

ENVIRONMENTAL DEGRADATION IN THE MOUNTAINOUS REGIONS OF PAKISTAN

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ABSTRACT

Environmental degradation in the mountainous regions of Pakistan is accelerating due to increase in population, exploitative agriculture and mining, melting of glaciers, deforestation and devegetation, and intervention of people with nature. This situation is resulting in soil erosion, floods, limited supply of fresh water and fuelwood for domestic use, decline in agricultural productivity, loss of biodiversity and migration of people to the plains.

Although dozens of institutions have been established and international conventions/protocols signed to protect the environment, but little effort is made to mitigate the miseries of the mountain people and to check the environmental degradation in the mountain regions of the country.

This article presents the possibility of increasing forest-cover; improving efficiency of cooking stoves, micro-hydel plants for generating electricity for domestic purpose and cottage industries; developing appropriate technologies for income diversification; and maintaining biodiversity for beneficial use. Pertinent priority-areas are identified for improving quality of life of the mountain people and preserving indigenous knowledge and mountain ecosystem. Active cooperation should be sought with the ICIMOD for sustainable development of mountain regions.

1. INTRODUCTION

Environmental degradation is fundamentally linked to poverty and hunger in the majority of developing countries, including Pakistan. This was stated by the Pakistan delegation at the United Nations Conference on the Human Environment, held in Stockholm from 5 to 16 June 1972. This was the first major step on global level in the field of environment that provided awareness in protecting the environment and creating institutions to control environmental degradation, either in the plains or in the mountains. As a sequel to this, the United Nations established the UN Environment Programme at Nairobi. Pakistan prepared the country report on Environment, created an Environment and Urban Affairs Division in 1974 and promulgated the Pakistan Environmental Protection Ordinance in 1983.

The Earth Summit was held in Rio de Janeiro (Brazil), in 1992 (3-14 June), which was attended by more than

100 heads of states and 30,000 delegates, and brought the environmental issues to the forefront. Agenda-21 contained chapter 13, Managing Fragile Ecosystems: Sustainable Mountain Development. The major Earth Summit achievements included:

- i. Agenda-21, comprehensive blueprint to the global actions to affect the transition to sustainable development;
- ii. The Rio Declaration on Environment and Development;
- iii. A set of principles to support the management of forests worldwide.

There United Nations Framework Convention on Climate Change (UNFCCC) was adopted. This Convention was signed by 154 states, including Pakistan. UNFCCC aimed at stabilization of greenhouse-gas concentration in the atmosphere. Another legally binding Convention on Biologically Diverse Species was also signed.

Another World Summit to Sustainable Development was organized in Johannesburg in 2002. Declaration on Sustainable Development agreed to make a determined effort to respond positively to the need to produce a practical and visible plan to bring about poverty eradication and human development.

The third meeting of the UNFCCC was at Kyoto (Japan) in 2005, which adopted the Kyoto Protocol and the parties agreed to reduce their combined greenhouse-gas emission by 5.22 per cent below the 1990 level during the period 2008-12, but this major reduction is not being achieved by most countries. The protocol also introduced clean-development mechanism, in order to achieve sustainable-development goals in developing countries. So far these promises and targets have not been achieved by the developed countries, nor by the developing countries. Pakistan has also acceded to this protocol.

The voluminous report prepared by the UNFCCC was considered at the Climate Change Summit in Copenhagen from 7-18 December 2009. The global warming is unequivocal and the delay in reducing the greenhouse-gas emissions significantly increases the risk of severe climate-change impacts. It confirms that climate change is now threatening the world with rise in temperature, long summers, severe winters and snow, rise in seawater level, and depletion of the ecosystem. The pandits of Climate Change

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prophesied that thousands of glaciers will disappear by the year 2035, causing floods, soil erosion, unsettlement of population and other miseries. The summit ended with a non-binding agreement to reduce greenhouse-gas emissions and temperature, and noted that the institutional framework could not be established to assist developing nations to address climate change. The fund, amounting to \$30 billion, was announced for this purpose, which could go upto \$200 billion by the year 2020. These promises were never implemented, as in the past. The organizers hoped that the climate-change meeting in Mexico this year may give positive results, subject to commitment from the United States.

