global poverty (see, for example, Stern, 2007).

However, the relationship between climate change and poverty is subtler than first appears. The possible socioeconomic impacts of climate change will depend largely on how climate sensitive households' different assets are and on the support networks that they have access to. These impacts will also depend on how climate shocks are transmitted through the economy, for example, through labor markets and migratory movements; on how international trade flows respond; on changes in disease vectors; and, above all, on the adaptation and mitigation policies that governments implement.

This article does not discuss the factors that are identified in *Laudato Si'* as causing this unprecedented environmental crisis. Instead, it summarizes the main results of the different methodologies that have been used to measure the potential impact that climate change could have on poverty and global welfare.



# CLIMATE CHANGE AND POVERTY

## THE RECENT EVOLUTION OF POVERTY AND EQUALITY

From a long-term perspective, poverty indicators have improved enormously over the last century in almost every place on earth. Although there are regions where rates of poverty and extreme poverty continue to be high, the data available reveals that the proportion of people living in poverty and extreme poverty has come down substantially: while 200 years ago four out of every five people were considered poor, today only one out of every five people fall into this category (Ravallion, 2013).

It is encouraging that recent statistics also show that this downturn in the absolute rate of extreme poverty (based on a poverty line of US$1.25 per capita per day) has accelerated over the last three decades. This is because developing countries, especially China, have been reducing poverty at a rate of one percentage point per year, which is much higher than the annual rate observed in previous decades (see Chen and Ravallion, 2013, for more details). Even considering these improvements in the indicators, approximately 1 billion people continue to be poor, and many more are at risk of slipping back into extreme poverty.

In developing countries, inequality indicators have improved hand-in-hand with those for poverty over the last few decades, although the data shows that this trend has reversed in recent years, especially after the global financial crisis of 2008, which has made income distribution more unequal (Ravallion, 2013). Latin America has been part of this global trend, although it has only witnessed a downturn in the rate of improvement of inequality indicators rather than an actual reversal (see Gasparini, Cruces, and Tornarolli, 2016).

The improvements observed in poverty and inequality rates can be explained by several factors. Economic growth has doubtless played a leading role in this process, as has the design of more effective public policies. This improvement in economic performance has been accompanied by improvements in other aspects of well-being, such as increases in life expectancy, reductions in child mortality rates (especially during the first year of life), and lower morbidity rates, among many others. Technological innovations in the agriculture sector have contributed to achieving sustained increases in productivity, reducing the cost of food and, in recent years, isolating crops from the damaging effects of extreme climate

**1 BILLION**

PEOPLE IN THE WORLD LIVE ON LESS THAN US$1.25 PER DAY

events. The latter has played a central role in reducing rural poverty.

It should come as no surprise, therefore, that no small number of experts believe that we may be able to eradicate extreme poverty in as little as 20 years. In this sense, poverty no longer seems to reflect scarcity, but has instead essentially become a problem of identifying and redistributing resources.

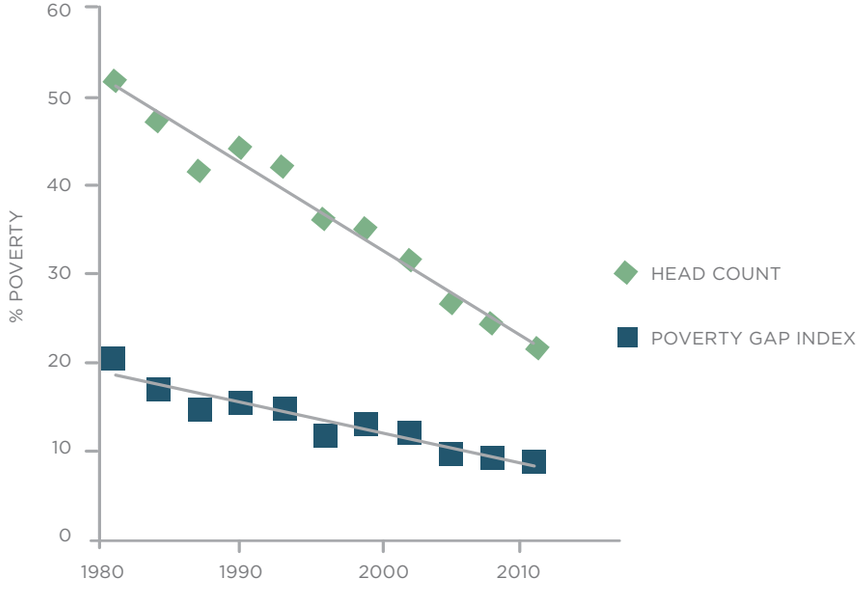
To be able to achieve this goal, we obviously need to keep up the rate of poverty reduction that we have witnessed in the last 20 years. However, we should not take it for granted that developing countries will be able to manage this. Doing so will not only require sustained economic growth and strong policies of redistribution, which Pope Francis seems to think are not viable under today's economic system, but will also depend largely on how the process of environmental degradation unfolds, particularly climate change.

## THE THREAT OF CLIMATE CHANGE

All the advances in social welfare and poverty reduction listed above could be significantly affected by irresponsible greenhouse gas emissions of human origin. Measurements of carbon dioxide in the atmosphere have revealed that, for the first time ever, current concentrations stand at over 400 ppm (parts per million) throughout the year, while in the preindustrial era levels were close to 280 ppm.

FIGURE 1

**THE EVOLUTION OF POVERTY IN DEVELOPING COUNTRIES, 1981–2010.**




Note: Both poverty measurements are based on a poverty line of US$1.25 per day (PPP 2005).
Source: Chen and Ravallion (2013).



GDP WILL DROP
BY AN AVERAGE
**9%**
FOR EVERY 1°C INCREASE
IN TEMPERATURE

According to the many reports of the Intergovernmental Panel on Climate Change (IPCC), this accumulation of greenhouse gases is responsible for global climate change. In fact, recent months have seen monthly deviations in global temperature of around 1.5°C in relation to preindustrial levels—precisely the upper limit to warming that forthcoming international negotiations are supposed to be aiming to achieve.

Climate change manifests itself on two main fronts, which could have different implications for human welfare, especially that of the world's poorest people. First, climate change is associated with a gradual, although potentially nonlinear, change in the average levels of certain variables, particularly global temperature. Second, this change will also affect the variability of the climate system, increasing the frequency and intensity of extreme climate phenomena.

The consequences that the accumulation of greenhouse gases have on the climate system and the environment are being intensely studied at present, so our understanding of their potential impacts is still incomplete. For the moment, we can state with a certain degree of precision how these emissions will affect the average temperature in different regions of the world and how much sea levels in coastal areas will rise toward the end of the 21st century. We can project changes in average rainfall patterns with less certainty. The main uncertainty in such predictions still lies in how the accumulation of greenhouse gases will affect the variability of the climate system, especially the frequency and scale of extreme rainfall events, drought, heat waves, and tropical storms.

Although the changes in average climate and sea-level values toward the end of the 21st century may be significant, if they unfold gradually, they may allow for a certain degree of adaptation that will mitigate their impacts on welfare. For example, the types of crops that are produced in each region could vary in response to the climate sensitivity of agricultural production. Likewise, technological innovations could make crops more resistant to the new climate reality.

It is thus highly likely that the greatest social costs of climate change will be the consequence of extreme climate phenomena. Natural disasters are one of the key factors in understanding how vulnerable households are to falling into poverty or remaining in it (Sen, 2003; Skoufias, 2003).

## IMPACTS ON WELFARE

In its early days, the science of economics was interested in studying the impacts of climate on economic activity, especially agriculture and trade. For example, the sources of the comparative advantages that David Ricardo argued determined trade flows between countries depended largely on the availability of natural resources and labor, but also on each region's or country's climate. In time, however, economic science gradually began to leave the climate factor out of its analyses, relega-

AGRICULTURAL PRODUCTIVITY IN BRAZIL WILL FALL BY **18%** IF TEMPERATURES RISE BY 1.5°C

ting it instead to economic geography.

Since the 1980s, the surge in studies on economic development has rekindled interest in understanding how the climate impacts welfare. This interest is partly because surveys of rural households in poor regions of the planet have become widely available since then. There is extensive literature that analyzes the effect of climate shocks—especially droughts and floods—on the welfare of rural populations that depend critically on harvests for their subsistence. This literature attempts to establish a causal relationship between these shocks and households' performances on various socioeconomic fronts, such as per-capita consumption, the decision to send children to school, female labor force participation, decisions on risk diversification, and illness rates, to mention just a few. In general, these studies conclude that climate shocks tend to seriously impact the immediate welfare of households and their decisions relating to the allocation of intrafamily resources. Some studies, such as the well-known article by Maccini and Yang (2009), even establish a long-term relationship between the climate (in this case, rainfall) during people's first year of life and different measures of economic welfare and performance when they are adults.

Another recent branch of the literature focuses on studying the impact of today's climate on how countries develop. These cases move away from the household-oriented perspective to analyze macroeconomic aggregates such as gross product. For example, Barrios, Bertinelli, and Strobl (2010) attribute a substantial amount of Sub-Saharan Africa's growth gap with the rest of the developing world during the second half of the 20th century to the absence of rain there. Dell, Jones, and Olken (2009) examined how temperature affects GDP using crosscutting data from 134 countries. Among other results, they report that each additional (average annual) increase of 1°C is associated with a drop in GDP per capita of around 9 percentage points, and that higher temperatures could reduce growth rates (Burke, Hsiang, and Miguel., 2015).

Although these studies are important to understanding the relationship between climate and economic performance, they do not analyze the possible impacts of climate change on poverty or welfare. One initial way of looking at this problem is by analyzing the impact that economic growth has on poverty by estimating elasticities—that is, percentage changes in the poverty rate as a consequence of percentage changes in GDP. This information will need to be complemented later with projections on how climate change will affect future growth. These two sources of information will allow us to infer future increases (or reductions) in poverty in comparison with a situation in which climate change is absent. Estimating the growth elasticity of poverty is not a complex task (Adams, 2004). What is difficult is knowing how far future growth may differ from a situation in which there



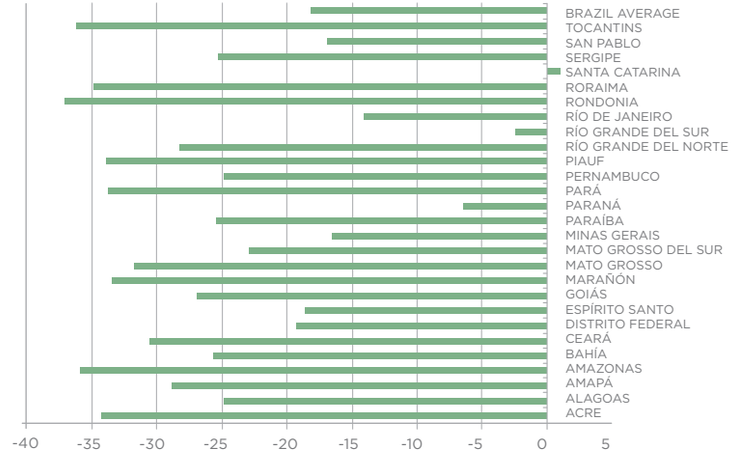
## CLIMATE CHANGE AND AGRICULTURAL PRODUCTIVITY IN BRAZIL

Understanding how climate change will affect economies' future growth is essential to understanding how it will impact the population's welfare. Agriculture is undoubtedly one of the sectors that will be most affected by climate change, so analyzing the climate sensitivity of crops has become a priority. There are few studies on Latin America which go into sufficient detail and cover enough geographic area to be able to infer with a certain degree of precision how agricultural productivity will respond. One interesting exception is the recent study by Assunção and Chein (2016), which contains simulations for Brazil for 2030–2050. This research is particularly significant due to the importance of agriculture in Brazil's economy and because Brazil plays a key role in the international grain market.

The study reports that, as a consequence of a future increase in average temperature of 1.43°C and an average reduction in rainfall of 1.44%, agricultural productivity in Brazil will drop by 18%, although this will vary significantly among the country's geographic regions, as is shown in the following figure.

