



Soil as the New Soldier in Fighting Climate Change

Iceland's Lessons for World Sustainability

**Speech by
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Distinguished professors, scientists, students,

Ladies and gentlemen

A few days ago the United Nations Climate Change Conference was opened in Copenhagen, convened to discuss the gravest problems now threatening mankind and examine possible solutions, advanced technologies and frameworks of cooperation which could allow us to rally all countries, all people, hoping that we have the necessary wisdom and a sense of responsibility to succeed.

Settling the differences between the emerging economies and the industrialized countries is a formidable task, but the increased awareness of an immediate threat and the progress made by research and scientific discoveries offer more hope of succeeding than we had a few years ago.

For a long time, it was an uphill battle even to discuss climate change, because the doubters and the nay-sayers occupied centre stage. Recently, we have seen a fundamental shift, primarily because the evidence is now overwhelming. Research on the Arctic and the Greenland ice sheet indicates that the point in the melting process, which was expected to occur in the middle of the 21st century, has in fact already been reached. Global warming is now several decades ahead of schedule.

In Iceland we are witnessing the alarming rate at which our glaciers are melting. Some mountains and valleys that were covered by ice for centuries, have now become exposed.

My country can indeed be described as a theatre of climate change because major natural systems are located either within Iceland or in the ocean around the country. We have the largest glaciers in Europe, and for over a century we have been struggling to contain the largest desert in Europe. The Gulf Stream encircles our island, mixing with the water produced by the melting of the Arctic, creating what can be described as the motor driving the global conveyor belt of ocean currents and influencing the climate all over the world.

However, Iceland is not only a theatre of the processes and consequences of climate change. It can also serve as an inspiration, as an example of how to retard change through a comprehensive transformation of our energy systems, which also brings an enormous economic advantage.

Since I visited Ohio two years ago, we have seen significant change in the global debate. More now acknowledge that all nations must act in order to prevent global warming; an increase in world temperatures by only a couple of degrees would cause disasters in the most densely populated regions of the globe.

In recent years we have gained increasing awareness of how our eco-world is in fact a single system, how developments in one particular area of the grand mechanism of our existence may have hitherto undreamt-of consequences in another. The most dramatic contemporary manifestation of this interdependence is the relationship we have come to understand between climate change and the destruction of the soil, and how this constitutes a vicious circle.

Land degradation, manifested in the loss of carbon from the terrestrial ecosystem, is one of the major contributors to the buildup of greenhouse gases in the atmosphere. As land loses its cover and vegetation retreats, its capacity to capture carbon is reduced, and this in turn accelerates climate change. Warmer years may result in droughts, affecting water resources and an endless number of eco-systems, often furthering the spread of dangerous diseases.

In the last three years I have had a number of meetings with President Hu Jintao and other Chinese leaders and also with ministers and other prominent figures in India. I have observed a fundamental shift in their view on climate change. China is clearly determined to reduce the pollution which now erodes the quality of life in its growing urban regions. The emerging middle class wants to preserve its health and enjoy the freshness of the air. The leaders have also discovered that air pollution in the cities is a potential source of social unrest. This might partly be the

reason why they have become more constructive, deciding this year to announce the target of reducing ‘carbon intensity’ by 40-45% by the year 2020 compared to the level of 2005.

In his speech at the UN Climate meeting in New York last September, President Hu Jintao stated:

“Global climate change has a profound impact on the survival and development of mankind. It is a major challenge facing all countries. . . . We should make our endeavour on climate change a win-win for both developed and developing countries.”

He added that China has taken steps to tackle this challenge by radically increasing forest coverage and volume, by enhancing the share of non-fossil fuels in energy production and by improving energy efficiency.

Just like India, China depends heavily on the water resources in the glacial regions of the Himalayas. They affect fundamentally seasonal balancing, irrigation, food and hydroelectric production. There are strong indications that the glaciers in the Himalayas, of which there are thousands, might disappear completely within the next 20-30 years, given the present rate of climate change. Thus, China and India could suffer the most immediate and disastrous consequences suffered by any country. Their leaders might argue, correctly, that it is greatly unfair that the more than two billion people living in those countries should be so severely affected when climate change is primarily caused by the economies of Europe and America.

The deterioration of the Himalayan glaciers and their water systems is a strong reason for India and China to monitor current and future climate change more closely than ever before; to become active partners

in the search for solutions. For them, the stakes are indeed higher than for most Western countries. It is therefore, in my opinion, not inconceivable, given the climate threats faced by China and India, that they could in the next 10-20 years achieve greater CO₂ reductions than either the US or Europe. The common excuse, which is so often quoted, for non-action in the West — that China and India are not doing enough — might thus be reversed. By 2025, the two Asian giants could be calling on the US to match their CO₂ reductions.

