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Opportunities and challenges of food production for human health and the enviroment in the Americas: *Environmental Challenges*

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"We stand at a critical moment in Earth's history, a time when humanity must choose its future. As the world becomes increasingly interdependent and fragile, the future at once holds great peril and great promise. To move forward we must recognize that in the midst of a magnificent diversity of cultures and life forms we are one human family and one Earth community with a common destiny. We must join together to bring forth a sustainable global society founded on respect for nature, universal human rights, economic justice, and a culture of peace. Towards this end, it is imperative that we, the peoples of Earth, declare our responsibility to one another, to the greater community of life, and to future generations."

The Earth Charter

"`Business as usual' in our globally interconnected food system will not bring us food security or environmental sustainability. Several converging threats – from population growth, climate change and the unsustainable use of resources – are steadily intensifying pressure on people and governments around the world to transform the way food is produced, distributed and consumed."

Commission on Sustainable Agriculture and Climate Change, March 2012.

SUMMARY

GLOBAL ENVIRONMENT

Humanity has always influenced its environment, generating gradual, but constant, global change, which has beeen accelerating at an exponential rate from the beginning of the industrial revolution. We are quickly reaching a criticl point in history, where human beings must choose their future. Our way of doing things has significantly modified the Earth's capacity to maintain its thousand-year old equilibrium. We live in a world where pollution, waste, demographic processes, the increase in consumption, the intesification of agriculture, the depletion of the agricultural frontier and soil nutrients, erosion, desertification, the disappearance of tropical rainforests and biodiversity, overfishing, and countless other processes have ultimately resulted in important atmospheric changes, and are seriously compromising the ability of ecosystems to continue to provide the environmental services that make life in the planet possible.

In 1987, the report titled "Our Common Future"[1] , stated that it was possible to achieve economic growth based on sustainable policies, and expand the base of environmental resources in search of a better future, as long as decisive political actions which could, from that moment forward, allow for the adequate management of environmental resource, in order to guarantee sustainable human progress and the survival of humanity in the planet. The concept of sustainable development arises from the need for a new development model that, instead of what was already happening at that time, would not lead to more poverty, vulnerability, and environmental degradation.

Program 21 (Agenda 21), agreed upon in Rio in 1992, mentions that humanity is now at a decisive period of history, where in order to achieve a level of development with greater quality of life for all, it was necessary to avoid the continuing degradation of ecosystems, on which our well-being is dependent, and the necessity to integrate concerns regarding both development and the environment. It stablishes the necessity of an integrated approach to planning and organizing land resources, which in essence is an approach that would allow the coordination of sectorial planning and management activities related to the use of land and resources, through, among others, the landscape's ecological planning[2], a concept that has seen renewed vigor almost two decades after COP 10 and the Convention on Biological Diversity in Nagoya, Japan. In the chapter on agriculture, Program 21 mentions that "The absence of a coherent national policy framework for sustainable agriculture and rural development (SARD) is widespread and is not limited to the developing countries. In particular the economies in transition from planned to market-oriented systems[3] need such a framework to incorporate environmental considerations into economic activities, including agriculture." It also mentions the the need to apply "sound policy decisions pertaining to international trade and capital flows also necessitate action to overcome:

a) a lack of awareness of the environmental costs incurred by sectoral and macroeconomic policies and hence their threat to sustainability;

b) insufficient skills and experience in incorporating issues of sustainability into policies and programmes; and

c) inadequacy of tools of analysis and monitoring.

Principle 8 of the Rio Declaration establishes that "To achieve sustainable development and a higher quality of life for all people, States should reduce and eliminate unsustainable patterns of production and consumption and promote appropriate demographic policies." Principle 15, also, named the precautionary principle, establishes that, "In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific

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[1] United Nations. 1987. Report of the World Commission on Environment and Development: Our common future. Consulted el 20 enero 2012.

[2] United Nations. 1992. Program 21.

[3] El sistema de mercado organiza y coordina las actividades humanas no a través de la planificación estatal sino mediante las interacciones mutuas de los compradores y vendedores.

certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."

In 2005, the Millenium Ecosystem Assessment[4] indicated that 60% of ecosystem-provided serices that support life on Earth are degrading or are being used in a non-sustainable manner, and warned of the dangers if this degradation persists. Among the most important processes are the decrease in fisheries due to overexploitation, the unsustainable use and decrease in quality of fresh water, the decrease in the atmosphere's capacity for self-cleaning, the decrease in the global abundance of pollenizers. The sharp decrease in forests and species, the degradation of natural pest control due to the use of pesticides, and the increased degradation of soils. Also, the changes that have taken place are increasing the probability of nonlinear changes, such as accelerated, abrupt, and possibly irreversible changes, which also accentuate poverty and increase social conflict. "Only by understanding the environment and how it works, can we make the necessary decisions to protect it. Only by valuing all our precious natural and human resources can we hope to build a sustainable future.

Achieving this, however, will require radical changes in the way nature is treated at every level of decision-making and new ways of cooperation between government, business and civil society. The warning signs are there for all of us to see. The future now lies in our hands."

El desafío de recuperar los ecosistemas y al mismo tiempo satisfacer una mayor demanda de sus servicios puede tener respuesta favorable en algunos de los escenarios estudiados, pero ello implicaría cambios importantes en las políticas y las instituciones. Además, esos cambios tendrían que ser de gran envergadura, y en la actualidad todavía no están en marcha. La conclusión primordial de esta evaluación es que las sociedades humanas tienen capacidad para reducir las presiones negativas sobre los servicios naturales y, al mismo tiempo, continuar utilizándolos para aumentar el nivel de vida de todos.

Unfortunately, development in harmony with nature has not been achieved. Given the fast pace of change, in 2002, at the Johannesburg summit, world leaders agreed to achieve a significant reduction in the rate of loss of biodiversity by 2010 . In 2010, the Global Biodiversity Outlook 3[5] reaches the regrettable conclusion that the goal has been reached; rather, the pressures leading to this loss remain constant or are increasing. In the foreword, Secretary General of the United Nations Ban Ki-moon states that current trends are bringing us closer to a series of inflection points that would catastrophically reduce the ability of ecosystems to provide essential services. He further states that, "The consequences of this collective failure, if it is notquickly corrected, will be severe for us all." This report emphasizes the contribution that conservation of biological diversity makes to the ability of ecosystems to moderate the scale of climate change and reduce the impacts it causes, thus giving ecosystems and human societies a greater capacity for recovery. The Secretary General concluded his speech by stating, "To tackle the root causes of biodiversity loss, we must give it higher priority in all areas of decision-making and in all economic sectors. As this third Global Biodiversity Outlook makes clear, conserving biodiversity cannot be an afterthought once other objectives are addressed – it is the foundation on which many of these objectives are built. We need a new vision for biological diversity for a healthy planet and a sustainable future for humankind."

In an effort to bridge the gap of lack of understanding of the economic, social and environmental relevance of ecosystems, UNEP launched the report of The Economics of Ecosystems and biodiversity[6] (TEEB) which focuses on the global economic benefit provided by biodiversity, the costs of the loss of it and lack of protective measures against the costs of effective conservation. This report states that the economic invisibility of economic flows in nature flows contributes significantly to the degradation of ecosystems and biodiversity, and, in the long run, will have very serious consequences for life on the planet; we can no longer afford to take nature for granted. This report estimates that between 2000 and 2050, 750 million hectares (the size of Australia) of natural ecosystems will be turned into man-made landscapes.

[4] PNUMA 2005 Evaluación de ecosistemas del milenio. consultado 02.12.2011

[5] Secretaría del Convenio sobre la Diversidad Biológica, Perspectiva Mundial sobre la Diversidad Biológica 3. Montreal, 2010. 94 p.

[6] PNUMA. 2010. TEEB – Informe sobre la economía de los ecosistemas y la biodiversidad para las empresas – Resumen ejecutivo 2010

The appraisal of natural capital is not new. In 1997, Costanza et al[7] estimated the economic value of 17 ecosystem services in 16 biomes. Globally, their estimated value lies between 16 to 54 billion U.S. dollars (10^{12}) with an average of 33 billion per year, while overall gross domestic product barely reaches 18 billion. Possibly, in the case of many production systems, if external factors were to be internalized, that is, if actual environmental costs were incorporated in the long term, they would not be profitable, and, in some cases, result in irreversible losses. In the future, all production systems should fully incorporate all costs (water, greenhouse gas emissions, pollution, soil degradation, etc.) in order to evaluate their usefulness to mankind.

Climate Change

Climate change is undoubtedly the worst consequence of global change. The first scientific reports appeared in the early 80's[8]. However, after 30 years of evidence, there are still many who would prefer not to accept the reality of the situation. Today, with the increase of atmospheric CO_2 concentrations[9], we are fast approaching a point of irreversible change in the planet, known as inflection or "tipping" points. According to a report[10] published before the Durban Summit, the International Energy Agency said that, if we cannot achieve a reduction of emissions over the next five years, there will be an irreversible change in the planet, and we would have lost our last chance to keep the planet like we know it today. The same report reveals that fossil fuel subsidies, which encourage consumption, exceeded 400 billion dollars. The possibilities under the current developmental paradigm of reducing global warming are practically nil, since 80% of emissions from the energy sector are already committed to existing facilities or facilities under construction[11].

While the rulers in the Conferences of the Parties (COP) of the United Nations Framework Convention on Climate Change (UNFCCC) negotiated a cap of 450 parts per million (ppm) of equivalent CO_2 (all emissions are calculated based on their CO_2 equivalent) and a temperature increase of 2C, science tells us with absolute clarity that CO_2 concentrations should be reduced to 350ppm or less[12,13], a level surpassed in 1987, in order to maintain a temperature increase below 2C. As long as politically correct language remains the tool of choice, and the great interests continue to determine the course of the talks, no action will be taken to ensure a better future.

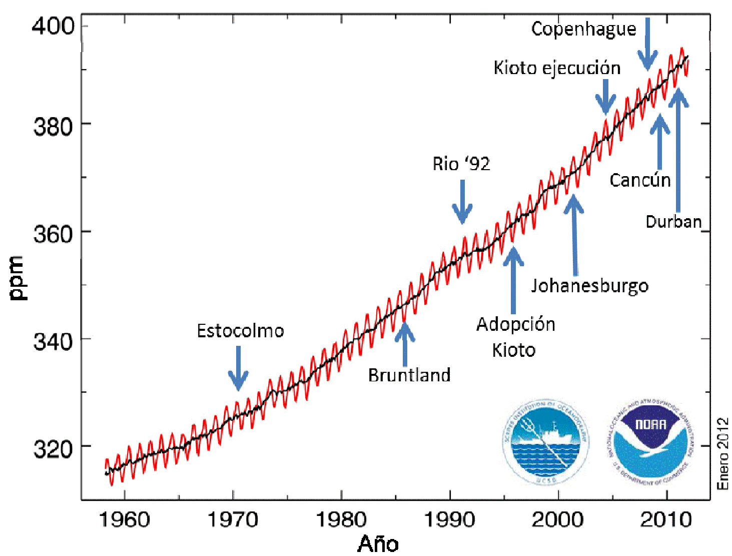

Fig. 1. CO_2 atmosférico Observatorio Mauna Loa

So far, none of the summits have managed to achieve a reduction in the rate of increase of greenhouse gases (Fig. 1), which continues to

[7] Costanza, R. et al. 1998. Tha value of the world's ecosystem services and natural capital. Nature 387, 253-260

[8] Hansen, J. et al. 1981. Climate impacto of increasing atmospheric carbon dioxide. Science 213 (4511): 957-966.

