Chapter 5

Food in the 21st Century: Global Climate of Disparities

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5.1 Food in the 21st Century: Global Climate of Disparities

We are living in a unique and defining moment in history. It is unique with respect to the progress in science and technology that has been achieved in the past half century. Beginning with men on the moon in the 1960s and continuing with the green revolution of the 1970s, the information revolution of the 1980s, and the genetic revolution of the 1990s, the 20th century ended with the mapping of the human genome.

These scientific and technological achievements are formidable accomplishments with significant potential for the future. But today we live in a world of disparities where a fifth of the global population exists in poverty and hunger. The poor are poor because they lack tangible assets, lack formal education and technical skills and have little access to such basic needs as health care and safe shelter. And the poor often face political and social discrimination.

Some 800 million people go hungry every day, and over one billion live on less than a dollar a day. Without social, economic, and scientific progress, a third of the world's expected population of some 9 billion could be living in poverty in the second half of the 21st century. Every minute of every day, 15 children and 15 adults die of hunger in the developing world. During the course of this four-day meeting alone, some 200 000 people will die from a lack of food. This food insecurity affecting over 10% of the world's population is a sad indictment of the world's failure to respond adequately in a time of unprecedented plenty.

The challenge of poverty reduction is not an option but an imperative in a world of interdependence, reciprocity and interpenetration. The progress in science and technology, including the knowledge revolution and environmentally sound management of natural resources, has the potential to reshape and manage the emerging challenges of the 21st century. It is a defining era of knowledge-based decisionmaking that can put the world on a path toward equity and sustainability.

5.2 The Critical Role of Knowledge

It is knowledge that is available, accessible, and affordable that will drive progress in the 21st century, and perhaps become more relevant than capital. Living at a time of rapid changes and challenges, timely action based on credible and comprehensive information is critical.

Information becomes knowledge when it has utility. It needs to be policy relevant, scientifically credible, and available at the right place at the right time. Knowledge empowers and enables. In an open forum, it promotes synergy, transparency, and accountability.

Science and technology are increasingly becoming proprietary, and owning knowledge is becoming the order of the day. Does this mean that those who cannot afford it will be denied the fruits of scientific participation and progress? The number of patent applications has grown from 1 million in 1985 to over 7 million today. Recently a US company even attempted to patent turmeric – an herb valued for centuries in India for its medicinal properties! Fairness, justice, or ethics – which way do we turn?

The internet and other communication developments have ushered in a new era of knowledge sharing. Access to the internet is growing rapidly; in the next 4 years the number of people with access will double to one billion. In the past 10 years, the number of websites increased from 1 000 to 20 million today. But it is a world of disparities: it costs 2 months average wage to access the internet in Bangladesh, in comparison to 1% of the monthly average wage in the United States. Also some 50% of the population in the United States and a third in the European Union are internet users, whereas less than 0.5% of the population in Asia and Africa use the internet. Such a continuing knowledge divide would extenuate the wide inequity gaps and hinder progress towards goals of sustainable development, especially the reduction of hunger and poverty in the world.

W. Steffen et al. (eds.), *Challenges of a Changing Earth*

5.3 Environment and Sustainable Development

From Stockholm to Rio and now to Johannesburg, in just 30 years we have begun to understand our living environment. Sustaining this environment demands local, national, and international action.

Climate change, air and water pollution, pests and diseases, economic and social turmoil, and even genetically modified crop contamination do not recognise or respect political and geographical boundaries. It is critical that we act based on rational analysis, but at the same time we must be wise in our actions. Without responsible decisionmaking, compromises, and even sacrifice, the children born at the end of the 21st century may face a bleak future indeed. We must begin now to consider our response to global changes and challenges, because the actions taken today will affect the quality of life for us and for generations to come.

The rapid population growth of the past 50 years combined with the explosive increase in consumption is threatening the ability of ecosystems to supply our needs and to absorb the impacts of pollution and waste generated by human activities. The good news is that the rate of population growth is decreasing, and world population is very likely to stabilise towards the close of the 21st century. However the next 50 years are critical, as the number of people continues to increase, especially in Africa and Asia. These two regions will add some 3 billion people to their populations by the year 2050.

Many developed countries and some developing countries such as China are likely to see a significant reduction of their populations. At the same time, new problems of a demographic divide will come to the fore: an aging population in some developed countries and a younger population in developing countries, with an implication of human capital migration; underconsumption vs. overconsumption – synonymous with the poor-rich divide with implications for environmental change and degradation; and a science and technology and communication divide, exacerbating progress towards an equitable and a sustainable world.

On the economic front, the disparities around the world are growing ever wider, while at every meeting and forum the international political and scientific community continues to stress the pressing need to reduce the widening gaps between the haves and have-nots.

5.4 Global Environmental Change

Food production systems interact with land resources, forest ecosystems, and biodiversity, and climate change will affect these systems both positively and negatively. Ensuring soil fertility, genetic diversity, agricultural water resource management, and adapting to the impacts of climate change are critical to enhancing production, while agricultural practices of inefficient fertiliser and pesticide use as well as lack of land and water conservation measures and conversion of forest areas will result in irreversible damage to ecosystems and loss of production potentials.

The rapid land-cover changes, biotic fluxes, and extinction of living species of the past 50 years are worrisome. The disturbing truth is that we do not even know what biodiversity is being lost around the world – in our forests, in the oceans, and on land. China, which once had 10 000 land-race varieties of wheat, now has less than a thousand. No one knows what genetic traits leading to insect and disease resistance, stronger plants, higher yields, or even better tasting crops may have been irrevocably lost.

The need for food for an increasing population is threatening natural resources, as people strive to get the most out of land already in production or push into virgin territory for agricultural land. The damage we are inflicting on the environment is increasingly evident: arable lands lost to erosion, salinity, desertification, and urban sprawl, disappearing forest and threats to biodiversity, and water scarcities.

About 70% of the world's fresh water goes to agriculture, a figure that approaches 90% in countries such as China and India, which rely on extensive irrigation. Though renewable, fresh water is a finite resource, not evenly distributed across countries, regions or even seasons. Two-thirds of the world's population live in areas that receive only one-quarter of the world's annual rainfall, while sparsely populated areas as the Amazon Basin receive a disproportionate share. Because of extensive upstream use, some of the world's major rivers – the Nile and the Ganges, for instance- barely run into the sea any more. The growing water scarcity in the future will pose a serious threat to food security, poverty reduction, human health, and protection of the environment.

Thirty years ago, the world faced a global food shortage that some predicted would lead to catastrophic famines. The danger was averted because an international research effort enabled scientists to develop and farmers to adopt high-yielding varieties of major food crops. The lessons of that green revolution indicate that an integrated biological, environmentally sound, and socially viable strategy has to be at the core of the next precision green revolution.

In the 21st century, we now face another threat – perhaps a more devastating environmental threat of global warming and climate change. There may be uncertainties, but we cannot be complacent, not when the most fundamental of human survival need for food is at risk.

5.5 Global Agro-Ecological Assessment

Given the complex and interlinked components of the food security challenge in the 21st century, it is clear that solutions that deal with one part – for example, crop productivity, land use, water conservation, or forest protection – will not be sufficient. The issues are connected and must be dealt with as an interlinked holistic system to ensure sustainable management of natural resources.

Future land use and agricultural production are not known with certainty:

- What will be the spatial extent and productivity of arable land in each country?
- What will be the availability and adoption of agricultural technology?
- What new improved genetic crop varieties will come available?
- What impact will climate change have on specific countries and regions, on forest ecosystems, on biodiversity and on water resources?

The agro-ecological zone (AEZ) methodology follows an environmental approach: it provides a standardised framework for the characterisation of climate, soil and terrain conditions relevant to agricultural production. Crop modelling and environmental matching procedures are used to identify crop-specific environmental limitations under assumed levels of inputs and management conditions. The main elements in the AEZ framework are shown in Fig. 5.1.

The AEZ approach is a GIS-based modelling framework that combines land evaluation methods with socioeconomic and multiple-criteria analysis to evaluate spatial and dynamic aspects of agriculture. Land and climate resources are assessed to quantify crop production. All important food and fibre crops are considered.

The global AEZ resources database comprises of a digitised overlay of climate (derived from 1901 to 1996 time series climate data set, Climatic Research Unit, University of East Anglia); FAO/UNESCO soil map of the world linking soil associations and attributes, elevation and slope distribution; global land cover data set: crops, forests, woodlands, wetlands; and spatial population distribution by grid cells. A large amount of agronomic farm management data from around the world has also been incorporated.

A total of some 2.2 million-grid cells covering all countries' land resources are delineated. For most countries, a grid cell amounts to a land area of some 5 to 10 thousand ha. For each grid cell, the assessment considers 28 possible crops at three levels of inputs, namely low, intermediate and high. The high level assumes the

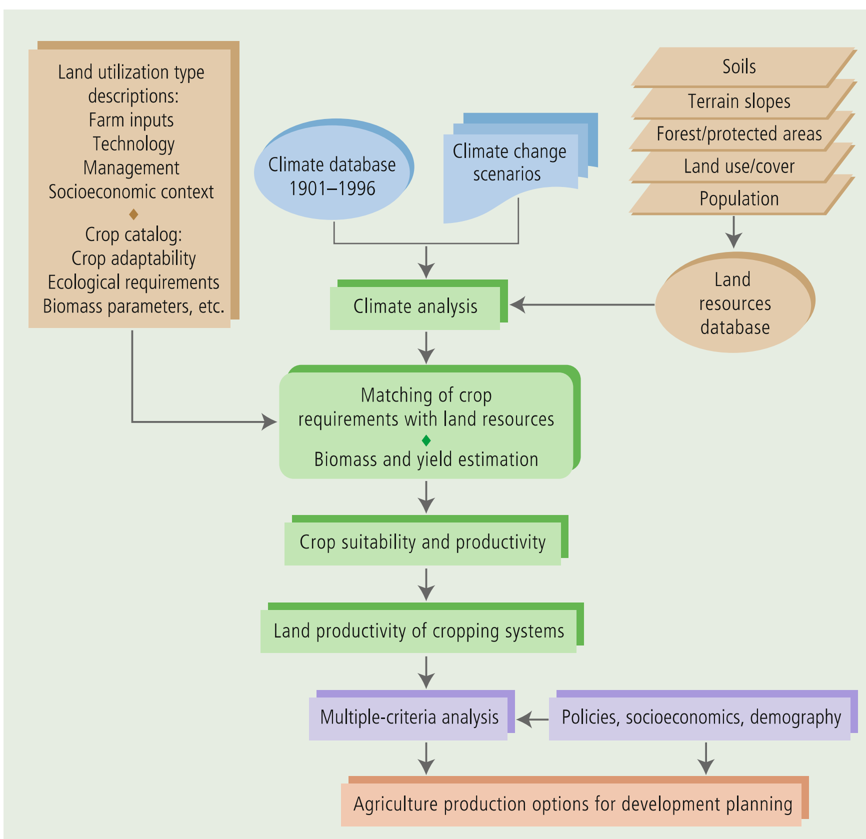

Fig. 5.1. AEZ methodology (reproduced with permission from Land Use Project/IIASA 2001)

best farming technology, inputs, and management known today. Sustainable natural resources management and precision agriculture are also at the core of this technology. Future developments in new crop varieties and productivity can be incorporated into the scenario approach.

5.6 Global AEZ Findings

Natural resources constraints to crop production. Three-quarters of the global land surface – over 10.5 billion ha – suffer rather severe constraints for rain-fed crop cultivation: 13% is too cold, 27% is too dry, 12% is too steep, and 65% is affected by unfavourable soil conditions, with multiple constraints coinciding in some locations.

Climate change will have positive and negative impacts, as some constraints will be alleviated while others may increase. This detailed information, at the country level, is relevant to agricultural research – including biotechnology – which is focused on the priority and viability of relieving constraints, covering land areas where the returns to research investments could be substantial. For example, agricultural research in Mexico has resulted in the application of biotechnology to increase plant tolerance to aluminium, thus countering soil toxicity problems common in some tropical areas.

Land with cultivation potential. In Asia and Europe, the rain-fed land that is currently cultivated amounts to 90% of the land that is potentially suitable or very suitable for agricultural production. In North America, some 75% of the potentially suitable or very suitable land is currently under cultivation. By contrast, Africa and South and Central America are estimated to have some 1 billion ha of land in excess of the currently cultivated land of some 350 million ha. However, most of this additional cultivable land is concentrated in just seven countries – Angola, Congo, Sudan, Argentina, Bolivia, Brazil, and Colombia.

Cultivation potential in forest ecosystems. About a fifth of the world's land surface – some 3 billion ha – is under forest ecosystems. Eight countries – Russia, Brazil, Canada, the United States, China, Australia, Congo, and Indonesia – account for 60% of the world's forest land. During the past decade, some 127 million ha of forests were cleared, while some 36 million ha were replanted. Africa lost some 53 million ha of forest during this period – primarily from expansion of crop cultivation.

The AEZ results show that some 470 million ha of land in forest ecosystems have crop cultivation potential. However, using this land for agriculture would have serious implications, as forests play a critical role in watershed management and flood control, and serve as carbon sinks and stores of biodiversity.

Irrigation and multiple cropping. Currently about 200 million ha of arable land are irrigated in the developing countries, and some 54% of this is accounted for by China and India. Irrigation contributes some 40% of production on 22% of cultivated land in the developing countries. For cereals, the major component of food consumption, the share of irrigated production in total world production is almost 60%. The AEZ results for cereal production highlight the important role of multiple cropping and irrigation:

- Rain-fed multiple cropping increases production by about 25% in developing countries and some 10% in developed countries, in comparison to a single rain-fed crop per year;
- Rain-fed and irrigated multiple cropping increases production by about 75% in developing countries and some 50% in developed countries in comparison to a single crop per year.

The AEZ methodology and the spatial database provide a comprehensive and detailed basis for ecological assessments and quantification of regional and national crop production impacts of climate change.

5.7 Global Warming and Climate Change

Global warming will affect agro-ecological suitability of specific crops as well as their water requirements. It may also lead to increased pest and disease infestations.

The increasing atmospheric concentration of carbon dioxide will enhance plant photosynthesis and contribute to improved water-use efficiency.

Increased climate variability and extreme events are reported in some countries. In the absence of mitigation and response capacities, losses from damage to the infrastructure and the economy, as well as social turmoil and loss of life could be substantial. And this burden will fall on the poorest people and in the poorest countries.

It is only in poor countries that drought turns to famine and often that results in substantial economic losses, population displacement, suffering and loss of life. The social and economic costs of such occurrences may undo, just in a day or a month, the achievements of years of development efforts. The challenge of integrated mitigation and adaptation to climate change, variability and extreme events will entail incorporating these issues in long-term strategies for development that are equitable and sustainable.

Responses to climate change can be of two broad types. The first type is adaptive measures to reduce the impacts and risks, and maximise the benefits and opportunities of climate change, whatever its cause. The other type of response involves mitigation measures to reduce human contributions to climate change. Both adaptive measures and mitigation measures are necessary elements of a coherent and integrated response to climate change. If future emissions are higher, the impact will be stronger, and vice versa. At the same time, no matter how aggressively emissions are reduced, climate change is a reality for the 21st century, since existing emissions in the atmosphere will remain for decades to come. Thus, adaptation to climate change is inevitable.

If we are to stem global warming, we have no choice but to reduce the rapidly increasing emissions of greenhouse gases such as carbon dioxide. But in doing so, the contribution to and consequences of such emissions as well as the different national development needs and priorities have to be central in reaching economically efficient and environmentally effective agreements.

Here, the good news is that the scientific understanding of global warming is growing by the day, and we are already at the point where uncertainty is no longer an acceptable excuse for inaction. These are the challenges that politicians, policy makers, and scientists must meet, in the interest of everyone everywhere.

The AEZ climate impact assessment is based on a range of projections of the ECHAM4 model of the Max Planck Institute of Meteorology, the HadCM2 model of the Hadley Centre for Climate Prediction and Research, and the CGCM1 model of the Canadian Center for Climate Modeling.

All three climate models predict that global warming will occur and that the heat index will rise. Precipitation is more likely to come in heavy and extreme events. In some cases, the Canadian model predicts drier conditions than do the Max Planck and the Hadley models. There is uncertainty in future climate prediction. Our aim has been to analyse the robust conclusion of various climate model predictions and in this context, an analysis of the AEZ results is also relevant to further improvements and refinements of the various climate models.

The AEZ approach fully accounts for optimal adaptations of crop calendars as well as switching of crop types. Yield increases resulting from higher carbon dioxide concentrations in the atmosphere are also incorporated.

5.8 Impact of Climate Change on Worldwide Cereal Production

The results of changes in cereal production in the 2080s based on the three climate models, for single rain-fed cropping, multiple cropping, and multiple rain-fed and irrigated cropping on currently cultivated land and at a high level of inputs and management, are illustrated in Fig. 5.2. The number of countries affected is shown in the bar charts.