2. PHYSICAL POSITION OF MOUNTANOUS AREAS

The whole of Pakistan lies in the warm temperature-zone between 24°N and 37°N latitude. Out of six major regions of Pakistan, three are the Northern Mountains, the Western Bordering Mountains and the Balochistan Mountains. The northern mountains cover the area of Kashmir and northern parts of Pakistan. These mountains have an average height of 20,000 feet and are permanently covered under snow. Some of the highest peaks in the world are to be found in the northern Himalayan region (K2 - 28,250 feet high). The low hills, about 3,000 feet high, known as Sivaliks, lie adjacent to the plains. The western mountains consist of several parallel ranges and are much lower than the Himalayas. Most of the ranges lie outside the paths of monsoon and so (the rainfall being low) these are almost bare of vegetation. South of the Kabul river lies the famous Khyber Pass, which connects Peshawar with Kabul. Also south of Kabul river is Safed Koh range, with an average height of 12,000 feet and peaks frequently covered with snow. The Balochistan mountains consist of north west, the large part of which is desert; the north east range is higher than the south and contains valuable deposits of coal, iron, chromites and other materials. Some of the valleys are baskets of fruit trees of apples, plums, peaches, pears, apricot, grapes and figs.

Less than 20 per cent of the 88 million hectare land of the country has the potential for intensive agriculture. Its area classified as forest covers 4.57 million hectares or 5.2 per cent of the land area, of which less than 3 million hectares are actually under some form of tree-cover. And the government is committed to increasing the forest-cover to 5.7% by 2011 and to 6.0% by the year 2015, whereas area under forest should be 20-25 per cent of the total land area. The

coniferous forests in the mountainous areas consist of Deodar, Spruce, Fir and Dir and the Baluchistan hill-forests flourish with Pines and Juniper.

The distribution of forests is as follows: total state forest – 61.5%, total private forests – 34% and mixed forests – 4.5%. Depletion of forest resources due to mismanagement and declining agricultural productivity are threatening the socio-economic fabric of the mountain people.

The mounting threats to the mountain ecosystems of Pakistan are numerous: poverty, population-growth, exploitative agriculture and mining, deforestation, intensive rains and severe drought, climate change, unfair treatment to mountain people and loss of biodiversity and traditional knowledge. We examine a few of these in detail.

Pressure of Population: Pakistan's population was only 32.9 million at the time of its creation (1947), and it is projected to reach 173 million in the current year, while for the year 2025, the projected figure is 221 million. It may just be possible to accommodate this quantum of people by adopting sustainable-development programmes. Nearly 67.5 per cent of the country's population is living in rural areas and mountainous regions, where extreme poverty and hunger prevails.

The mountainous areas of Pakistan have the highest population per cultivated hectare, the highest ratio of human-to-land, and the greatest pressure to use extreme marginal soils and slopes most intensively. Increasing population has adverse pressure on land, natural resources, migration of people to plains, security and environmental balances.

3. WATER AVAILABILITY AND MELTING OF GLACIERS

Pakistan is divided into nine major ecological zones, which are very divergent in nature ranging from depth of Arabian Sea to the towering mountains of the western Himalayas, Hindu Kush and Karakoram. These ranges stretch across Afghanistan, Bangladesh, Bhutan, Myanmar, China, India, Nepal and Pakistan. The glaciers are the main source of fresh water for the millions of people of the region. Fresh water is now a scarce source in Pakistan, where 92 per cent of the land is covered by arid or semi-arid regions. The water resources originating from Indus river and its tributaries vary seasonally and their distribution is uneven. Water availability in Pakistan continues to change, both in total amount and per-

Table-1: Per-Capita Water Availability from 1951 to 2001, and Projections for 2013 and 2025

Year	Population (million)	Availability (m ³)
1951	34	5300
1961	46	3950
1971	65	2700
1981	84	2100
1991	115	1600
2001	141	1200
2013	181	850
2025	221	659

capita availability. In 1951, when the population was 34 million, the per-capita availability was 5,300 cubic meter. This has now decreased to 1,105 cubic meter, and is projected to further reduce to 659 cubic meter per-capita per year in 2025 (Table-1). The water requirement for agricultural sector is not as good as for drinking water.

It is reported that some 1.1 billion people in developing countries have inadequate access to water and 3.6 billion people lack basic sanitation. Close to half of these countries suffer at any given time from the health problems caused by water and sanitation deficits (for example, malaria, diarrhea). These deficiencies are also prevalent in the mountainous regions, where the entire source of water is glaciers, flowing streams and water falls.