FIGURE 2

**FIGURE. PERCENTAGE CHANGE IN AGRICULTURAL PRODUCTIVITY FOR THE DIFFERENT STATES OF BRAZIL (2030–2049)**




Source: Assunção and Chein (2016)

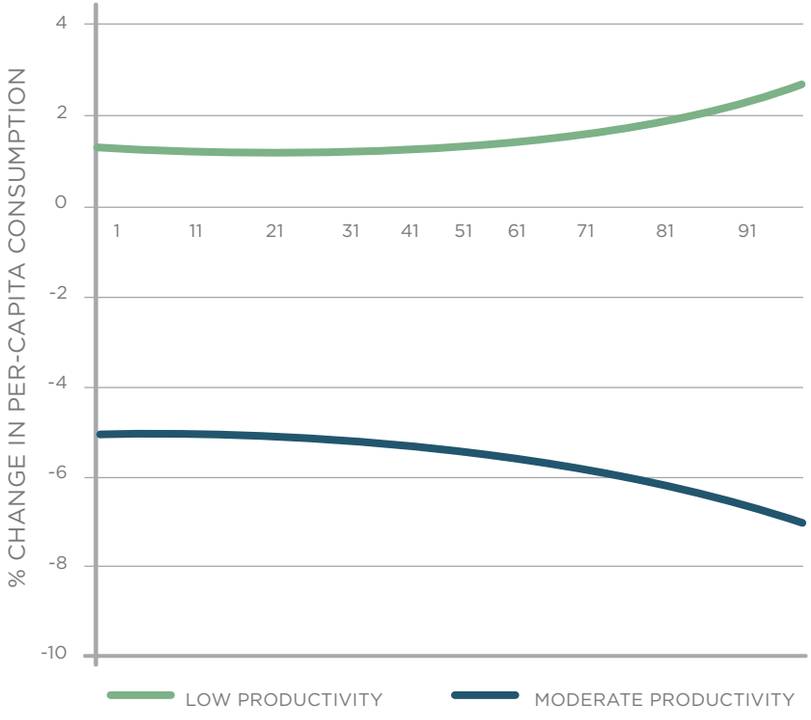
Some areas in the south of Brazil may even benefit from climate change, while the impact in the north and northeast of the country will be decidedly negative. According to the authors, in the absence of technological change or strong policies of redistribution, the socioeconomic disparities between geographic regions could increase.

When interpreting these results, two factors should be borne in mind. First, these simulations assume there to have been some adaptation to climate change (land use, crops, inputs, sowing dates, etc.) but do not contemplate technological change, so they are almost certainly overestimating the true impact of climate change on productivity. Second, understanding how these changes in productivity translate into changes in the welfare of households in Brazil is a much more complex undertaking. It will depend, among other things, on the evolution of international prices, on how much productivity falls in Brazil in comparison with the rest of the world, how productive land is distributed among households, the proportion of income that households obtain from farming, and so on .

is no climate change, especially regarding impacts on agricultural productivity (see box). To estimate this, studies tend to use Integrated Assessment Models (IAMs). These general equilibrium models can be used to predict how the IPCC's different greenhouse gas emission scenarios will affect the future performance of the economy (see, for example, Nordhaus, 2011).

One of the first estimations of the impacts on poverty based on IAMs (Anderson, 2006) revealed that a temperature increase of 3.9°C by 2100 would reduce the gross product in Southeast Asia by 2.5% and in Africa and the Middle East by 1.9%. These growth projections are then converted into changes in poverty through growth elasticities of poverty. The results show that by the end of the 21st century, climate change will generate 12 million new poor people in Southeast

FIGURE 3
**CLIMATE CHANGE CURVE OF INCIDENCE**




Note: This graphic shows the curves of incidence for climate change for 2030 in rural households in India arranged in percentiles of current per capita consumption. "Low productivity" refers to a change in the climate with severe impacts on the global output of agricultural commodities and high prices, while "moderate productivity" describes a scenario in which climate change has limited impact on global output and agricultural prices remain stable.
Source: Jacoby, Rabassa, Skoufias (2015).



## DISTRIBUTIONAL INCIDENCE OF CLIMATE CHANGE

The main aim of the model presented in Jacoby et al. (2015) is to obtain a formula that links climate-induced productivity shocks with the price of the main assets that rural households possess: labor and land. The model contemplates an economy that is made up of three sectors: agriculture, manufactures, and services. Each sector produces a final good by combining capital (land, in the case of agriculture), unskilled manual labor, and intermediate goods.

In this context, climate change is essentially a shock that will affect agricultural productivity, which will impact the prices of households' production factors and ultimately affect their consumption possibilities. In other words, as well as impacting crop prices, climate change will affect the value of households' labor and productive land.

The percentage change in household consumption $\dot{m}_h$ (the usual measure of welfare) is given by the following formula:

$$\dot{m}_h = \lambda_{wh}\dot{w} + \lambda_{Rh}\dot{R} - \sum_j \theta_{jh}\dot{p}_j$$

Where $\dot{w}$ s the percentage change in wage value, $\dot{R}_h$ is the percentage change in return on active land, is the share of total income that household h derives from the possession of each asset, and $\dot{p}_j$ is the percentage change in the price of each crop j. The term $\theta_{jh}$ indicates whether the household is a net consumer of that crop (that is, production minus consumption).

In their empirical exercise, Jacoby et al. (2015) used hundreds of thousands of pieces of data on rural households in India to estimate how climate would affect agricultural productivity, using an adaptation of the Ricardian model in Mendelsohn et al. (1994). The main results are represented as curves of incidence (CI), which show the percentage changes in household consumption arranged in percentiles.

The figure shows two CIs that assume two global scenarios (low and moderate productivity) based on the GTAP model, with the exception of the impact on India, which the authors calculated themselves. When global productivity is low, crop prices increase, even in India. But when households are net suppliers of crops they benefit from this situation. These extra earnings make up for the fall in returns on land and labor. In this scenario, the CIs show that all households in rural India benefit from climate change, with the richest households increasing their per-capita consumption by between 2.5% and 3%.

However, when global productivity is moderate (because the impacts of climate change are less harmful), the conclusions are reversed. Agricultural prices do not go up sufficiently and households that are net suppliers cannot make up for the drop in the returns on their assets. In this case, the richest households will suffer the greatest welfare losses.

Asia and 24 million in Sub-Saharan Africa, based on a poverty line of US$2 per day. Although these numbers are high in absolute terms, they are not when considered in relation to projected total population numbers. Furthermore, Anderson (2006) does not model climate change adaptation, which will significantly reduce impacts on welfare.

## LOOKING BEYOND AGGREGATES

Although understanding aggregate impact is extremely important to identifying the scale of the problem at hand, it is also true that these impacts will be very varied, even among vulnerable households. This is because households possess different combinations of assets, the climate sensitivity of which may vary. Likewise, some households produce excess food while others are simply consumers. In these cases, changes in agricultural prices can have very different repercussions on the welfare of each type of household.

One of the first studies to take this heterogeneity into account was Hertel, Burke, and Lobell (2010). This study analyzes the impact of climate change in 15 developing countries using a general equilibrium model for global trade (Purdue University's Global Trade Analysis Project, GTAP). Heterogeneity is introduced by considering various types of household that will be affected differently by changes in agricultural prices.

The authors use three scenarios of how climate change could affect agricultural productivity by 2030 to analyze changes in food prices, economic welfare, and poverty levels. Specifically, effects on poverty come about in two ways: changes in household incomes and changes in the real cost of living on the poverty line. The impact of increases in food prices on household incomes depends on the source of these incomes. If income increases more rapidly than cost of living for a household on the poverty line, for example because that household is a food producer, then poverty levels will fall, and vice versa.

Hertel et al. (2010) present various results in connection to this. The most noteworthy of these include the fact that major changes in the cost of living caused by low global agricultural productivity do not translate into large increases in poverty levels. This is because households will substitute their consumptions, and food will represent a smaller part of total expenditure in the future.

Hertel et al. (2010), one of the pioneering studies on the impact of climate change on poverty, is also significant because it focuses on the role of international agricultural markets and on how their prices will impact the welfare of the poorest sectors of the population.

Jacoby, Rabassa, and Skoufias (2015) introduced another major transmission channel to understand how climate change—increases in the average temperature by 2030—will affect the welfare of rural households. Their model (see box) contemplates not only the role of agricultural prices (based on the GTAP model), food production, and the composition of household consumption, but also the role that the labor market will play in transmitting these shocks. According to their line of argument, climate change will affect agricultural productivity and thus the return on the assets that rural households possess, which are essentially land and labor. The drop in productivity will affect the prices of agricultural goods and thus the value of households' consumption baskets. But although local effects on productivity may end up being negative, they may be tempered if this loss in productivity is less marked than in other parts of the world. This would clearly only be the case if countries remain open to trade in agricultural products, which may not happen, as was observed during the global food crisis of 2010–2011.

Using data from tens of thousands of rural households in India, the study by Jacoby et al. (2015) shows that labor markets will neutralize any distributive effects of climate change. In other words, future increases in the earth's temperature will affect agricultural productivity, but it will not necessarily be the poorest people in the poor regions of the world who will be most affected by this. Instead, changes in per-capita consumption will be proportional to the different percentiles of income distribution.

## EXTREME CLIMATE EVENTS

The studies mentioned above model the impacts of changes to the average values of climate variables. However, as was argued earlier, the greatest social costs will certainly come from changes in the variability of the climate system. In this sense, Ahmed, Diffenbaugh, and Hertel (2009) is one of the few studies to use general equilibrium models (also the GTAP) to estimate the impacts of extreme climate phenomena on poverty toward the end of the 21st century. To do so, the study examines data on heat waves, droughts, and floods in 16 developing countries during two periods: 1971–2000 and 2071–2100. In the author's simulations, there were substantial increases in the occurrence of heat waves and droughts in the 16 countries in question.

The scale and spatial diversity of the changes in climate variability reveal that these will have a significant impact on poverty. Of the 16 countries analyzed, those with the highest percentages of the population falling into poverty because of changes in climate variability include Bangladesh, Malawi, Mexico, Mozambique, Tanzania, and Zambia. For example, in Malawi and Tanzania, the fall in agricultural productivity caused by increased climate variability will generate a 7-percentage-point increase in poverty.

These negative impacts on welfare suggests that the risk mitigation mechanisms that are currently available to households provide only limited protection for welfare when climate patterns are erratic. More studies are undoubtedly needed to understand how changes in extreme climate phenomena will affect welfare.

## THE NEED FOR EFFICIENT AND EQUITABLE ACTION

Although it has only been in circulation for a short time, *Laudato Si'* has become a landmark document on our current ecological crisis. Using simple language, it attempts to reach ordinary people and get them to react to the inescapable destruction of our planet, demand solutions, but above all to rethink their own behavior.

The enormous challenge ahead of us lies not only in rapidly mitigating carbon dioxide emissions without slowing economic growth but also in adapting to the new climate reality. The latter will not be easy as the need to adapt will be greater in the poorer regions of the planet, which is precisely where the capacities and resources for efficient adaptation are least abundant.

Pope Francis acknowledges this, and his encyclical is also a call for us to face

up to our debt to the underprivileged, who suffer current environmental damage the most and who will suffer the consequences of climate change disproportionately. "...Many of the poor live in areas particularly affected by phenomena related to warming, and their means of subsistence are largely dependent on natural reserves and ecosystemic services such as agriculture, fishing and forestry. They have no other financial activities or resources which can enable them to adapt to climate change or to face natural disasters, and their access to social services and protection is very limited" (*Laudato Si*',§25).

Although the above paragraph is very true, when it comes to implementing adaptation policies, the studies discussed throughout this article underline the importance of considering the diversity of impacts on the welfare of vulnerable households. Identifying the most vulnerable populations is essential if we are to minimize the damage caused by climate change.

Another factor that emerges from these studies is the importance of labor markets and the international grain trade in tempering or magnifying these shocks. However, *Laudato Si*' warns us of the dangers of applying the prevailing market logic when attempting to take on the problem of climate change. In the Holy Father's words, "...The same mindset which stands in the way of making radical decisions to reverse the trend of global warming also stands in the way of achieving the goal of eliminating poverty." In short, Pope Francis believes it to be very improbable that the current economic system, which he understands to have caused this ecological crisis, can somehow reverse the planet's critical state and alleviate poverty. We therefore need a solution that contemplates fairer intra- and intergenerational treatment based on differential responsibilities for the world's richest countries.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# “Integrative **Humanism** reaches the roots of the problem”

**Víctor Manuel Fernández**
Chancellor
Pontifical Catholic University of Argentina

Hundreds of experts from all around the world contributed to the process of drafting the encyclical letter *Laudato Si'*. The chancellor of the Pontifical Catholic University of Argentina, Archbishop Víctor Manuel Fernández, explains that the scientific community's open involvement in the creation of the document has been key to it reaching such a wide audience. He also underlines the originality and interdisciplinary nature of the Pope's approach, which connects environmental issues to the protection of the most vulnerable, to a particular form of education, and to rethinking our relationship with others and nature.

Archbishop Víctor Manuel Fernández has been chancellor of the Pontifical Catholic University of Argentina since 2009. He studied theology in Córdoba and at the Pontifical Gregorian University in Rome and was a professor of ethics and hermeneutics. He is the author of over 300 publications, including scientific articles and books published in Argentina and several countries in Latin America and Europe. His work has been translated into English, Portuguese, French, Italian, and Polish.