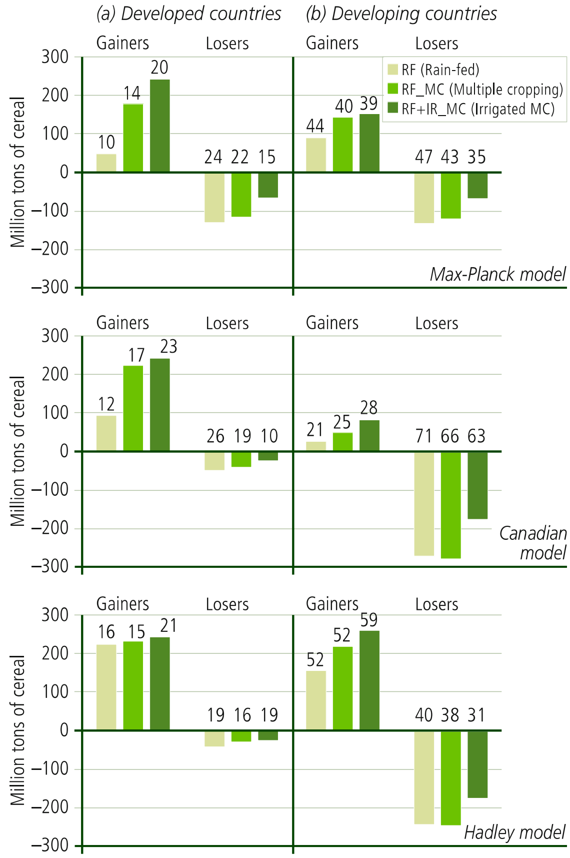

Fig. 5.2. Impact of climate change, 2080s; number of countries is shown above *bar charts* (reproduced with permission from Land Use Project/IIASA 2001)

With climate change, multiple cropping, in comparison to a single crop per year, provides an additional potential production increase of about 120 million t in developed countries for the Max-Planck and Canadian models. In the case of the Hadley model, the increase is much less pronounced at 10 million t. For the developing countries, the Max-Planck and Hadley results show an increase in production of some 55 million t, and the Canadian model shows a production increase of some 15 million t.

When irrigation is considered as well, depending on the climate projection model, further net increases of 10 to 60 million t for the developed countries and some 10 to 40 million t are attained for the developing countries.

For the developed countries, climate change impact for the rain-fed multiple cropping and irrigation results highlight a net gain in cereal production of some 200 million t in the case of all three climate models. Here about half the developed countries gain, and the remainder lose or have little change in cereal production.

For the developing countries, the net gain is some 30 million and 50 million t for the Hadley and the Max Planck models respectively and a net loss of about

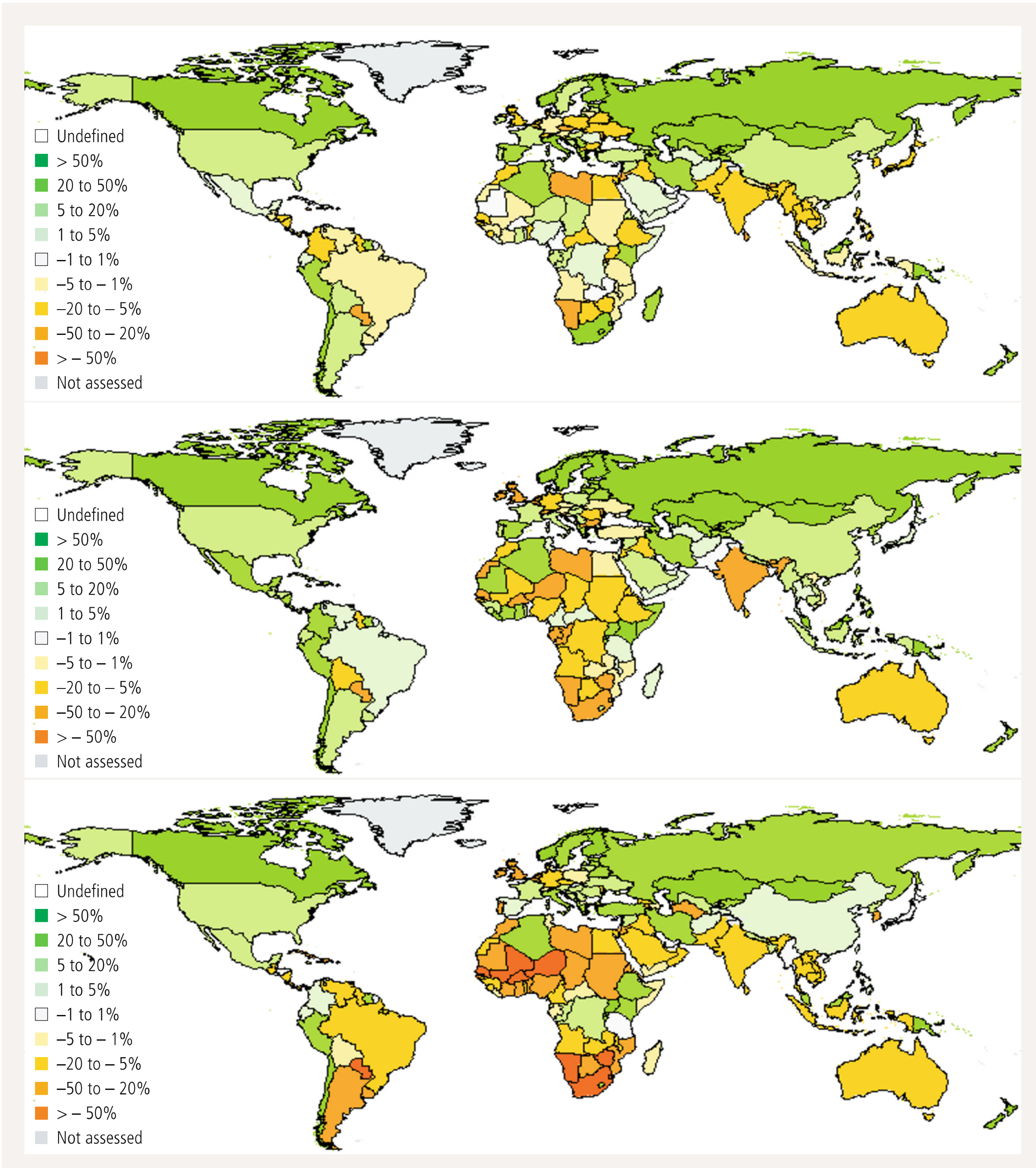

Fig. 5.3. Country-level climate change impacts on cereal production potential on currently cultivated land 2080s (reproduced with permission from Land Use Project/IIASA 2001)

170 millions for the Canadian model. Of the 117 developing countries in the world, 39, 59 and 28 countries gain and 35, 31 and 63 countries lose cereal production due to climate change for the Max Planck, Hadley and the Canadian models respectively.

The results highlight that climate change will benefit the developed countries in terms of net gain in cereal production due to climate change substantially more than the developing countries.

The results in terms of percentage losses and gains for individual countries are shown in map form in Fig. 5.3. Among the developed countries, the winners for all three climate models include Canada, the United States, Spain, France and Italy while losers include the United Kingdom, Germany, Poland and Australia. In the developing regions, India, Thailand, Colombia and many sub Saharan African countries lose production while countries such as China, Mexico, Chile and Kenya gain production.

At the global level, the gain in cereal production due to climate change amounts to some 230 million t for the Max Planck and the Hadley models and only about 20 million t for the Canadian model. However, in spite of this positive global outcome, there is profound concern for many developing countries that lose production due to climate change.

An important feature of the global agro-ecological assessment of climate-change impact is that it is a uniform assessment of all developed and developing countries. This provides for a level comparison of the impacts of climate change. The information is especially relevant to most developing countries and some developed countries that have not yet assessed the impact of climate change on their economies and environment, especially their agriculture sector. Countries such as the United States, the United Kingdom, Canada, France, Germany, and Japan have undertaken scientific assessments of the potential impacts of climate change on their economies and the environment.

Any negotiations, such as the Kyoto Protocol, between the well informed and the less informed will always be constraining. We hope that the results of the AEZ study with a worldwide coverage will contribute to this need for knowledge and information.

5.9 Food Security and Climate Change

Of the 117 developing countries in the world, some 94 countries account for the 792 million undernourished people, as estimated by the Food and Agricultural Organisation of the United Nations. Sixteen of these countries, each with a relatively high per capita GDP of over US$3 000, are not considered here.

Of the remaining 78 countries, 28 countries with a population of 2.2 billion account for 223 million undernourished, and their average daily per capita calorie deficit is about 220 calories. China is among this group of countries. Another 25 countries including India account for 339 million undernourished out of a total population of some 1.5 billion. The average daily per capita deficit of this group of countries is 285 calories. The remaining 23 counties have a total population of some 460 million, of which 220 million are undernourished with a daily per capita deficit of some 360 calories.

At present, the total population of these 78 countries amounts to some 4 billion, and it is projected to increase to over 7 billion by 2050. Currently over half of the populations in most of these countries derive their livelihoods from agriculture. Also, in many of these countries agriculture accounts for 20% to 30% of the total gross domestic product. The current food gap for the undernourished population of these countries is estimated at some 25 million t.

The impact of climate change on potential domestic cereal production in these food insecure countries is shown in Fig. 5.4. Depending on the climate model, some 17 to 37 countries gain cereal production due to climate change. Among these countries, China, with some 140 million undernourished and a corresponding food gap of some 4 million t, gains about 100 million in cereal production due to climate change. In contrast, India, accounting for some 200 million undernourished and an equivalent food gap of about 6 million loses some 30 million t in cereal production due to climate change.

The impact of climate change on cereal production is cause for serious concern in some 25 to 45 "losing" developing countries (Fig. 5.3). These countries have a total combined population of about 1.3 billion to 2.1 billion, of which about a fifth of the population is undernourished. Comparing the decrease of over 60 million t cereal production for the Max Planck model and some 150 million t for the Hadley and the Canadian models, with the current food gap for the undernourished of some

Fig. 5.4.
Food security: Impact of climate change on food production, 2080s (reproduced with permission from Land Use Project/IIASA 2001)

Model	Number of Countries	1995 Population (millions)	Under-nourished (millions)	1995 Cereal Production (million t)	1995 Cereal Gap (million t)	2080s Climate Impact (million t)
Losing						
Max-Planck	27	1661	386	362	–12	–60
Hadley	25	1379	321	277	–10	–156
Canadian	45	2077	396	467	–12	–135
Winning						
Max-Planck	20	1592	210	481	–6	99
Hadley	37	2057	275	598	–8	192
Canadian	17	540	166	100	–6	42

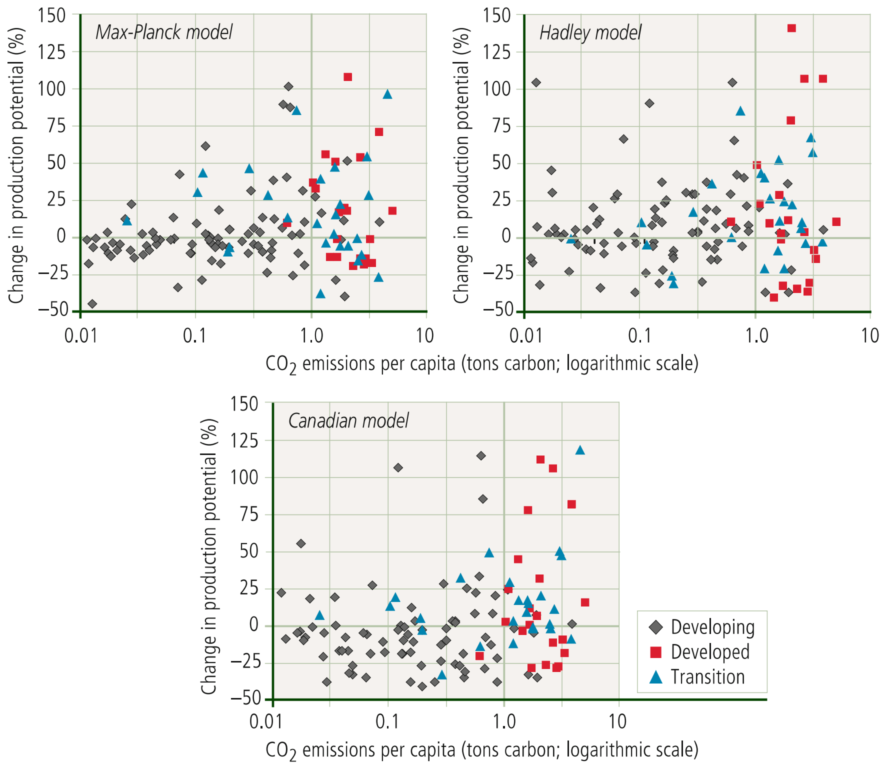

Fig. 5.5. Climate change impacts and carbon dioxide emissions, 2080s: Fairness and equity (reproduced with permission from Land Use Project/IIASA 2001)

10 to 12 million t, the substantial loss due to climate change in domestic production in the 2080s implies that the number of the undernourished may drastically increase.

Many of these countries are poor, agricultural-based economies. They often lack the foreign exchange to finance food imports. Hence any domestic production losses resulting from climate change will further worsen the prevalence and depth of hunger, and this burden will undoubtedly fall disproportionately on the poorest and the most vulnerable.

5.10 Climate Change Impact: Fairness and Equity?

Global warming raises the issue of fairness, as illustrated in Fig. 5.5. This shows the magnitude of climate change impacts on cereal production potential in relation to average cumulative (1950 to 2000) per capita carbon dioxide emissions. The cumulative emissions over the past 50 years for the developing countries, accounting for more than four-fifths of the world's population, totals less than a quarter of global emissions. Yet, many of these countries will suffer substantially from the impact of climate change on food production.

The world community of nations must fairly and equitably meet the challenge of addressing climate change mitigation policies. This must take into account differences between nations in their past and future emissions, as well as socioeconomic considerations. The timely implementation of economically efficient and environmentally effective international agreements on climate change and national adaptive measures will be critical in the context of achieving worldwide societal goals of equity and sustainable development.

5.11 Concluding Remark

Diverse and disparate as they are, humans are a single species on Earth. They bear responsibility for most of the global changes currently under way. It seems only right that humanity should give a moment of thought for the many other countless living species that also inhabit the Earth and bear the brunt of the impact of human activities. Threatened with extinction, for example, members of the animal world have no voice and they are not often seen. But their plight must not be forgotten as humankind efforts to secure its own future.

General References

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The Wealth of World Diversity

Humanity, Nature and Sustainable Development

Overview
Dimensions of Diversity
Demography and Human Diversity
Environment and Nature's Diversity
Diversity and Sustainable Development
Human Capital and University Diversity

Dr Mahendra Shah
First Open Science Conference Plenary Presentation
Senior Scientist, IIASA
Amsterdam, 10th July 2001





World Population, July 2001
6,194,528,577 +







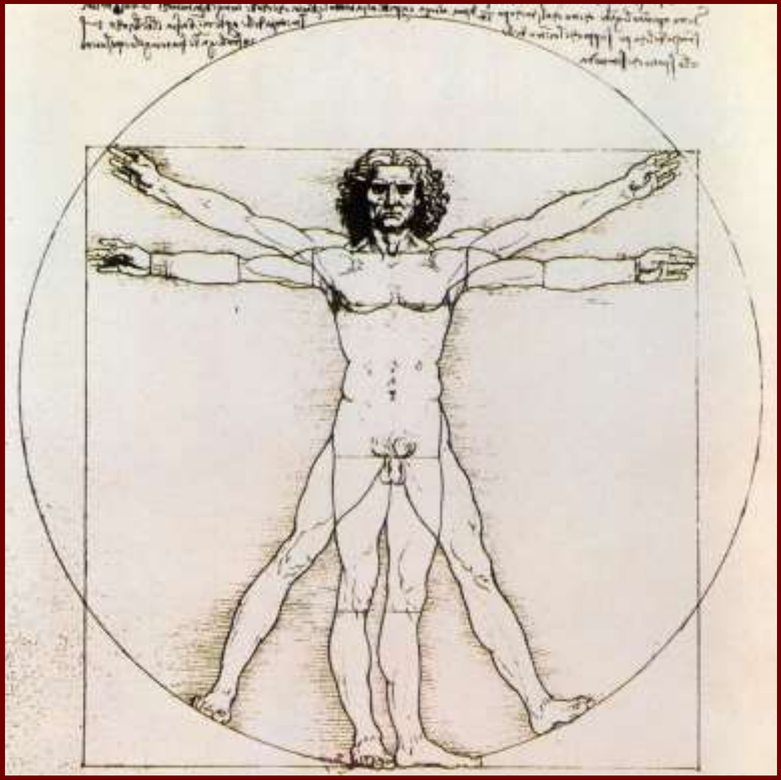

The Challenges of Sustainable Development

Shah M M 2001

The Wealth of Diversity

"Nature never breaks her own laws"
"The noblest pleasure is the joy of understanding"