It came to my attention a couple of years ago, and was confirmed in dialogues with glacial experts here in Ohio, that research on the Himalayan glaciers was very limited and that only a few Indian scientists had specialized in glaciology. I therefore decided to initiate a research project aimed at enhancing the monitoring of the glaciers in these regions. Since the Himalayas include the borders of powerful countries, information on these developments is subject to military considerations. The principle of guarding information within military circles — just the opposite of what applies in the scientific community — has resulted in very little being known about what is really going on in the hydrology of the Himalayas. The need for scientific research is all the more urgent since the livelihood of two billion people may be at risk.

I have accepted the invitation to make a State Visit to India next month when I will attempt to stimulate constructive discussions on how to increase scientific cooperation in this area. Already, Icelandic glaciologists have started a dialogue with some of their Indian colleagues. Notwithstanding the military dimension, I have great confidence that the Indian and Chinese authorities will welcome co-operation on research in this area and thus help all of mankind to understand better one of the most crucial aspects of climate change.

But there are other alarming statistics which should serve as a wake-up call for us all. The UN Millennium Ecosystem Assessment (MEA) has ranked land degradation among the world's greatest environmental challenges, pointing out that it threatens to destabilize societies, endangering food security and increasing absolute poverty. Deteriorating soil and agricultural land; shrinking vegetation cover and forests; diminishing supplies of clean water; the threat of growing social and ecological vulnerability — all of these are not just local difficulties — they are pressing global issues.¹

We know that the world's agricultural land, per capita, has decreased over the last three decades, while at the same time per capita food consumption has increased by approximately one sixth. At first it looks like a riddle: How can we be consuming more as arable land is shrinking? Yes, farming is becoming more productive, helped by enhanced technologies, more efficient irrigation and new fast-growing seeds. But this raises worrying questions: How much of modern farming is unsustainable? How much can we squeeze out of the land without putting too much strain on it? And to invoke an inconvenient truth: How do we tackle the threat of regional but increasingly serious water shortages? All of these questions must now be put at the top of the global agenda.

For the first time the world faces a task of immense proportions: the challenge to produce enough food will be greater over the next 50 years than in all previous human history.

More carbon is stored in soils than in living matter and the atmosphere combined; soils contain 82% of all active terrestrial carbon. A substantial proportion of today's greenhouse gases in the atmosphere originate from carbon and nitrogen compounds from soils, due to over-

exploitation of this resource, and further climate change may accelerate the release of carbon from soils, especially in the Arctic.

Annually, approximately two gigatonnes of carbon are sequestered in soil organic matter, four times less than the annual amount of carbon released by human activities.

A recent study (Bellamy, 2005) argues that organic matter is generally decreasing in world soils. The percentage of soils in Europe with less than 2.6% organic matter rose from 35% to 42% in the period 1980-1995. The main reason, it is claimed, is the increase in temperature; this trend is significantly lowering carbon sequestration in the soil.

I recently discussed this challenge with an Icelandic scientist, Professor Kristin Vala Ragnarsdottir, who heads the Faculty of Engineering and Natural Science at the University of Iceland. In a review she points to two methods of increasing carbon sequestration in soil. One is to mix different kinds of organic matter, such as charcoal, algae and mammal or fish bones with the soil. This strategy is inspired by the black soil or 'terra preta' found in the Central Amazon; it has proved to be exceptionally good for farming and long-term carbon sequestration. There is evidence which indicates that the prehistoric Amazonian Indians enriched or even produced this rich, black soil. Whether this can be done on a large scale is a fascinating question, discussed enthusiastically by Al Gore in his new book, *Our Choice*.

The other method which Professor Ragnarsdottir describes is to mix rock dust with soil with the aim of speeding up the weathering process, which allegedly binds CO₂. She argues that there is now evidence that the addition of rock dust may be another 'low-tech' method of reducing CO₂ in the atmosphere since the gas is consumed in the weathering of rocks, which forms the basis of soil formation. This could be relevant in many

different parts of the world but it would require a revolutionary change in our view of and use of rock dust.²

Although I have benefited from numerous dialogues with Professor Rattan Lal and many of his Icelandic and other colleagues, I am not a soil scientist myself, and I leave it to the experts to evaluate ideas of this kind. However, it seems beyond dispute that land use can be one of the key pathways to resolving the problems created by the ever-increasing release of carbon.