[9] http://co2now.org/Current-CO2/CO2-Trend/acceleration-of-atmospheric-co2.html Consultado 26 enero 2012

[10] International Energy Agency (2011)World Energy Outlook 2011. http://www.iea.org/weo/docs/weo2011/es_spanish.pdf, consultado el 22 de enero201

[11] International Energy Agency (2011)World Energy Outlook 2011. http://www.iea.org/weo/docs/weo2011/es_spanish.pdf, consultado el 22 de enero 201

[12] Hansen, J. et al. http://arxiv.org/ftp/arxiv/papers/0804/0804.1126.pdf Consultado 25 enero 2012

[13] Hansen, J. et al. Earth's energy imbalance and implications. http://pubs.giss.nasa.gov/docs/2011/2011_Hansen_etal.pdf Consultado el 31 Enero 2012.

grow exponentially[14]. The last summit of the UNFCCC in Durban in late 2011 ended once again in failure; its only achievement was to extend the period of the Kyoto Protocol agreed in 1997 (but that could only be implemented in 2005) and the promise to develop a new global agreement to take effect by 2020. In the Kyoto Protocol, countries agreed to reduce emissions of greenhouse gases (GHGs) in the period 2008 to 2012 in no less than 5% of the levels of 1990[15].

In 2007, the Intergovernmental Panel on Climate Change (IPCC) predicted its worst climate change scenario based on an increase of two parts per million (ppm) of CO_2 per year, which was surpassed in 2008 with 2.5ppm. In 2010, global emissions increased by 5.9% to record emissions of over the 30 Gigatons[16] while in 2011, the ninth warmest year in history after 2010 was decreed to be the warmest year, exceeded all records of greenhouse gas emissions, resulting in an yearly average of 391.57ppm and a total of emissions that exceeded 33 Gt of equivalent CO_2. This makes it virtually impossible to achieve the target agreed in 2009 in the Copenhagen Accord which was of not exceeding an overall increase in temperature of 2C.[17] A recent study by the Massachusetts Institute of Technology (MIT)[18] made using improvements to the prediction model, indicates that, under current scenarios, global warming would be two times more extreme than previously thought, reaching 5.1C between 2091 to 2100 instead of the estimated 2.4C by 2003; there is a 9% chance that global average temperature will exceed 7C by the end of the century, but there is only 1% chance that this increase is limited to less than 3C. According to the director of MIT[19], this would have catastrophic consequences, and the danger is much greater than was estimated just three or four years ago, and thus requires serious policies of greater urgency.

According to renowned scientists such as Dr. James Hansen[20], a temperature increase of 2C would lead to disastrous consequences for the planet. Many interpret the 2C global average as tolerable, "two degrees higher than the current temperature...things have been worse." However, the planet does not heat evenly, with significantly greater increases occuring in mountains and at the poles. Additionally, increases in temperature over land are higher than over the oceans, and can reach 1.5 times the global average. In areas with decreased rainfall, temperature increases are amplified, probably due to reduced evapotranspiration. "A local increase in a world of 3C +2 C (1C above the global average) would become 7.5 C in a world of +4 C."[21]

Additionally, recent estimates of the impact of a 2C increase are now more severe and put us in a range of climate change between going between dangerous and extremely dangerous. "The science of climate change, coupled with the emission scenarios of Annex 1 and Non-Annex 1[22] countries suggests a framework for mitigation and adaptation radically different from many previous analyses, especially those that inform policy makers.[23] " two recent NASA[24] studies indicate that climate is more sensitive than previously thought and that a rise of 2C could generate non-linear changes that could raise sea level 25 meters above its current level, even in this century. It is difficult to predict how the planet will respond to changes, since during the last 65 million years ago, when CO2 increased by natural causes, it did at an average rate of 0.0001 ppm per year, and it is

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14 Adaptación del autor de http://www.esrl.noaa.gov/gmd/webdata/ccgg/trends/co2_data_mlo.pdf

15 Naciones Unidas (1998) Protocolo de Kyoto de la Convención Marco de las Naciones Unidas sobre el Cambio Climático. 24p.

16 Global Carbon Project

17 Ramanathan, V. y Xu, Y. (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States, 2010 (107) no. 18. Pp 8055-8062.

18 Sokolov, A.P. et al. (2009) Probabilistic Forecast for 21st Century Climate Based on Uncertainties in Emissions (without Policy) and Climate Parameters. Journal of Climate, V22, 5175-5204. http://journals.ametsoc.org/doi/pdf/10.1175/2009JCLI2863.1 Consultado el 12 diciembre 2011.

19 http://thinkprogress.org/romm/2009/05/20/204131/mit-doubles-global-warming-projections-2/ Consultado el 14 de enero 2012.

20 http://arxiv.org/ftp/arxiv/papers/0706/0706.3720.pdf Consultado el 12 de diciembre 2011.

21 New, M., Liverman, D., Schroder, H. y Anderson, K. Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications. Phil. Trans. R. Soc. A 2011 (369), p. 6-19

22 Los países Anexo 1 de la Convención Marco de Cambio Climático son los 35 países desarrollados (industrializados) que acordaron limitar sus emisiones de gases que incrementan el efecto invernadero a través del Protocolo de Kyoto. http://unfccc.int/resource/docs/convkp/kpspan.pdf Consultado el 23 febrero 2012.

23 Anderson, K. y Bows, A. (2011) Beyond ‘dangerous’ climate change: emission scenarios for a new world. Phil. Trans. R. Soc. A (2001) 369, 20-44.

24 Hansen, J.E., and Mki. Sato, 2011: Paleoclimate implications for human-made climate change. In Climate Change: Inferences from Paleoclimate and Regional Aspects. A. Berger, F. Mesinger, and D. Šijači, Eds. Springer, in press.

currently increasing by more than 2 ppm per year – we have no referent. Under the current scenario, if no new policies are implemented with urgency, the path taken would be more dangerous, with raises in temperature between 3 and 4C[25] or even coming to 6C or more ,[26],[27] by 2100. The goal of maintaining the temperature rise to 2C or less, procured at world summits, it is almost impossible to achieve.

Extreme abnormalities both in intensity and coverage, have increased. Extreme temperature anomalies covered the 7% of global area where observations were made during July and August 2009, 13% in 2010 and 9% in 2011, with such consequences as drought and fires in Moscow (2010), northern Mexico and southern United States (2011)[28]. Last year ended with the recording of extreme weather events in almost every country in Latin America.

Through further analysis of climate behavior during the past 65 million years, NOAA concludes that climate change occuring after carbon dioxide emissions generate irreversible changes for over one thousand years, with severe consequences such as droughts and increases in sea level[29], which means that current generations are leaving behind a future of great difficulties and uncertainties for the next 50 generations. This is far from what was agreed at the Johannesburg Declaration on Sustainable Development[30] 10 years ago: "From the African continent, the cradle of humankind, we solemnly pledge to the peoples of the world and the generations that will surely inherit this Earth that we are determined to ensure that our collective hope for sustainable development is realized."

The cost of avoiding severe climate change would be, on average, 1% of the global GIP up until 2050[31], a small ammount compared to the losses generated or the military budgets of many countries.

Global warming results in an increase in sea level. Many authors and decision makers continue to use the IPCC 2007 projections, which state that the increase will be between 18 cm in the best scenario and 59 cm in the worst-case scenario. Unfortunately, the small print on this report states that these values represent only an increase caused by thermal expansion of water and does not include the melting of glaciers. Since the implementation of satellite measurements, the increase in sea level has been risen faster than IPCC predictions, reaching 3.4 mm per year presently. The acceleration of glacier melting observed between 2005 and 2010 significantly increases the degree of their contribution during that period[32]. Several authors who have published since the last IPCC report put the maximum range of sea level rise between one and a little over two meters[33]. A recent study done with adjusted models leads to a projected rise in sea level between 75 and 190 cm for the period between 1990 and 2100[34]. Still, these values may be conservative because, according to the World Bank[35], the increase of greenhouse gases could well generate increases from 1 to 3 meters and,due of unexpected processes, that lead to the accelerated breakdown of ice sheets in Greenland and West Antarctica, could lead to increases of up to 5 meters.

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25 New, M., Liverman, D., Schroder, H. y Anderson, K. Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications. Phil. Trans. R. Soc. A 2011 (369), p. 6-19.

26 http://www.washingtonpost.com/national/health-science/world-on-track-for-nearly-11-degree-temperature-rise-energy-expert-says/2011/11/28/gIQAi0lM6N_story.html Consultado el 22 de enero 2012.

27 World Energy Outlook, 2011. Resumen ejecutivo. 11p.

28 Hansen, J., Sato, M y Ruedy, R. 2012. Perceptions of climate change: the new climate dice. http://www.columbia.edu/~jeh1/mailings/2012/20120105_PerceptionsAndDice.pdf Consultado el 29 enero 2012.

29 Solomon, S. et al. (2009) Irreversible climate change due to carbon dioxide emissions. PNAS V106 no 6:1704-1709.

30 Declaración de Johannesburgo sobre el Desarrollo Sostenible, 2002.

31 Stern, N. (2006) Stern review report on the economics of climate change; Executive summary. http://www.hm-treasury.gov.uk/d/Executive_Summary.pdf

32 Cazenave, A. y Llovel, W. Annu. Rev. Mar. Sci. 2010. 2:145-173.

33 Rahmstorf, S. A new vie won sea level rise. nature reports climate change | VOL 4 | APRIL 2010 | www.nature.com/reports/climatechange.

34 Vermeer, M. y Rahmstorf, S. (2009) Global se level linked to global temperature. Proceedings of the National Academy of Sciences of the United States of America. Vol 106 no 51, pp 21527-21532.

35 Dasgupta, S. et al. 2007. The impact of se level rise on developing countries: A comparative analysis.

In addition to a further increase in emissions, there are other aggravating factors that were not incorporated in the 2007 IPCC repor. Among them we can mention the thawing of permafrost in polar areas. These soils, very rich in organic matter, have begun to thaw, releasing significant amounts of methane, which have increased by 31% between 2003 and 2007[36]. Recient studies[37] indicate that methane release estimates from Arctic lakes have been significantly underestimated, with massive releases of methane in the Arctic Ocean been discovered even recently. Since methane has a significantly greater ability to capture heat than CO2 (about 60 times more during the first year and 23 times more over 100 years), these accelerated increases are possibly leading to an irreversible process of catastrophic consequences. The difficulty of determining the amount of these emissions in such vast territories makes it extremely difficult to make accurate projections of the resulting change in climate[38]. However, just the release of methane from the East Siberian Arctic Shelf could trigger an abrupt climate change[39] process.

All this leads us to a very important conclusion: that we should use scenarios that are even worse than the worst-case scenario reported in 2007 by the IPCC. Very often, one sees decision makers and technics using other, more benign scenarios, which are already obsolete. Today, even working with the IPCC's worst case scenario (A2), we would be underestimating the impact.

There are many causes of global change, populaton growth being among the most important. Throughout history, human beings have not been necessarily friendly to the environment, but now we are many and the changes went from being local, as was the case of the fall of Mayan civilization to global[40]. Additionally, population growth is coupled with an economy that consumes more and more, beyond the planet's productive capacity. The economy is largely based on extractive processes grounded in the use of fossil fuels and mining and is characterized by the pursuit of quick profits, which are distributed among a few, but with consequences that must be assumed by most people, even those without any responsibility in this cases. This style of development has led to strong impacts, with increasingly rapid deterioration of ecosystems[41] the biodiversity[42], and world climate stability[43] and thus leading to a decline in possibilities for future development using the current model.