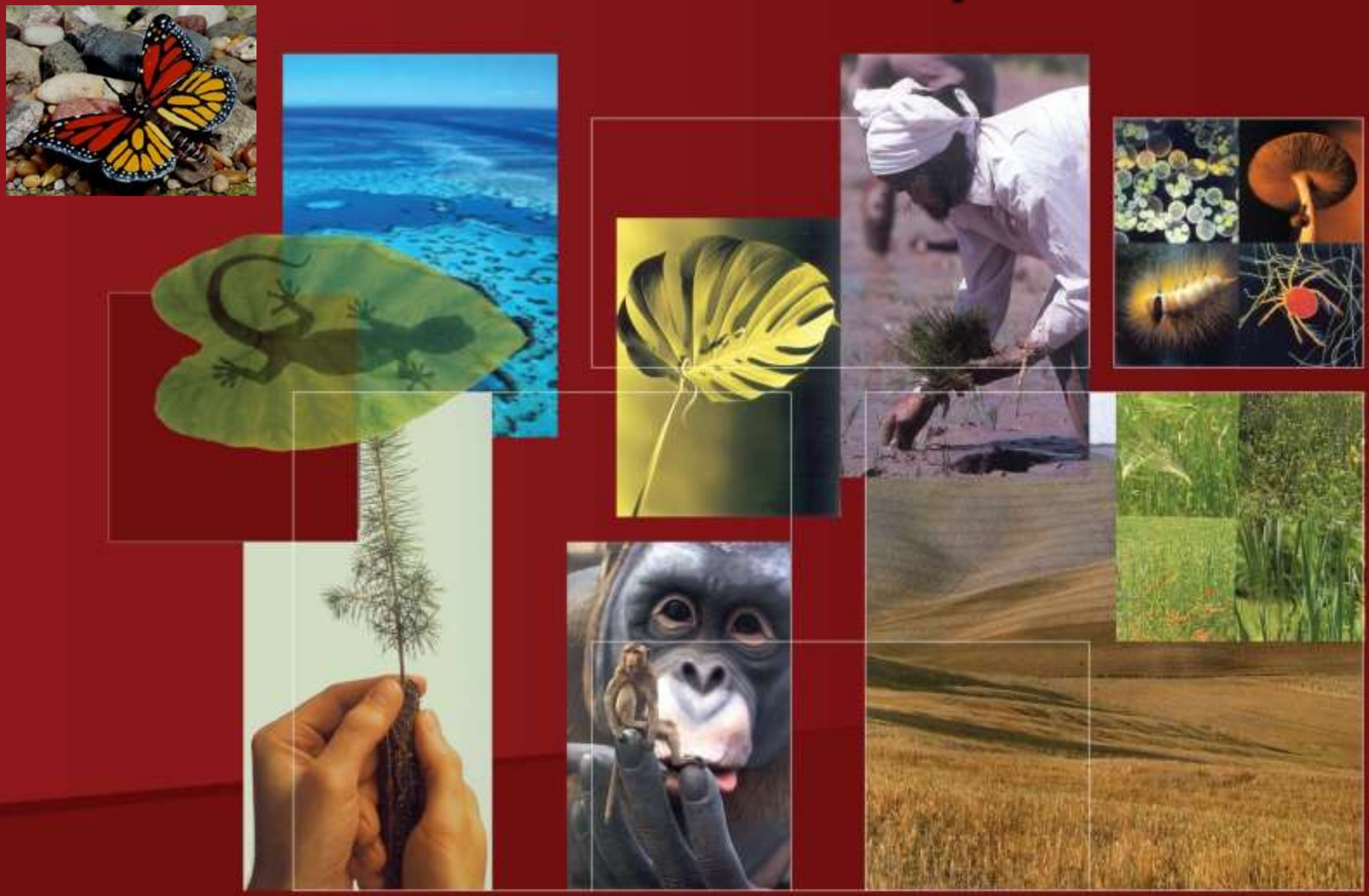
Leonardo da Vinci, c 1496



Diversity results from the capacity of systems to **respond, adapt, and evolve** through **self-organization** on the basis of differing time and space dependent environment, experience, symbiosis, relationships, and reciprocity. The **interconnectedness** and **interdependencies** in diversity creates the tensions and synergies that lead to **sustaining evolution and more robust outcomes.**

The biological diversity of nature lies in the **variety of life and its processes**…vast array of organisms, the genetic differences among them, the communities and ecosystems in which they occur, and the ecological and evolutionary processes that keep them functioning yet ever changing and adapting. Biodiversity is interconnected..different types of organisms live side by side in complex ecological networks of interdependency, each relying for nutrients and energy on those that share its **habitat.**

Biodiversity



The Web of Life

Human Diversity

Endowing Humanity with Tremendous Potential

Human diversity is the common heritage of humanity…..**uniqueness and plurality** of identities and individuality….source of harmonious relationships and the sharing of ideas and experiences enabling collective creativity and innovations….. **generation and accumulation of knowledge**…….important for human progress including, artistic and intellectual development, emotional stability and ethical behavior, material and spiritual well-being **living sustainably in and with nature**.

Diversity in a system is high if each component brings **uniqueness** to the system, be it different ideas and approaches, varying experiences and diverse information, and **inter-relationships**. In contrast diversity is low if the system components are **similar** and contribute the **same information**.

Appreciating Diversity

Eyes open and focused
Ears sharp and tuned
Vocal clarity and reasoned

Dimensions of Diversity

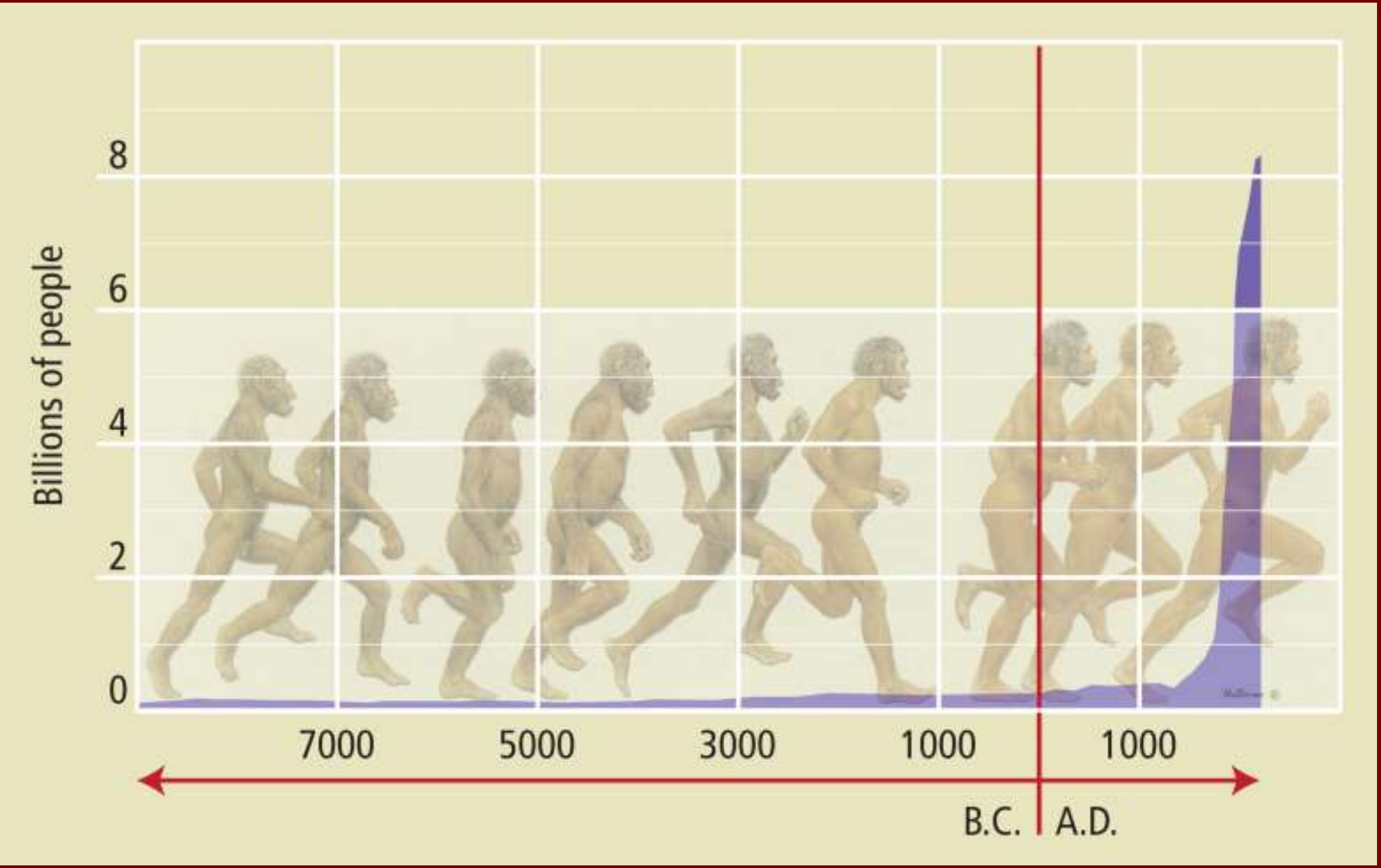
- How to recognize and understand diversity
- How to value and respect diversity
- What influences reduce diversity
- What comprises the right balance of diversity
- Can there be too much diversity
- Can diversity be irrelevant
- How to make diversity more productive
- How to mobilize diversity to promote development

Demography and Human Diversity

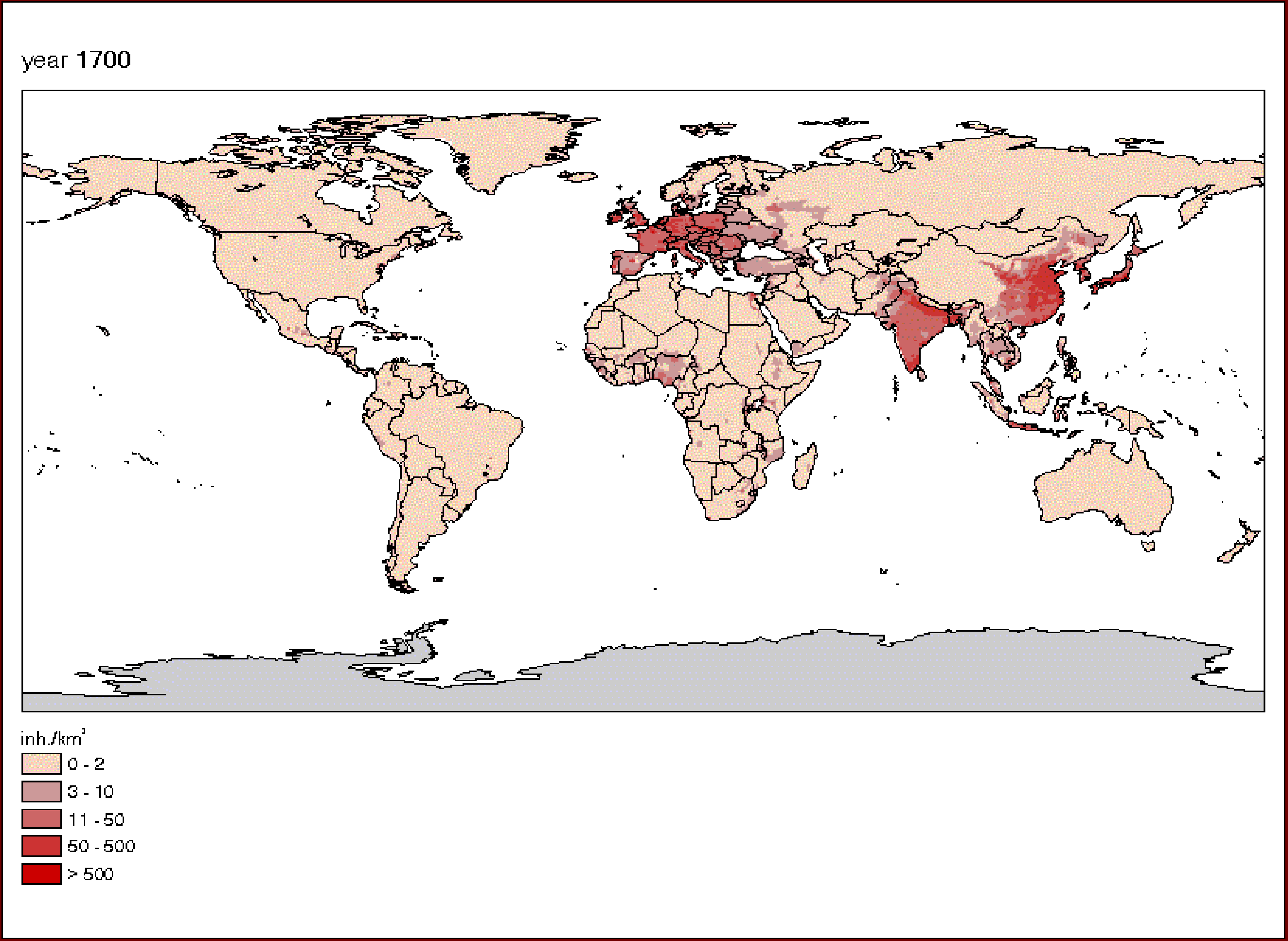
"I want the cultures of all the lands
to be blown about my house as freely as possible.
But I refuse to be blown off my feet by any"

Mohandas Gandhi, c 1930

Human Population

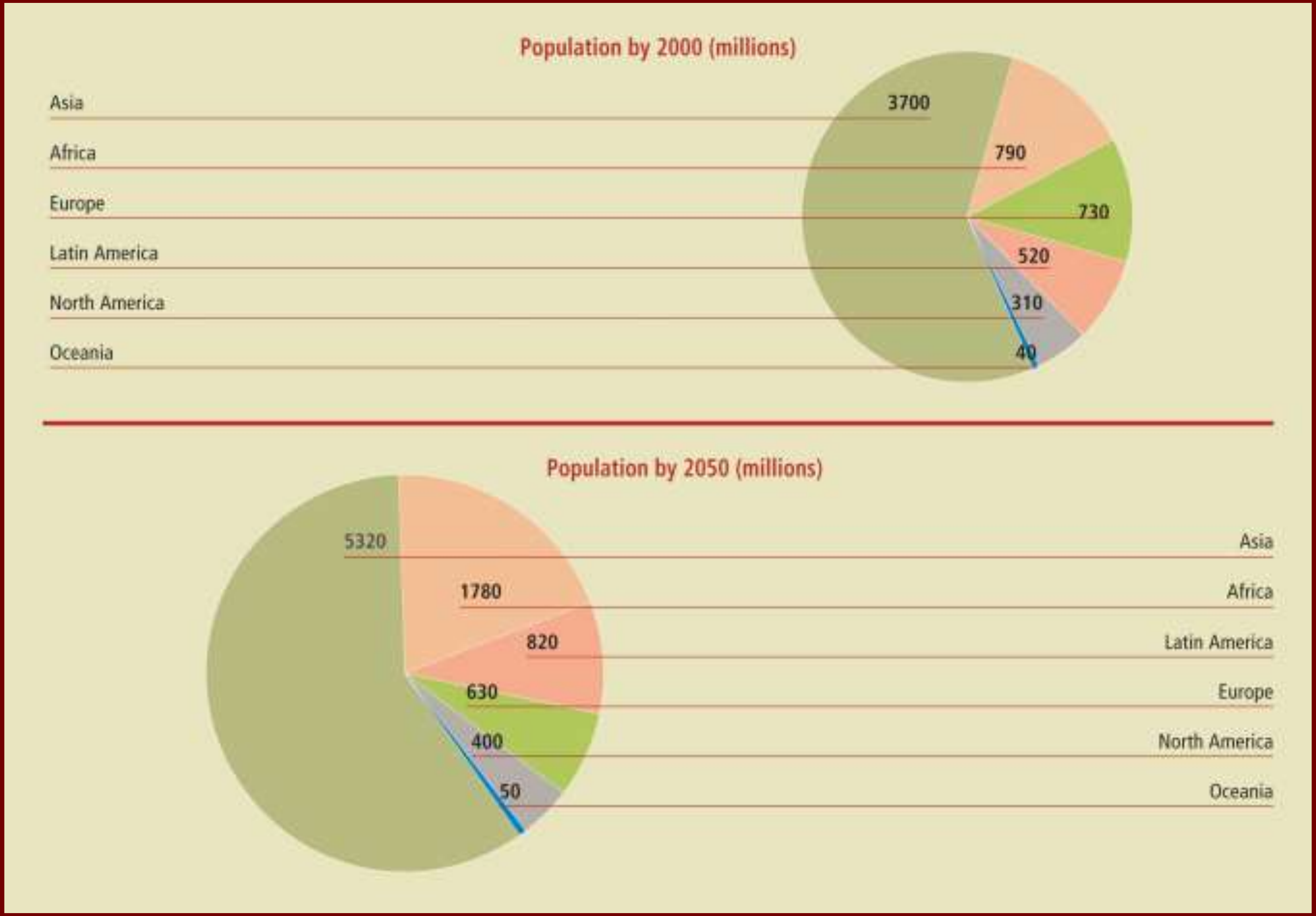


Regional Diversity and Demography, 1700 – 1990



Demographic Transition 2000-2050

Population 2000, 2050 regional distribution



Threats to human diversity

Politics without principle

Power without humility

Pleasure without conscience

Wealth without work

Knowledge without character

Business without morality

Science without humanity

Worship without sacrifice

Mahatma Gandhi

1900-2000
A century of unprecedented changes in human diversity

- Social and Political
- Wars and Tyrannies
- Human Rights and Entitlements
- Religious Diversity
- Language Diversity
- Fashion Diversity
- Food Diversity
- Music Diversity
- Entertainment Diversity
- Transport and Habitation Diversity
- Science and Technology Diversity
- Knowledge Diversity

Dominating influence and power of a few over many

Diversity of Weapons














The 20th Century of War and Tyrannies

Human Rights

Food
Water
Education
Health Care
Social Security
Clean/Safe Environment
Freedom form Harassment
Freedom from Discrimination
Opportunities for Participation