**Can you describe the process of drafting the encyclical? How did the Pope interact with scientists, academics, and experts, given that he wanted his message to reach all people of good will, not just Catholics?**

We know from Pope Francis that an early draft of the encyclical put forward by the Pontifical Council for Justice and Peace was built on through the wealth of contributions and critiques that the Pope received from over 200 specialists and institutions from around the world, to mention only the most significant contributions. These came not just from ecologists, but from professionals working in very varied fields. The result is a rich fabric of ideas that have been inspired by diverse points of view. In the encyclical, the Pope stops to recognize that the global ecological movement has already traveled a long, fruitful road and has created numerous citizen organizations that have helped raise awareness. He also acknowledges everything that the Church's Magisterium has learned from countless "scientists, philosophers, theologians, and civic groups who have enriched the Church's thinking on these issues" (Pope Francis, 2015, 7). Nor must we forget that for centuries the Holy See has been home to the Pontifical Academy of Sciences, which currently numbers several Nobel laureates among its members. I do not believe that the process of drafting any other papal document has involved such a wide range of people.

> THE ACT OF REFLECTION IS A WAY OF FREEING OURSELVES FROM TODAY'S THROWAWAY CULTURE

**In the context of the social discussions of 1891, Pope Leo XIII spoke of "new things" in his encyclical Rerum Novarum. What are the "new new things" in *Laudato Si'*?**

What is new about *Laudato Si'* in comparison with the Church's previous social teaching is the integrated form of humanism it puts forward. Before the encyclical, the Church's magisterial documents underlined the centrality and superiority of human beings. This encyclical, in contrast, lays bare how human power is threatening nature and anything else that is more fragile than it. Although it continues to support the superior role of human beings, it suggests they should be understood as an integral part of creation as a whole and that they have a serious responsibility to care for the world. This integrative humanism has several features: a) its arguments on the environment are closely connected with the social vindication of the poor and the least developed countries, such that environmental issues are framed in the context of "the acknowledgment of the other." It focuses not only on how we relate to the environment, but also on we related to each other; b) in an enormous interdisciplinary undertaking, it posits an integral form of ecology which brings together multiple aspects of the environmental problem in an integrated fashion, including economic, cultural, and social issues, and so on; and c) this reflection is profoundly humanist, because it is an educational approach that seeks to free us from today's "throw-away culture." In so doing, integrative humanism hopes to reach the deepest roots of the environmental problem.

**What do you believe to be the main message of *Laudato Si'* for public policy makers and global leaders?**

I would highlight certain phrases of the document that address them directly: "there are too many special interests, and economic interests easily end up trumping the common good"; "those who will have to suffer the consequences of what we are trying to hide will not forget this failure of conscience and responsibility"; "many of those who possess more resources and economic or political power seem mostly to be concerned with masking the problems or concealing their symptoms"; and "political planning tends to lack breadth of vision. What would induce anyone, at this stage, to hold on to power only to be remembered for their inability to take action when it was urgent and necessary to do so?"

> THE ENCYCLICAL REVEALS THE THREAT OF HUMAN POWER OVER NATURE

**How can we prevent the lack of transparency in public mechanisms or market failures in the private sphere from conditioning our efforts to care for the environment?**

The text of the encyclical answers this explicitly when it recognizes that instrumental, technocratic rationality "is at work whether resources are allocated by the market or by state central planning." It clearly does not ignore environmental disasters or the fact that the unbridled, irrational exploitation of environmental resources has also taken place in countries with statist, left-wing governments, not just in countries with liberal economies. Although few people have realized this, the encyclical's position is very balanced in this regard. Its criticisms of the excesses caused by blind trust in market forces are well-known, and it is true that they are very incisive, but it also argues that "the myopia of power politics delays the inclusion of a farsighted environmental agenda within the overall agenda of governments." In relation to corruption, it says: "Unless citizens control political power—national, regional and municipal—it will not be possible to control damage to the environment." This is why it sets out the following challenge: "in

view of the common good, there is urgent need for politics and economics to enter into a frank dialogue in the service of life, especially human life." This demonstrates that the key to understanding texts like *Laudato Si'* lies in reading them from start to finish, not interpreting them through commentators' remarks.

**What is the "dialogue" that needs to be built between the preservation of the environment, social policy, and economic policy? How can we "globalize" this dialogue in view of the fact that environmental demands are often excuses for developed countries to reduce market access for less developed countries?**

The Pope discusses this dialogue in the most practical chapter of the encyclical, chapter 5. One key aspect is that all sectors with a stake in these issues and that are affected by them need to be able to put their point of view forward so that we can reach a balanced consensus. However, the Pope is realistic when he says that dialogue around the environmental impact of a project is not easy because each party defends its own point of view using only part of the available information while concealing other parts. Each side thus takes a polarized position without looking at all the available information. The same process is happening at a global level, so much so that the supposed concern over "green" issues in some countries is merely an excuse to protect their own interests. However, it cannot be denied that environmental issues now play a much more prominent role in the international political agenda than in the past. The same is true of poverty: no government wants to seem indifferent to these matters.

**Inspired by Romano Guardini, Pope Francis invokes the dangers of technocratic power without values or direction while also calling on us to create useful technological innovations that could, for example, help boost renewable energies. How can we reach a balance in relation to technology?**

The encyclical does not criticize technology itself but rather the technocratic paradigm and the boundless power this unleashes. Indeed, the Pope says "How can we not feel gratitude and appreciation for this progress, especially in the fields of medicine, engineering and communications?" He also acknowledges the value of business, which he describes as "a noble vocation, directed to producing wealth and improving our world," but he regrets the fact that there has been "excessive technological investment in consumption and insufficient investment in resolving urgent problems facing the human family." He also laments the slowness and lack of creativity around "intelligent and profitable ways of reusing, revamping and recycling" or developing alternative sources of energy, for example. He is not asking for less technology and less production, but rather for a new direction in technological and economic growth.

**What do you think the encyclical's most important impact has been to date?**

It has put the question of our responsibility to the weak, the environment, and the most vulnerable on the agenda, together with the question of thinking about other ways of producing, doing politics, and living well. In this sense, I have seen how the encyclical has been widely recognized by many world leaders, thinkers, and extraordinary professionals. Not long ago, a French survey of high-profile figures working in politics, economics, and science ranked *Laudato Si'* among its ten most recommended books. This shows that the Pope has achieved his aim of entering into dialogue not just with believers but with "all people of good will."



# NEW FORMS OF SLAVERY

Respect for workers' rights is a core issue in all trade negotiations. Compliance with labor standards may make products more expensive but it is fundamental to eradicating illegal and informal employment.

**51%**

OF LATIN AMERICANS CLAIM THAT SOCIAL ISSUES ARE THE NUMBER ONE DEVELOPMENT PRIORITY

**46%**

OF PEOPLE ARE WILLING TO PAY MORE FOR PRODUCTS IF THE PRODUCTION PROCESS RESPECTS WORKERS' RIGHTS

PEOPLE'S WILLINGNESS TO PAY MORE FOR GOODS THAT WERE MANUFACTURED IN COMPLIANCE WITH LABOR STANDARDS INCREASED BY **5** PERCENTAGE POINTS IN 2016

**WILLINGNESS TO PAY TO ENSURE THAT WORKERS' RIGHTS ARE RESPECTED**

Question: Imagine that your country signs an integration agreement with other countries in the region (Latin America and the Caribbean). Would you agree or disagree on the need to include commitments relating to the rights of local and foreign workers, even if this implied paying approximately 20% more for products? *"Strongly agree" and "agree" are the only responses shown


Source: www.iadb.org/intal/alianzalb *Note: no data for Mexico 2015.

Stefano Zamagni
University of Bologna

# Civilization and integral ecology

A TRUE ECOLOGICAL APPROACH ALWAYS BECOMES A SOCIAL APPROACH; IT MUST INTEGRATE QUESTIONS OF JUSTICE IN DEBATES ON THE ENVIRONMENT, SO AS TO HEAR BOTH THE CRY OF THE EARTH AND THE CRY OF THE POOR.

*Laudato Si'*

Globalization and industry 4.0 are transforming the relations between countries to make them increasingly interdependent, creating the same path for rich countries, those that have barely moved beyond poverty, and poor countries. The concept of integral ecology asks us to rethink global economics from a fresh perspective, in which the quest to maximize individual benefits is replaced by the importance of our relationships with others, and in which development takes on an ethical and spiritual dimension. This text looks at the challenges facing the business community in this regard. *Laudato Si'* functions as a guide for this task: it is a transcendental document that will be an essential point of reference for social and ecological issues for many years to come.

History does not move linearly, and we are living in a truly special time in history: 23% of global output from the birth of Christ to today was produced after 2000, and—if we understand "history" as the total number of years lived by all people on earth—twenty-eight per cent of human history since the birth of Christ has been lived during the last century. In nearly all Organisation for Economic Co-operation and Development (OECD) countries, the period from 1970 to 2011 saw a spectacular increase in life expectancy of around ten years. Humanity seems to find itself on a launch pad, and the risk is high that all this could turn into a tower of Babel that is destined to collapse if we do not succeed in coupling the irreversibility of technological progress with progress in our ability to manage these advances in a context of social and environmental sustainability and of integral human development.[1]

The phenomena of globalization and the fourth industrial revolution (so-called Industry 4.0) make it urgent and necessary that we bring principles and values up to date in the light of the res novae of a world in rapid transformation. This succession of innovations and transformations is what spurs us to reflect on how to deepen our understanding of the insights and foundational principles that Pope Francis condensed in the exhortation Evangelii Gaudium and the encyclical *Laudato Si'*. The pontiff sought to shake consciences in the face of a scandal created by humanity that, while despite having ever greater potential available to it, has still not succeeded in overcoming structural afflictions that are an affront to human dignity. In particular he focused attention on not contenting ourselves with the erroneous conviction that the "magnificent progressive fortunes"[2] of the market will necessarily transport us toward a better



# CIVILIZATION AND INTEGRAL ECOLOGY

future. The economy does not have an autopilot, and Adam Smith's thesis of an invisible hand that can reconcile the sum of individual self-interests into the common good is valid only under conditions that are so implausible that they have never transpired. The same competition that brings so many benefits to consumers is in no way the natural outcome of the interaction of market forces; rather, it is possible only because the appropriate authorities oppose the tendency toward oligopolistic concentration.

The functioning of the economic system is characterized by immense potentials and rebalancing mechanisms, but these are not automatic; they work only if activated by the right intentions and by adequate levels of spiritual, physical, human, and social capital. The great historical global inconsistency has been the dizzying growth of wellbeing in some areas of the world but not in others, which have remained cut off and marginalized. Globalization has burst this inconsistency, transforming the misery of the latter into a threat to the wellbeing of the former. The transformation of markets from local to global and the possibility of transferring "weightless" goods—sound, data, images, money—almost instantaneously from one place on the planet to another, the billion people who live below the threshold of extreme poverty compete with their low cost of labor against workers in countries accustomed to living with much better salaries and better safeguards. This process is progressively eroding those salaries and safeguards. High-income countries can no longer save themselves; they must start to attend to these safeguards if they want to defend young people's wellbeing and employment, which are being threatened by the erosion of national systems of production. This is why working for the poor and committing oneself to promoting their dignity is today not just the heroic choice of missionaries; it is necessary and urgent to defend the rights, benefits, and safeguards of all.

## THE HUMAN ENVIRONMENT AND THE NATURAL ENVIRONMENT

The main theme of the encyclical is summed up in its subtitle: Integral ecology is the key principle of the text. Precisely because the world is an ecosystem, one can not act on one part without others being affected. This is the meaning of the sentence "We are faced not with two separate crises, one environmental and the other social, but rather with one complex crisis which is both social and environmental" (Pope Francis, 2015). Ecology and economy have the same root—oikos—which points to the common home inhabited by mankind and by nature. But since the

THE GHG EMISSIONS OF THE WORLD'S POOREST 3 BILLION PEOPLE ARE EQUIVALENT TO THOSE OF JUST **70 MILLION** OF ITS WEALTHIER INHABITANTS

start of the Anthropocene—a term coined by Paul Crutzen, who won the Nobel Prize in chemistry in 1995—which began in the second half of the 18th century with the first industrial revolution, human society has increasingly "kicked nature out of the house." Natural resources have been savagely depleted with no regard whatsoever to either whether or not they could be reproduced or the negative externalities that productive activities were causing. "Official" economic science has played a major part in this process of exploitation, in that it has only recently begun to take ecological constraints into account in its growth models.

And not only that, mainstream economics has convinced multitudes of unsuspecting scholars and naive executives that the goal of maximizing short-term profit was a necessary condition for continual progress. This legitimized—though certainly did not justify—the vice of "short-termism," which was one of the factors that triggered the 2007-08 financial crisis.