We will now analyze a few of the most important sources for global change, and their consequences to humanity.

Population Growth and Food Production

Estamos ante una explosión demográfica sin precedentes con aproximadamente 200 000 nacimientos diarios. Recién en el año 1800 se llegó a los primeros mil millones de habitantes, se tardó 123 años en llegar a los dos mil millones y solo se requirieron 12 años para pasar de 5 a 6 y de 6 a 7 mil millones, alcanzados en octubre del 2011. A pesar de haber gran incertidumbre, se espera que la población mundial alcance entre 8.1 y 10.6 mil millones de habitantes en el 2050.

We are facing unprecedented demographic explosion, with approximately 200,000 births per day. World population reached it's first billion people in 1800, it took 123 years to reach two billion and only 12 years were

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36 Bloom, A.A. et al. Large-scale controls of methanogenesis inferred from methante and gravity speceborne data. Science, 2010 (327), pp 322-325.

37 http://www.independent.co.uk/news/science/vast-methane-plumes-seen-in-arctic-ocean-as-sea-ice-retreats-6276278.html Consultado el 24 de enero 2012.

38 Walter, K.M., Smith, L.C. y Chapin III, F. S. (2007) Methane bbling from northern lakes: present and future contirbutions to the global methane Budget. Phil. Trans. R. Soc. A 2007 (365), 1657 – 1676.

39 Shakhova, N. et al. (2010) Extensive methane venting to the atmosphere from sediments of the East Siberian Arctic Shelf. Science (327) no. 5970, pp. 1246-1250.

40 Earth Observatory. 2011 Maya deforestation and drought. http://earthobservatory.nasa.gov/IOTD/view.php?id=77060&src=eoa-iotd Consultado el 21 enero 2011.

41 PNUMA 2005. Evaluación de los ecosistemas del milenio. http://www.pnuma.org/forodeministros/15-venezuela/ven09tre-EvaluaciondelosEcosistemasdelMilenio.pdf

42 PNUMA 2010 Perspectiva mundial sobre la diversidad biológica 3. http://www.pnuma.org/deat1/pdf/GBO3-final-es.pdf

43 IPCC (2007) AR4

required to go from 5 to 6 and then 6 to 7 billion, reached in October 2011. Despite great uncertainty, it is expected that world population will be between 8.1 and 10.6 billion people in the 2050[44].

Aside from the impact due to many human beings who need to meet their needs, demographic planetary changes will have other important effects in countries. In many developed countries, birth rates have fallen below the replacement rate, and as a result their population is aging, resulting in fewer working adults, affecting pension systems and the overall production . In turn, in the next 40 years, 97% of population growth, expected to be about 2.3 billion people, will take place in less developed regions, nearly half (49%) in Africa[45]. In Latin America, there has been a change in demographics for the past 40 years, going from having reproductive rates among the highest in the world to levels below the world average, and which is also leading, though with marked differences between countries, to a gradual aging of the population[46]. This population shift will have long term positive effects on production, especially by reducing the pressure on ecosystems, but generate other problems in the areas of social security coverage and the very economies, if the current model is to be kept.

According to FAO, in order to meet the food needs by 2050, agricultural production must increase by 70% globally, and developing countries, the numbers should be close to 100%, not including the demand for other products such as biofuels. This corresponds to an increase in annual production of about 1 billion tons of cereal and 200 million tons of meat. According to the report, given the limitations for further expansion of the agricultural frontier, which could become something less than 5% globally especially in Latin America, 80% of the increase of production in developing countries must come from increased yield (67%) and crop intensification (12%). The question of how to increase yields without increasing and rather reduce energy consumption and therefore GHG emissions, instead of what has occurred to date, remains open to discussion

Current world population growth has been accompanied by changes in agricultural production, with increments between 1969 and 2010 of 2.7 times for cereals, 1.6 times for tubers, and of four times in the case of meat, an increase that must be maintained in the future in order to meet the needs of the growing population. About 22% of the total area of the planet, equivalent to 3 billion hectares, is arable. Of these, about half is already under cultivation (1.4 billion hectares in 2008). The remainder is covered with forests and under the current scenario changing land use is not reccomended.

Investments in agriculture and rural areas in developing countries should be increased by 50% in order to meet food demand by 2050, reaching figures of around 209 billion US dollars [47] per year if 2009 prices remain constant, an substantial increase compared to the average of 142 billion US dollars spent annually between 1997 and 2007[48]. Developing countries could meet the increase in food demand through domestic production, especially because, with current projections, net cereal imports would rise from 135 million tons in 2008/2009 to 300 million tonnes in 2050[49].

Available arable land per capita will continue to decline, from 0.415 ha in 1961 to 0.214 ha in 2001, which will probably require increases in grain yield close to 25%, from 3.32 t / ha in the 2005 to 4.34 t / ha in 2030.

Consumption

Not only does the number of people that is affecting the future viability of civilization, so does the type of development. The current economic model is based on markets and consumption, with the premise that the more consumption, the more development. Consumption can bring fringe benefits, especially in richer countries.

44 7 Billion and Counting, David E. Bloom, Science, July 29, 2011 Vol. 333 no. 6042: 562-569.

45 7 Billion and Counting, David E. Bloom, Science, July 29, 2011 Vol. 333 no. 6042: 562-569.
46 CEPAL (2005) Dinámica demográfica y desarrollo en América Latina y el Caribe. CEPAL, Santiago, 67p.
47 ftp://ftp.fao.org/docrep/fao/meeting/018/k6077s.pdf
48 ftp://ftp.fao.org/docrep/fao/meeting/018/k6077s.pdf
49 ftp://ftp.fao.org/docrep/fao/meeting/018/k6077s.pdf

However it comes with real costs. A ninefold increase in consumption, accompanied by a quadrupling of world population, results in an increase in the rates at which raw material is extracted from ecosystems, transformed into "commodities" (goods) and then returned to the ecosystems as waste of 36 times[50].

Many nations have followed and are following this development model. However, it will not be attainable by most. The dream of development such as the one of the United States for the whole planet is utopian. Despite having only 4.6% of the world, their society consumes 25% of global energy and, even if it has lost the first place, it remains a major source of greenhouse gas emissions, and hence of global warming.

Current development has exceeded the capacity of the planet; in 2007 humans consumed what the planet took 18 months to produce[51]. By 2011, it was estimated that the world's population used 135% of the resources that the planet was capable of producing (ecological footprint). This means that the surplus (35%) must be covered through the depletion of resources such as fisheries, forests and others and through the accumulation of waste products such as carbon dioxide in the atmosphere and oceans. Case in point: presently, by September of each year, humanity has already consumed what the planet could produce during that year[52].

Cereals (including wheat, rice and corn) account for approximately 50% of human calorie consumption,[53] making any changes in their production affect directly and immediately a large part of the world population. Currently, almost half of all cereal production is used for feeding animals, so that increased consumption of meat products, as population income increases, will generate greater pressure on the future on the grain production, and the demand for the next 30 years is significantly highter than the one predicted by international agencies[54].

Inequality

Inequality within countries and regions, as well as between them, is another major concern for current development. Around one billion people worldwide are undernourished, while in some countries, millions of people suffer from chronic excess food consumption[55]. 12% of the world's population living in North America and Western Europe account for 60% of private expenditure in consumption, while the third living in South Asia and sub-Saharan Africa accounts for just 3.2%[56]. Although with even lower levels of consumption, the consumer class is growing in developing countries; China and India now have more than 20% of them, equivalent to 362 million people, more than Western Europe. In contrast, there are more than 2.8 billion people trying to survive with less than $2 per day and over a billion lack access to drinking water potable[57]. According to the United Nations Population Fund[58], Latin America and the Caribbean have the highest levels of socioeconomic inequality in the world. While the richest 10% receives 48% of total income, the poorest 10% receives only 1.6%.

The population structure is also changing; groups with better socioeconomic conditions live longer and have fewer children, while , indigenous and black, and poor people, who are less educated and live in rural areas have more children and a lower life expectancy. Poverty in the region in 2010 stood at 31.4% including 12.3% of people living in extreme poverty or indigence. In absolute terms, these figures amount to 177 million poor, including 70 million indigents. Despite these figures, there has been progress since the nineties, with a cumulative reduction of poverty of 12.4%, while extreme poverty has fallen by 6.3%[59].

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50 Farley, J., Browun Gaddis, E.J., Rees, W.E. y Van Dis, K. Managing our global footprint through restoration of natural capital at a global scale. In: Aronson, J., Milton, S.J. y Blignaut (Ed.) (2007). Restoring natural capital: science, business, and practice. Island Press, Washington D.C, 384 p.

51 Ewing B., D. Moore, S. Goldfinger, A. Oursler, A. Reed, and M. Wackernagel. 2010. The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.

52 http://www.footprintnetwork.org/en/index.php/GFN/page/earth_overshoot_day/ Consultado en 14 diciembre 2011.

53 FAO 2003 FAO (2003). World agriculture: towards 2015/2030. FAO, Rome. ftp://ftp.fao.org/docrep/fao/004/y3557e/y3557e.pdf

54 Keyzer et al. 2005. Diet shifts towards meat and the effects on cereal use: can we feed the animals in 2030? Ecological Economics 55(2):187-202

55 http://ccafs.cgiar.org/sites/default/files/assets/docs/climate_food_commission-final-mar2012.pdf (consultado el 24 de marzo 2012).

56 http://www.worldwatch.org/node/810#1

57 http://www.worldwatch.org/node/810#1

58 http://lac.unfpa.org/public/cache/offonce/pid/2023;jsessionid=2732912EFBF3D54F97B4380270601A76 consultado el 20.12.2011

59 CEPAL (2011) Panorama Social de América Latina. 49 p.

Urbanization

Urbanization is another important demographic change, Latin America and the Caribbean are the most urbanized regions among developing countries relying on 77.4% of urban population in 2005, second only to North America (80.7%) and having already exceeded Europe (72.2%)[60]. This trend will continue, since the region has one of the highest rates of urbanization in the world.

Globally, in 2007, the world's urban population surpassed the rural population, reaching in 2010 3.5 billion people. It is expected that the next four decades the entire population growth of urban areas, especially in developing countries where it is estimated that by 2050, doubling the urban and the rural population is reduced by 600 millions[61]. The rural population decline involves a land grab by big business and the mechanization of production, necessary for the reduction of labor.

Urban growth makes its mark continues to grow, particularly trends in some countries where the population will acquire economic power moving to suburban areas that then end up joining the great metropolis. Between 1970 and 2000, the overall urban area had an increase of nearly 58,000 km2. Due to population growth and rural exodus, it is expected that by 2030 urban coverage is increased by more than 1.5 million square kilometers[62] which undoubtedly affects the availability of fertile agricultural land and adds significant challenges to the provision of water, waste treatment and waste water. The development will have significant impacts on food demand and distribution. As you increase the "economic development" is an increase in consumption (general and food) and in many cases there is an overconsumption and waste.

The future urban dynamics is not yet entirely clear, especially for the consequences of climate change. Interestingly, recent population estimates still do not fully incorporate the likely impacts of climate change, probably because of the enormous uncertainty that exists. The loss of glaciers in the Andes for example, water will leave several major cities in South America. Migration processes of climate refugees, for now more evident in other regions such as Africa, will also impact the demographics of our countries.