International Commitments in a World of Disparities

Religious diversity

All Religions : A foundation and source of values, morals, and norms

Language Diversity

+ 6000 to go : The world loosing 2 languages every month

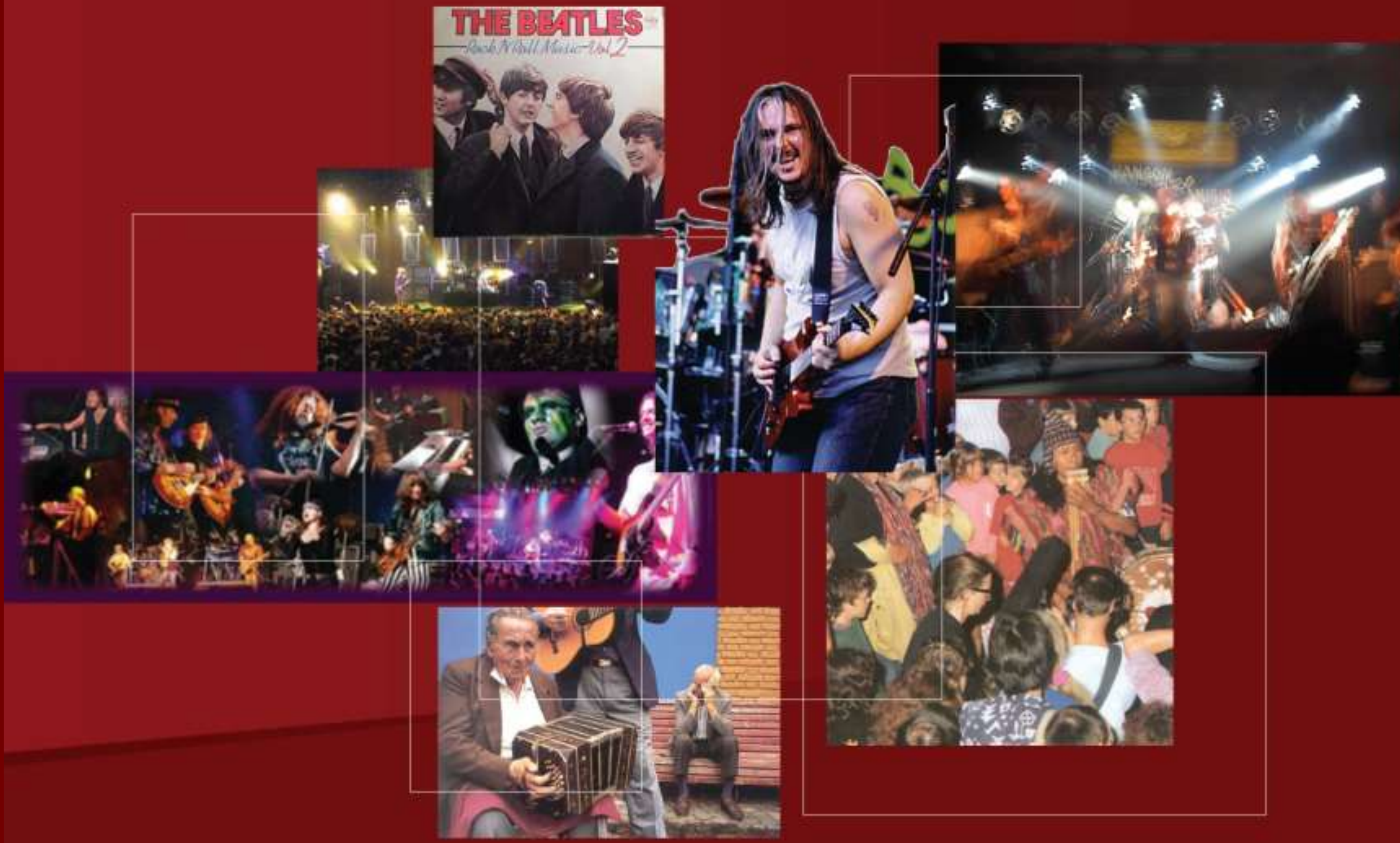
Fashion Diversity

The growing culture of jeans and tee shirts

Food Diversity

Multi-national corporations driving the change in food consumption diets

Music Diversity



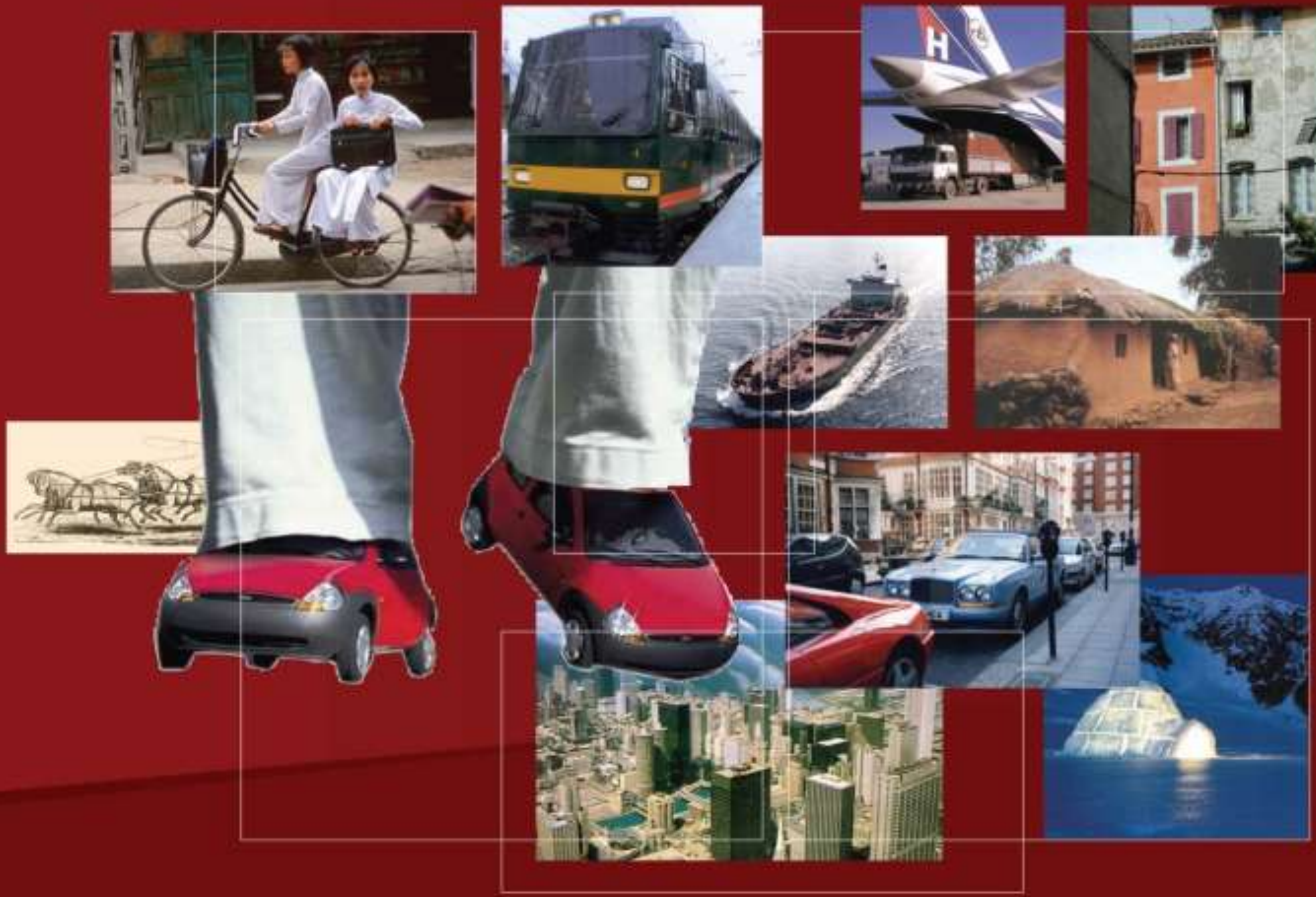
The rise of "electronic pop" culture

Entertainment Diversity

Global Media TV and Films

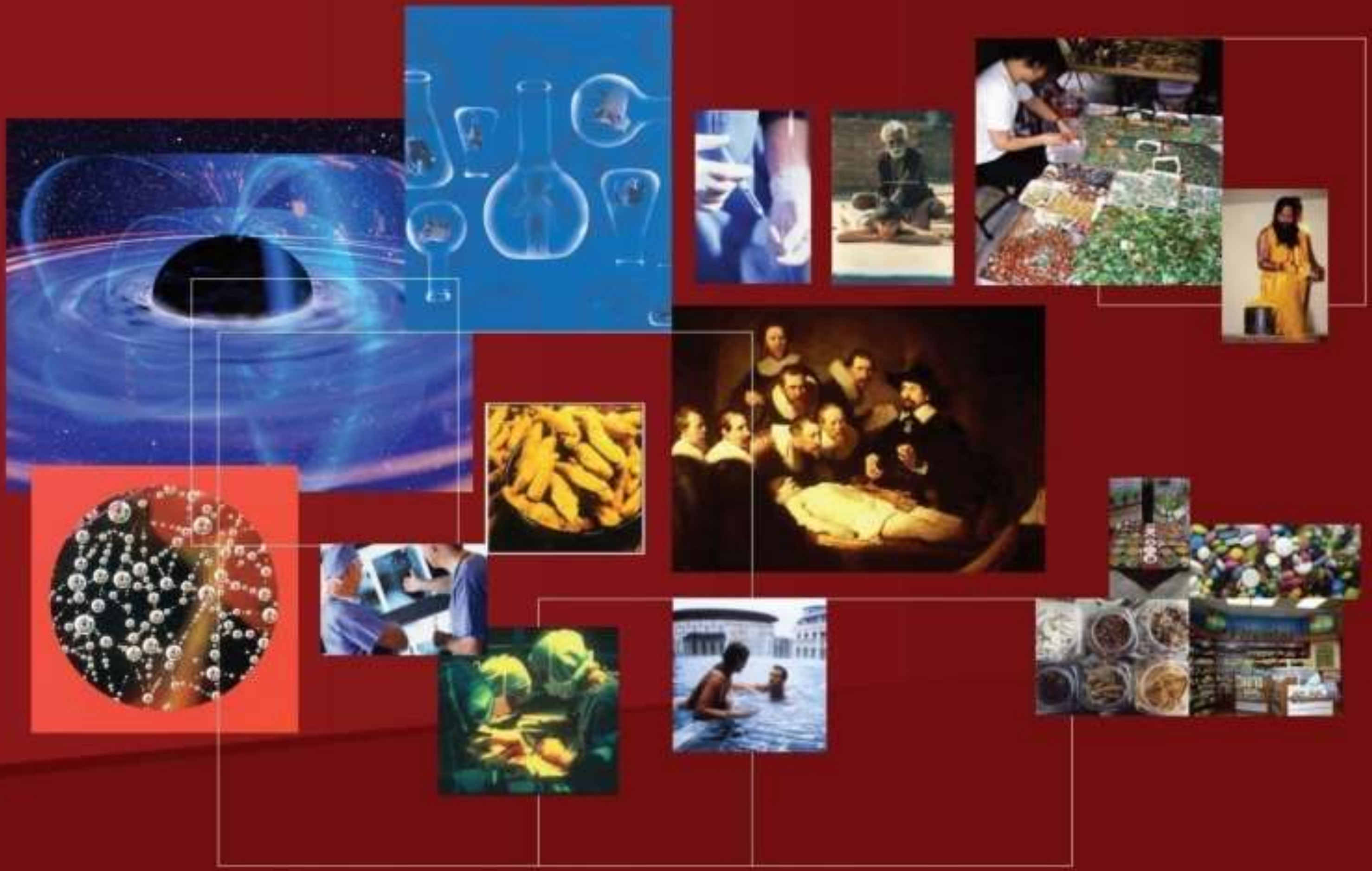
The rise of soap operas and violence in entertainment

Transport Diversity and Habitation Diversity



The dominance of motor cars – Pollution for global warming

Knowledge Diversity



Traditional knowledge and modern science in a competing world

Knowledge Disparity

Information Revolution : A Digital Divide

Internet Access Costs (Monthly Income)

Bangladesh 200%   United States 1%

Internet users (% of population)

USA 50%, Europe 35%, Asia & Africa 0.4%

Science and Technology : A Capacity Divide

Researchers per Million population

Japan (4000), USA(3000), Europe(2000), Latin America(550), Asia(250), Africa(70)

Ratio of per capita Investment in Science

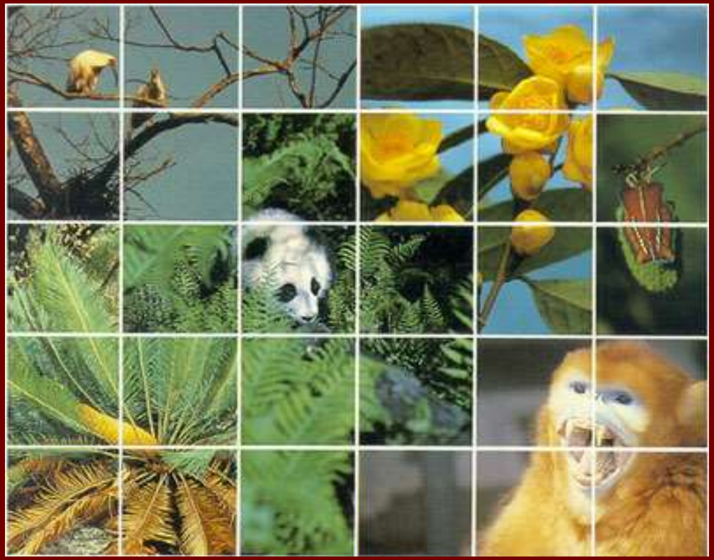
Developed and Developing Countries 220 : 1

Patent Applications

1985 : 1 million   2000 : 7 Million

Environment and Nature's Diversity

"It should not be believed that all beings exist for the sake of the existence of man. On the contrary, all the other beings too have been intended for their own sake"
Moses Maimonides, c 1190