My country is proud of its long-standing tradition of land conservation, and demonstrates vividly how carbon lost to the atmosphere can be recaptured in soil and vegetation through land restoration programmes. A special law was passed one hundred years ago, dedicated to fighting the Icelandic desert which, by the way, is the largest in Europe. Sowing and preserving grasslands, planting trees and nurturing forests have enjoyed popular support for decades now in my country, and recently the preservation of wetlands was added to our agenda. In the past, these endeavours were inspired by practical and economic purposes. Afforestation was even driven by aesthetic reasons. But in recent years, the need to reduce CO₂ emissions has added a whole new dimension to our activities. In the past millennium Iceland may have lost the equivalent of more than one billion tons of CO₂ through soil erosion and ecosystem degradation, compared to the current annual release of 5 million tons. At the Copenhagen Conference, the inclusion of constructive and responsible land use and the recovery of land quality in the new international agreement is therefore a priority mission for the Icelandic delegation.

I have described how Iceland provides a unique opportunity to understand the links between human attitudes, human behaviour, land succession and ecosystem development. Through the work of the SCS

(Soil Conservation Service) over the past 100 years, we have been working on a nationwide reclamation project in response to overgrazing and subsequent erosion by wind and water. The project includes local sheep farmers and other land users, engaging them in conservation practices on both private and common lands. In addition, Iceland has undertaken a nationwide research project for the IPCC to study carbon sequestration on reclaimed land and has established 1,000 sampling plots throughout the country which will be sampled once every five years to document long-term changes in soil quality, which includes the soil carbon stock. This information, and data from related studies, will provide the background and baseline for a comprehensive, interdisciplinary project whose results will be of significance for many areas of the world.

The 'Farmers Heal the Land' program, which is aimed at promoting land restoration and sustainable land management, has succeeded at engaging 25% of the sheep farmers in the country. Most landowners, however, believe that land cover change, and in particular the development of bare patches of soil, is a historical problem, as opposed to a modern-day concern, and that it is driven largely by their land use, interacting with natural climatic factors. Overgrazing is not seen as a problem by a large majority; in fact, most believe conditions have improved over the past 50 years as practices have changed with less use of common pastures; people have left the rural areas, and individual farmers have engaged in reclamation work with the Soil Conservation Service. Thus, while there have been success stories, there is often a disjunction between research and the transfer of technology to the land manager.³

In my younger years, the Icelandic State subsidized the draining of wetlands. At that time, they covered large areas of Iceland and made them

unsuitable for harvesting or even grazing. Farmers received grants to drain them, the aim being to increase the availability of arable land, and improve pasture quality. The result in some places was a profusion of ugly drainage ditches which many saw as greatly damaging the pristine landscapes of our country. Now we have learned to appreciate the wetlands, recognising that they are valuable not only for their beauty but also for their powerful binding potential for carbon.

Interestingly, the Agricultural University of Iceland is located within an extensive wetland area, encompassing estuaries, rivers and lakes. The University is expecting that its entire campus area of about 1,500 acres will be declared a 'Ramsar site', or a wetland of global importance. Recently, we opened a Wetland Center at the University of Agriculture's Hvanneyri Campus dedicated to wetland preservation and international research efforts.

The work done at the Agricultural University and other institutions of learning has been valuable for my country, and our research community has had the fortune to work with many distinguished scientists in other parts of the world. Thus, Icelandic universities have signed an agreement with the Ohio State University on student exchanges and academic cooperation. which is already working very well. Experts from both sides were involved in the preparations for the productive international Conference on Soils, Society and Global Change which was held in Iceland in September 2007 to commemorate the 100th anniversary of the Icelandic Soil Conservation Service. The Ohio State University made a great contribution to this prestigious conference and together, the teams of enthusiastic soil scientists from our two countries did a truly remarkable job.

I hope I am not playing down the importance of other deserving team-members if I mention the name of Professor Rattan Lal, who has been a great inspiration for all involved in the Iceland-Ohio collaboration. His scientific experience, practical mindset and diplomatic skills have been of immense importance. As Rattan knows, I keep his monumental Encyclopedia of Soil Science in a conspicuous place in the Presidential Library to remind me and my visitors continuously of the importance of soil preservation and land care.

The history of agriculture since Iceland was first settled around eleven hundred years ago is indeed a worthy subject of attention, and it offers many lessons for the present global debate. The middle ages were for my nation a glorious period, in which we created unique literature, including the epic sagas. However, the use of land was unfortunately a tragic example of short-sighted exploitation of limited and vulnerable resources.