Water

Water is one of the most critical for humanity. Only 2.5% of global water is fresh and of this, 98.8% are in the form of ice or water subterranean[63]. Water is an increasingly scarce resource and current forecasts suggest climate change will be a much more limited resource in the near future. In the mid-nineties, some 80 countries where 40% was the world's population suffered from shortage of water[64]. For the year 2020, is expected to increase water demand by 40% and 17% require more water to produce food to meet population growth. According to the report GEO4[65] by 2025, 1.8 billion people will live in countries or regions with absolute water scarcity and two thirds of the world population will live under conditions of water stress, defined as the limit to meet the water demands for agriculture, industry, domestic use, energy and the environment. As we approach peak oil production, we are reaching the "peak" water availability[66].

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[60] Naciones Unidas. (2006). World Urbanization Prospects, The 2005 Revision

[61] United Nations Department of Economic and Social Affairs, Population Division. (2011). Population Distribution, Urbanization, Internal Migration and Development: An International Perspective. Naciones Unidas, 363 p.

[62] Seto KC, Fragkias M, Güneralp B, Reilly MK (2011) A Meta-Analysis of Global Urban Land Expansion. PLoS ONE 6(8): e23777. doi:10.1371/journal.pone.0023777

[63] Gleick, P.H., ed (1993). Water in Crisis: A Guide to the World's Freshwater Resources. Oxford University Press.

[64] Commission on Sustainable Development (CSD). 1997. Comprehensive Assessment of the Freshwater Resources of the World. Report of the Secretary-General. United Nations Economic and Social Council, New York.

[65] PNUMA. 2007. Global Environmental Outlook 4. p. 129

[66] Palaniappan y Gleick http://www.worldwater.org/data20082009/ch01.pdf Consultado 29 enero 2012

Gleick[67] classifies water use limits in three categories and concluded that human beings have great difficulty understanding these limits:

- Renewable water limits: we can not increase the water we are taking from the river when we already took it all
- Limits on non-renewable water: when, similar to what happens with oil, we pump more water from a non-renewable aquifer that we should [68].
- Ecological limits to water: when the use of additional water causes more environmental damage than economic benefits

The last decade has introduced the concept of water footprint. This is based on a mapping of the territory based on where water is produced and where it is consumed, allowing pinpoint the spatial distribution of the water footprint of a country. For reference, the global water footprint, conservatively estimated, averaged between 1997 and 2001 of 7450 cubic gigámetros year (109m3/año), which corresponds to a global average consumption per capita annual 1240m^3 with large differences between countries , with the United States consumes twice the world average (2480m3) while China consumes 700m3 per person per day. Most of the water is used for crop production (85%), equivalent to 6390 Gm3/year field level. Rice is the largest consumer and accounts for 21% of the total volume of water used for production at the field level, followed by wheat with 12%[69]

Por otro lado, la presencia creciente de multinacionales en el sector hídrico ha ido convirtiendo el agua de ser un bien público en una mercancía, "el agua se está volviendo cada vez más una mercancía de jugadores globales"[70], lo que ya está teniendo efectos en la distribución del agua y posiblemente genere conflictos futuros para el acceso al agua de pequeños productores sin recursos.

ANGRICULTURE AND THE ENVIRONMENT

The Green Revolution

Food production has been a major concern of mankind throughout its history. To meet the demands of a growing population, man was extending its agricultural frontiers continuously. We initially used the land more fertile agricultural skills but as demand grew, it was necessary to incorporate more and more marginal lands and generating significant land use changes. To keep the demand satisfied during the twentieth century was invested increasingly in crop improvement. A classic example of this is wheat English, it took a thousand years to go from 0.5 to 2 tons per hectare, however only 40 years were required to take 2 to 6 tons per hectare. The genetic improvement and agricultural practices together with the development of inorganic fertilizers and pesticides yields increased further, leading industrialized countries have food surpluses in the second half of the century. [71]

Historically, overall, the conditions for developing countries were different. Colonial powers traditionally invested in extractive operations and very little on food production and at the time of independence, especially in Africa, many countries found themselves with rapidly growing populations with unmet food demands. For 60 years, in many developing countries, the levels of hunger and malnutrition were high, which led to the

[67] http://www.newsecuritybeat.org/2011/10/watch-understanding-peak-water-can-help.html Consultado el 29 enero 2012

[68] No toda el agua subterránea es renovable bajo las condiciones climáticas mundiales, ya que se formaron bajo climas mucho más húmedos que prevalecieron en el planeta hace 1000 o 10000 años atrás . Algunos de estos acuíferos están siendo utilizados o contaminados con intensidad creciente en muchas partes del planeta.

[69] A. Y. Hoekstra · A. K. Chapagain (2006) Water footprints of nations: Water use by people as a function of their consumption pattern. Water Resource Management 21:35-48.

[70] Barlow, M.; Clarke, T. Blue Gold: The Battle against Corporate Theft of the World's Water; The New Press: New York, NY, USA, 2002

[71] International Food Policy Research Institute. (2002) Green Revolution, Curse or Blessing?

establishment of networks of agricultural research and extension so as to be able to transfer and adapt technologies.

This prompted the replacement of traditional agricultural practices "technological packages" with what was initially achieved significant increases in yields. Traditional knowledge, based on a close and understanding of ecosystem functioning were lost. Instead of adapting crops to the capabilities of ecosystems was decided to transform ecosystems and artificially provide the elements necessary for production.

There has been much debate about whether the achievements of modern agriculture of high intensity are greater than the negative. With the Green Revolution began the intensification of agricultural production, having been introduced crop varieties with genetic uniformity that required a lot of complementary inputs such as irrigation, fertilizers and pesticides, which often replaced natural capital. Fertilizer management replaced soil quality while herbicides were an alternative to crop rotation as a means of controlling weeds. The successes are huge and because of the green revolution, agriculture has been able to meet the food needs of most of the growing population. But the price you pay is high and includes groundwater pollution, the release of greenhouse gases, loss of genetic diversity, eutrophication of freshwater ecosystems and marine. The loss of fertility and soil erosion, increased crop diseases and livestock inputs with high energy demand and associated chemistry question the ability of these production systems can be followed to maintain. It requires seeking new production systems that generate similar production levels, but with lower environmental costs.[72]

Among the negative external effects of intensification include land degradation, salinization of irrigated areas, the excessive extraction of groundwater, increased resistance to pests and erosion of biodiversity. The massive use of global seeds and breeds "improved", standardization of production systems, often attached to farm machinery and the "packages", genetic selection prioritized in productivity per hectare, the spread of AI artificial in livestock production, among others, has also led to an erosion of agricultural biodiversity, not only of species, breeds and varieties but also of the same variety of genes. Since the beginning of agriculture 12,000 years ago, have been collected, developed, managed and used as food, approximately 7,000 plant species and several thousands of animal species. Over 90 percent of crop varieties have disappeared from the fields in the last 100 years and 690 livestock breeds have become extinct. Only 15 types of crops and domestic animals eight represent 90 percent of the energy requirements of the current global power. [73]

Genetically Modified Organisms

Genetically modified organisms (GMOs) have come with the promise to increase yields, increase resistance to diseases and adverse environmental conditions and reduce pesticide use, among others. There are huge controversies in science, with favorable and unfavorable opinions about the use of GMOs, often linked to the source of funds for research. However, according to Garcia and Altieri[74], independent reports have increasingly been confirming that the expected benefits have not been fully achieved and that the implications for nature and agriculture itself long term, despite the uncertainty, can be severe and have led to legal disputes, political and many socioeconomic and environmental concerns. These authors argue that there are no studies that support the reduction of pesticides in the long term given the lack of studies that track the use of all pesticides and herbicides. As an example, they cite that herbicide-resistant crops can reduce the use of Roundup (trade name for glyphosate, a nonselective herbicide for broad spectrum developed by Monsanto that has produced several plants genetically modified to be tolerant to it) but increase the use insecticides and insect pests that are increased by eliminating certain herbs that provide nectar and pollen to natural enemies of these. These authors conclude that the benefits of organic production systems far exceed those obtained in the long term with GMOs.

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[72] Tilman, D. 1998. The greening of teh Green revolution. Nature 396, 211-212.

[73] ftp://ftp.fao.org/SD/SDA/SDAR/sard/SARD-agri-biodiversity%20-%20spanish.pdf Consultado el 9 de marzo de 2012.

[74] Garcia, M.A. & M.A. Altieri. 2005. Transgenic crops: implications for biodiversity and sustainable agriculture. B. Sci. Technol. Soc. 25(4): 335-353.

The potential of genetically modified organisms to threaten biodiversity is substantial. It is unknown what the long-term impacts exist and despite the precautionary principle, the gains in the short term have been placed back over the long term sustainability.

Genetically modified crops, reinforcing the genetic homogeneity, contributing to the loss of biodiversity and increased vulnerability to climate change. Genetically modified plants do not act as their natural counterparts, interact in new ways and can affect plant, soil and animals that consume them.

Expert Don Huber [75] in a January 2011 letter to the Secretary of Agriculture of the United States warns of the emergence of a new body to science, a pathogen detected only by electron microscopy apparently severely impact the health of plants, animals and probably humans. This organism is found in significantly higher concentrations in soybeans and Roundup Ready corn, ssuggesting a link with the RR gene or the presence of Roundup. Further notes that this information could be extremely risky for the export markets of soybeans and corn from the United States. As a consequence of this organism have been observed an increased occurrence of spontaneous abortions and infertility among others in pigs, horses and cattle, being that the latter have abortions observed rates of 45%.

These crops can cross with wild plants and pass the modified genes, affecting wild populations of insects and food chains. In America, millions of acres infested with glyphosate-resistant weeds with a growth rate of 40% annually. The increase of resistant weeds has led to increased use of herbicides and tillage techniques that increase erosion. As a solution to the problem, companies are recommending new plants resistant to toxic herbicides such as 2,4-D. This pesticide mimics human hormones with severe health consequences.

Toxins from Bacillus thuringiensis (Bt) incorporated by genetic engineering to crops, are active in the soil after the stubble was incorporated, combining clays and humic acids with negative consequences in insects that are the subject of combat.

Genetic engineering could be useful in the production of species and varieties with greater adaptability and already has generated various phenomena resistant crops, yet the consequences of genetic manipulations are not yet well understood. Agricultural biotechnology is a powerful tool, but until now the use has been directed mainly to generate more profit and the consequences are unpredictable.

In summary, while the potential of genetically modified crops to promote biodiversity and sustainable agriculture is negligible[76] or at least questionable, the potential negative impacts or threat of GMO technology, given the evidence to date is substantial, especially because GMOs are true biological novelties that would not exist through natural processes. Some of the impacts of GMOs are:

- Spread of transgenes to wild plants and weeds.
- Reduction or increase of resistance in target organisms through the acquisition of transgenic traits via hybridization
- The evolution of insect pest resistance to Bt toxins
- The accumulation of Bt toxins, which are active on the ground linked to clay or humic acids.
- Breach of natural control of insect pests by the action of the Bt toxin in natural enemies
- Unanticipated effects on non-target herbivorous insects
- By horizontal gene transfer vectors and recombinant taxa unrelated to the formation of new pathogens
- Escalation in the use of herbicides with environmental impacts, including population decline and diversity of herbs

[75] http://fooddemocracynow.org/blog/2011/apr/6/don-hubers-cover-letter-euuk-commissions/ Consultado 18 enero 2012.
[76] http://www.guardian.co.uk/environment/2011/oct/19/gm-crops-insecurity-superweeds-pesticides Consultado el 4 de febrero 2012.

- Reduction of populations of herbs with consequent declines in bird populations that feed or protect the herbs or maintained by arthropods feed on herbs
- Selection of herbicide resistant weeds and noxious herbs.