It was in an attempt to straighten out the "crooked timber" of modernity that Pope Francis so strongly denounced the prevailing growth model. *Laudato Si'* articulated and defended three main theses. The first is that the fight against poverty and sustainable development are two sides of the same coin: "The human environment and the natural environment deteriorate together" (Pope Francis, 2015, §48). This implies that all initiatives based on the premise of separating the fight against poverty from environmental conservation are destined to fail. Indeed, while poor countries fear collusive accords between environmentalists and neoprotectionists designed to limit their access to markets in advanced countries—the concern of eco-imperialism—on the other hand environmentalists in the global North fear that environmental protection measures may be swept away by the World Trade Organization (WTO), encouraging a race to the bottom in setting environmental standards.

This is the consequence of the absence of an integral vision that prevents us from understanding that environmental and social degradation are two sides of the same coin. Sandra Postel (1992) argued that the world economic system seems incapable of simultaneously confronting the problem of poverty and that of environmental protection. She argues that treating the ecological ills of the earth separately from the problems caused by indebtedness, trade imbalances, inequalities in levels of income, and patterns of consumption is like seeking to heal cardiac illness without combating the patient's obesity and his cholesterol-rich diet.

The practical consequences of this issue are highly significant. Consider the question of climate inequality: 70 million of the planet's richer inhabitants emit 100 tons of greenhouse gases per capita per year, which is equivalent to the amount emitted by the over 3 billion poorest inhabitants, who are the ones who are most affected by climate change. The question is not just whether climate inequality is unjust or not—it certainly is—but whether the laws of the biosphere will allow this situation to endure, given the fact that these laws are nonnegotiable.

For example, carbon tetrafluoride or tetrafluoromethane, CF4, is nearly indestructible, and it has a greenhouse effect thousands of times greater than that of $CO_2$. This is why Eric Neumayer, an economist from the London School of Economics, proposed calculating the cumulative historical emissions over about two centuries as a basis for assigning responsibility for climate change and obligations to remedy the situation. It goes without saying that poor countries welcome this proposal but wealthy ones oppose it. This is why Marco Morosini, of the Climate Policy Group, has suggested calling our age the Plutocene (the Age of Wealth) rather than the Anthropocene (see Avenire, December 12, 2015).

Likewise, Chancel and Piketty (2015) suggest researching the links between the environmental crisis and the increase in economic inequality. Their suggestion is to consider emissions consumed as well as those produced. That is to say, it makes little sense to evaluate a nation on the basis of the $CO_2$ its companies produce if one does not also consider how much the consumer habits and lifestyles of its inhabitants impact the environment. For example, today the Chinese emit the equivalent of 6 tons of $CO_2$ per year per person (which is in line with the world average) compared to 13 tons for Europeans and over 22 tons for North Americans. In other words, the problem is that Westerners continue to give themselves the right to pollute at least twice as much as the world average.

**23%**

OF THE TOTAL GLOBAL OUTPUT SINCE THE BIRTH OF CHRIST WAS PRODUCED AFTER THE YEAR 2000

### THE ECOSYSTEM AS A GLOBAL COMMON GOOD

The second thesis of *Laudato Si'* is that the ecosystem is a global common good (Pope Francis, 2015: §§23 and 174). It is thus neither a private good nor a public good. It follows that neither traditional market instruments—from privatization to Ronald Coase's idea of emissions trading (Pope Francis, 2015: §171)—nor nationalizations by governments meet this need. It is well known that the commons are subject to devastating consequences that are typical of situations known as the "prisoner's dilemma": each waits to see what the other will do to take advantage of them, with the result that no one makes the first move. The fact is that while there still is no global governance of the economy, we must reckon with a single climate system with a single ozone layer, and so forth. This is the essence of global common goods: the use of these by one country does not diminish what is available to other countries, and conversely no country can be excluded from using it (of course, emissions of pollutants are clearly "global bads").

However, as economic theory has known for some time, common goods give rise to an annoying consequence known as the "tragedy of the commons" (Hardin, 1968). If the common good is global, the negative consequences will also be global. In 1990, the Intergovernmental Panel on Climate Change showed that greenhouse gases had led to a rise in average temperature, leading to consequences that we are all familiar with. And yet very few countries acted

unilaterally to reduce their emissions. Analogously, the European Union proposed introducing a carbon tax in Europe, but it changed its plans after seeing that other countries (especially the USA) were not following its example. These are precisely the characteristics of the common good that make unilateralism a fallacious strategy for environmental policy.

Even if it were possible to reach some form of international accord or treaty through negotiation, compliance would be an ongoing problem. Examples of such problems are the Montreal Protocol regulating the use of CFCs and the aforementioned Kyoto Protocol on climate change.

Why did the Montreal Protocol produce the desired results, while the Kyoto Protocol has essentially failed, as noted above? The answer is clear. The Montreal Protocol includes an incentive mechanism that encourages all countries to participate and become signatories; that is, it is in the interest of each country to abide by the rules set out in it. This is not the case with the Kyoto Protocol, whose authors were not able to find a mechanism capable of ensuring compliance.

Having traveled as far as they possibly can from the community, the modern individual has become the first victim of modernity. Obsessively turned inward upon his or her own subjectivity—analytically represented by a preference map—the person contemplated by the dominant theory is characterized by a wholly inhospitable autonomy and separateness, dismissing any relationship that does not serve their own ends. The acute awareness of this individualistic isolation has contributed to sparking an intense longing for reciprocity, as is confirmed by a growing body of empirical and experimental research (see Sacco, Vanin, Zamagni, 2006). When the idea of society as a system of needs to be met is transferred to the narrative of a self-referential individual whose fundamental concern is maximizing some objective function under constraints, the outcomes are destructive. Consider the ecological question, or the various social poverty traps caused by positional competition.

Economic science can be open to relationality only if it takes a step back from possessive individualism—without, however, rejecting its benefits, the foremost of which is that of extracting the individual from the grasp of communalism—and thus increases both its explanatory and its normative value. Note that the relationality which I am speaking of is not exchange but reciprocity. The former has an instrumental nature: each time I begin an exchange it is obvious that I enter into relationship with someone, but that person is only a means to my own end. The latter pursues the power of what may happen in relationships between agents, which in economics is captured by the notion of common goods. No contemporary thinker has seen this distinction better than Hannah Arendt. In her famous essay "The Human Condition," she wrote that what is public is what is in the light, which can be seen and discussed: "Everything that appears in public can be seen and heard by everybody" (Arendt, 1958: 59). What is private, in contrast, is what is removed from sight: "the term 'public' signifies the world itself, in so far as it is common to all of us and distinguished from our privately owned place in it" (Arendt, 1958: 61). What is common, on the other hand, is "the world itself as common to everybody and distinct from the space that everybody occupies privately" (Arendt, 2009: 61).

So what actually underlies the "tragedy of the commons"? As noted, Hardin's argument is that if humanity does not limit individual freedom, it risks going the way of the inhabitants of Easter Island and will end up destroying the common goods on which human life depends. Shortsighted in-

**250 MILLION**

PEOPLE WILL HAVE TO TO MIGRATE FROM THEIR HOMELANDS BY 2050 DUE TO CLIMATE CONDITIONS


**SUPERFICIAL ECOLOGY VERSUS SOCIAL ECOLOGY**

In the 1980s, Murray Bookchin, the founder of social ecology, was already arguing that the idea of being able to dominate nature arose from man's domination of his fellow man. He was bitterly attacked both by environmentalists of the time, who cared little for social problems, and by social movements, who considered the environment a "secondary contradiction." In Laudato Si', social ecology moves from the margins to the forefront of ecological discourse: "a true ecological approach always becomes a social approach; it must integrate questions of justice in debates on the environment, so as to hear both the cry of the earth and the cry of the poor" (Pope Francis, 2015: §49).
This brings with it a fierce rejection of a form of ecology that the Pope describes as "superficial" and that expresses a false trust in partial solutions and environmental technology. He also eschews the misanthropic attitudes that are typical of "deep ecology" and that see "men and women and all their interventions as no more than a threat, jeopardizing the global ecosystem" (Pope Francis, 2015: §60). The Pope has rejected both catastrophism—the disaster scenario of temperature increases of over 2°C—and the reduction of the environmental question to a utilitarian cost–benefit pragmatism. In more general terms, the vision that springs from the encyclical is that of holding the biosphere and the noosphere in harmony. The term "noosphere" was coined in the 1920s by Teilhard de Chardin to refer to all human beings that have the capacity to plan their actions and have a conscious and common project. As Ludovico Galleni suggested in Verso la Noosfera [Toward the Noosphere], the noosphere, as a common entity with its own purpose, must interact symbiotically with the biosphere.

dividuals who pursue nothing but their own self-interest inadvertently end up sawing off the branch that they are sitting. Hardin's example of common land that shepherds bring their flocks to is a good illustration of this. Rational choice, which leads one to maximize one's individual interest, would suggest that each shepherd should add another animal to their herd, because by so doing they would gain, say, x, while the availability of grass decreases by only a fraction of x, since the consequent damage is divided among the other n-1 shepherds.

Essentially, it is as if those using the pasture do not take the reduction in the common good (the pasture grass) entailed by their choice into account when they act. They do not consider the critical issue of the common good because each person sees only his individual interest. In other words, each is an idiótes, literally "one who sees only himself." (Recall the famous statement by the great Greek statesman Pericles in the 5th century BCE, as reported by Thucydides, that democracy cannot work well if the majority of those who make up the polis act like idiótai.) With individuals of this sort, it is clear that sooner or later a critical threshold will be passed, which triggers individual perception of the imminence of the tragedy, but this happens when it is too late. Paradoxically, as this unfolds, the race to hoard resources intensifies as their scarcity increases.

**WEO**

A WORLD ENVIRONMENT ORGANIZATION WOULD NEED TO HAVE SIMILAR CHARACTERISTICS TO THE WTO

## ECONOMIC BIODIVERSITY

The third thesis regards Pope Francis's strong defense of economic biodiversity. A market economy wishing to lean toward integral ecology cannot ignore the different types of business that exist. At the very least, it needs to make room for companies that produce value—and thus wealth—while anchoring their own actions in principles such as mutuality and intergenerational solidarity. Denying or obstructing this would imply irresponsibly renouncing integral human development. We must never forget that there are three aspects to development: the material (hence, growth), the socio-relational, and the spiritual. The relationship between these is multiplicative rather than additive, which implies that all the three dimensions should be maintained in equilibrium overtime.

As Amartya Sen suggests, there is serious conceptual confusion between "market omissions" (that which the market does not do, but could) and "market failures" (what the market does, but does badly). Instead of inclusive initiatives (ones that aim to include essentially everyone in the productive process), this confusion has given rise to political practices that implement exclusive initiatives that shut "surplus people" out of the market or exclude them on the grounds that they are irrelevant, and the only attention that is paid to them is in the form of welfare assistance. After thoroughly analyzing the current state of affairs, Pope Francis suggests adopting an ecological view that brings all these aspects of value into play and can thus perceive the risk of being crushed by the deadly cycle that couples the increases in efficiency (power) bought by techno-science with the unlimited expansion of subjectivity (the will to power). This is why we must once more espouse the idea of a limit, and why technical reason is no longer a reliable guide as a model of integral human development. Indeed, we should keep in mind that the combination of power and the will to power generates the hubris that leads to collapse.

What then should we do? There are various ways of addressing today's challenges. We might call one such way "laissez-faire fundamentalism," which puts forward a plan for technological transformation guided by self-regulating systems, in which the political system takes a hands off approach and collective action becomes impossible. It is easy to see the risks of authoritarianism that are inherent in such an approach due to the absence of democracy.

A second way is the neostatist approach, which argues firmly for regulation by the national government. The idea is to revive public intervention in the economic and social spheres by renewing and rethinking these. But it is clear that this would not only produce undesired effects, it could also lead to disastrous consequences for countries in transition. In fact, in current conditions, implementing new free market policies could damage the already low levels of prosperity in developing countries.

The strategy that the Church's social doctrine prefers rests on five pillars.

a. Economic calculations are compatible with a variety of behaviors and

### CORPORATE CIVIL RESPONSIBILITY

Daron Acemoglu and James Robinson (2012) distinguished between extractive and inclusive market institutions. The former set the rules of the game that favor the transformation of the added value created by productive activity into parasitic rents, allowing multiple forms of tax evasion and corruption. The latter, by contrast, are institutions that tend to facilitate the inclusion of all resources in the productive process, especially labor, which ensures respect for basic human rights and the reduction of social inequality. So, companies that are "civilly responsible" leverage available resources to accelerate the transition from an extractive institutional structure to an inclusive one. This implies taking a step beyond the notion of corporate social responsibility, in that it is no longer enough for companies to be willing to limit achieving their own goals by satisfying conditions such as taking into account the needs and identity of all stakeholders. Instead, the notion of civil responsibility implies that companies—which have become political players in this phase of globalization in which national governance is being worn away—take part in designing a new lex mercatoria. (The drafting of the 15th-century *lex mercatoria* was a process in which merchants themselves, the entrepreneurs of the time, played a part.)

types of institutions. It is therefore necessary to defend the weakest forms of enterprise so as to learn for the future. This means that there must be a selection filter in place, but it must not be set too tightly, such that any solution that exceeds a certain threshold of efficiency can survive. The global market must thus become a place in which local variations can be improved on, which means rejecting the deterministic view that there is only one way of operating in the global market.