The web of life

Threats to Nature’s Biodiversity Air, Water and Land Pollution

Extinction of species

Freshwater and Marine Ecosystems






Climate Change





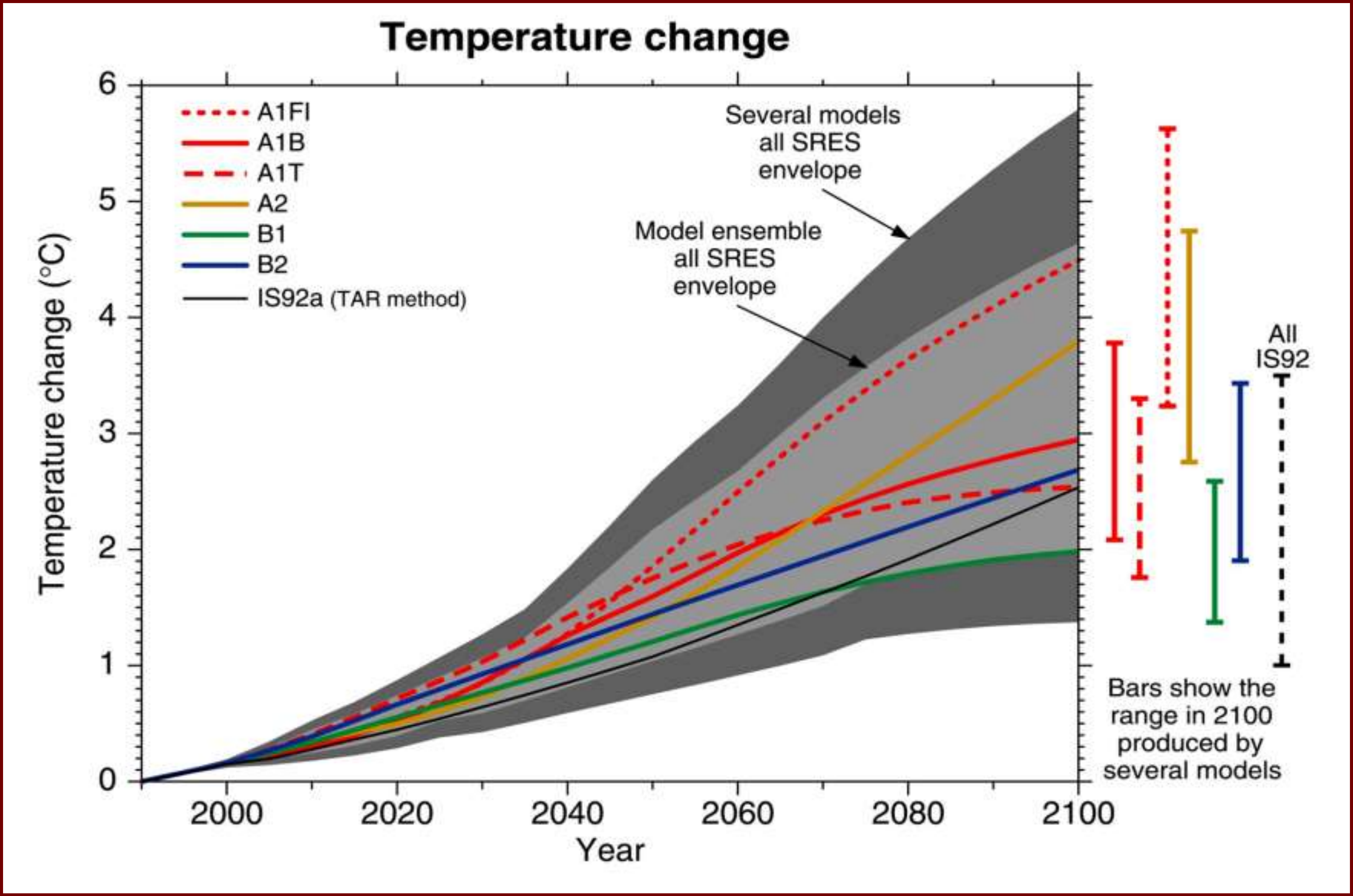




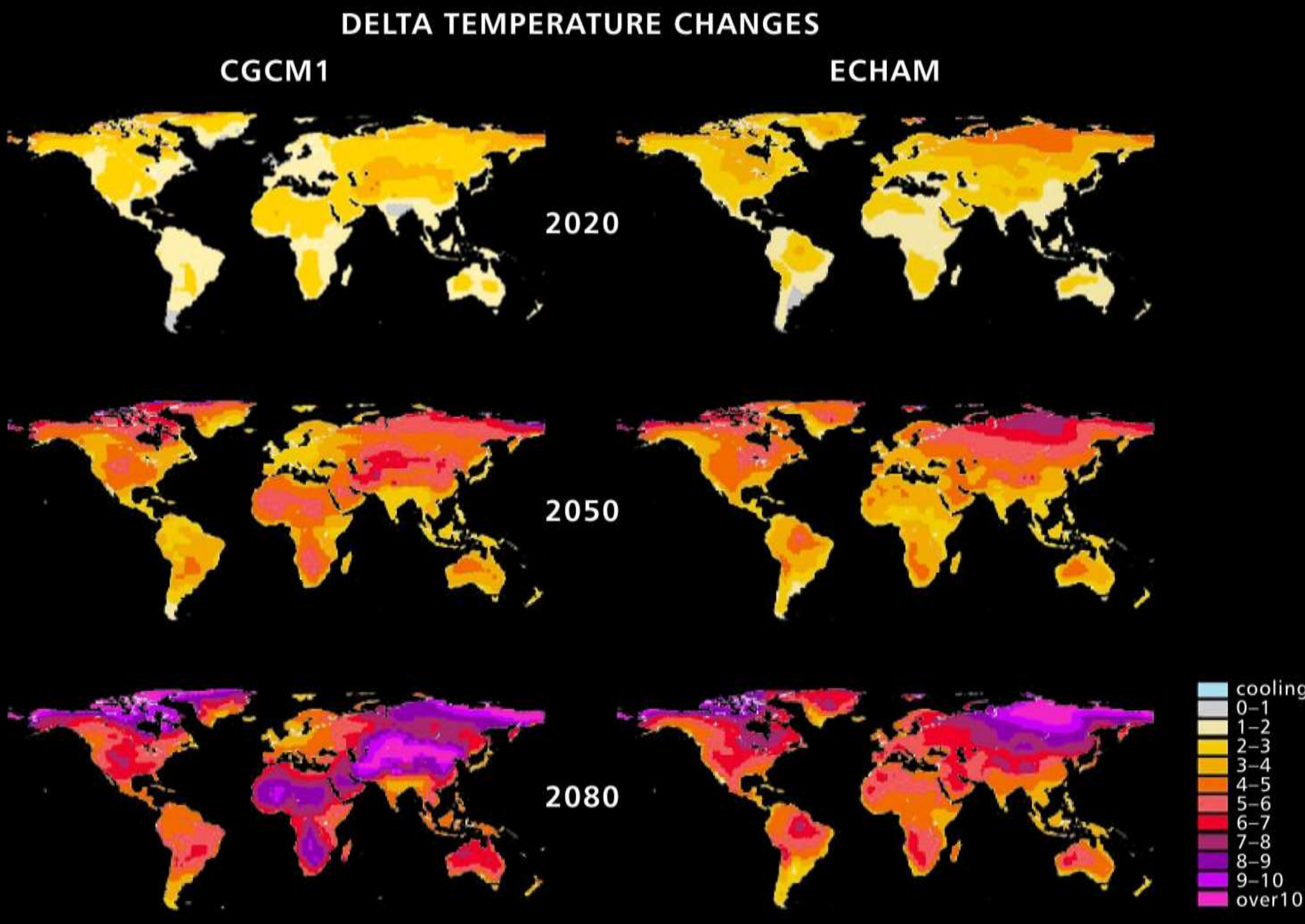


A global & inter-generational threat weather catastrophes & change

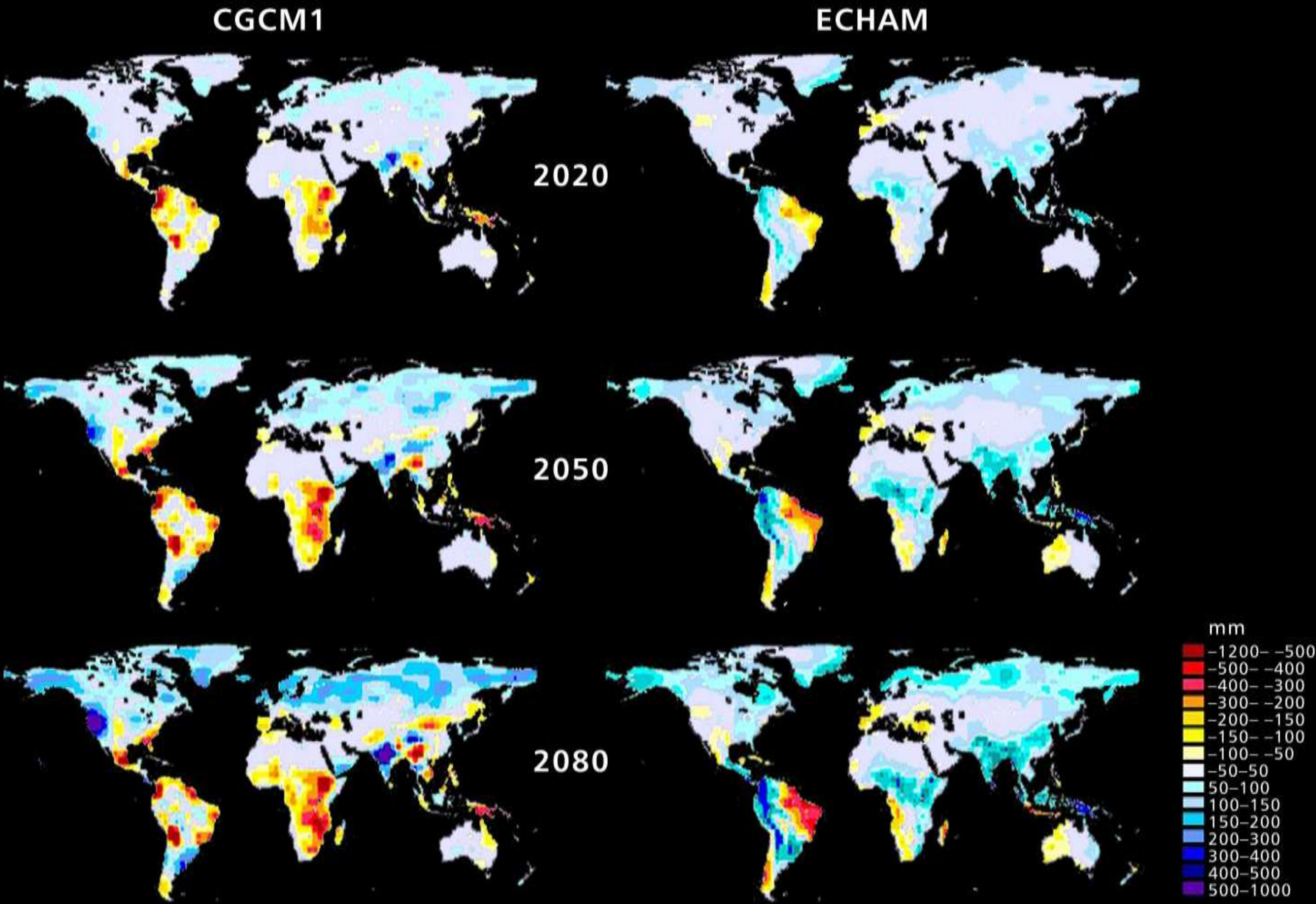
IPCC SRES Scenarios



Source: IPCC, 2001.


DELTA TEMPERATURE CHANGES
CGCM1
ECHAM
2020
2050
2080
cooling
0–1
1–2
2–3
3–4
4–5
5–6
6–7
7–8
8–9
9–10
over10

DELTA PERCIPITATION CHANGES



HEALTH EFFECTS OF CLIMATE CHANGE

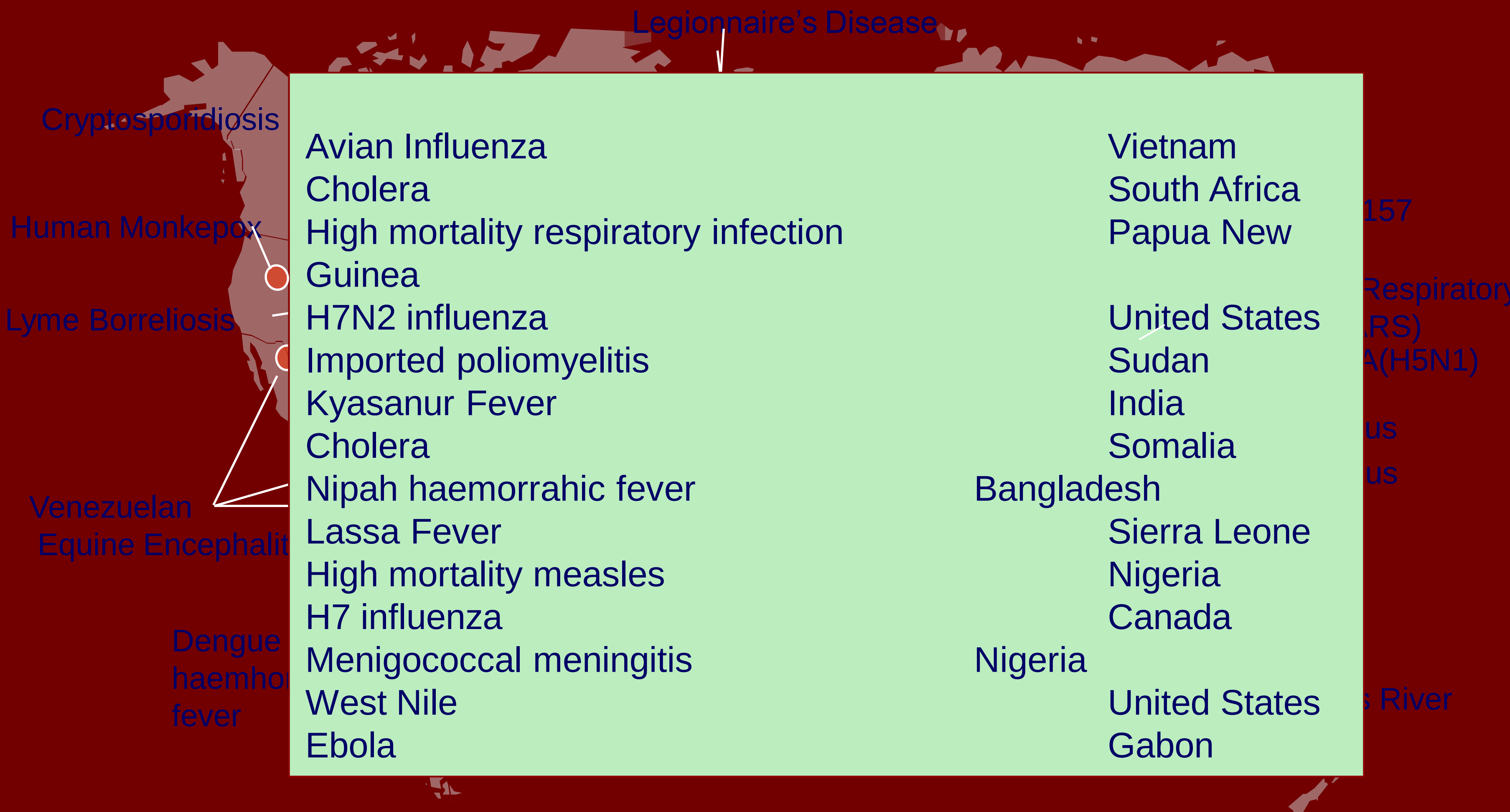
CLIMATE CHANGE

Temperature Rise [1]
Sea level Rise [2]
Hydrologic Extremes

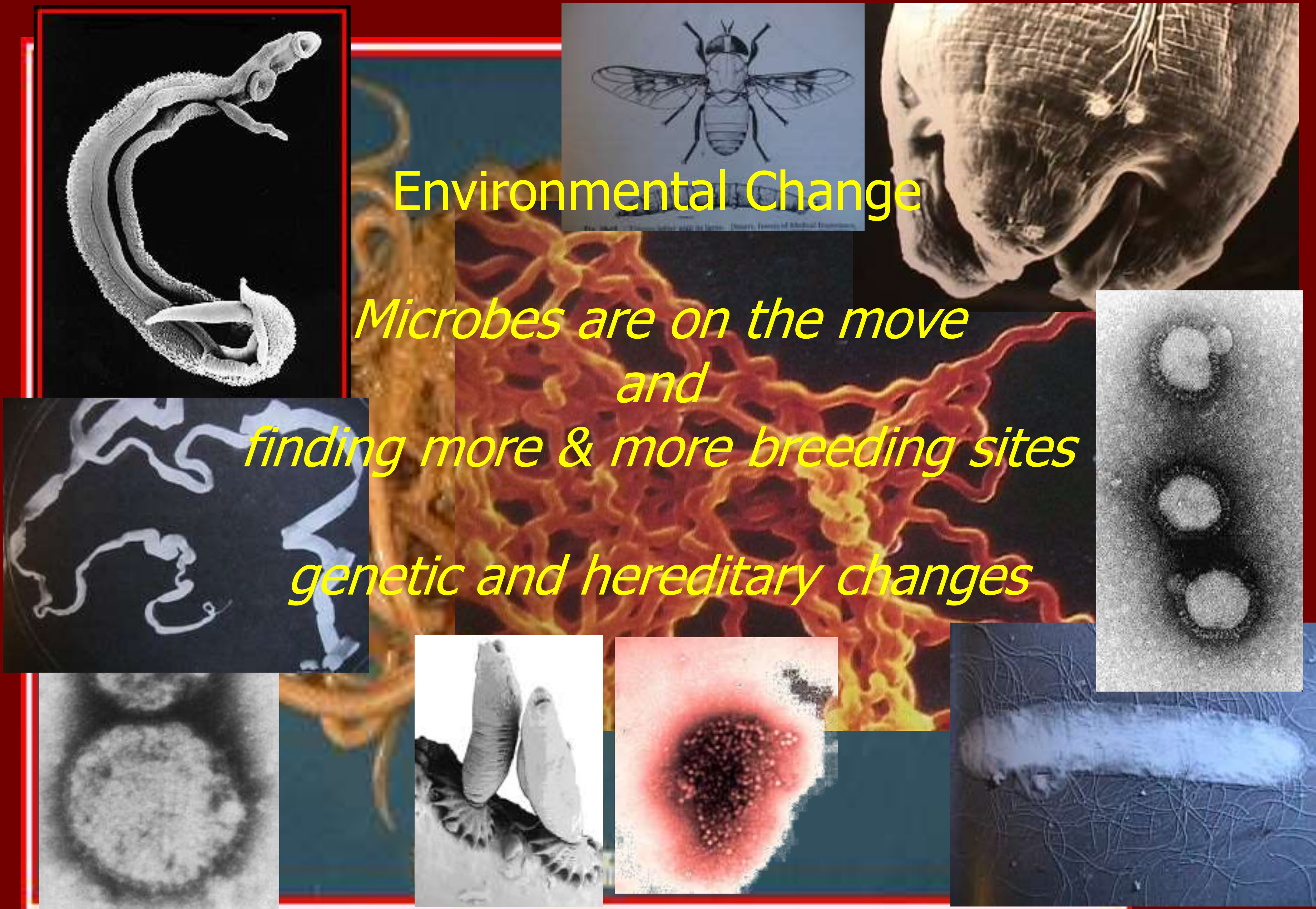
[1] 3° C by yr. 2100
[2] 40 cm " "
IPCC estimates

Global Warming Effect	→ Heat Stress Cardiorespiratory failure
Air Pollution	→ Respiratory diseases, e.g., COPD & Asthma
Vector-borne Diseases	→ Malaria Dengue Encephalitis Hantavirus Rift Valley Fever
Water-borne Diseases	→ Cholera Cyclospora Cryptosporidiosis Campylobacter Leptospirosis
Water resources & food supply	→ Malnutrition Diarrhea Toxic Red Tides
Environmental Refugees	→ Forced Migration Overcrowding Infectious diseases Human Conflicts

Emerging / re-emerging infectious diseases,1997–2007



Avian Influenza	Vietnam
Cholera	South Africa
High mortality respiratory infection	Papua New
Guinea	
H7N2 influenza	United States
Imported poliomyelitis	Sudan
Kyasanur Fever	India
Cholera	Somalia
Nipah haemorrahic fever	Bangladesh
Lassa Fever	Sierra Leone
High mortality measles	Nigeria
H7 influenza	Canada
Menigococcal meningitis	Nigeria
West Nile	United States
Ebola	Gabon



What health consequences for future generations ?