There are already significant impact on the markets. In September 2011 the European Court of Justice banned the sale of honey contaminated with pollen from genetically modified maize produced by Monsanto. This has implications for all beekeepers who are in proximity to GM crops. The bottom line is that it has been shown that GM products are not harmful to humans.

Biocofuels

One of the most important current controversy is that of biofuels. On the one hand, present alternatives to nonrenewable energy sources, but on the other hand, there are increasing reports about negative impacts. In short, biofuels are "good and bad", depending on their classification of the manner in which they occur.

Science has made great progress in this field, we have generated efficient conversion processes of various kinds of waste (agricultural, domestic, etc.). Energy sources. The production of biodiesel and ethanol by batteries culture (bioreactors) of lipid-producing algae is one of the most promising technologies, produce 30 times more oil by the hundredth part of the water tradicionales[77] crops. In recent years we have worked with a variety of new species and species in the improvement for increasing the level of oil produced, exceeding 60% currently its biomasa[78]. Since algae can double in very cortos[79] intervals, a few days, their growth is exponential. The progress achieved in the so-called second generation biofuels will determine the long-term replacement of fossil fuels.

Biofuels are also not offer advantages over the use of petroleum derivatives. Production of biodiesel from African palm oil, soybean or rapeseed for example, if one takes into consideration all aspects of production including land use change, have proved more pollutants in GHG emissions that fuel use fósiles[80]. The momentum of increased consumption of biofuels, including by the European Union, was due to serious miscalculations, according to several recent statements by many científicos[81,82,83].

Additionally, the increased use of biomass for energy has increased demand in agricultural markets. Between 2000 and 2008, biofuels derived from agricultural products increased three times, consuming 10% of global coarse grains. The replacement of food crops could bring economic benefits to some farmers but it represents a serious threat to food security, especially by the fact that in most developing countries has reached the limit of the agricultural frontier. A World Bank study blames biofuels[84] of an increase between 70 and 75% of food for the period between 2002 and 2008. The UNEP report, "The environmental food crisis"[85] discusses the food crisis

[77] http://www.diversified-energy.com/auxfiles/pressReleases/SimgaeSystem.pdf Consultado el 4 de febrero 2012.

[78] http://www.oilgae.com/algae/oil/yield/yield.html Consultado el 4 de febrero 2012.

[79] http://gas2.org/2008/11/02/thailand-scientists-discover-new-algae-species-can-be-used-to-produce-biodiesel/ Consultado el 4 de febrero 2012.

[80] http://www.euractiv.com/climate-environment/biodiesels-pollute-crude-oil-leaked-data-show-news-510437 Consultado el 4 de febrero 2012.

[81] http://www.eea.europa.eu/about-us/governance/scientific-committee/sc-opinions/opinions-on-scientific-issues/sc-opinion-on-greenhouse-gas Consultado el 4 de febrero 2012.

[82] http://www.euractiv.com/sites/all/euractiv/files/scientists%20biofuels%20letter.pdf Consultado el 4 de febrero 2012.

[83] http://www.guardian.co.uk/environment/2011/oct/07/european-biofuels-target-us-scientists Consultado el 4 de febrero 2012.

[84] Mitchell, D. 2008. A Note on Rising Food Prices.World Bank Policy Research Working Paper Series. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2008/07/28/000020439_20080728103002/Rendered/PDF/WP4682.pdf Consultado el 4 de febrero 2012.

[85] Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. G., Kaltenborn, B. P. (Eds). February 2009. The environmental food crisis – The environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environment Programme, GRID-Arendal, www.grida.no

and concludes that due to crop competition with biofuels, low cereal stocks, high oil prices and market speculation associated extreme weather events.

Soils

After many years, it was found that the removal of human beings in their relationship with ecosystems, understanding the functioning and the limits thereof, has resulted in a high proportion of degraded soils. Often, the technology packages look down as an inert material that is added to water for irrigation, fertilization and nutrients for proper consistency by mechanical tillage. However, soils are alive in sound condition. Millions of organisms, many of them microscopic, play an important role in maintaining the productive capacity of these.

Currently the planet is 1.9 hectares of biologically productive land per person to provide resources and absorb wastes, however, on average, 2.3 hectares are already used. This footprint has a range between 9.7 hectares for the average American and 0.47 hectares for an average person Mozambique[86].

On the other hand, during the last century, soil erosion began to exceed new soil formation in large areas of the planet. Possibly a third or more of all agricultural land loses topsoil faster than it does to form. According ISRIC[87] 46.4% of world agricultural soils are showing a significant decrease in productivity and destruction of its biological functions. 15.1% of them can no longer be used for agriculture and biological functions that have been severely destroyed and would require large investments in traditional techniques to achieve restoration. Due to the loss of biological activity, approximately 9.3 million hectares (0.5% of world agricultural soils) are damaged beyond resilience. Soil degradation in the period between 1981 and 2006 was 24%, resulting in a loss rate of almost 1% anual[88].

15% of degraded soils are found in South America, where deforestation is a major cause of degradation in this region (41%)[89]. In Central America, the degradation has reached alarming levels, both by the percentage of degradation as the severity of it. The range is 75% of degraded agricultural land in El Salvador to 27% in Honduras[90,91] and the leading cause (58%) is overgrazing and bad practices agrícolas[92].

With land degradation processes are accelerated desertification, according to Mr. Luc Gnacadja, Executive Secretary of UN Convention on Desertificación[93], cost about U.S. $ 43 billion a year.

Soils are the foundation of our civilización[94] The soil remediation requires comprehensive approaches, based on ecosistemas [95]. The use of traditional knowledge originarias [96] populations has demonstrated significant advantages over occidental[97] knowledge. The incorporation of ancestral knowledge in ecological restoration processes through the use of assisted natural processes of regeneration, shows that the Lacandon Indians in Mexico improve the productive capacity of suelo[98].

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86 State of the World 2011

87 International Soil Reference and Information Centre (ISRIC)

88 Bai ZG, Dent DL, Olsson L and Schaepman ME 2008. Global assessment of land degradation and improvement. 1. Identification by remote sensing. Report 2008/01, ISRIC – World Soil Information, Wageningen

89 International Soil Reference and Information Centre (ISRIC)

90 Estado de la Región, 2008.

91 FAO, 2005.

92 International Soil Reference and Information Centre (ISRIC)

93 http://www.goodplanet.info/eng/Contenu/Points-de-vues/Desertification-costs-US-42-billions-per-year/(theme)/1662 Consultado el 23 de enero 2012.

94 Brown, L. (2006) Natural systems under stress. http://www.goodplanet.info/eng/Contenu/Points-de-vues/Natural-systems-under-Stress/(theme)/1662 Consultado el 23 enero 2012.

95 World Resources Institute (2003) An ecosystem approach to drylands: building support for new development practices.

96 Dietmont, S. et al. (2006) Lacandon Maya forest management: Restoration of soil fertility using native tree species. Ecological Engineering 28: 205-212.

97 Levy-Tacher, S. I. y Castellanos, M. Comunicación personal, 2008.

98 Levy T., S.I, Aguirre R, J.R., Martınez R., M.M. Duran F., Y.A., 2002. Caracterización del uso tradicional de la flora espontanea en la comunidad Lacandona de Lacanha, Chiapas, Mexico, Interciencia, 27, 512–520.

The Agriculture Frontier

Despite technological advances in food production in Latin America and the Caribbean has been based heavily on the agricultural frontier expansion and very important in changing land use in forested areas. About 64% of global forest loss occurred between 2000 and 2005 occurred in Latin America and the Caribbean (FAO, 2005). Unlike what happened in the last century, today the process of change in land use are largely caused by small farmers and other agriculture and livestock for corporativas[99]. International markets have increased the demand for products such as soy, which has accelerated the conversion of land to large areas of monoculture, led to a decrease in staple food production, forcing countries to increase imports of these and making Basic food security depends on international markets.[100] At the same time, liberalization of imports has reduced the viability of small farming escala[101]. This will have important implications for the future, especially due to climate change has already begun and will discuss further.

CLIMATE CHANGE AND AGRICULTURAL PRODUCTION

Climate change is affected by this issue of agriculture to various greenhouse gases, but climate change is also having significant impacts on agriculture.

Impacts of Agriculture and Livestock on Climate Change

Globally most GHG emissions (61%) come from energy use, with the change in land use (mainly deforestation) and agriculture produced 18.2% and 13.5% of emissions respectively . According to ECLAC, Latin America and the Caribbean, the largest emitter of greenhouse gases is the change in land use in 2005 represented the 46% of agricultural emissions and 20%.

Globally, agricultural emissions are equivalent to the transport sector. For developing countries, emissions of CO2 from the change in land use will increase to 33% and less developed countries reaches 62%. Most emissions come from developing countries being the major sources Indonesia and Brazil, with 34 and 18% respectively. By incorporating the use of fuels and electricity in agricultural activities, total global emissions up to 15%. Methane (CH4) and nitrous oxide (N2O) represent approximately 45% of emissions each and the rest is CO2 from energy use. At the level of activity, soil management is the largest issuer, with 40% of the total sector, followed by methane emissions from animals. Other sources include methane from rice cultivation (10%) and manure management (7%). There are also contributions from CO2 by clearing fields and biomass burning.

The Carbon Footprint of Agriculture and Food

It is still nascent but increasingly there is awareness of the importance of carbon footprint in everyday life. In Europe and especially in England is where progress is being made more limited, initially voluntary, now increasingly mandatory to reduce the amount of carbon emitted domestically. It is estimated that food accounts for 20% of the carbon footprint of UK[102]. There are already calculating the carbon footprint of food available on the Internet (http://www.foodcarbon.co.uk/) and even some food and bring the carbon footprint on the label. Now people are starting to use this information to make purchases.

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[99] Banco Mundial (2007) Informe sobre el Desarrollo Mundial 2008; Agricultura para el desarrollo.

[100] FAO. 2007e. El estado mundial de la agricultura y la alimentación 2007

[101] Banco Mundial (2007) Informe sobre el Desarrollo Mundial 2008; Agricultura para el desarrollo.

[102] http://www.guardian.co.uk/environment/2007/jun/07/food.foodanddrink Consultado el 1 de febrero 2012.

The carbon footprint of food has three components: food production, transport ("Food miles" or "kilometers Food" - food miles) and its eventual disposal, including if appropriate packaging. Originally there was greater concern for the "food miles", however this data individually does not say much but he was leading people to consume products that had little transport and these are not necessarily those with the lowest total carbon footprint. For example, a vegetable grown in the north of Europe may have a higher carbon footprint than one produced in Africa and is transported there due to the use of artificial heating and lighting required to produce it in the northern countries, which generates much more CO2 than transportation. Lamb uses four times more energy to produce in the UK, including transportation, to bring New Zelanda[103]. There are already methods to calculate the food miles of multi-ingredientes[104] food, for example, a pizza and salad consumed in Cape Town, South Africa, has a footprint of 80 697km[105]. On the other hand, a study from the University of Lincoln[106] clearly demonstrated that only the transport is insufficient to measure the impact of a product as the energy base of the country of origin, production methods and processing, with significant in end product footprint.

In recent years it has been working on various ways of accounting for all energy used and carbon released into the food from farm to table. Foodstuffs may have a high mark if they are prepared from intensively managed crops with high use of agrochemicals (petroleum) and fertilizers (90% of nitrous oxide, one of the three main greenhouse gases, with a retention Heat 300 times stronger than CO2, comes from the fertilization of the fields). Also influences whether there was a change in land use (soy or livestock produced in areas where forest have toppled a giant carbon footprint), the type of soil management (pineapple intensively produced where huge amounts of soil carbon are lost atmospheric erosion or water bodies) or by the biology of production (rice and livestock are major emitters of methane to the atmosphere).