3.1 Melting of Glaciers

There is no seriousness about the accelerated melting of glaciers in the region, although measurements taken reveal a general shrinkage of mountain-glaciers on global scale, due to increasing global temperature, The International Panel on Climate Change (IPCC) in the Fourth Assessment Report (2007) pointed out overwhelming evidence of the global relevance of climate change, and its consequences are now a well accepted truth. Just consider the impact of climate change on glaciers and snow-cover in the mountainous areas, resulting in flooding of rivers, soil erosion and loss of biodiversity due to more frequent weather events. The Panel's report projected that an increase of 1.0 to 6.0 degree Celsius in the annual temperature of the region is likely to result in decline in the current covering of glaciers by 43 to 61 per cent by 2100. The declared probability of thousands of glaciers in the Himalayas "disappearing by the year 2035 and perhaps sooner is very high, if the earth keeps warming at the current rate". Although, now IPCC admitted that in drafting the paragraph in question, the clear and well established evidence were not applied properly. Nevertheless, the IPCC stood by the conclusion about loss of glaciers in this century in

major mountain ranges, including the Himalayas.

There is no doubt that the glaciers are melting and it is a threat to the ecosystems as well as to agriculture, forestry, water conservation and safety of the people living in the region. Considering this situation, the International Center for Integrated Mountain Development (ICIMOD) has documented 3,253 glaciers in Nepal alone, spread over 5,324 square kilometers. In other countries of the region, this task has not been undertaken; these countries have not yet established a warning system to study and watch the effect of climate change on the glaciers. China, India and Pakistan have used glaciers only for defense purposes.

Institutions with trained manpower and equipment are needed for research on the impact of climate change on glaciers, assessment of the change in the pattern and amount of river-flows from glacier melting, as well as in the climate-pattern and consequential effect on local communities, agriculture, ecosystem and communication. So, using the experience gained by the ICIMOD is of value to Pakistan.

4. DEFORESTATION AND FUEL-WOOD REQUIREMENTS

Forest-cover in Pakistan is less than 25 per cent of the world-average. The trees and shrubs are presently the major resource for providing energy and, naturally the local people resort to cutting of trees and using dried branches and leaves. Notwithstanding the growing scarcity of energy-sources, it is estimated that 90 per cent of all rural households still meet their fuel requirements (for heating and cooking) from fuel-wood and other biomass sources. The wide range of various forms of biomass in Pakistan, as source of energy, is given in the Table-2.

In the mountain regions, the major source of energy is fuel-wood (derived from trees), shrubs and animal dung. There is increasing demand for energy and, thus, more pressure on forest resources due to

Table - 2: Percentage of Various Forms of Biomass in Pakistan as Source of Energy

Biomass	Percentage
Fuel-wood	54
Bagasse	16
Shrubs	6
Cotton Stubs	6
Animal Dung	16
Others	2
Total	100

increasing population, as well as inefficient cooking stoves.

It is essential that affordable substitute-fuels for household use should be made available and that extensive community reforestation programme is undertaken. Local people need to be involved to protect and nurture the forests. There is a need to develop wood-fuel plantation, as a part of reforestation effort, through community-based management approach. Training is needed on planting and tending the young trees in order to planting fast-growing species.

The government agencies and NGOs working in the field should look into the Domestic Energy-Saving Project sponsored by the German Agency for Technical Cooperation (GTZ) during the 1980s. This project aimed to develop an energy-efficient cooking stove for individual domestic use and an efficient Tandoor (oven) for bakers to supply bread to a whole community. Traditional cooking stoves have an efficiency-rating of 10 to 15 per cent, depending on the quality of design. The cooking stove designed by GTZ had an efficiency of 30 to 35 per cent and assisted in reduction of wood consumption. Some 100,000 stoves and tandoors had been provided, primarily for Afghan refugees. The Pakistan Council for Renewable Energy Technologies (PCRET) has more than 30 years of experience in developing appropriate technologies for efficient cooking stoves, preservation of food, and micro-hydel plants. These technologies can be adopted, with ease, to avoid deforestation.