Food and Health Security

"Let **food** be thy **medicine**
let thy **medicine** be **food**"

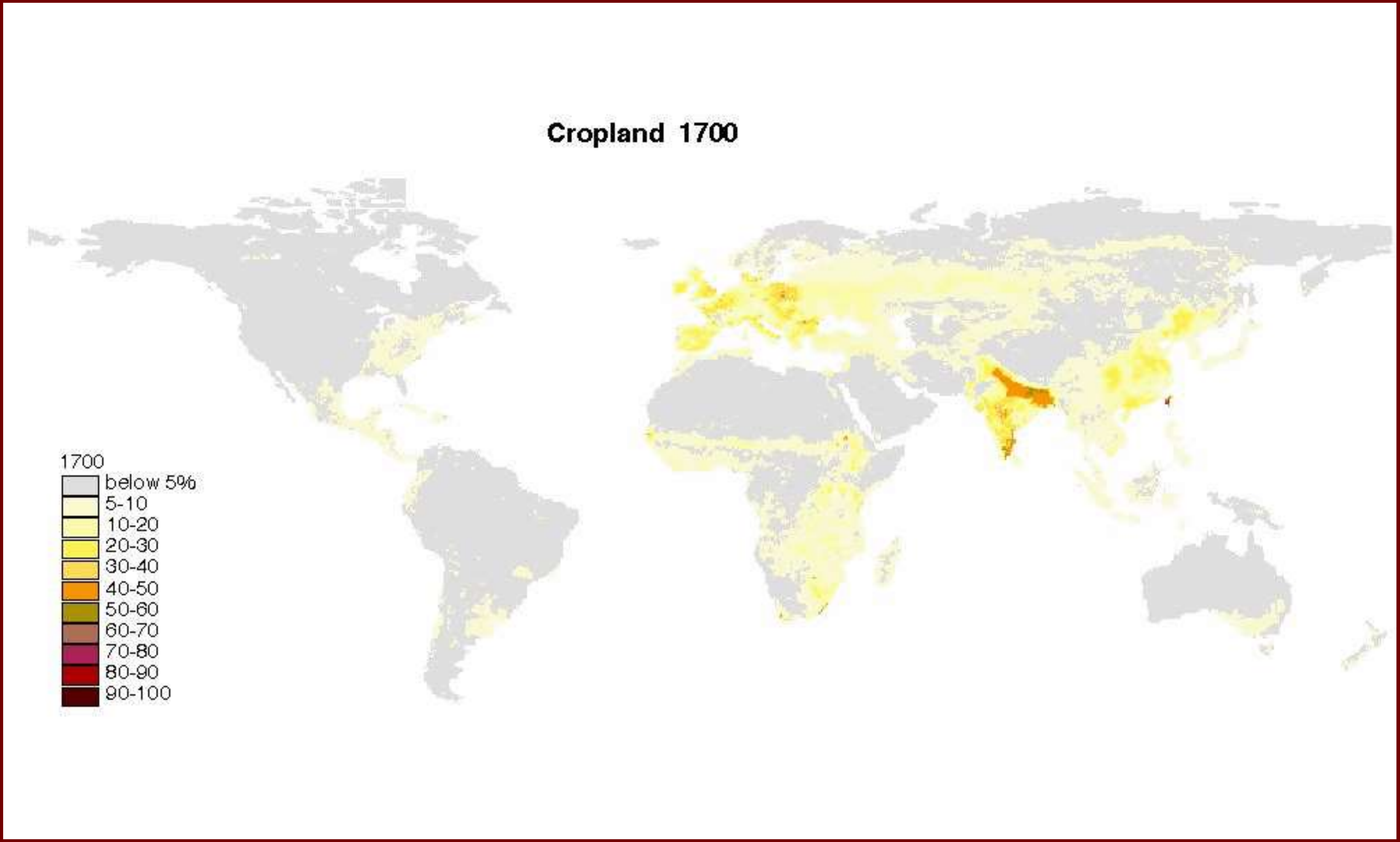
Hippocrates 460-377 BC

Challenges of World Food Security

- Land Degradation
- Water Scarcity
- Biodiversity Loss
- Demographic Growth
- Lifestyle and Diet Changes
- Climate Change
- Poverty and Hunger

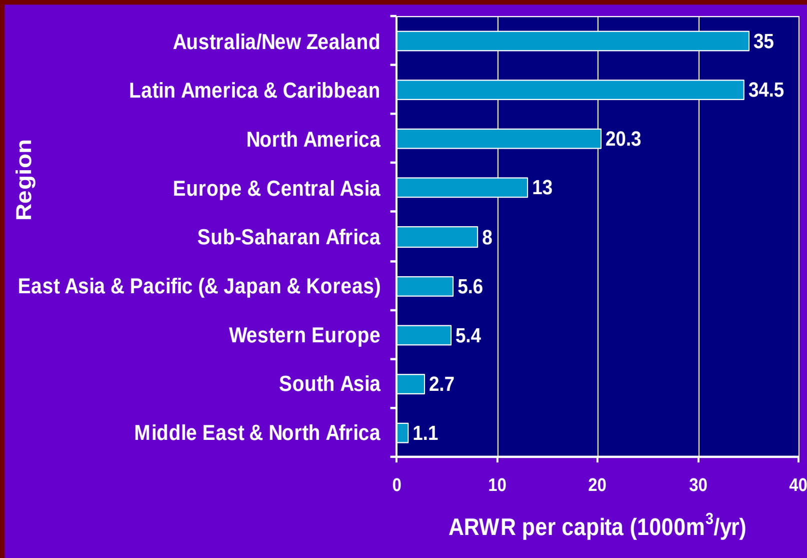
Expanding Cropland 1700-1990

Fraction of grid cell in croplands



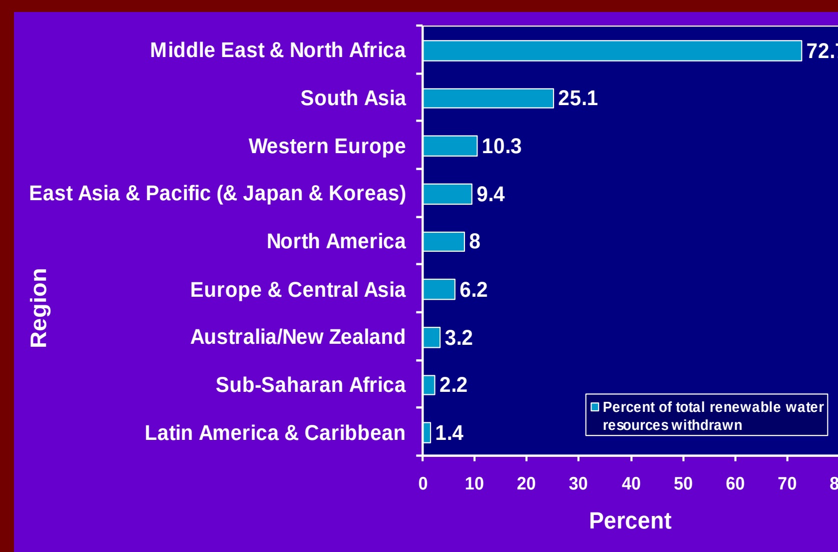
Agriculture Resource Security

Water Scarcity in Dry Areas



Actual Renewable Water Resources per capita

Total renewable water resources withdrawn (%)



Green Revolution Intensive Mono Cropping

Intensive Meat and Fish Production


Aquaculture in the Tam Giang lagoon

Towards world-wide Food Security

- Who are the food insecure ?
- Where are the they ?
- What makes them vulnerable ?
- When are they in need ?
- What needs to be done ?

Information and Knowledge: Spatial and Temporal

From Information to Knowledge

From Knowledge to Scientific Analysis

From Science to Policy Making

From Policy to Governance

From Governance to Implementation

Monitor, Evaluate and Adapt

Decision Making and Implementing Actions under Uncertainties

Bridging Science and Policy Actions

- It is not enough to simply build scientific tools and assume that they will be found, used and result in policy actions
- It is not enough to collect and analyze huge quantities of data and assume that this knowledge will be transferred into effective policy actions
- The challenge to scientists is to ensure that their tools and analysis are in the realm and perception of policy and decision makers

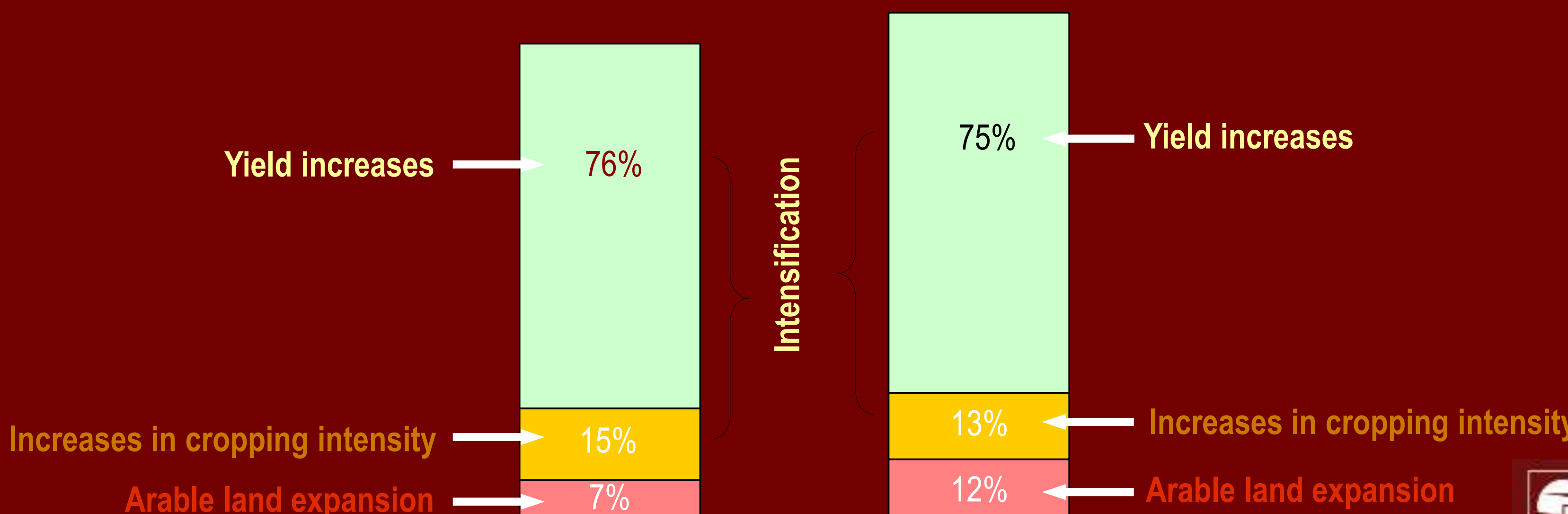
Issue, Priority, Credibility, Timeliness….

Food and Agriculture Outlook

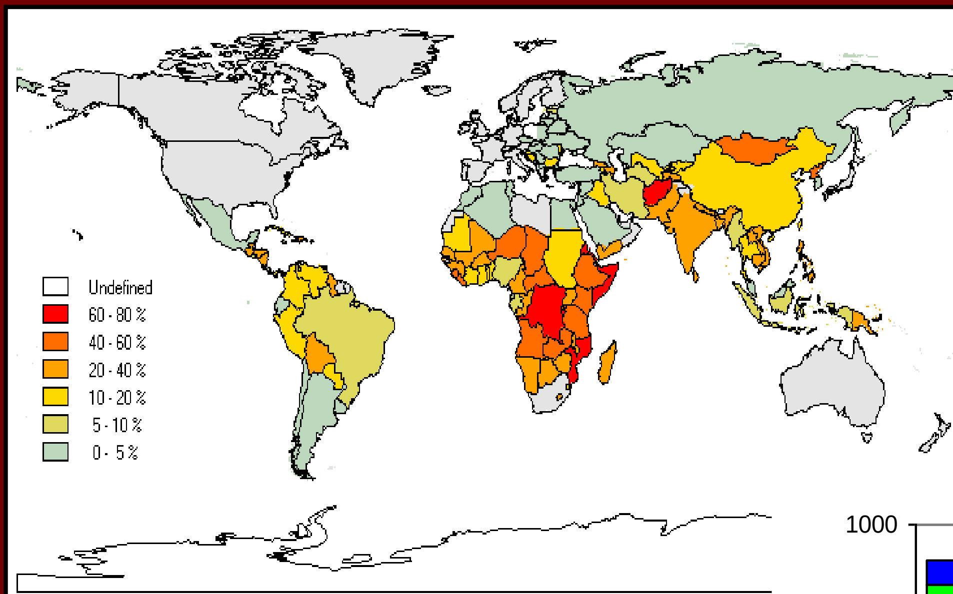
Growth 2000-2050	Scenario B1	Scenario A2r
Arable land	7%	12%
Cereal production	62%	69%
Ruminant meat	68%	73%
Other meat	74%	85%
Agriculture	81%	86%

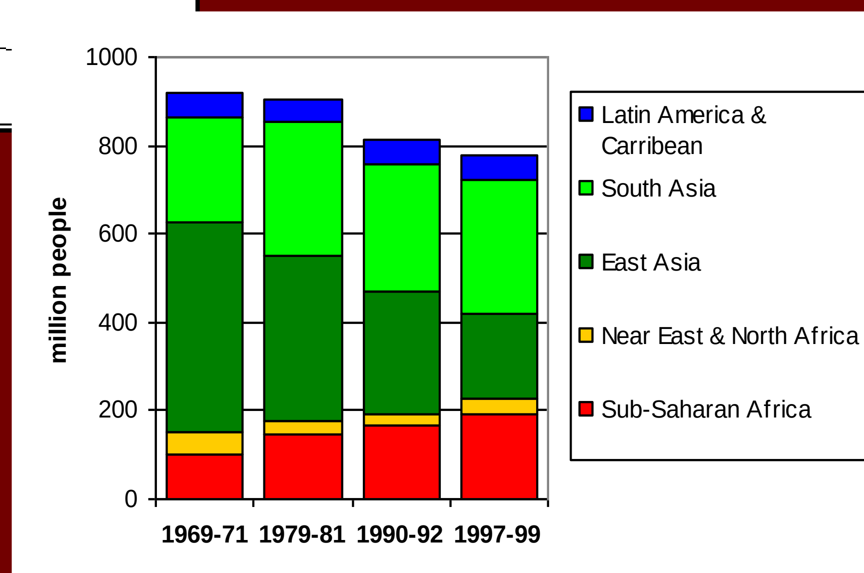
Source:
World Food System simulations of IIASA GGI scenarios, Fischer et al. (2005).