In the last decade has been working to establish the "ecological footprint" of food products, which includes impacts on the environment and social environment in addition to the emission of greenhouse invernadero[107].

Impacts of Climate Change on Agriculture

The agricultural and livestock production is closely associated to climate and its variability. Global warming leads to important changes that affect the production of food. Paradoxically, developing countries, especially the poorest will be hardest hit and are now facing a real threat and direct food security. Additionally, developing countries are especially vulnerable because their economies and hence their population, are closely linked to agriculture and natural ecosystems to ensure their welfare, so climate change will multiply the risk in countries where agriculture and other systems based on natural resources and fail to meet the demandas[108].

The expected impacts of global warming impact on agriculture can be grouped in a short and not exhaustive in the following:

- Climate disasters: droughts, storms (hurricanes, typhoons) and floods
- Temperature increase
- Physiological changes
- Sea level rise
- Increased pest

[103] http://news.emigratenz.org/2008/01/31/say-no-to-food-miles/ Consultado el 1 de febrero 2012
[104] Pirog, R. y Benjamin, A. 2005. Leopold Center for Sustainable Agriculture. Iowa State University. http://www.farmland.org/programs/localfood/documents/foodmiles_Leopold_IA.pdf Consultado el 1 de febrero 2012.
[105] http://www.docstoc.com/docs/69667181/Grace-Stead-Reducing-The-Carbon-Footprint-of-Tourism---Spier-Event- Consultado 1 de febrero 2012.
[106] Saunders, C. y Barber, A. 2007. Comparative energy and greenhouse gas emissions of New Zealand's and the UK's Dairy Industry. http://researcharchive.lincoln.ac.nz/dspace/bitstream/10182/144/1/aeru_rr_297.pdf Consultado el 1 de febrero de 2012.
[107] Collins, A. y Fairchild, R. 2007 Sustainable Food Consumption an a Sub-national Level: An ecological footprint, nutritional and economic analysis. Journal of Environmental Policy and Planning Vol 9(1): 5-30
[108] Moorhead, A. (2009) Climate, agricultura and food security; a strategy for change. CGIAR, 45 p.

- Loss of biodiversity and genetic
- Ecosystem loss of function
- Water scarcity and pollution
- Loss of soil fertility
- Loss of phenological relationships

All these processes will affect independently or in combination, generating different exchange processes that can trigger chains which increase the scale, many of which is unknown. Change is now the rule rather than the exception. This is extremely difficult for farmers because they can change erratically normal processes, is difficult to determine the best time to plant or harvest.

Extreme events are possibly the most visible to the average person. Throughout the world, news of floods have become frequent. Only last year the weather severely affected several regions. According Oxfam[109] at the end of 2011, storms in El Salvador affected between 30 and 40% the production of corn and beans 75%, with losses estimated at U.S. $ 134.5 million. In Guatemala, the loss amounted to over U.S. $ 38 million. In Mexico, lost more than 300000 hectares of corn, pastures, bananas, vegetables and fruit affecting more than 29 000 producers. These were not isolated phenomena, since in recent years have reported crop losses by rains and floods in all countries of the isthmus.

South America also has been affected by flooding. Colombia was affected almost the entire territory of what was called "the worst natural disaster in its history"[110]. In recent years there are hundreds of news of severe flooding in virtually all countries of the region, taking firsts in news around the world. Reported damage to infrastructure, loss of lives and extensive damage to agriculture and livestock.

Droughts, another cause of loss of agricultural production has also become everyday news. In January of this year, Argentina has suffered losses amounting to nearly $ 800 million in soybean and maíz[111]. At the same time, Mexico is facing the worst drought in more than 70 years in two thirds of its territory, causing losses of 80% of bean production, 50% of corn production and trigo[112] and death of a ganado[113] 450 thousand heads. In addition to drought, crops have suffered from repeated freezing and flooding.

The increase in sea level will affect large areas of farmland. Countries such as Guyana lost 40% of its agricultural land with an increase of just underground mar[114] level, other countries like the Bahamas, Suriname, Argentina, Jamaica and Belize are also heavily impacted by agricultural extension afectada[115],. However, the involvement of wetlands by rising sea levels affect production such as coastal shrimp production in Ecuador, which would be severely impacted.

Physiological processes are closely linked to climate. At low latitudes, the temperature increase, which is associated with a decrease in water availability would result in serious injury. In tropical zones usually species develop at temperatures near or above the optimum and slight increases lead to reductions in productivity. In cold areas, temperature increases of 1.5 C to 2C could have favorable results while larger increases to 3C would have negative effects on production in all regions.[116] In the case of coffee for example, increased temperature

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109 http://www.efeverde.com/contenidos/noticias/oxfam-las-inundaciones-ponen-en-peligro-la-alimentacion-en-centroamerica Consultado el 22 enero 2012

110 http://www.voanews.com/spanish/news/latin-america/intensas-lluvias-azotan-sudamerica-120772349.html Consultado el 20 de diciembre 2011.

111 http://www.lanacion.com.ar/1437930-preven-perdidas-millonarias-en-los-cultivos-por-la-sequia-colorpreven-perdidas-millonarias-en-los-cultivos-por-la-sequia

112 http://spanish.china.org.cn/international/txt/2012-01/21/content_24463347.htm consultado el 02 enero 2012.

113 http://spanish.peopledaily.com.cn/31614/7710626.html Consultado el 23 de enero 2012.

114 http://news.bbc.co.uk/2/hi/americas/7977263.stm Consultado el 16 de diciembre 2011.

115 Dasgupta, S. et al. 2007. The impact of se level rise on developing countries: A comparative analysis.

116 Magrin, G. (2008) Agricultura y Cambio Climático Global.

accelerates the grain ripening process, which lowers the quality and taste thereof. A temperature increase of 3C at the end of this century raise the lower limit of coffee growing almost five meters per year[117]. For many, as the case of Brasil[118], this means the end of production since the height limitations in growing areas. In other countries, this could mean increased pressure on remaining forests on the peaks, which could have negative impacts on water production. Climate change could lead to decreased production of 34% of coffee in Veracruz, Mexico leading farmers profit of $ 500 to U.S. $ 50 per hectárea[119].

There are other threats that have not yet been clearly recognized. We know that the ability to adapt to changes depending on the variability of the genes in populations. This means that those plants or animals that have a high genetic diversity within their populations have a greater chance to adapt, as some individuals survive in changing conditions and can repopulate. Now if we see the evolution of the breeding process, they have been oriented in the opposite direction. The genetic homogeneity has been the basis of the selection process. In the case of livestock, artificial insemination and embryo transfer then have generated a very specific selection of genes that have significantly increased production. We know from the various processes of livestock exports from Europe to tropical countries the ability to adapt is severely limited. These animals do not have the genetic diversity needed to adapt to major changes in climate and indigenous populations, such as the local cattle in Latin America, originally imported by the Spanish conquistadors, has virtually disappeared from the region. According to FAO, about 75% of plant genetic diversity has been lost since 1900 as monoculture increased mass.

Phenological changes, which are those that relate to biological production cycles, although they have been widely documented, given its great complexity, are not yet well understood and therefore addressed. The advance of spring in Europe, for example, has led to the loss of synchronicity between the migration of birds and insect populations. Evolutionarily, appearing shoots and flowering plants both wild and in crops, food availability creates explosions in populations of insects, however, the crop damage is lessened by the arrival of migratory birds that controlled by feeding their young. With the advancement of warm days, spikes in insect populations are occurring before the arrival of the birds. This not only makes bird populations are declining rapidly because there is not enough food available to the pigeons, but also has impacts on crops as biological control exercised by the birds originally ceases to exist. These alterations may also occur between plants and their pollinators. Additionally, it has been the migration of insects, both elevation and latitudinally, possibly in search adecuados[120] temperatures or habitats. This, possibly associated with deforestation and the impact of pesticides used in pineapple production has generated intensive in northern Costa Rica, the disappearance of pollinators for the cultivation of passion fruit, forcing producers to have to pollinate by hand in the past four years[121].

On the other hand, the increase of pests is also a result of disturbances of ecosystems, both direct (use of monocultures) and indirect (climate change). Coffee production is a crop that is being severely impacted by climate change. On one hand, the increase of temperature affects the quality of the coffee and thus its flavor. Changes in precipitation, both by excessive rainfall that increase erosion and cause bigger problems by excess moisture with increased disease (Mycena citricolor), drought or pest altitudinal migration as the coffee berry borer (Hypothenemus hampeii).

The alteration of ecosystems is also multifaceted. Changes in temperature and precipitation have different effects in different species and lead to population changes with increases in some that are better suited to the changes and decrease or disappearance of other more sensitive. In the medium to long term, these changes will alter ecosystem function, affecting nutrient cycling and water, the interaction between species and possibly the appearance of the different ecosystems we know today.

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117 Baker, P.S. y HAggar, J. (2007). Global warming: the impacto n global coffee. Manuscrito. Consultado el 10 de diciembre 2011 en http://www.catie.ac.cr/BancoMedios/Documentos%20PDF/cafe_gw_baker_09.pdf

118 Magrin, G. (2007)

119 http://web.catie.ac.cr/congreso/jeremy/Paper_climate.pdf Consultado el 10 de diciembre 2011.

120 http://www.jmcprl.net/PUBLICACIONES/F13/CAMBIO%20CLIMAT%20ESPA%C3%91A/06_biodiversidad_animal.pdf Consultado 13 diciembre 2011

121 Comunicación personal, comunidades campesinas, Reserva de Biosfera Agua y Paz, Costa Rica. Abril 2009.

Climate change affects agriculture and human welfare through brokering 1) biological effects on yields, 2) the resulting impact on prices, production and consumption, and 3) the impact on caloric intake and child undernutrition. The impacts of climate change will be more severe in the most vulnerable areas, either by high levels of poverty, lack of infrastructure, previous damage to ecosystems, in particular watersheds.

The impacts of climate change will be of multiple scales in multiple sectors. Agricultural production remains the basis of livelihood for a substantial proportion of the population, from the level of subsistence to commercial. Studies indicate the region centroamericana[122] losses due to impacts on the agricultural sector of around 19% of GDP with a grim scenario for countries with reductions in income from rent of land or property up to 66%. When analyzing the variables of precipitation and temperature, some areas of Latin America may be benefited, such as South Argentina[123], however these increases may not offset losses in the north of that country. The loss of large areas of the Amazon forest to climate change by increasing drought will lead to changes in rainfall patterns over large areas of the continent that can not yet foresee.

According to Nelson et al.[124], the price of major agricultural products will increase even without climate change due to increasing population and income and the growing demand for biofuels. In the case of rice will increase 62%, wheat 39%, maíz63% and soja72%. The additional increase in prices due to climate change will be for rice between 32 and 37%, 94 to 110% for wheat, 52 to 55% for corn and 11 to 14% for soybeans. By 2050 calorie intake will be below 2000 levels worldwide. For an average consumer in a developing country, this reduction would be 10%.

According to these authors, the investments required to improve productivity and reduce child undernutrition would be:

- 60% increase in crop yield over baseline
- 30% increase in the number of animals
- 40% increase in the production of oil and meal
- 25% increase in irrigated areas
- 15% increase in the efficient use of water at the basin

For Latin America and the Caribbean, these authors suggest that to counter the effects of climate change on nutrition, countries should increase investment total additional per year from $ 1162 to 1315000000, which is divided among other research in agriculture from U.S. $ 392 to 426,000,000, the expansion of irrigation between $ 30 to 31 million, the irrigation efficiency between U.S. $ 128 to 129.