Nor should we forget that globalization inevitably pushes the institutional variety in each country back. None of this is surprising, because the rules of free trade conflict with cultural diversity and view institutional differences (for example, different welfare models, education systems, perspectives on the family, the importance placed on distributive justice, and so forth) as a serious obstacle to their expansion. This is why it is essential to remain alert and ensure that the global market does not constitute a serious threat to economic democracy.

b. The application of the principle of subsidiarity at the transnational level. This requires that civil society organizations be recognized by states but not authorized by them. The function of these organizations should go beyond mere advocacy or criticism; they should play a major part in monitoring the activities of multinational corporations and international institutions.

What does this mean in practice? Civil society organizations should play public roles and have public functions. In particular, these organizations should exert pressure on the governments of the more important countries to sign an agreement that would drastically limit the advantages of suddenly withdrawing capital from developing countries.

c. The national states, and in particular those of the G8, should reach an agreement to modify the constitutions and statutes of international financial organizations and overcome the Washington Consensus, which was created in the 1980s after experiences in Latin America. Ultimately, this would require creating standards that reflect the idea that private property and free trade are not the only sources of efficiency, which is also generated by policies such as competition, transparency, technology transfer policies, and so forth. The application of a biased, distorted, and unilateral vision by the IMF and the World Bank has unfortunately led to excessive indebtedness and national financial repression. We should recall that in a financially repressed economy, inflationary pressure places a wedge between national deposits and interest rates on loans, with the result that national companies are artificially forced to seek foreign loans, and domestic savers are induced to deposit their funds abroad.

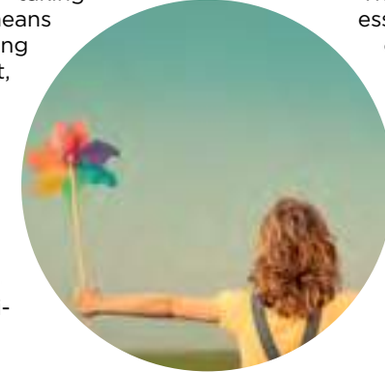
d. Civil society organizations should encourage the Bretton Woods institutions, the United Nations Development Programme (UNDP), and other international agencies to include wealth distribution indicators among their development parameters, and also indicators that quantify respect for local details. These indicators should be considered when developing international classifications and when drawing up plans for intervention and assistance. Pressure should be exerted to gain acceptance for the idea that development must be fair, democratic, and sustainable. The lack of global institutions (not global bureaucracies!) is what makes it difficult to solve so many problems of our time, in particular the environmental problem. While markets are becoming more global, the transnational institutional framework is still that of the postwar world.

e. Finally, a rich tapestry of nonutilitarian experiences should be created as a base on which to establish a model for consumption and, in more general terms, lifestyles that allow a culture of reciprocity to take root.

To be credible, values must be lived out, not just stated. It is thus of fundamental importance that those who set out on the journey toward a transnational civil society must commit themselves to creating organizations whose modus operandi revolves around the principle of reciprocity.

## FROM "FACTUM" TO "FACIENDUM"

Chapter 5 of *Laudato Si'* suggests "Lines of Approach and Action." This new approach is highly significant. Pope Francis did not limit his discourse to the factum, or to what mankind does, but pushed on further to the faciendum, to what mankind is capable of doing. In Genesis we read that mankind is called to till and take care of the earth (Gen. 2:15). Tilling means that mankind must take the initiative and cannot remain passive with respect to natural rhythms. On the other hand, taking care of the earth means caring for it, accepting it, and welcoming it, not exploiting it. The strategy that the Pope has adopted the transformation of existing power structures. He believes that neither "revolution" nor mere reformism are sufficient for taking on the present challenges. I will limit myself here to making just three suggestions in the direction that Pope Francis is clearly advocating.



The first concerns the urgency of creating a World Environmental Organization (WEO) along the lines of what happened a few years ago when the WTO was established. What makes the problems of our times so hard to solve is the lack of global institutions, and the foremost problem that we are facing is the environment.

Markets have gone global, but today's transnational institutional structure has changed little since the postwar era. However, in 1944, the Bretton Woods negotiators could not have even remotely imagined the ecological issues we now face. One might object by asking whether the international treaties currently in place are not enough to regulate the relationships between agents, just as contracts do within a country's borders. The analogy is dangerously misleading, because contracts established within a country can be enforced by the state in that country, but there is no transnational authority capable of ensuring that treaties between states are complied with. In other words, international environmental agreements are not binding.

This is why a WEO is necessary. In the long term, we cannot continue in a situation in which the market has become global while the structure of governance has remained basically national or, at most, international. Today there are around two hundred "multilateral environmental agree-


ments" (MEAs) in the world. Notable examples are the aforementioned Montreal Protocol, the Convention on Biological Diversity, the Convention on International Trade in Endangered Species, the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes, the Kyoto Protocol, and so forth. In the absence of a WEO, it is plain that these agreements will never be enforced, as a country need only not ratify the agreement to void its regulatory function. Worse still, under current conditions, there are incentives for individual states to create "pollution havens" to gain a competitive advantage in international trade.

An organization of this type must undertake three priority tasks. First, it must interact with the WTO to make the rules of free trade compatible with one another and with proposals to protect the environment and to enforce them among all parties. Second, a WEO should intervene whenever price signals fail to anticipate irreversible environmental losses, a situation that is increasingly frequent today. As we know, there are thresholds for environment degradation thresholds up to which economic activity does not prevent the regenerative function of the environment. Past those points, however, irreversible changes may be caused when economic activity exceeds the ecosystem's capacity to assimilate it. In such situations, market mechanisms seize up, hence the need for oversight by an agency designed for that purpose.

Finally, a WEO must squarely face the question of ecorefugees, that is, of global warming as a factor in creating new streams of refugees. According to the UNHCR, by 2050 the world could find itself managing the forced migration of between 200 and 250 million people who are leaving land that is either scorched, completely submerged, or devastated by deforestation and overheating. Between 1997 and 2020 in sub-Saharan Africa alone, the estimates are of around 60 million forced migrants who wish to remain in their homes but cannot. This is a tragic consequence of "land grabbing." Yet neither the Convention on Climate Change nor the Kyoto Protocol contemplate measures of assistance or protection for the increasing numbers of those will be hit by the effects of climate change. Even today, environmental refugees do not figure in any of the international legal system's categories. In the USA, the border patrol budget has gone from US$200 million per year in 1993 to the current US$1.8 billion, and yet illegal immigrant numbers have doubled from 5–6 million to 12 million in that time. If we want to end the current short-sighted policy of militarizing borders, creating a WEO with adequate power and resources is indispensable.

My second suggestion for action is to address financial transformation. Finance is a tool with formidable potential for ensuring the proper functioning of economic systems. A good financial system allows savings to use them efficiently and channel them toward the most profitable uses. It transfers the value of activities through space and time and implements insurance mechanisms that reduce exposure to risk. It connects those who have financial means but no productive ideas with those who have productive ideas but no financial means. Without this connection, a community would never move beyond the mere potential to create economic value. As the French economist Gaël Giraud (2014) suggested, finance could be placed at the service of an ecological transition. We must want to do so, however!





## CIVIL RESPONSIBILITY

My third major suggestion for action draws the notions of consumer and corporate responsibility into discussion. We are currently living through the transition from being a society of producers to a society of consumers. In the former, consumption is a means to an end, such as the accumulation of capital, profit, power, or something else; in the latter, consumption becomes the end and production the means. The industrial society we left behind a few decades ago was a society of producers, in which producers led the dance. In the mid-19th century, the great economist and philosopher J.S. Mill coined the term "sovereignty of the consumer" to indicate that the market economy would one day reach the point at which consumers' free and informed choices would indicate their preferred modes of production and types of goods and even impose these on producers. However, the real turning point did not come until August 1962, when US President J.F. Kennedy officially launched the consumer movement in a speech to the US Congress. He argued that consumers should not be thought of as passive customers, but as citizens, as individuals who use their purchasing power to send signals to both the political system and to companies—messages that condense the value judgments and specific cultural matrices of a community.

Today we are forced to choose between two versions of the consumer society, which by now has replaced the production society. The first version is best summed up by the slogan "buy more, pay less," which is typical of a society that revolves around low costs. The French philosopher Gilles Lipovetsky coined the term "turbo consumer" to describe this: the function of low-cost society is to lower production costs so as to lower selling prices and thus to increase the intensity of production, seen as the ratio of consumption per unit of time. The schizophrenic drift of this consumption model is easy to grasp, because lowering costs affects wage levels and welfare services. This gives rise to a practical contradiction that is the source of troubling social situations, namely that each of us is simultaneously a worker and a consumer. As workers we have an interest in increasing our income; as consumers we aim to pay as little as possible for the goods we demand. The two positions cannot co-exist.

The slogan for the other version of the consumer society is "consume better and be happy." We know that there are two dimensions to consumption: one is acquisitive, the other is expressive. The first—which humans share with animals—is what drives us to satisfy our basic needs. Through the second, the expressive dimension of consumption, we refresh and express our own identity, be it in terms of gender, culture, or religion. The need for recognition drives us to do so, and at times this need may be stronger than biological needs. In his famous work If This Is a Man, Primo Levi wrote memorably on this very point. Why, one might ask, do we need to be recognized? To be happy: Aristotle was the first to be astute enough reach this response. For humans to be happy, for us to thrive, we need to be recognized and to recognize others. And consumption is one of the main ways in which we


practice this recognition. That is why voting with our wallets and stock portfolios, taking part in civil protests, boycotting products, and so forth are all initiatives that should be supported and encouraged. They are the necessary premises for creating a new type of consumer society, which is quite different from creating a neo-consumerist society.

Note that even today, so-called strategic marketing is predominately oriented toward the acquisitive dimension of consumption, both in theory and practice. It is easy to guess why. One reason I would draw attention to is a dearth of culture. Most of our fellow citizens are unacquainted with these matter: the problem is not one of information but of education. With rare exceptions, we lack educational projects that are designed to promote civilly responsible consumption. And yet something is stirring. We are beginning to see the use of the word "societing" instead of the now obsolete term "marketing," and the notion of customization or personalization is spreading, denoting an approach in which consumers are coproducers of the goods and services they use. All this is happening because various forms of active citizenship have been gaining strength.

## SOCIAL LEGITIMACY

Pope Francis refers repeatedly in his encyclical to the need for us to change our way of life, but this will only be possible when business world understands that it is time to go beyond corporate social responsibility. Extensive theoretical and empirical research reveals that today's society no longer considers it sufficient for a company to limit itself to making profits in whatever way it can in order to attain social legitimacy, while still considering this necessary. With rare exceptions, nobody seems willing to continue believing in Milton Friedman's well-known statement that there is "one and only one social responsibility of business—to use its resources and engage in activities designed to increase its profits so long as it stays within the rules of the game." We know, in fact, that the economic value chain and the social value chain do not always go hand in hand, and that the former always prevails over the latter in such cases.

The expression "corporate social responsibility" (CSR) was created in the USA within the business world to ensure that enterprises would continue to be the main structures in the market economy. In his book Social Responsibility of Businessmen, Howard B. Bowen (1953) wrote that "the social responsibility of businessmen … refers to the obligations of businessmen to pursue those policies, to make those decisions, or to follow those lines of action which are desirable in terms of the objectives and values of our society." Bowen (and others) conceive of a form of CSR that lacks an ethical foundation. Indeed, a quarter century went by before business ethics were successfully included in the CSR discourse.

What led to the gradual abandonment of the argument that "good ethics is good business," seen by many as a sort of dogma of faith, as if to say that what is good for business is good for ethics? Simply this: the acknowledgement that Adam Smith's invisible hand often ends up with cramps that prevent it from fully accomplishing its task, as the news stories of the last decade have





covered extensively. As Kaushik Basu (2010) wrote in his Beyond the Invisible Hand: Groundwork for a New Economics, there are two sides to this celebrated principle has two sides. The one described by Smith is the bright side; the other, masterfully evoked by Franz Kafka in The Trial, is the dark side and produces perverse effects. Kafka's allegory is a lucid description of how possessive individualism can lead to inauspicious outcomes in the absence of an appropriate institutional structure—that is, of specific rules of the economic game. In such situations, Kafka's invisible hand gains the upper hand over Smith's. (Contrary to what one might think, Smith himself was clear on this point.)