Sources of growth in agricultural production, 2000-2050



Hunger in a World of Plenty





World Food Summits 1974,1996, 2002

MDGs 2000

34 Years of Failure to Deliver

The faces and voices of Hunger

Fatima and Jabil………Naigzy and Tesfai……..Ethiopia

Yearning a Life Time for a Secured Future

Mira, Afghanistan

Farida, Afghanistan

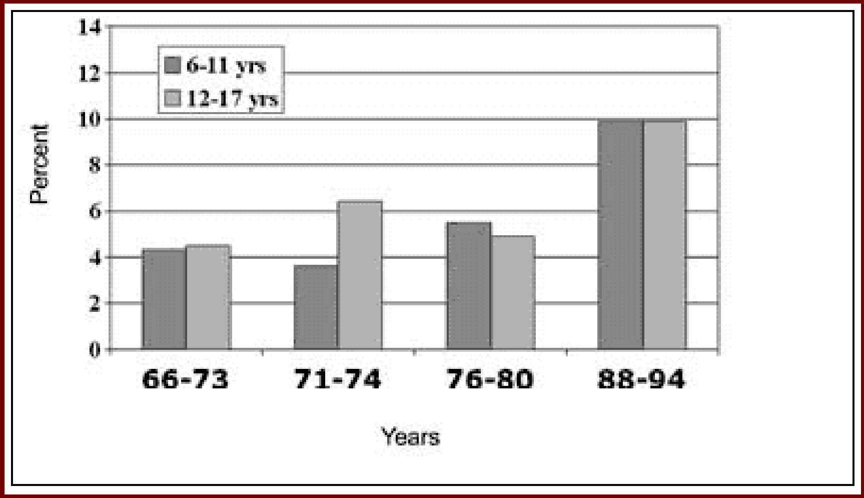
Tatiana in Moscow

Hunger in Russia : + 6 Million

George in Washington DC

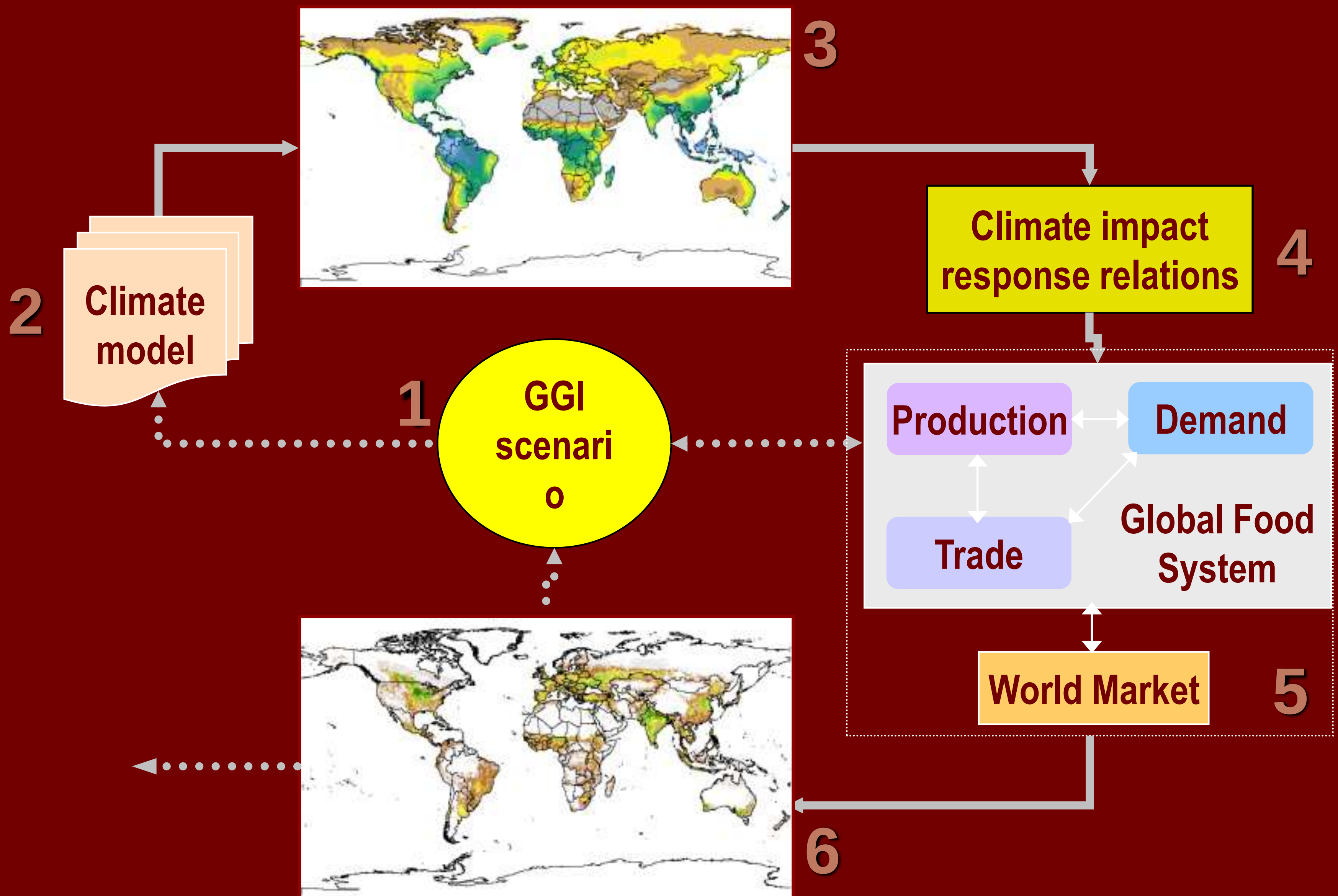
5.4% of USA Population on Food Stamps

And the consequences of much too much food and lifestyles

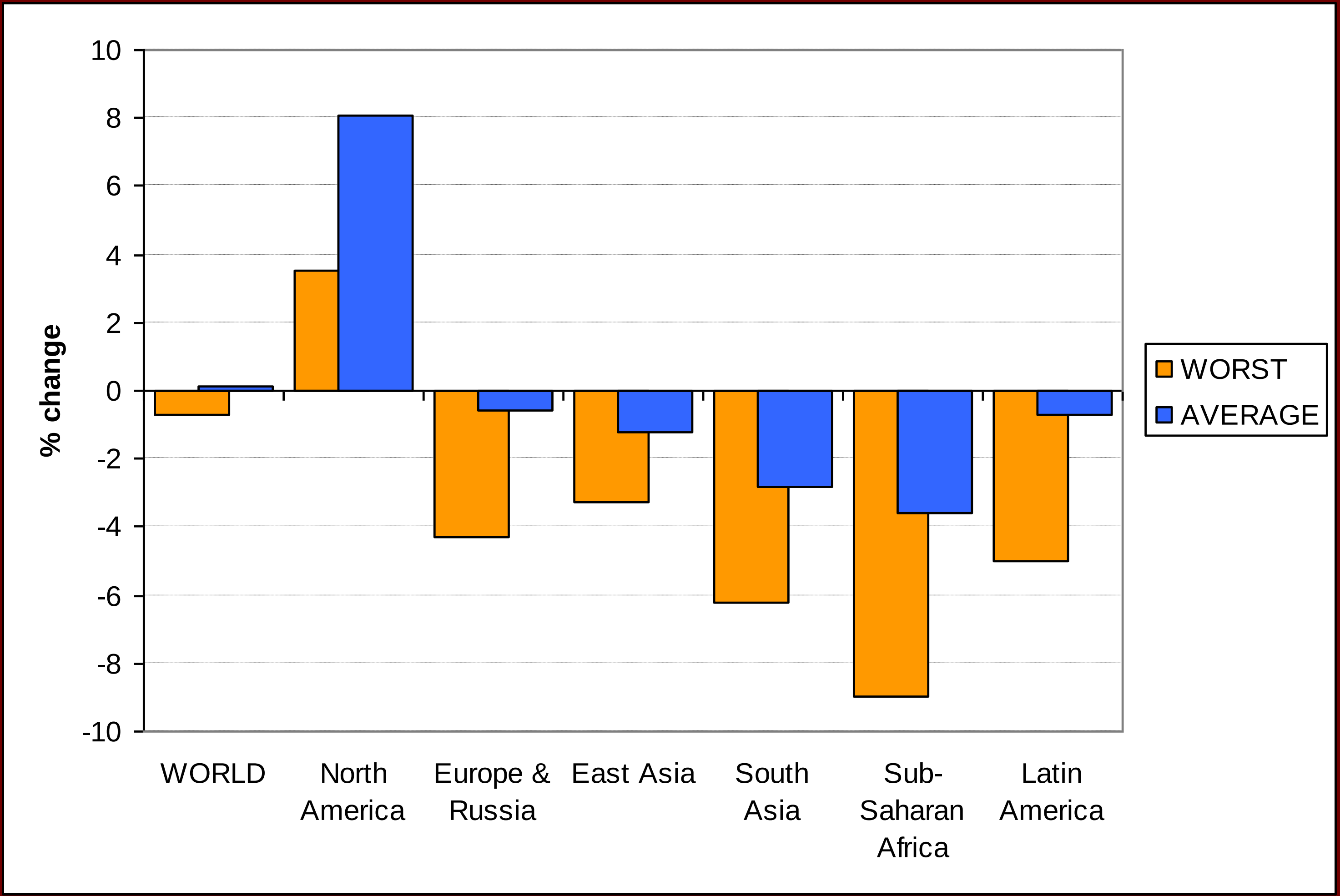


EDUCATION

Land Resources and Food Security
Ecological - Economic Analysis



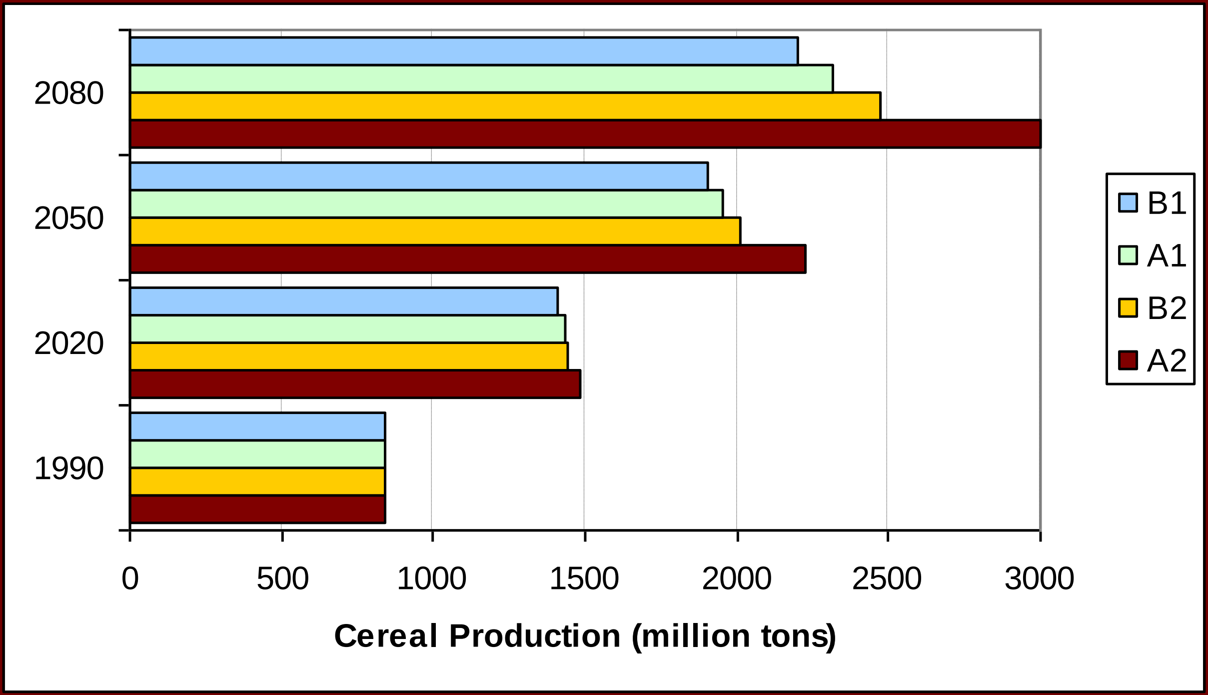
Simulated Impacts of Climate Change on Regional Crop and Livestock Production – 2080s



Note: percent changes relative to SRES A2 reference projection without climate change. The diagram is based on food system simulations using climate projections obtained from four climate models for the IPCC SRES A2 emissions scenario.

Cereal Production, Net Imports of Developing Countries

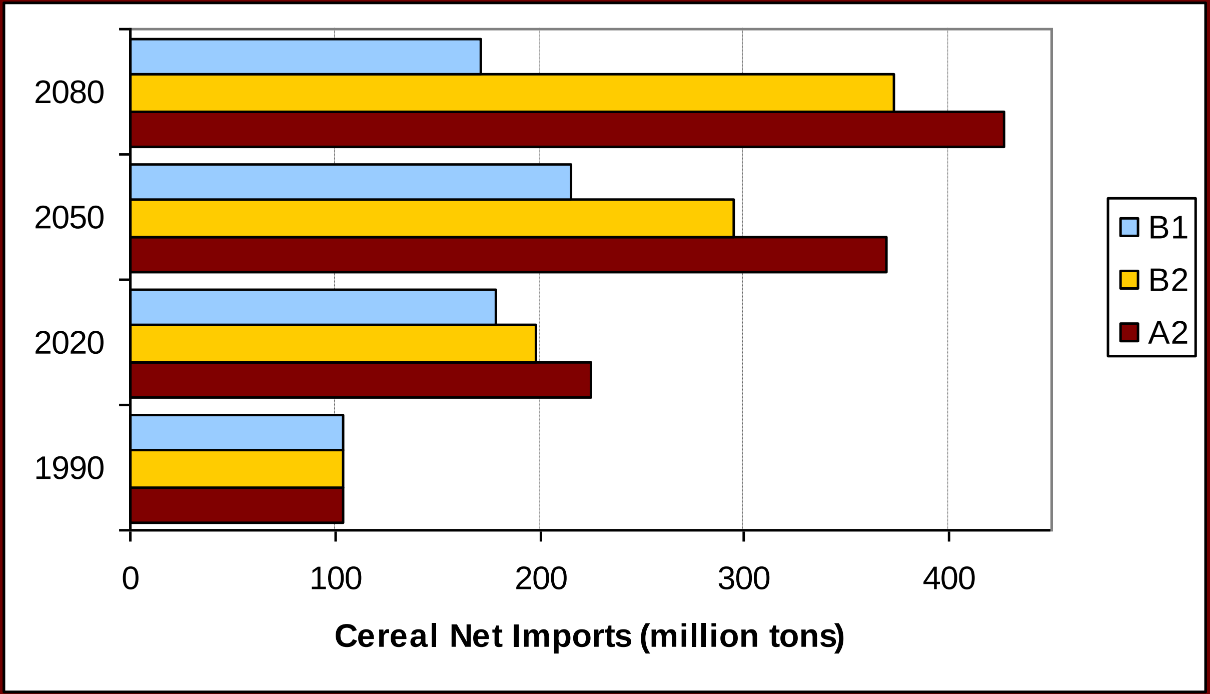
projected for different IPCC economic development paths