- Development of appropriate policies and programs
- Increase investment in agricultural production
- Revitalize the national research and extension
- Improve the collection, dissemination and analysis of global information
- Place the adaptation as a key on the international agenda of climate talks
- Recognizing that improving food security goes hand in hand with adaptation to climate change
- Supporting adaptation strategies based on communities
- Significantly increase funding for adaptation programs

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122 Ramírez, D., Ordaz, J.L. y Mora, J. 2010. Istmo centroamericano: efectos del cambio climático sobre la agricultura. CEPAL, México, 76p.
123 IPPC 2007
124 Nelson, G.C. et al. 2009 Climate change, the impact on agriculture and costs of adaptation. International Food Policy Research Institute, Washington DC, 19 p.

Climate change will affect food security. Currently already see criticism of this countries dependence on imported food staples, in the case of Mexico totaled more than 40% in[125] promedio, which severely limits the capacity of national food self-sufficiency. This has its origins according to economist Roland Córdoba[126] in signing the FTA with the U.S. and Canada.

The rate of increase in yield of major food crops is decreasing, while for wheat the increase was 5% per year in 1980 was only 2% in 2005, in the case of rice was reduced from 3% to 1% year.

A recent report by the Commission on Sustainable Agriculture and Change Climático[127] reads:

"The transition to a global food system that fulfills human needs, reduce their carbon footprint, adapt to climate change and is in equilibrium with the planet's resources requires concrete and coordinated actions, implemented at the same time of urgent . Based on solid scientific evidence, the Commission on Sustainable Agriculture and Climate Change has identified basic action points and measures a high priority. This report suggests some key actions to achieve food security to climate change:

1) Integrate food security and sustainable agriculture in national and international policies
2) Significantly increase the level of global investment in sustainable food systems over the next decade
3) Sustainable intensification of agricultural production while reducing emissions of greenhouse gases and other negative environmental impacts of agriculture
4) Develop programs and policies to help people and the most vulnerable to climate change and food insecurity
5) Restructuring the food access and consumption patterns to ensure that they meet the basic nutritional needs and to promote healthy and sustainable food models worldwide
6) Reduce losses and wastage in food systems, with attention to infrastructure, agricultural practices, processing, distribution and domestic habits
7) Create comprehensive information systems, shared and integrated to encompass human and ecological dimensions.

Agriculture and Climate Change Mitigation

During recent years evidence has accumulated on the ability to capture carbon soil. Originally the floors were much richer in carbon, which has been lost over years of use of traditional farming systems. This is reversible if you manage to change land management practices to conservation tillage, minimum tillage or zero with tillage and no removal or burning of agricultural residues.

One big advantage is that carbon sequestration is the potential for sequestering carbon quickly, offering an alternative to mitigate short term, with a potential equivalent catch from 1400 to 2,900,000,000 tons of CO2 equivalent per year. It is known that the binding capacity decrease as soils become saturated at 50 to 100 years time. No large investment or new technology, only the change in agricultural practices. According to a report of the European Union: "The real challenge is to ensure that land users and policy makers aware of the importance of managing soil organic matter and its potential to prevent desertification and contribute to climate change mitigation, and to introduce this into their daily activities and policy development, respectively. "

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[125] http://www.eluniversal.com.mx/nacion/193244.html Consultado el 23 de enero 2012.

[126] http://spanish.china.org.cn/international/txt/2012-01/21/content_24463347.htm Consultado el 23 enero 2012.

[127] Beddington J, Asaduzzaman M, Fernández A, Clark M, Guillou M, Jahn M, Erda L, Mamo T, Van Bo N, Nobre CA, Scholes R, Sharma R, Wakhungu J. 2011. Lograr la seguridad alimentaria ante el cambio climático: Resumen para responsables de la política de la Comisión sobre la Agricultura Sostenible y el Cambio Climático. Programa de Investigación del CGIAR sobre el Cambio Climático, la Agricultura y la Seguridad Alimentaria (CCAFS). Copenhague (Dinamarca). Disponible en Internet en: www.ccafs.cgiar.org/commission.

The improvement in the nutrition of ruminants and better management of rice crops could generate methane emission reductions of 15 to 56% and better management could also reduce emissions of N2O from 9 to 26%. The global mitigation potential for agriculture to 2030, considering all gases can vary from 4500 to 6,000,000,000 tons of CO2 equivalent, if not taken into consideration economic and other barriers.

It should be noted that the benefits are not limited to mitigation processes. Increasing carbon in soil involves an increase in fertility of the same and therefore higher production levels. The same is true for the fermentative processes in ruminants resulting methane is actually wasted feed and rejected to the atmosphere. Its reduction would mean important savings in economic terms.

Forest ecosystems promise a greater mitigation, given the volume of catch in the vegetable matter than the soil. However, we must remember that as the impacts of global warming will increase in forest ecosystems, they go from being sinks to become carbon emitters. Massive droughts in the Amazon in 2005 and 2010 are unprecedented recorded, that of 2005 as "the drought in 100 years", but was followed by a more just five years later. It is estimated that due to the death of trees by drought, Amazon released more than 5 billion tons of carbon in 2005 and probably more than that in 2010. For reference, the United States released in 2009 by fossil fuels around 5.4 billion tonnes. Scientists say the days when the Amazon rainforest continues to act as a natural buffer of carbon emissions made by man may be numbered.

THE WAY FORWARD

"Our current dilemma in agriculture is that so spectacularly industrial methods have solved some of the problems of food production have been accompanied by" side effects "so prejudicial as to threaten the survival of agriculture itself and perhaps this dilemma not limited to agriculture. My immediate concern is with the irony of farming methods that destroy, first, the health of the soil and eventually end up destroying the health of human communities."[128]

The comprehensive analysis of global social and environmental issues, especially the changes already observed in the climate and the multiple relationships with food production, can only lead to the conclusion that we must make a paradigm shift arrangements "cosmetic" will not achieve reverse current trends in time. This paradigm incorporates ecology as the basis for the production and closely coupled to human welfare, including food security, nutrition, health and the right to a prosperous life for all inhabitants of the planet. All over the world are beginning to see outbreaks of initiatives to make these changes, from community initiatives to international organizations.

The future of agriculture and livestock then will depend on how quickly we get the change. It requires massive implementation of holistic production processes, which are based on the optimization of ecological processes and become independent as quickly as possible the use of fossil fuels, energy-intensive processes and high inputs. The restoration of degraded soils and ecosystems will be essential as well as the suitability of land uses that allow recovery. Forest restoration and strengthening of protected area systems to improve water catchments and reduce erosion and extreme events caused by changes in rainfall patterns and increasing extreme events will be essential.

In the preparatory process for Rio +20 meeting, the Secretary General of United Nations for the 66th Session of the Assembly General[129] summarizes agricultural technology for development as follows: "The return of high food prices 2008 and the need to adapt to climate change has revived interest in technologies suited to small farmers, especially women. Sustainable intensification of production by small farmers will require a shift towards a knowledge-intensive agriculture, which combines local knowledge and the most current science of sustainability to adapt practices to ecosystems and increase resilience to climate change, price and other

[128] Barry, Wendell. Solving for Pattern. The Gift of Good Land: Further Essays Cultural & Agricultural. North Point Press, 1981. (Traducción del autor)

[129] United Nations 2011 Agricultural Technology for Development. http://www.slideshare.net/undesa/agricultural-technology-for-development Consultado el 1 de febrero 2012

processes. It requires a radical shift in the focus of national agricultural plans substantial investments to develop the productive capacity of small farmers, helping to achieve the Millennium Development Goals and increase food production in 70% required by 2050 . It is necessary and urgent to use a holistic approach to increase productivity and resilience of agriculture and ecosystems support as efficient and fair operation of supply chains."[130] He further states that the path to sustainable agricultural production will be considerably different from that followed the Green Revolution.

This statement is based on the food crisis of 2008 accompanied by volatility in prices has generated challenges to current food system has seen an increase of almost 10% in the number of undernourished between 1990-92 and 2010. An important conclusion is that sustainable intensification of agriculture is the only way to avoid chronic food insecure and that 75 to 90% of staple foods are produced and consumed locally. The report says the new agricultural paradigm will require that small producers are at the center of innovation systems, forging developme agendas, research and extension. Additionally requires a radical change in current policies, a change that would result in the strengthening of existing fragmented innovation systems, a redesign of educational systems and investment in agricultural development throughout the value chain and management sustainable resources through innovative partnerships with producers. Small farmers should be at the heart of food systems well adapted to agroecosystems to enhance both environmental and economic resilience. The development of sustainable agricultural practices, tailored to agroecosystems allows greater diversity and thus greater protection against invasive pests and extreme events.

The International Assessment of Agricultural Knowledge, Science and Technology for Development (IAASTD for its acronym in English)[131] concludes that, despite significant scientific and technological advances in our ability to increase agricultural production, we have subtracted attention to the social and environmental consequences of our achievements. Today we would be in a good position to reflect on these consequences and to outline various policy options that can meet future challenges characterized by food security and livelihoods under increasingly constrained environmental from internal and external agriculture and globalized economic systems.

In a recent book called "Saving for crecer[132]" FAO analyzes the current paradigm of intensive agricultural production, which can not meet the challenges that lie ahead, in order to grow, agriculture must learn to save.

To achieve the required fundamental changes, all countries should also promote sustainable consumption and production patterns, with developed countries taking the lead, looking for the benefit of all countries, taking into account the Rio principles, especially the principle of responsibility common but diferenciada[133].

In the last 40 years of last century it was possible to double production of grain due mainly, as we saw, to increased use of water, fertilizers, pesticides, new varieties and other techniques of the Green Revolution. If you intend to meet future demands for food, building half of the usable land on the planet and is under intensive grazing or agriculture, to address the need to double food production would be causing eutrophication of terrestrial, freshwater and coastal between 2.4 and 2.7 times higher, by the use of nitrogen, phosphorus and pesticides. This eutrophication and habitat destruction would cause unprecedented ecosystem simplification, loss of ecosystem services and species extinctions, with costs generally are not incorporated in decisions productivas[134].

We need to develop agricultural production in urban and peri-through techniques such as hydroponics, which can produce small areas and encourage urban household production for own consumption. Even the new LED

[130] http://www.un.org/esa/dsd/resources/res_pdfs/ga-66/SG%20report_Agricultural%20technology.pdf Consultado el 29 de enero 2012 (traducción del autor).

[131] http://www.agassessment.org/reports/IAASTD/EN/Agriculture%20at%20a%20Crossroads_Synthesis%20Report%20(English).pdf Consultado el 29 de enero 2012

[132] http://www.fao.org/ag/save-and-grow/es/1/index.html Consultado el 29 enero 2012

[133] Naciones Unidas. Plan de implentación de Johannesburgo. http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIChapter3.htm Consultado el 29 enero 2012.

[134] Tilman, D. et al. 2001. Forecasting agriculturally driven global environmental change. Science, 2001, 292 (5515) 281-284.

lighting technologies with specific spectra for growing plants, growing conditions can generate even in confined spaces and low power consumption.