When this happens—and the 2007–08 crisis is just the most serious of the many episodes of "market failure"—is it not perhaps sufficient to insist on a personal level of ethics, according to the principle that if everyone in a given company behaves properly, starting with its managing director and board, the results will be good? The answer is decidedly negative because, as an economic institution, the company itself—not just those who hold a stake in it—is a moral agent that is itself responsible. Socially responsible firms have certainly accomplished much in terms of growth and progress, but this is no longer enough. Already today, and increasingly in the near future, companies will be asked not only to produce wealth in a socially acceptable way but also to compete with the state and the agents of organized civil society to redesign the economic and institutional structure they have inherited from the recent past. This is about the company no longer contenting itself with respecting the rules of the game laid down by others. Consider the rules of the labor market, the banking system, the structure of the tax system, the characteristics of the welfare model, and so forth. As a player in the market club and an influential member of this, the firm is being asked to agree to contribute to rewriting all the rules that either have become obsolete or that are not capable of sustaining integral human development. This is the heart of the notion of a civilly responsible company.

We are on the eve of a new entrepreneurial epoch that is characterized by its rejection of a model based on the exploitation of mankind or nature in favor of a model centered on the logic of reciprocity, and by the quest for meaning in business activities, which cannot be reduced to a mere "money machine." (On September 4, 2008 Dennis Hevesi—not Pope Francis, as has sometimes been suggested—wrote in the New York Times, quoting the business writer Michael Hammer, "I'm saddened and offended by the idea that companies exist to enrich their owners. That is the very least of their roles; they are far more worthy, more honorable, and more important than that.") Indeed, enlightened entrepreneurs increasingly believe that profit cannot be the sole goal of a company and that there cannot be trade-offs between profit and civil engagement.[3] How one generates profit is just as important as how much one produces. The idea of "shared value," which is now universally accepted, at least on paper, necessarily requires civilly responsible companies to go beyond the instrumental view of CSR.

We must thus rethink the role of the entrepreneur in generative terms in the new economic context that has emerged in the wake of the phenomena of globalization and the fourth industrial revolution. It is now accepted


that economic action cannot be reductively understood as everything that serves to increase production, in the hope that this will be sufficient to ensure social harmony. Instead, economic action must seek to foster community life. As Aristotle well understood, community life is very different to mere commonality, which could describe relations between members of a herd of animals. Indeed, animals eats for themselves and seek, where possible, to take food from others. In human society, however, the good of the individual can only be attained through the work of all. In particular, the good of the individual cannot be enjoyed unless it is enjoyed by others. This is the great challenge facing civilization. Humanist management of this situation must learn to reap the benefits of this through a massive dose of courage and intelligence.

## THE REVOLUTION OF ST. FRANCIS

Fifty years ago, the historian Lynn White (1967) observed that, consciously or unconsciously, our attitudes regarding nature have been conditioned by religious views of the world: "what people do about their ecology depends on what they think about themselves in relation to things around them. Human ecology is deeply conditioned by beliefs about our nature and destiny—that is, by religion."

White concluded his essay with these words: "Possibly we should ponder the greatest radical in Christian history since Christ: Saint Francis of Assisi (...) The key to an understanding of Francis is his belief in the virtue of humility—not merely for the individual but for man as a species. Francis tried to depose man from his monarchy over creation and set up a democracy of all God's creatures. (...) The profoundly religious, but heretical, sense of the primitive Franciscans for the spiritual autonomy of all parts of nature may point a direction" (White, 1967). Centuries later, another Francis has taken up this idea. Echoing Teilhard de Chardin, *Laudato Si'* declares that the ultimate goal of the journey of the universe is the fullness of God: all creatures advance, with us and through us, toward that common end.

Religious traditions have always embraced a wide range of interpretative positions. Rabbis, Christian theologians, and imams in the West and the Middle East and Buddhist monks and Confucian scholars in the East must all interpret their respective traditions over the course of time. The potential alliance between religion and ecology focuses directly on the current process of discernment and exegesis, aiming at a constructive phase in which scholars of various religions can state their sources of awareness and potential or actual ecological action in the context of the various traditions. The common values that the majority of the world religions uphold in relation to the natural world can be summarized as veneration, respect, moderation, redistribution, responsibility, and renewability. Although interpretations vary regarding these principles both within each religion and among the various religions, all are moving toward an increasingly broad understanding of their own cosmological orientations and ethical commitments, toward an ecology that incorporates all aspects of the question in its entirety. Although these have




previously been understood primarily in relation to other human beings, today we tend to extend them to the natural world to ensure respect for the planet's myriad species, as an ethic extended to every form of life, limiting the use of natural resources in combination with supporting effective alternative technologies and an equitable distribution of wealth. Religions can lead to a broader recognition of human responsibility for the continuity of life on our planet and contribute to renewing the energies of hope to be sure that this transformation is completed.

The message of hope that emanates from *Laudato Si'* is that the certainties that technical and scientific progress offer us are not enough. Such progress has already increased our ability to find the means to achieve goals of every sort, and will continue to do so. But although the means to achieving certain ends are today in a far more auspicious state than once they were, this is not necessarily true of the ends themselves. We might express this conundrum as "what good things should I desire" rather than "what must I do to obtain what I want?" Mankind today is burdened by the necessity of choosing its ends, not just its means. Hence the need for a new hope: faced with the chain of increasingly powerful means, contemporary mankind does not seem able to find ways of responding to it other than by letting itself be enslaved or rebelling. When the chain of means was less powerful, this was not the case. It is understandable that those who lack a certain thing hope to possess it: this is the old form of hope. But continuing to believe that today would be an error. Seeking out means in themselves would be foolish—new hope must focus on ends. Today, hope means precisely this: not considering ourselves to be either merely the results of processes that fall outside our control or self-sufficient entities with no need to enter into relations with others.

**NOTES**

[1]A longer version of this article was included in Ingeborg, Kirchschläger, and Sturn (2016). I would like to thank the editors for giving their permission for me to publish this version in English.

[2]A reference to a very well-known line from Giacomo Leopardi's poem "La ginestra."

[3]In Italy the legal concept of the "società benefit" [benefit company] was introduced into law in December 2015, modeled after the American "benefit corporation", which saw its birth in 2010.

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# YOUNG PEOPLE AND ECO-INTEGRATION

Young Latin Americans show above-average environmental awareness in comparison with the region's population as a whole. Over half the region's citizens aged between 16 and 25 believe that the environment is important for development and they rate the struggle against climate change to be the second-most-important innovation priority after healthcare.

### CARE FOR THE ENVIRONMENT AND DEVELOPMENT

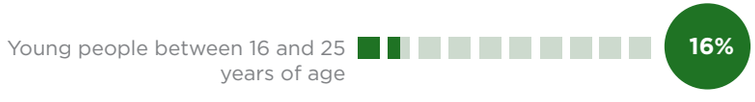
Question: Which of the following topics are most important for development in your country? Responses for the environment and climate change


### WILLINGNESS TO PAY FOR SUSTAINABLE PRODUCTS

Question: Imagine that your country signs an integration agreement with other countries in the region (Latin America and the Caribbean). Would you agree or disagree on the need to include commitments relating to care for the environment in such regional integration agreements, even if this implied paying approximately 20% more for products?


### THE IMPACT OF NEW TECHNOLOGIES

Question: What do you think should be the number one priority for scientific and technological innovations in the next 15 years? Responses for the fight against climate change and environmental protection.




### CONNECTIVITY AND SOCIAL INCLUSION

Question: Do you or anyone in your household own one of the following? Responses for cellphones among young people between 16 and 25 years of age who "sometimes" or "often" do not have enough to eat.


Source: www.iadb.org/intal/alianzalb

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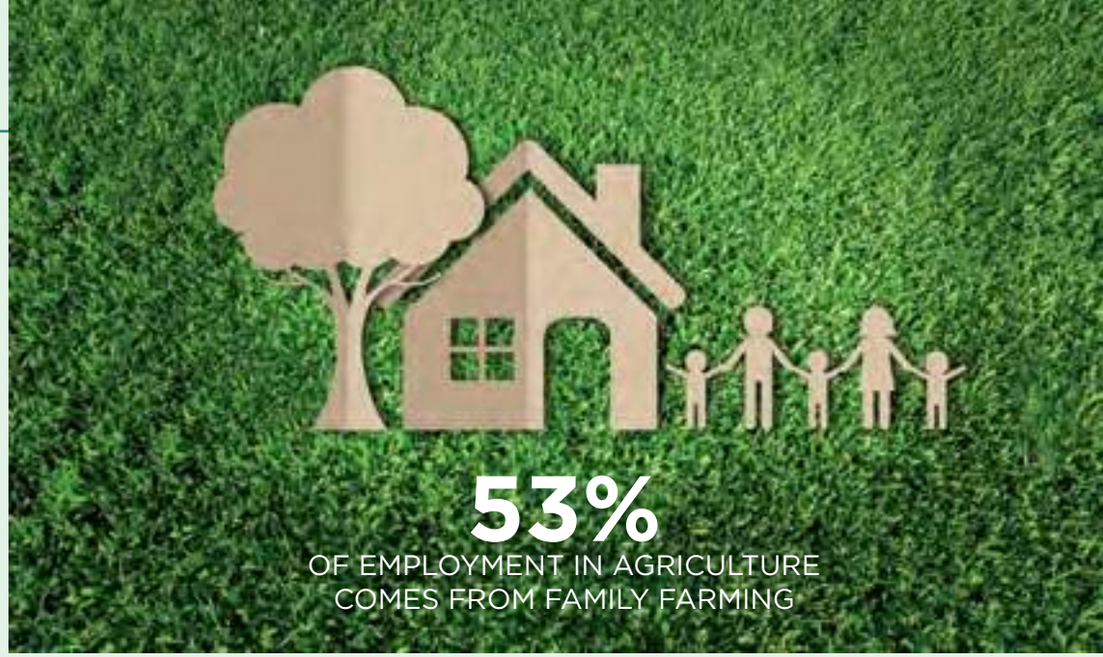
# FAMILY FARMING

## ITS ROLE IN REDUCING POVERTY




Family farming in Latin America is widely recognized as being the main activity of a considerable share of poor households in rural areas. In many countries, the incidence of rural poverty is greater among family farms in remote areas with low population densities and low agricultural productivity (such as the northeast of Brazil). These low-income families also suffer the consequences of reduced access to basic necessities such as education, health, housing, and connectivity, even though younger generations have reached higher levels of schooling than their parents.

The heterogeneity that exists within peasant family farming (PFF) means that it is unrealistic to focus on a single support strategy for this sector, which is heterogeneous in terms of its income levels and assets (scale, physical capital), the composition of its output and productivity, its integration with commercial markets, its chances of being incorporated into dynamic commercial agriculture, and the general nature of the restrictions to development that it faces. Any support strategy for PFF should contemplate this diversity.

A major constraint on analyses that attempt to capture this heterogeneity is the lack of appropriate statistics, a situation which is referred to in Brazil as "statistical poverty." The vicious circle of insufficient basic information and the diversity within PFF make it hard to identify effective strategies that contribute to generating higher incomes and family welfare, reducing poverty, and establishing a rural middle class that participates actively in the country's development.

At the international level, there is no consensus over the definition of small-scale farmers, although out of operational necessity for implementing their programs, some countries have established ceilings on capital, the size of land holdings, or numbers of hired workers. A distinction tends to be drawn between subsistence farms (the majority), farms in transition, and those that have already been incorporated into the commercial sector, one of the classification criteria for which is the use of hired workers versus the exclusive use of labor from within the family, which predominates in the subsistence category. However, such information is not always available.

**DIVERSIFICATION**

A SMALL-SCALE FARM PRODUCES TEA, YERBA MATE, COTTON, TOBACCO, SUGAR, GRAINS, AND LIVESTOCK

In several countries, large numbers of young people are turning their backs on farming and rural areas. This is due to their having different income expectations, but also to reduced access to basic services in rural areas (education, healthcare, housing, connectivity) and to social activities, sports, technical training, and the arts. In other words, a general lack of public goods and physical and social infrastructure.

Several recent studies show that PFF plays a significant part in aggregate agricultural output and employment. For example, in Argentina, Juárez et al. (2014) indicate that although the share of small-scale farming in Argentina's total agricultural output remains a minority, it does account for a significant proportion of output in several areas. PFF represents 25% of the aggregate agricultural output of items such as tea, yerba mate, cotton, tobacco, and sugar cane, 40% of the total output of cereals and oilseeds, and 20% of livestock production. The authors emphasize that family farming accounts for approximately 53% of employment in agriculture and that 60% of these jobs are informal. Similar statistics for Chile (Martinez, Namdar-Iran, and Sotomayor, 2014) indi-

cate that in 2009, family farming (both subsistence farming and family-run businesses) represented 22% of the gross value of agricultural output (and 61% of employment), in contrast with 38% for medium-scale agriculture and 40% for large-scale agriculture (which together account for 39% of employment).