PRODUCTION

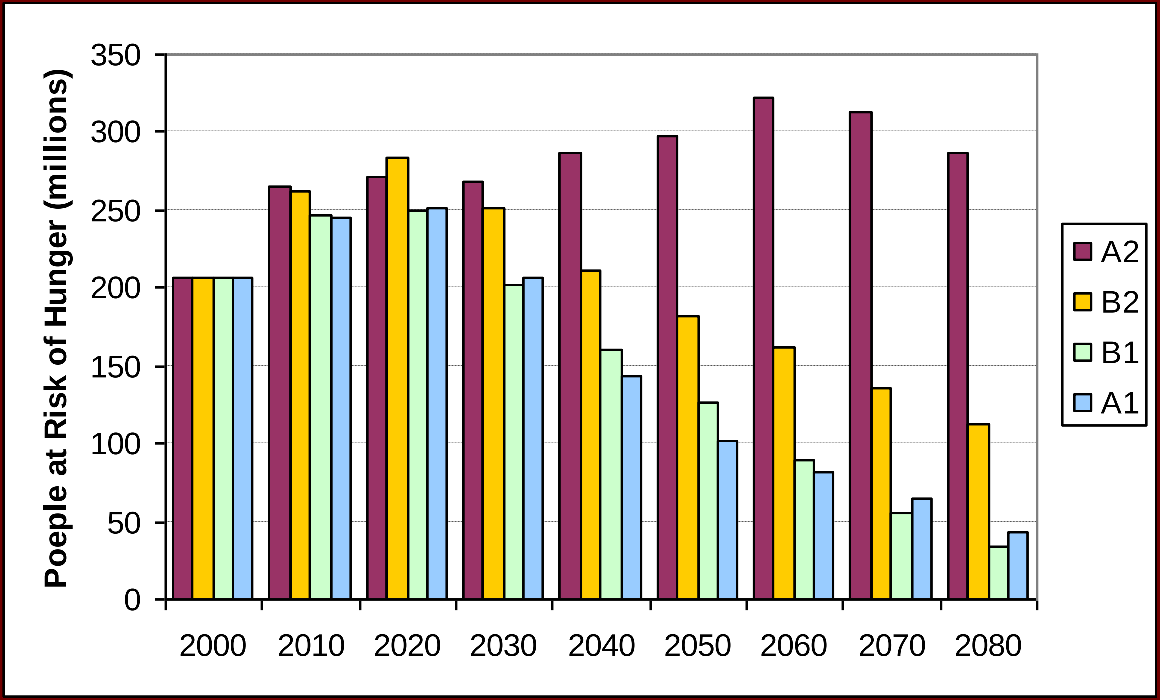
Source: Fischer et al., 2002

NET IMPORTS, CEREALS



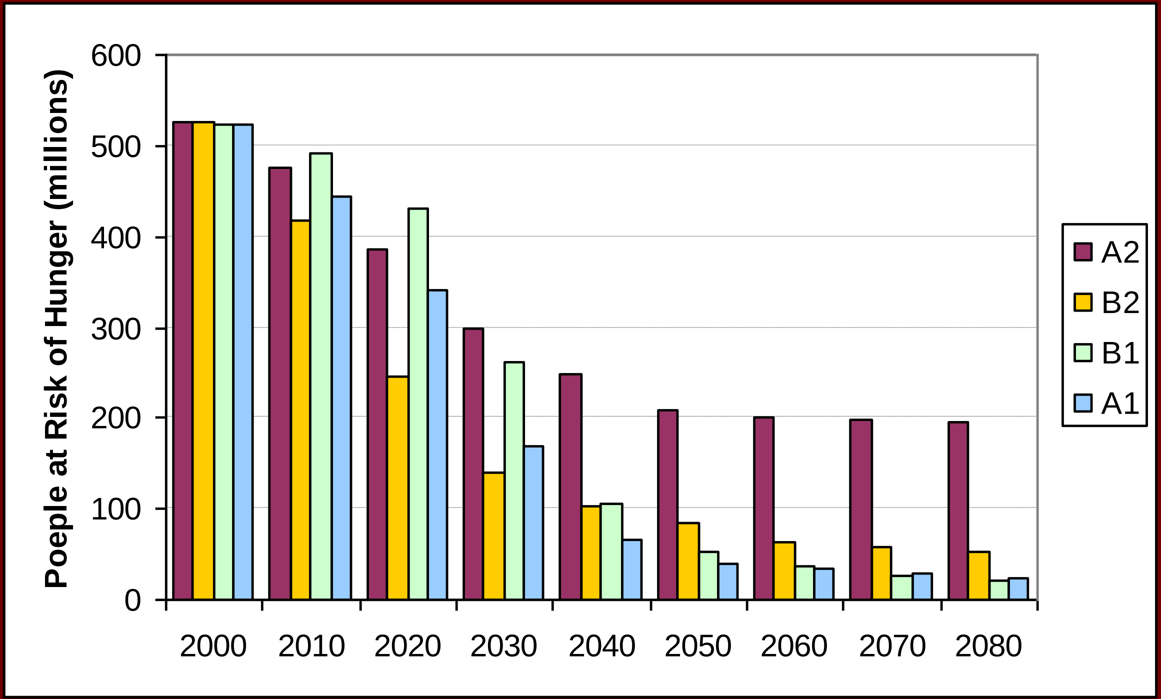
Number of People at Risk of Hunger

projected for different IPCC economic development paths



AFRICA

Source: Fischer et al., 2002



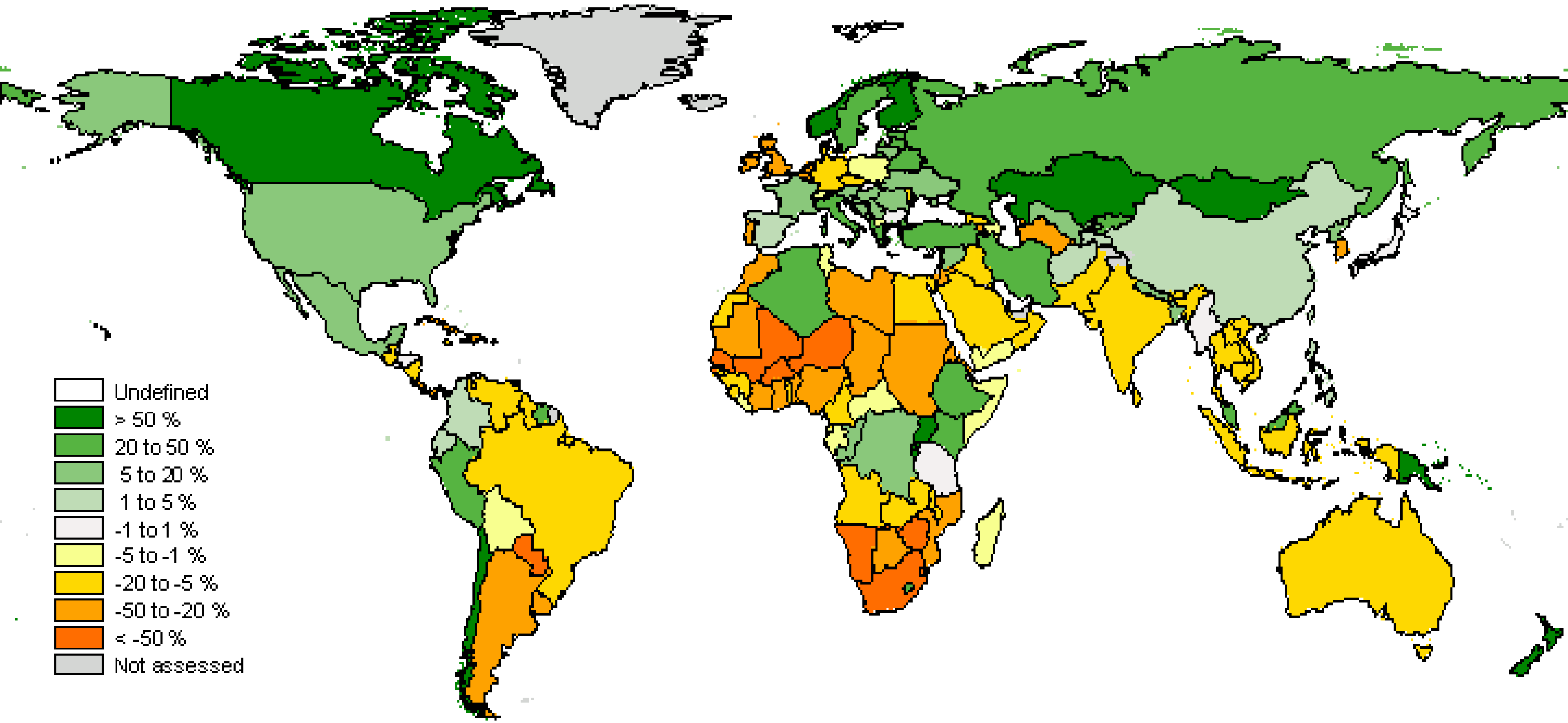
SOUTH, SOUTEAST and EAST ASIA

India : Impact of Climate Change on Agriculture – 2080s

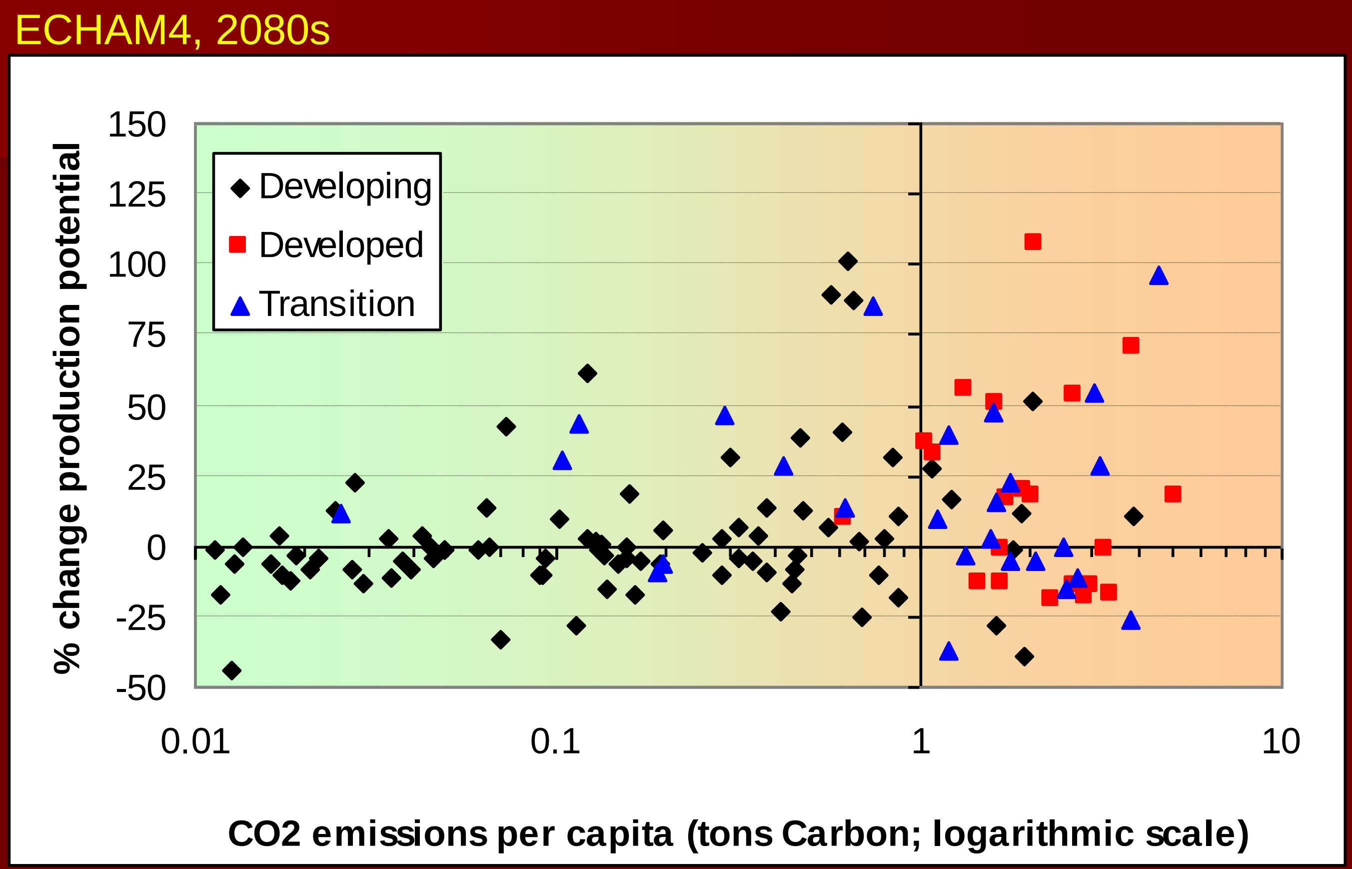
	Cereal Production	GDP Agriculture	Cereal Consumption
H3A1f	-15.7	-4.8	-7.5
H3A2	-15.9	-7.9	-6.4
H3B2	-9.8	-4.4	-4.4
H3B1	-5.7	-1.0	-3.8
CSA1b	-9.6	-1.8	-4.6
CSA2	-10.4	-3.9	-4.1
CSB2	-8.2	-2.8	-4.9
CSB1	-7.5	-2.7	-5.0
CSA2	-5.7	1.0	-2.2
CSB2	-5.4	2.5	-1.2
NCA2	-10.3	0.9	-0.4
NCB2	-5.7	1.9	0.1

Note: percent change relative to respective reference projection without climate change

Climate Change Impact on Cereal Production
CGCM1, 2080s



Climate Change Impacts and Carbon Dioxide Emissions

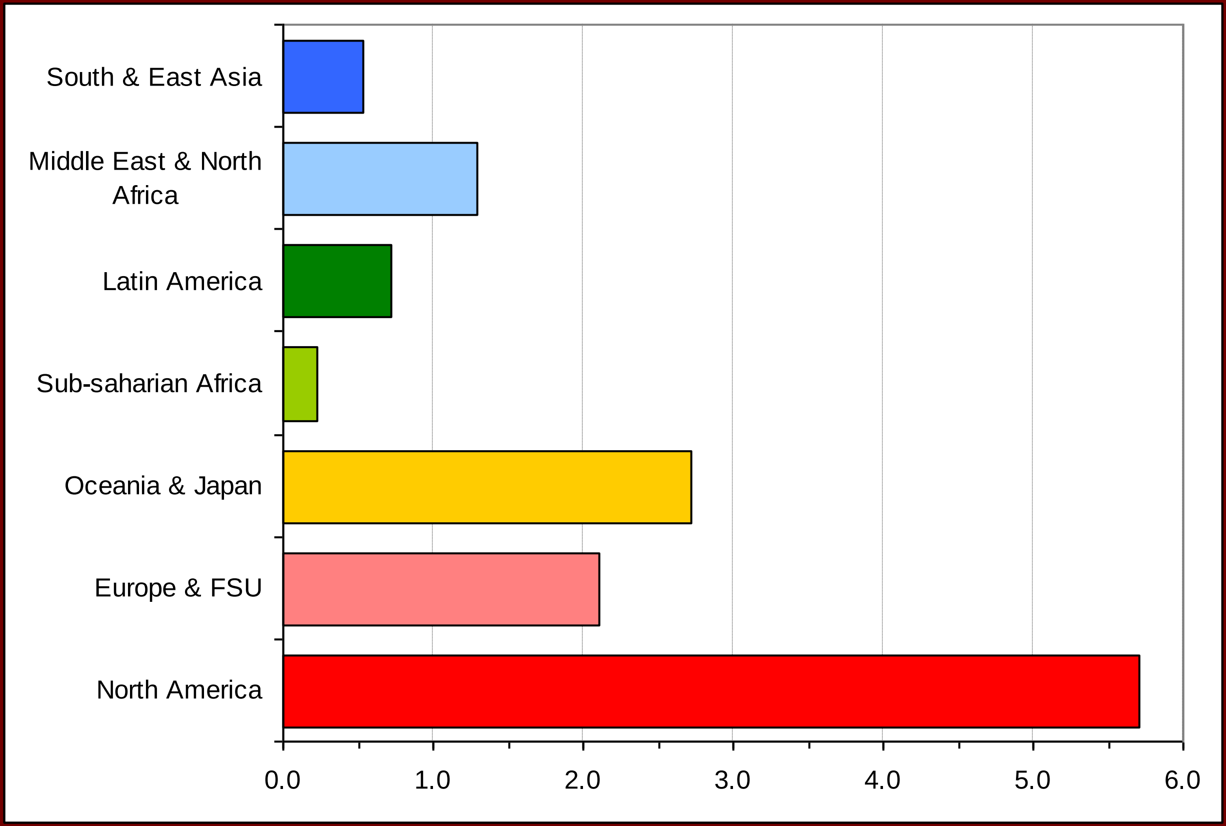


(Fairness and Equity?)

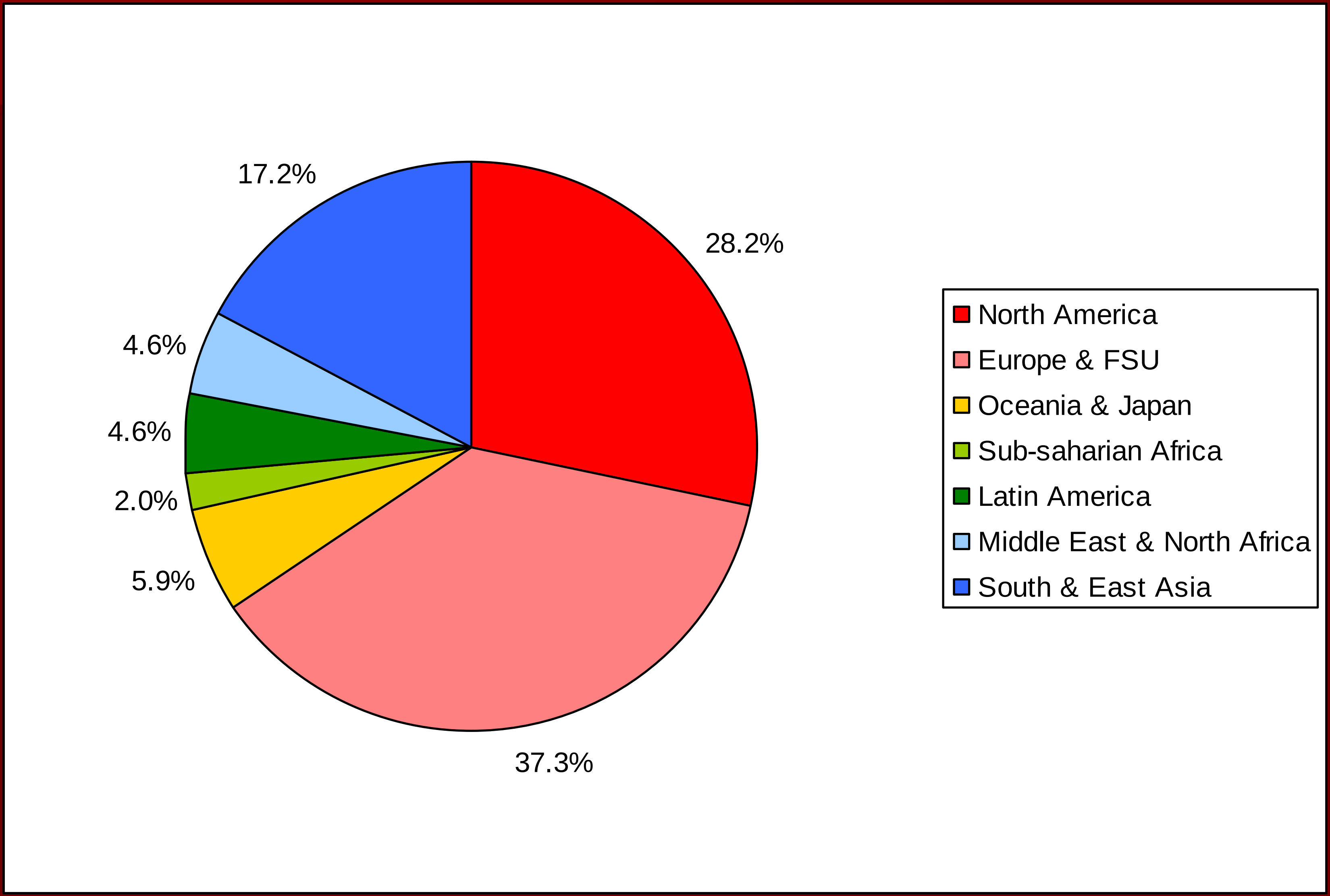
Greenhouse gas emissions since 1950:

75% from developed countries, 25% from developing countries

Year 2000 Per Capita CO2 Emissions in Mt



CO2 Emissions – Cumulative share 1951-2004



Responsible International Investment in Agriculture
Transparency and Accountability
Social, Environmental and Economic Sustainability

Information and Knowledge
The Foundation of Responsible Land Investments
Land Tenure Guidelines and Principles of RAI

Agro-ecological zones and National/International Economy

IIASA – FAO Methodology, Modeling, Policy Analysis

Integrated Agro-ecological Socio-Economic Spatial Global Assessment

Agricultural Development and Food Security

IIASA

The 21st Century

Charting a Secured Future for a World on the Brink

- **Food Crisis : Hunger and Obesity**
- **Energy Crisis: Fuel, Emissions….Biofuels, Cereal prices**
- **Health: Persistent and Emerging Diseases**
- **Poverty: Employment and Livelihoods**
- **Population: Migration and Conflicts**
- **Society: Ethical and Moral Values**
- **Globalization: Disparities and Interdependencies**
- **Climate Change: Mitigation, Fairness and Adaptation**
- **Scientific Barriers: IPRs or Public Goods**
- **Governance: Self Interests or Common Responsibility**
- **Natural Resources: Degradation and Exploitation**

Achieving Sustainable Development in the 21st Century
An Imperative - Not an Option

Diversity and Sustainable Development

"Our biggest challenge in this new century
is to take an idea that sounds abstract
– sustainable development –
and turn it into reality for all the world's people"
Kofi Annan, 2001

Sustainable Development

Stockholm 1972
Preserving and Enhancing the Environment

Earth Summit : Rio 1992
Agenda 21 and Rio Declaration

Johannesburg : August 2002
Turning Agenda into Actions

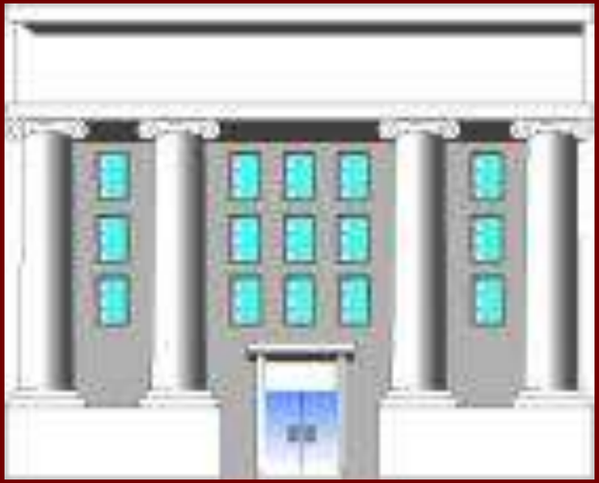
" Meeting the needs of the present without compromising the ability of future generations to meet their own needs"

Needs : Material, spirtitual, values, relationships, freedom to think, act, participate.

Human Capital and University Diversity

"A university should be a place of light, of liberty, and of learning"

Benjamin Disraeli, c 1873



Human Capital

"to make our national human capital the envy of the world"

University Diversity

Foundation for a human capital revolution

Enhancing the role, relevance, and effectiveness of universities

- Education Diversity - Right balance of science, technology and humanities
- Human Diversity - Right balance of the nations' human diversity among students and staff
- Nature's Diversity - Knowledge for local social, environmental and economic development priorities
- Sustainable Development - Curricula for course, mandatory for undergraduates and postgraduates
- Knowledge Revolution - Private-public investments in information and Communication Infrastructure
- Entrepreneurship - Center of advice to build indigenous science, technology, and business capacity

Nam et ipsa scientia potestas est

Enhancing the role, relevance, and effectiveness of universities

- Civil Society - Knowledge empowerment and enfranchisement to participate in national development and policy making
- Government - Knowledge empowerment for development and policy making and in international negotiations
- Funding - Long term public commitment; A Global Endowment Fund for Higher Education and Research
- Governance - Relevance, scope and timing of reforms in the context of national development
- International - Network of centers of excellence for education, research and staff and student exchange

Nam et ipsa scientia potestas est

"Development is another name for peace"
Julius Nyerere, c 1976



All life is precious
Humans may Rule the Earth
But survival of all species' is interlinked

Destruction of the Earth's Environment and Ecosystems
Will threaten the survival of many species

And the first to perish
Will be the closest human relative



All life is precious
You Human may Rule the Earth
But survival of all species' is interlinked

If you continue to destroy the environment
We all are sure to perish

And the first to perish
Will be your closest relative

THANK YOU

IIASA