Our medieval literature describes how the country was covered with woods from the sea to the mountains when the first Vikings came from Norway, but what followed was desertification, due partly to overgrazing and exploitative chopping of the woods. Within the first few centuries, about 80% of the original woodland had been cleared and the grasslands of the interior became the desert we can see today. The soil was carried from the highlands down to the lowlands and out to the sea.

It is indeed disturbing when we understand how this process of deterioration came about. The woods were destroyed or burned, with sheep grazing accelerating the process. The result was that to this day, Iceland remains the largest desert in Europe, despite the great efforts made to reclaim its lost soil.

In his recent book *Collapse: How Societies Choose to Fail or Succeed*, Professor Jared Diamond discusses the Icelandic case of soil erosion as an illustration of a society that, as it were, chose to fail. For centuries, the Icelandic settlers and their descendants certainly did not understand how sensitive the recently settled land was to the agricultural practices which they had brought with them from Norway and other parts of Northern Europe. The vegetation in Iceland was more fragile than what they had been used to in their former homelands. As Professor Diamond argues, they simply did not know how to farm a volcanic island with such a scanty membrane of soil. Consequently, large regions of my country became victims of the winds; the soil eroded away and huge amounts of carbon were released.

The Viking immigrants offer us an important lesson. They did not suddenly throw caution to the wind when they settled in Iceland, but they found themselves in an environment which appeared lush but was actually fragile. Their previous experience could not possibly have prepared them for the challenges ahead, and their situation was somewhat akin to the one facing the global community in our time.

The conservation of soil and vegetation ultimately became an important issue in my country; this development began in the last stages of our campaign for independence. Towards the end of the 19th century, people with foresight and vision understood that special efforts were required. A crucial milestone was the establishment of special agencies for forestry and soil conservation in 1907, only three years after the Danish Government had agreed to grant Iceland Home Rule, so enabling the nation to leave the colonial past behind and establish authority over its domestic affairs.

People, enthusiastic to take good care of the land they could now govern, were determined to heal the wounds inflicted by their unwitting or short-sighted ancestors. Land reclamation, in the form of cultivating trees and reclaiming grassland, became a popular endeavour; gradually it won the support of farmers and city-dwellers alike.

The history of land use in Iceland is significant because it can serve as a warning about what is bound to happen when ignorance and greed are allowed to control our conduct. At the same time, it can be an encouraging tale of a visionary people who, through increased awareness, organized a resistance campaign against land degradation.

In the thirteenth century, when the bountiful resources of Iceland had been greatly diminished, the country went through a series of local battles which may be described as a version of civil war. In the following four centuries, the land deteriorated even further with a cooling climate and volcanic eruptions, resulting in even more erosion; eventually the population itself was considered to be in danger of extinction.

Environmental challenges can often translate into armed conflicts, as demonstrated by recent examples of how soil erosion becomes the root cause of humanitarian crises, vicious and tragic ethnic confrontations. Darfur is but one example. A score of countries in Africa, Asia and elsewhere, have seen the deterioration of the land and the enlargement of the deserts threaten to sow the seeds of severe conflicts in the years to come.

It is important to understand the complex ecological, economic and social interplay of land use, water resources, energy production and carbon emissions. Increased greenhouse gas emissions will bring higher temperatures and in consequence more wind; lack of water will erode the soils in densely populated areas which are highly dependent on traditional

agriculture. Now the Caspian Sea and the Lake Chad, two huge water reservoirs, have more or less disappeared, leaving large regions open to dust and wind erosion.

At the same time, the accelerated melting of the Greenland and Antarctic ice caps, similar to what is happening to the glaciers of Iceland and the Himalayas, will make the ocean level rise considerably, washing away excellent farmland soil in Bangladesh, the Mekong delta and various other parts of the world. With increased poverty, social unrest, even warfare, people have very little chance of using their farmlands in a sensible and far-sighted manner.

These wide-ranging issues can indeed be resolved, but without sensible land use, the suffering countries will never get close to the rescue. Many nations are now in the footsteps of the tenth-century settlers in Iceland. Like my ancestors, they have the choice whether to run their agriculture in a sustainable way. The experience of Iceland should teach us all to make the wiser choice: to aim whenever possible for sustainable practices.

We need to work with the grassroots, with farmers who understand that their own long-term interests lie in sustainable farming, and here again, the Icelandic experience can be of help. Some decades ago, our farmers were suspicious of land care initiatives; instead they wanted to keep on doing what they had always done. Gradually, the tide turned. Now the farmers are successful partners in reforestation, land restoration, soil preservation, and other sustainable projects, so creating a strong foundation for our future food security.

This success story in caring for the land forms the basis for the suggestion of an International Year of Landcare, put forward at the International Forum commemorating 100 years of successful

conservation and restoration of soils in Iceland, and further evaluated by Emily Mutota, a fellow of the Icelandic Land Restoration Training Programme.