Nellemann et al.[135] recommend the following steps to improve food security:

a) With effect in the short term:

1. Regulation of prices and higher grain stocks to limit speculation in the markets, including the reorganization of the infrastructure and institutions of the food market to regulate prices of food and provide safety nets.
2. Remove subsidies on first generation biofuels, which would stimulate the production of biofuels based on waste, provided they do not compete with food animals. This includes the elimination of subsidies on goods and agricultural inputs that are fueling the development of the food crisis, and promote investment in the shift to sustainable food systems and energy efficiency.

b) In the medium term:

3. Reduce the use of cereals and fish feed, developing alternatives.
4. Supporting farmers in developing diversified and resilient systems ecoagriculture that provide critical ecosystem services (water, habitat, genetic diversity, pollination, pest control, climate regulation).
5. Increased trade and market access by improving infrastructure and reducing barriers to trade. However, this does not imply an approximation of a completely free market, since it requires the regulation of prices and government subsidies.

c) Options with long-term effects:

6. Limit global warming, including the promotion of agricultural production systems and climate-friendly implementation of policies to help mitigate climate change.
7. To increase awareness of the pressures of a growing population and consumption patterns in the sustainable functioning of ecosystems.

The Agriculture and Climate Change Mitigation

As discussed earlier, agriculture plays an important role in causing climate change. As the land use change one of the main causes of emissions, it is necessary to stop the expansion of the agricultural frontier. There are many degraded lands should be returned to production or restored to functional landscapes, allowing you to recover their ecological function and the provision of environmental services. The restoration with natural methods, using traditional techniques, involves the capture of vast quantities of carbon by incorporating organic matter, being an excellent form of mitigation.

On the other hand, it is necessary to reduce emissions of methane from traditional production systems, such as flooded rice fields or livestock. This implies changes in technology but also the application of best practices by eg reducing the use of grain in cattle.

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[135] Nellemann, C., MacDevette, M., Manders, T., Eickhout, B., Svihus, B., Prins, A. G., Kaltenborn, B. P. (Eds). February 2009. The environmental food crisis – The environment's role in averting future food crises. A UNEP rapid response assessment. United Nations Environment Programme, GRID-Arendal, www.grida.no

The reduction of chemical inputs, especially pesticides and fertilizers through appropriate agricultural practices not only reduces emissions of greenhouse gases, especially nitrous oxide, also allows recovery of biological activity and thus the fertility of the soil and .

There is still much ground to cover for recognition in the market mechanisms, especially carbon markets, the different ways in which agriculture itself can become a net carbon emitter to a major ally in the fight against climate change.

Adapting to Climate Change

Adapting to climate change means learning to live with it. In these moments will be decisive, since the impacts of climate change, as we saw above, are already being made. We can classify the adaptation:

- Delayed: Based on the reconstruction or restoration after the attacks occurred since.
- Reactive: It is immediate, as changes are happening
- Occasions: The adaptation is performed according to the circumstances that are occurring in the short or medium term
- Creative: The best results can offer. Future scenarios are used and, choosing the most favorable and probable strategies are devised to minimize negative impacts by strengthening the resilience and adaptability. It is based on the pursuit of objectives that provide the most comprehensive benefit most. Creative management is long term and seeks to improve the quality of life and economic indicators.

Unlike mitigation, adaptation there are no recipes. Policies and adaptation strategies should be developed locally, in a participatory manner, where the responsibility lies with all sectors of government, civil society and private sector, with reliable and sufficient scientific information, experts and the incorporation of local knowledge. Given the diversity of impacts of climate change, with significant altitudinal and latitudinal variations, the close relationship between the degree of preservation or deterioration of ecosystem functions, crops and their associations, used at each location, the presence of protected areas or nearby natural areas (which increase the presence of pollinators and biological pest control), among many other factors, requires the adaptation processes are developed specifically for each location. Adaptation processes can vary over very short distances. For example, in the upper basin may be needed process of restoring forest cover to prevent runoff and regulate water flow, while in downstream interventions may be required to deal with possible flooding. Adaptive processes will be different for large areas of monoculture, which are extremely susceptible, or highly diversified systems, much more resilient.

Requirements for adaptation to climate change

- Holistic and multilevel approaches, from local to global.
- Ecosystem-based adaptation, seeking a balance between use and conservation, so that it can have long-term with the largest number of ecosystem services.
- Risk analysis and vulnerability in order to identify priorities for action and make decisions about what is feasible to try to rescue or to keep and what must be sacrificed.
- Valuing real, whether economic or spiritual, seeking to incorporate processes actual costs, so-called externalities.
- Collaboration at all levels, public - private, intersectoral, local to global.
- Management of complexity requires holistic process and not compartmentalized which means a paradigm shift in institutional research and teaching.
- Implementation - learning: the assessment and permanent incorporation of lessons learned.
- Uncertainty and precautionary approach to be essential not to increase the risk, if there are doubts about the impacts, it is better not to perform the actions.
- Scientific information is of fundamental importance. It involves continuous monitoring, the use of simulations and models, filling gaps in knowledge, but especially the use of information for action.
- Recognition full and incorporation of local knowledge, knowing that the people living in ecosystems and dependent upon information and knowledge are vital for managing them.
- Knowledge opportune time to guide management processes and management of uncertainty.
- Participatory planning, allowing the stewards decision-making role in the processes of conservation and development.
- Technological development for widespread use throughout society.
- Values, ethics and transparency as a basis for decision making.

Since there are many approaches and procedures including the development of adaptation policies, however, is required to substantially increase the implementation of concrete actions in the field, both through technical assistance from ministries and departments of agriculture and in the private sector . You must pass the diagnosis and action planning, it is better to err by not doing anything, never have the perfect solutions.

In agriculture, we can divide adaptation actions into two interrelated areas estrechamente[136]:

(1) Improving the management of agricultural risks associated with increasing climate variability and extreme events. This includes expanding the collection of information systems (eg weather stations), monitoring, safety nets and intersectoral coordination.

(2) Local actions that promote adaptation to climate change accelerated progressively during decadal time scales, such as integrated packages of policy options, technology for farmers and food systems.

The incorporation of science, especially climate change science, traditional knowledge, whether community or indigenous people, is essential. The people who best know the functioning of ecosystems are those that grew in them and are closely linked. Examples of successful handling of ecosystem restoration processes using ancient techniques are becoming more frequent, however, changes in climatic conditions are not part of this knowledge and should be understood by local people so they can improve their skills adaptive. To ensure a better fit is required to strengthen personal skills, organizational and institutional in each community. Local governments should be able to support initiatives that promote adaptation, which involves having trained professionals not only in technical aspects must also be leaders and have general qualities. The public sector must look for changes in the institutional to finally ensure cross-sectoral and inter-working. Climate change and adaptive processes above are not the sole responsibility of the ministries of environment, as still happens in some countries. All state agencies must work together, from planning to implementation. It also requires integration with business and other sectors of civil society. Are much more organized communities, the greater will be its ability to adapt and maintain acceptable living conditions.

Working with models and scenarios will be essential. We must make the transition from adaptive management, referred to in the ecosystem approach, reacting to the advancement of management and processes to correct in the way management "creative". The creative management using various scenarios, we analyze the current status and seeks to identify those most favorable scenarios that are achievable with available resources or insurance to be achieved. The manager should "pull" the best development to these scenarios, using all the resources of inter- and transdisciplinary that they can grab.

This requires the strengthening of research, especially applied. It is necessary to improve the processes of making and monitoring information. It must assess the risks in order to have good plans for its management, especially prevention. It should have alternative plans (contingency) prepared, in order to reduce costs and shorten the above answer. The change can not be reactive, it would probably be too expensive and ineffective. Adaptation should be preventive, proactive and as mentioned, creative.

Systems and Sustainable Lifestyles

Are increasingly global and local initiatives based on the search for sustainable lifestyles. These are characterized by their holistic approach, looking at personal changes that together generate a collective change. These changes range from a fuel-efficient (less wasteful) consumption differential (changes to quality goods and services), the transition from net consumers to co-producers of goods and services (urban agriculture,

[136] Vermeulen, S.J. et al. 2010. Agriculture, Food Security and Climate Change: Outlook for Knowledge, Tools and Action. CCAFS Report 3. Copenhagen, Denmark: CGIAR-ESSP Program on Climate Change, Agriculture and Food Security.

subsistence agriculture). Are showing promising synergies for health, equity and welfare by re-evaluating the ways in which we live, eat and move[137].

The promotion of diversity (cultural, biological, economic, social) increases the resilience of any system, allowing a better adaptation to change. This means reversing the processes of homogenization promoted by consumer markets and mass media. The recovery of food traditions by valuing local products will improve the supply and thus the health of people, while ensuring the recovery of the diversity of species used by humans. The assessment of the local generating enormous benefits in terms of recovery of self-esteem and recovery of traditions and customs. Young people do not feel proud to continue with the traditions, often ancient. The role of elders in society as repositories and transmitters of knowledge is retrieved. The establishment of local networks interconnected with the global will allow the exchange of experiences and developing adaptation options from the local.

Climate change is not about technology, economics or politics. It comes to ethics, values, equity and peace: a new paradigm for human development. As never before in our history, common destiny requires us to seek a new beginning. This requires a change of mind and heart also requires a new sense of global interdependence and universal responsibility. We must imaginatively develop and apply the vision of a sustainable way of life locally, nationally, regionally and globally. Our cultural diversity is a precious heritage and different cultures will find their own ways to realize establecido[138].

We must regain the lead in shaping our societies and generate critical thinking, opportunities for dialogue and advocacy. These people produce and promote communication skills, charisma and leadership and a strong ability to integrate vocational training and a truly complete vision to break current paradigms and allow the emergence of new paradigms is a vision that incorporates strong values, ethics, spirituality and transparency and by implementing comprehensive planning processes, especially at local level with methodologies such as Agenda 21 locales[139].

We require recycled professionals who can manage and integrate various disciplines, with expertise on diversity issues with vision, creativity and strong leadership skills together with high in the search for consensus.

It requires the development of robust processes based on probabilities, incorporating trial and error, risk management and permanent systematization for effective communication.

Most important is the strong public - private partnership, incorporating from national governments to communities seeking to strengthen institutions at all levels:

- Central government institutions
- academic
- private enterprise
- NGOs
- municipalities
- Community and development organizations

Summary

The emergence of a new global civil society is creating new opportunities to build a democratic and humane world,

- valuing and recognizing safeguarding natural capital is irreplaceable
- fundamental changes in our values, institutions and ways of life.
- decreasing the consumption
- valuing people and society for what they are and not what they have
- with the participation of all in equitable development
- investing heavily in education, research and culture.

[137] SPREAD. Sustainable lifestyles: Today's facts and tomorrows trends. http://www.sustainable-lifestyles.eu/fileadmin/images/content/D1.1_Baseline_Report.pdf Consultado el 4 de marzo 2012.

[138] Carta de la Tierra. www.earthcharterinaction.org Consultado el 8 de marzo del 2012.

[139] PNUMA, Proyecto Ciudadanía Ambiental Global. (2005). Guía para la planificación estratégica sostenible local (Agenda 21 Local). 65 p.

We must lead from the future rather than from past experiences and outline the social technology for transformational change that will allow leaders in all segments of our society, including those in our own lives, to achieve its challenges those involved in creating change or shape their future, regardless of their formal positions in structures institucionales[140].

The choice is ours, form a global partnership to care for the Earth and care for one another or risk the destruction of ourselves and the diversity of life. We must realize that once basic needs met, human development is primarily about being more, not having more. Fundamental changes are needed in our values, institutions and ways of life.

"Let our time be remembered as the dawn of a new reverence for life, the firm resolve to achieve sustainable development, the quickening of the struggle for justice and peace and joyful celebration of life."[141]

[140] Scharmer, O. Teoría U. www.ottoscharmer.com Consultado el 10 marzo de 2012.
[141] Carta de la Tierra.