4.1 Micro-Hydel and Mini-Hydel Units

Instead of cutting down trees, resulting in deforestation and water and soil erosions, it is possible to generate energy locally for lighting the house as well as developing cottage industry in the Northern mountainous regions of Pakistan. Micro hydro-power plant (less than 1 MW) technology is well developed and is effectively being used in many countries of the world. A small decentralized hydel plant, based on natural water-falls, is a very desirable option for

generating electricity. Perennial waterfall is channelized and allowed to fall on the turbine from the forebay, through a penstock. In Pakistan, several water-fall sites have been identified. In collaboration with the local population, PCRET has installed over 235 units, with a total potential of generating 2.8 MW electricity. Experience gained by PCRET has been utilized by other organizations as well. In Pakistan, so far 290 micro-hydel plants, with a total generation capacity of 4MW, have been installed for electrifying about 300 villages comprising 25,000 homes. It is estimated that as much as 30,000 MW electricity can be generated through installation of such micro and mini-hydel (1-10 MW) plants. Local people are willing to cooperate to light their houses and start cottage industry, like floor mill and saw mill, etc.

Small hydro-power technology is today a mature and proven technology. It is rather strange to find that neither the government, nor the dozens of NGOs working in the mountainous regions are keen to adopt this technology to light the homes of the poor segment of the society living in very severe environmental conditions. Just to quote an example, in Austria there are 1690 small hydro-power plants with a total of 600 MW capacity.

4.2 Capturing CO₂

Another recent development is that engineers in Britain are developing forests of artificial trees to remove the CO₂ from the atmosphere. The synthetic tree, costing £15,000, could capture ten times of CO₂ from the air everyday, making it thousand times more efficient in absorbing carbon dioxide than a real tree, thus reducing chances of warming of the atmosphere due to green house effect.

Further researches are in progress on technology to beat the threat of global warming and disappearing of glaciers and forests and loss of biodiversity. One can only hope that it does not take as much time as that of reducing the cost of photovoltaic power-generation technology.

5. LOSS OF BIODIVERSITY

Biodiversity constitutes a capital asset, with great potential for yielding sustainable benefits. It provides food, clothing, natural drugs for medicinal use, as also supplements for improving quality of agricultural crops. There are an estimated 30 million species of animals and plants worldwide. Out of several thousands of plant-species investigated, only about 300 species have been commercially exploited, whereas only 30 crops account for 95 per cent of the world's food-consumption, mainly rice, wheat, maize, potatoes and casava. The natural ecosystems, including mountains, contain most of the earth's biodiversity. The indiscriminate use of natural resources has continuously led to environmental degradation, causing soil and water erosions, decline in agricultural productivity, rapid loss of habitat and genetic diversity. This further accelerates poverty, hunger, poor health, unemployment, migration to the plains and loss of biodiversity.

The governments should take necessary measures to establish and strengthen the national inventory of flora and fauna and ensure conservation of biological diversity in the mountainous region. It is also important to take appropriate actions to respect, record, protect and promote the wider application of the existing knowledge, innovation of practices of indigenous and local communities embodying traditional knowledge for the conservation of biological diversity and sustainable use of biological resources.

Pakistan is a signatory to the Convention on Biological Diversity. This Convention came into force in 1993 and has three objectives: conservation of biological diversity; sustainable use of biological diversity; and

fair and equitable sharing of benefits arising from utilization of genetic resources and associated traditional knowledge. Not much has been done to achieve/implement these objectives, whereas six multi-national corporations, namely Aventis, Dow, Du Pont, Mitsui, Monsanto, and Syngenta, are gaining more access to the wild species flourishing in the mountainous regions. The basic Pakistan Institutional Framework for Protection of Mountain Regions is given as follows:

6. INSTITUTIONAL FRAMEWORK FOR PROTECTING ENVIRONMENT IN MOUNTAINOUS REGION OF PAKISTAN

Since 1972, the government of Pakistan has initiated several strategic plans, established appropriate institutions, approved national policies and action plans, signed international agreements/protocols and launched dozens of programmes and projects to conserve environment leading to sustainable development, but very few related to integrated mountain development. Some of the actions taken are presented in Table-3.