In Brazil, it has been observed that small farms represent a large share of total farm numbers, but their contribution to the total value of production is relatively low. For example, according to the 1995 census, farms of up to 10 hectares accounted for 50% of the total production units and 12% of the aggregate output value. The following category, farms of between 10 and 100 hectares, represented 40% of the total number of properties, and have a 35% share in the total value. The remaining 53% of output came from farms larger than 100 hectares (World Bank, 2003).

In both Brazil and the United States, the trends in aggregate productivity growth suggest that growth in output as a whole is being led by medium- and large-scale commercial farms. According to Gardner (2003), at the beginning of the 1990s, 90% of aggregate sales came from 25% of the larger farms (compared to 50% in the 1940s). This includes the fact that small farmers account for the majority of the output

**84%**

OF BRAZIL'S FARMS MEET THE CRITERIA FOR FAMILY FARMING

**50%**

OF COLOMBIA'S GROSS AGRICULTURAL OUTPUT COMES FROM FAMILY FARMS

of certain products, generally labor-intensive ones. In Brazil, the FAO estimated that PFF represented about 38% of gross value of production and 84% of the country's farms (FAO, 2006). In Colombia, the relative contribution of PFF is higher, accounting for at least 50% of the gross agricultural output (Jaramillo, 2002). In middle- and high-income countries, the trends over time are conclusive: PFF's relative contribution to the gross value of aggregate production has been shrinking over time.

However, it is often observed that in certain regions of a country, agricultural activity depends greatly on PFF. Although PFF's contribution to total output is not driving the sector's aggregate growth, it does affect the social dimension, especially in terms of poverty reduction.

In short, PFF makes a significant contribution to the domestic food baskets, especially to nontradable goods, reduces the incidence of poverty by creating rural employment, and provides a form of subsistence for an underused rural labor force. It also contributes to creating greater political stability and peace in rural areas and to better management of the environment, forests, soil, flora, and fauna.

So how can we provide incentives for PFF? It is well known that Latin America and the Caribbean suffer the consequences of market failure, some of which are rectifiable. However, international evidence suggests that there are structural conditions that could limit economic opportunities for the small-scale farming sector in the future.

**RURAL EMPLOYMENT**

BY GENERATING JOBS, FAMILY FARMING HELPS REDUCE POVERTY

In rich and middle-income countries, there is a trend toward increasingly large and sophisticated farms. In contrast, in low-income countries, which often have high population densities, there is a trend toward smaller farms (Foster and Valdés, 2014).

In more sophisticated forms of agriculture, cutting-edge technology is the norm and markets are not neutral with regard to the scale of production. These markets are more integrated and consumers within them are more demanding in terms of traceability, consistent quality, etc. In this sort of agriculture, scale matters. In addition, the capacity to handle climate risk and price variability is an influential factor that is hard for PFF to manage.

Contract agriculture is a great opportunity for PFF in niches such as perishable products (industrial tomatoes, chickens). But this begs the question of whether small-scale farmers are too small to be able to raise their incomes and escape poverty. This observation is often made today in parts of Sub-Saharan Africa and India.

Any support program for PFF should include a territorial rural development strategy that revolves around diversification and services, in contrast to traditional rural development programs that focus on agricultural development. What is needed is to close the technology and training gap (land productivity, labor, technical efficiency, storage capacity, etc.). The strategy should include multiple objectives, intersectoral and interagency cooperation between ministries, with an emphasis on place-based approaches that encourage public–private partnerships and aim to mobilize new resources at the local level, as part of a new territorial rural development paradigm (OECD, 2006).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ANALYSIS

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# Social economics

## Genuine relationships as a welfare factor

IN ORDER TO CONTINUE PROVIDING EMPLOYMENT, IT IS IMPERATIVE TO PROMOTE AN ECONOMY WHICH FAVOURS PRODUCTIVE DIVERSITY AND BUSINESS CREATIVITY

*Laudato Si'*

The global crisis has revealed itself to be a profound ethical, cultural, and anthropological crisis. Setting our sights exclusively on growth in GDP has proved misleading. For many years, economists have claimed that individuals seek to maximize wealth so as to maximize its utility because "the richer we are, the happier we are." But we need to acknowledge that a good life, happiness, is a combination of material goods and relational goods. Other people are an absolute value that is not subject to transactions. An inclusive economy fosters a greater emphasis on relationships.

At the global level, including in Latin America, news media largely revolves around economic and financial issues. The subprime mortgage crisis of late 2008 undoubtedly signaled the start of a far-reaching, systemic crisis which we have yet to find a way out of. This is perhaps the case because we have not attempted to tackle it from the perspective of complexity theory, which would imply not only instrumental or methodological changes but profoundly cultural ones, in terms of behavioral norms and lifestyles.

For many years, economists have claimed that individuals seek to maximize wealth so as to maximize its utility (satisfaction) because "the richer we are, the happier we are." But we need to acknowledge that a good life, happiness, is a combination of material goods and relational goods. Relationships are a great source of concern because, in today's world, genuine relationships, trust, and fraternity are the scarcest commodities. Other people are an absolute value that is not subject to transactions. Utilitarian society replaces relational goods with consumer goods which neglect our relationship with nature, with community, with human rights, and with the most vulnerable. Giving and economic reciprocity are beginning to gain ground.

## THE DEMAND FOR NEW WAYS OF THINKING

The road ahead will depend on the choices we make. When it comes to new ways of thinking, we have no time to waste. One of the essential parts of the debate on an inclusive economy that fosters a life of dignity for all is developing a deeper understanding of what relationships mean.

We need to analyze the economy not as rigid behavior—as tends to be the case in both the private and nonprofit sectors—but through a reading of its social aspects: we need to place different agents within a constructive relationship, one that encompasses traditional companies, social enterprise, institutions, and different forms of association. In the view of both economists and political scientists and in operators' daily practices, these players are either in direct opposition to one another (be





it explicit or latent) or they allocate themselves complementary tasks (produce, regulate, and charitably share) based more on mutual impermeability than collaboration. In a relational good, the relationship itself is the good, a relationship that is more than a meeting of interests but is a free and open encounter. Relational goods require the motivations behind that particular relationship to be intrinsic to it.

Economic theory began to focus on relational goods when researchers realized that the lenses that economics was using to look at the world could not see the value in relationships and thus ran the risk of destroying them.

## TOWARD A NEW ECONOMIC PARADIGM

### The Concept of the Gift in Polanyi and Mauss[1]

The concept of the gift structures social relations and establishes connections and obligations within the circulation of goods (not only material goods, but also symbolic and knowledge goods) through the threefold obligation of giving, receiving, and giving back. It thus describes another sort of economic relationship which does not necessarily correspond to supply and demand, economic utility, equilibrium, or the market (Carranza Barona, 2013: 15).

According to Polanyi, the unity and stability of economic institutions are the fruit of a combination of a few patterns (forms of integration), the most important of which, according to historical and anthropological evidence, are reciprocity, redistribution, and exchange (Polanyi, 1957). Each form of integration is interrelated with certain institutional principles. Reciprocity is thus related to symmetry; redistribution, to centrality; and exchange, to the market. Although reciprocity may seem to be a form of redistribution, what sets it apart is that it is not mediated by a central authority. Polanyi also distinguishes between exchanges that are motivated by custom and market exchange, which is governed by the price system and the mechanisms of supply and demand. These elements may appear simultaneously in different human societies, in which the weight of each depends on the specific historical and social context. For Polanyi, the economic and the social are inextricably linked; this perspective chimes with the notion of the "total social fact" put forward by Marcel Mauss in his book The Gift (2016 [1925]).

Mauss develops his argument of the gift, which is summed up by this three-part obligation of giving-receiving-giving back, using ethnographic references to institutions such as the potlatch of the Kwakiutl (Kwakwaka'wakw) of British Columbia and the kula of the Trobriand Islanders in the northeast of Papua New Guinea. He also uses historical references to different societies, eras, and social context. The gift is not limited to describing merely the circulation of goods, but rather corresponds to a concept that structures social relations, not just economic relations, using gifts that are supposedly voluntary but are in fact compulsory.

UTILITARIAN SOCIETY REPLACES RELATIONAL GOODS WITH CONSUMER GOODS

In this way, Mauss contributes to expanding understandings of the link between the economy and society by describing other sorts of rationale and motivation in economic and social processes. The giving, receiving, and giving back of gifts are compulsory and complimentary elements in a total system in which the factors at play include not only economic aspects but also symbolic ones that are related to individual honor and prestige, and in which social reproduction plays a fundamental role.

Polanyi and Mauss suggest that the arguments of neoclassical economics falls short of understanding other forms of economy and the economic in a way that is broadly integrated with social and political factors. Further arguments to this end emerge from the critical analysis of the relevance of the underlying assumptions of utilitarianism and homo economicus from the perspectives of psychology, economic anthropology, experimental economics, and behavioral economics.

### The Principle of Giving Freely in *Laudato Si'*

Pope Francis, in all his writings, uses the expressions "gift" and "freely" as synonyms, which reveals how he is carrying on the innovative work of Benedict XVI in terms of contemporary economic science and the social sciences in general, which associate the gift with altruistic or philanthropic behavior. The gift that we find in the encyclical, however, is above all about self-giving, offering one's self up, and thus is based first on being and then on acting, an action that can take on various forms. It is, therefore, a way of acting, a "how" of acting. This is the truest and deepest meaning of freely giving and, in this sense, we can and should encounter free giving as we carry out all kinds of actions, including doing our duty, establishing contracts, operating in the market, and doing businesses.

> IN A RELATIONAL GOOD, THE RELATIONSHIP ITSELF IS THE GOOD

Giving freely is not, however, about discounts, presents, or loyalty program points, which are the gifts of the traditional market but whose essentially demanding nature mean there is has nothing free about them.

What is the function of the gift? It helps us understand that, in addition to legal goods, there is such a thing as freely given goods. A society that is moving toward authentic human development needs to put freely given goods on a par with legal goods. What is the difference between these? Legal goods are born of a duty, while freely given goods are born of the acknowledgment that each of us is connected to others and that they are thus part of us. The logic of legal goods is equivalence, and the logic of freely given goods is overabundance. Efficiency and justice are not enough to guarantee people's happiness.

These ideas that the encyclical puts forward open up perspectives with great potential for reflection in Latin America. As a single example, let's look at the world view of the indigenous peoples of the Andes, which needs to be reassessed based on the philosophical principles of connectedness, complementarity, symbolic conviviality, and reciprocity. These are what underlie the notion of Buen Vivir, or living well, which





relates to the Andean conception of time, according to which there are three pachas or worlds which form a whole: Hanan Pacha, Kay Pacha, and Uku Pacha.

### The Principle of Giving Freely and Reciprocity in "Sumak Kawsay"

"Sumak Kawsay" is a Quechan expression used in Ecuador; in Bolivia, the Aymara equivalent is "Suma Qamaña"; while in Paraguay, in Guarani, it is "Teko Porá." The idea translates into English as "Living Well" or "the Good Life." It is a dynamic, all-encompassing concept that expresses the spirit of these indigenous cultures and their way of being.

It is not about the individualistic concept of "living better," because one person living better implies that someone else is living worse. "Living Well" refers to living in harmony, in balance, that is, respecting and accepting differences and diversity along with the areas where we complement one another.

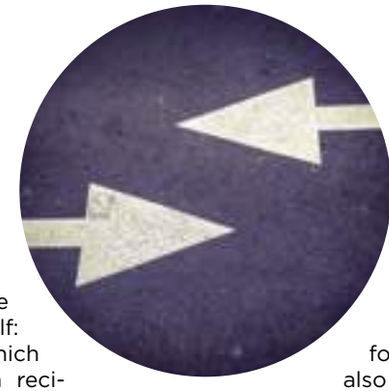
The Andean concept of "Sumak Kawsay" is associated with community life. There is no conception of the single individual: being a person is being with others, living in a family and a wider community. It is not that each individual is not valued, but rather that indigenous wisdom has it that the very concept of person includes relationships and community. This notion is an offshoot of the ethics and economics of solidarity, where accumulating, keeping back, or holding on for oneself are as inadmissible as people lacking things. It is an economics and ethics of reciprocity and balance in which goods are shared in a way that is at the same time generous and frugal.

If we look at nature, it is clear that trees do not live by and for themselves and nor do bees or ants or mountains... Instead, everything lives in connection with everything else, giving to everything else, complementing one another, in a state of permanent reciprocity that is referred to as "ayni."