A sufficient supply of food is an increasing global concern and perhaps leaders all over the world should aim to create an Earth Charter, a manifesto which would summon all stakeholders to tackle the compelling tasks of enhanced and sustainable land use, to develop an ethic of land care, accepted by land users and decision-makers alike.

The quality of the land for food production and water storage is fundamental to world peace; by contrast, misuse and mismanagement of the soil, degradation of ecosystems, soil erosion and desertification can create global problems of colossal proportions.

The global community will not be able to achieve goals essential to sustaining our future without a major improvement in the conservation and restoration of the world's soil resources. While demand for the soil's services are growing, the problems of unsustainable land use are intensifying in many parts of the world. Climate change exacerbates land degradation, primarily through changes in precipitation and evapotranspiration patterns. A creeping environmental crisis is thus affecting a growing proportion of the world's population.

Reductions in ecosystem functioning, coupled with erosion of soil and reduction in soil nutrients and moisture, are a major factor in the reduction of biodiversity in many parts of the world. This in turn can reduce production, accelerate land degradation and constrain our capacity for responding constructively to change while trying to meet current and future human needs.

Increasing food needs have mainly been met by clearing and irrigating more land, converting natural forests to agricultural land, and applying more fertilisers – all unsustainable land-use options that have had negative consequences for the health of soils, land and biodiversity. These options, however, are now narrowing. This is partly a result of the realisation of the effects of global greenhouse gas emissions and the loss of biodiversity, and partly a result of soil degradation.

These negative trends cannot be allowed to continue if societal needs, based on a properly functioning natural system, are to be met. A new vision is needed that places soil at the heart of global social, economic and environmental solutions.⁴

Using the words of Professor Rattan Lal at the 2007 Forum in Iceland, desertification control and restoration of degraded soils and ecosystems has a potential to sequester 0.9 to 1.9 billion tons of carbon per year globally. To put this in context of food security, increasing soil organic carbon in degraded land by 1 ton per hectare per year can increase global food production by 26-30 million tons per year.

At this Forum on Soils, Society and Global Change, which was held in Iceland two years ago, I outlined elements of an Action Program which could contribute to the solution of these problems:

First, the strengthening of education of agricultural experts from developing countries.

Second, the establishment of field laboratories to conduct site-specific research on desertification.

Third, sending experts to suffering locations to examine and give advice on what can be done about land degradation. The envoys could bring to these locations new modes of thinking concerning the selection

and adoption of land-use strategies, and new technologies to restore degraded soils and ecosystems, bringing the projects to the grass-roots level and encouraging active participation by the farming communities, by people in villages which are home to more than a billion people the world over.

Fourth, initiating efforts to back up research efforts on restorative technologies.

Fifth, including land use and the restoration of land quality – enhancing the carbon content of the soils – as a variable in the system of tradable carbon credits and using the revenues of the system to restore degraded soils and ecosystems.

Sixth, improving existing programs for graduate research and supporting international networks in the earth sciences.

Seventh, encouraging the four pillars of modern society — scientific communities, governments, business sectors and civic associations — to combine their resources to build the foundations for sustainable land use.

All these efforts could, together with other programs, help to support the struggle against climate change and thus secure a brighter future for all of humanity. The cooperation with the Ohio scientific community has helped to further my understanding of how to meet these challenges and I am indeed looking forward to our discussion here today.

I have chosen to preface our dialogue with references to the Icelandic experience because, due to the rapidly changing natural environment, people around the world are constantly finding themselves in circumstances for which previous times have failed to prepare them. Now more than ever, we must channel scientific knowledge and practical lessons into projects of paramount importance, while at the same time

remaining open to new ways of presenting complex tasks, mindful that our knowledge and understanding are inevitably always imperfect.

This mode of thinking must characterise how we approach the challenges which confront us, and how we construct the necessary cooperational framework. The art of human existence is indeed the art of adjustment. We react to something which was not expected, not even imagined. As Francis Bacon — the great pioneer of modern science — put it some 400 years ago: ‘He that will not apply new remedies must expect new evils.’

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¹ This paragraph quotes Mutota, 2008, p. 74.

² This paragraph refers to a conversation with Dr. Kristin Vala Ragnarsdottir on 3 November 2009 and an unpublished memorandum prepared by her.

³ This and the preceding paragraph are borrowed from Ferris, 2009.

⁴ This and a couple of preceding paragraphs are based on Dr. Andrés Arnald's Preface to Bigas et al. 2007, p. xi.