Freely giving, reciprocity, diversity, and complementarity of key aspects of Living Well. It recognizes differences and thus the richness, beauty, and growth that existing with others implies. Men and women are different and complementary, as are children and the elderly, work and celebrations. Reciprocal giving and sharing are highly valued. Living Well implies a different "social contract" that goes beyond social justice: it seeks a balanced life. And that is obviously impossible to achieve on purely individual terms. The Good Life is not possible on your own or by working against others; it is only possible by working with others and caring for life, all life. It also places greater emphasis on consensus than on democracy, in which decisions are voted on. Living Well is about reaching agreements after getting everyone in the community involved. Everyone has a say in decisions, the right to present their ideas, listen to those of others, and discuss them. This process and consensus guarantee that decisions are made with a view to the common good (Ramos, 2012).

### The Principle of Reciprocity, Which Can Change the Economy

Can reciprocity become a fundamentally important new word in contemporary social science? The culture of modernity has tried to relegate giving freely to the private sphere and has cast it firmly out of the public sphere. In particular, it has been driven out of economics, which is content to handle



contracts, incentives, good rules, and interests.

However, the most beautiful things in life are all about reciprocity: family, friendship, love, celebrations, community. But how many types of reciprocity are there?

There are three main forms of reciprocity, all of which are important, but the last of which is essential to rethinking the economy.

1) Contract reciprocity: this first form of reciprocity is one that traditional economics is familiar with in both theory and practice: it is contemplated by contracts, which are the main instruments of market economics. Contracts are two-way agreements: you give and you get; A and B exchange equivalent values.

A provides B with something that necessarily implies that B must provide something of equal value to A: if B does not reciprocate, A will not hold up their end of the deal. If they already have, they can turn to the legal system to fight their counterpart's nonfulfillment of the agreement. This is why contracts only work within civil society (one in which judges are not corrupt and laws are effective). The characteristics of the reciprocity that is typical of contracts are as follows: a) they are two-way (I provide or render something that demands that you do likewise, and vice versa); b) they are conditional (what I provide is conditional on what you provide); and c) they are equivalent (what the two parts provide or render must be estimated to be of a similar value and this equivalence is objective and is normally measured in monetary terms).

NEOCLASSICAL ECONOMICS FALLS SHORT OF EXPLAINING THE INTEGRATION BETWEEN THE SOCIAL AND THE POLITICAL

This type of reciprocity does not necessarily need benevolence or free giving to function: instead, incentives, fair institutions, good laws, and a transparent legal system are enough to make it function.

2) Genuine reciprocity: no one can deny that even in economic affairs there is a second form of reciprocity which differs from contract reciprocity. This is what we often find in the different forms of the social economy, in volunteering, and in other organizational dynamics.

There are three main differences between contract reciprocity and genuine reciprocity: a) as with contracts, genuine reciprocity also involves a two-way relationship, but the two transfers (from A to B and B to A) are independent of one another and free. However, two-way relationships are an important factor in all forms of genuine reciprocity. In fact, if there is no response on the part of someone receiving an act of free giving, this apparent relationship could, in fact, be covering up one of power or domination over the other, as is the case with handouts. Genuine reciprocity, in contrast, is about a relationship that is established between two parties whose ultimate goal is reciprocity itself: the relational good which is generated through reciprocal relationships and is the driving force of these; b) the logic of reciprocity is neither conditional (as in the case of contracts) or purely unconditional (as in the third type of reciprocity that we will elaborate on later), as if it is true that what the other provides is not a precondition for what I provide (in this sense, my actions are freely given), at the same time, if the other does not carry out their part, there is no reciprocity. Sooner or later, the other party must respond if the relationship is to continue existing. By way of example, we could say that this is the logic that motivates many volunteers: these are people that donate their time unconditionally at first, but if at some point they do not receive recognition or attention for this, their volunteering is thrown into crisis and may even stop altogether; and c) a third characteristic of genuine reciprocity is that the exchange is not one of objective "equivalent values" in terms of "quantity": in many cases (such as volunteering) a simple "thank you" may be considered an act of reciprocity. What is important is for both parts to feel that they are on equal footing because without substantial equality there is no reciprocity.

3) Unconditional reciprocity: in a gift economy, a reciprocal economy, this third form of reciprocity must also exist. It is clearly not the type that is typical of contracts or even genuine reciprocity, although it does share many features of the latter. What sets this third form of reciprocity apart? a) Openness: transitivity or openness means that, as an attitude, reciprocity may not be aimed at whoever began the relationship, but rather to a third party. In other words: A gives something freely to B and the experience is reciprocal not only if B responds to A but also if B reciprocates toward C. The reciprocity between A and B leads to other forms of reciprocity (between C and D). This openness is what makes this way of coming together very different from the notion of "shared interests" and is what defines it as "shared free giving." For example, in a company that invests money and resources in training its employees, even if the employee leaves the company and goes to work for an NGO, it could still be considered a reciprocal experience—that is, the reciprocity does not return directly to the employer. Another example is companies that pool their revenues so that people who are living in poverty can access and manage these and create a culture of cooperation among themselves; b) an unconditional nature: this exchange must be freely given. This implies seeing the behavior itself as a reward rather than the material results of it; it means finding meaning in my "self-giving" to others rather than in how the other responds to me. For this to occur, we need to build a culture which enables us to move forward even when we are alone or when the other's response is a long time in coming (Bruni and Calvo, 2009: 237).

THERE IS NO PLACE FOR UNCONDITIONAL RECIPROCITY IN TRADITIONAL CONTRACT RECIPROCITY

## TRUSTING ONLY IN EFFICIENCY IS NOT ENOUGH TO ACHIEVE SOCIAL JUSTICE

The essential idea is that, in a gift economy and an economy of reciprocity, all forms of reciprocity are important, but the third one is fundamental. A capitalist firm can perhaps survive exclusively on the first form of reciprocity; social enterprise also needs the second; while the gift economy and the economy of reciprocity need all three forms. And that's not all: activating the three forms of reciprocity "contaminates" the logic of reciprocity. How so? In a human reality in which both genuine and unconditional reciprocity play a part, contract reciprocity and the market are humanized and move from private interest to reciprocal aid. In this way, in today's economy, seeds of change are being sown, which will humanize our day-to-day relationships.

History, particularly more recent history, shows that people truly escape the poverty and exclusion trap much better through reciprocity than gifts (Bruni and Calvo, 2009: 241).

Globalization has massively expanded the areas of application of contracts and, as a consequence, it has displaced those of redistribution and free giving, leading to more unequal societies. Today, a global, regional, and local society that is not built on the basis of these three principles cannot expect to survive.

TABLE 1
**FORMS OF RECIPROCITY**

| CONTRACT RECIPROCITY | GENUINE RECIPROCITY | UNCONDITIONAL RECIPROCITY |
|---|---|---|
| TRADITIONAL<br><br>MAIN INSTRUMENT OF THE MARKET ECONOMY | FORMS OF SOCIAL ECONOMY, SOLIDARITY, AND VOLUNTEERING | GIFT ECONOMY, THE ECONOMY OF RECIPROCITY |
| TWO-WAY:<br>**A ⟷ B**<br><br>EXCHANGE OF EQUIVALENT FACTORS | TWO-WAY:<br>A ⟷ B<br><br>INDEPENDENT AND FREE THE RELATIONAL GOOD IS THE MAIN AIM | OPENNESS OR TRANSITIVITY<br>A ⟷ B C ⟷ D<br><br>FORMS OF RECIPROCITY FREELY GIVEN EXCHANGE, RATHER THAN AN EXCHANGE OF INTERESTS |
| 1. TWO-WAY<br><br>2. CONDITIONAL<br><br>3. EQUIVALENCE IN PRICE/ QUANTITY | 1. RELATIONALITY<br><br>2. NEITHER CONDITIONAL OR UNCONDITIONAL<br><br>3. EQUIVALENCE UNRELATED TO QUANTITY: "THANK YOU" | 1. OPENNESS<br><br>2. UNCONDITIONAL<br><br>3. RECIPROCITY AS A "CULTURE" |

### AN ARAB TALE BY WAY OF CONCLUSION

An ancient Bedouin tradition tells this tale:

A father (who some say was a very rich sheikh), feeling his end was nigh, began to divide up his estate. His herd of camels was to be divided between his three sons (Ahmed, Ali, and Benjamin, although the names vary from one version to another) as follows: as he was the firstborn, Ahmed would receive half; Ali would inherit a quarter of the flock; and as for Benjamin, he would have to make do with a sixth of it. Not long after, when the sheikh died, his sons were confused: it was impossible to divide up the herd between them because it was made up of exactly 11 camels. As it had become a source of conflict, they decided to take the case to the qadi. After listening to all sides of the story, the qadi reflected on it, drew some signs in the sand, and finally said, "take my camel, divide them up, and, Allah willing, you can give it back to me later." Surprised, but with no wish to contradict such a wise man, the sons left with the judge's camel. It didn't take long for them to realize how clever the qadi had been. With 12 camels, it was easy to divide them up: the firstborn kept six camels (half of 12); the second, three camels (a quarter of 12); and the third, two camels (a sixth of 12). The total was now exactly 11 camels. Each son received his share and the 12th camel was quickly returned to its owner (Ost, 2004: 843).

This ancient story helps us to better understand that trusting only in efficiency does not help us achieve social justice. Finding justice implies knowing when to make room for gifts and understanding how they can be a rich source of value and wealth. The wise Bedouin who donated his only camel ended up richer (by receiving gratitude) and facilitated a space which enabled a contract (market) to be fulfilled. This is why it is important for those who form part of a gift economy, of an economy of reciprocity, to produce not only goods and services but also relationships that are even richer in terms of their capacity for promoting economic value and social justice.

The story of the camels helps us think about this crisis differently. The question is, who will bring the 12th camel? Insisting on thinking that society and the economy act only on the basis of a primordial instinct that is generated by the efficiency of a system that goes as far as to penalize or disincentivize those who by their very nature and intrinsic motivations live out the principle of the gift and free giving will not help human development get back on course. Justice isn't the only thing that needs the gift to define itself: the market does, too.

**NOTES**
[1]For more on this point, see the work of César Carranza Barona (2013).

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CASE STUDY

# CITIZEN ENGAGEMENT

## THE ROLE OF SOCIAL ORGANIZATIONS


Nongovernmental organizations (NGOs) have a fundamental part to play in caring for the environment. Among other important undertakings, they raise awareness among citizens while acting as watchdogs to ensure the public sector is complying with environmental standards. The executive director of the Environment and Natural Resources Foundation (FARN), Andrés Nápoli, explains the importance of access to information, protecting indigenous communities, and reducing environmental conflict.

**What do environmental NGOs do in Latin America?**

NGOs are nonpartisan, not-for-profit organizations. FARN's main objective is to promote sustainable development through citizen engagement. We are active in different areas, which break down into research-related activities, defending environmental rights and the population's quality of life, enabling citizens to access available public information on the environment, facilitating and promoting citizen engagement in decision-making processes, but above all, contributing to public policy-making. FARN works on both a local scale and a regional one. We have been working on key issues relating to climate change, energy and mining, and the control, monitoring, and tracking of foreign investment flows to ensure that environmental safeguards are applied in projects that impact the environment

**Could you describe the current state of affairs regarding access to information on environmental issues in Latin America?**

Most countries in the region have started to make stronger demands to promote an authentic form of development that ensures social and economic progress together with environmental sustainability, which is placing pressure on government administrative bodies. This demand has also brought about a cultural shift in the way that policy decisions are made, one that aims to guarantee citizens the right to play a central part in the policy-making process. Most countries in the region have passed legal schemes that guarantee access to information and give citizens opportunities to take part in decision-making processes. However, the level of compliance with these standards remains low in most countries, which has sparked high levels of environmental conflict, something that states have not been able to channel effectively.

**Could you give some examples of this type of conflict?**

Some clear examples include the conflicts around mining activities, the demands of indigenous communities defending their territories, and struggles over access to land and drinking water. In this context, with the support of representatives from NGOs, 22 countries in Latin America and the Caribbean have begun the process of negotiating a regional agreement that aims to establish obligations for states party to this agreement to improve their laws, policies, institutions, and practices to safeguard citizens' right to information, engagement, and environmental justice. These points are enshrined in Principle 10 of the Rio Declaration on Environment and Development.

**What type of actions can we take to safeguard the homelands of indigenous communities?**

One of the main actions is ensuring that the rights that are established in our current legal framework are put into practice and improved, particularly the right for these communities to define their own development priorities and play a part in making decisions connected to the use, management, and conservation of the resources in their territories through prior consultations and free, prior, informed consent. We need to make headway on effectively implementing consultations and consent, particularly by raising awareness within different sectors of government (mining, energy, infrastructure, and agriculture, among others) at different levels (national, provincial, municipal) so that they include these practices as they carry out their functions. It is important to contribute to promoting alternative development plans so that communities can remain in their territories and carry out their economic activities according to their traditions, without being forced out.

# INTAL-LAB

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