The mountain people understand well the threats of expanding population, deforestation, excessive grazing, loss of biodiversity, flash floods, poverty and hunger. But their knowledge and resources are too limited for them to follow the integrated approach to solve the problems. The government agencies, too, have limited experience of working in the mountain environment and hence they should seek assistance from the concerned regional institutions, e.g. ICIMOD, which is described below:

Table - 3: Initiatives of the Government of Pakistan for Development of Mountainous Regions

Institutions	– National Council for Conservation of Wildlife
National Policies and Action Plans	– National Forestry Policy and Action Plan
Signatory to Conventions/Protocols	– On biodiversity, migratory species, wetlands of international importance, Kyoto protocol on climate change, desertification – Protection of substances that deplete ozone layer – Management of hazardous wastes – International trade in endangered species of wild flora and fauna
Programmes and Projects	– Forestry sector research and development project – Mountain-area conservatory project – Mainstreaming biodiversity on Juniper forest

7. INTERNATIONAL CENTRE FOR INTEGRATED MOUNTAIN DEVELOPMENT

The only regional centre for integrated mountain development is located in Nepal. The International Centre for Integrated Mountain Development (ICIMOD) was established on 5th December 1983, with its headquarters in Kathmandu, and legitimized through an Act of the Parliament in the same year. The centre brings together the countries of Afghanistan, Bangladesh, Bhutan, China, India, Myanmar, Nepal and Pakistan, to foster collective knowledge-sharing and coordinated action for sustainable mountain development and reducing environmental degradation. It is governed by a Board of Governors, consisting of one representative from each of the eight regional countries (initially five countries, later joined by Afghanistan, Bangladesh and Myanmar), and six independent members who are nominated by the ICIMOD Support Group, based on their professional expertise and experience.

Its mission is to enable and facilitate the equitable and sustainable well-being of the people of Hindu-Kush Himalayas by supporting sustainable mountain development, through regional cooperation. It is to develop and provide integrated and innovative solutions in cooperation with national, regional and international institutions, which foster action and change for overcoming mountain people's economic, social and physical vulnerability. Some of the programmes/projects deal with geographic-information system; remote sensing; soil and water-conservation technologies; management of aromatic and medicinal plants; conservation of biodiversity and sustainable use of biological resources; global warming; ecological state of rivers; energy-saving devices; flash-flood risk management; rural income diversification and developing mountain technologies for poverty alleviation. However, the central role as a regional centre of knowledge sharing, information exchange and capacity-building is yet to be established.

Pakistan contributes \$100,000 annually towards functioning of the ICIMOD, and the Secretary, Ministry of Food, Agriculture and Livestock, attends the Board of Governors' meeting regularly. Yet few projects are undertaken in the mountains of Pakistan. Furthermore, over 90 per cent of technical staff of ICIMOD belongs to Nepal, India and China (in that order). The rest of the countries have one or two experts employed in the Centre. This needs attention.

Pakistan has competent experts in all the subject

areas of investigation, related to sustainable development in the mountainous region. What is needed is more realization that mere policy-making does not solve problems or provide relief to the poor and vulnerable groups living in the mountain region. Action is needed and the role of local people in mobilizing their knowledge and skills for collective action should be appreciated. Coordinated effort is required for improving quality of life of the mountain people.

8. FUTURE LINE OF ACTION

a. Sustainable Mountain Development Cell

Considering the above-mentioned situation, it is essential to establish a Sustainable Mountain Development Cell in the Ministry of Food, Agriculture, Forestry and Livestock to: initiate action in the formulation of National Policy; review and study the administrative, financial, technical and other implications and the policy proposal; and to prepare action-plan to implement it. Needless to say, all stakeholders should be involved in this exercise and the institutional cooperation is vital in this multi-disciplinary area dealing with agriculture, biodiversity, climate change, land degradation, watershed management, socio-economic conditions of the mountain people and other relevant subjects.

Government at the appropriate level, with the support of regional and international organizations, should ensure that policy and policy-instruments support the sustainable development of the natural resources and rehabilitation of the environmental degradation in the mountainous regions of Pakistan. The policy is also required to comply with various objectives of the UN Conventions, like Convention on Biodiversity, Kyoto Protocol on Climate Change and Convention on Combating Desertification, and to acquire financial and technical support from the international agencies for the improvement of the fragile mountain ecosystems.

b. Reforestation and Continuous Training

Furthermore an important natural source is the forest and rangelands and their optimal utilization. Under the Millennium Development Goals related to forestry sector, Pakistan is committed to increase forest-cover from the existing 5 per cent to 5.7 per cent by the year 2011 and 6 per cent by the year 2015. This implies an additional 1.05 million hectares of land-area under forest. Presently, Pakistan is a forest-deficient country, facing timber and fire-wood shortage of about 29

million cubic meters. Beside attempting to introduce new fast-growing plant species, tree-planting campaigns are organized twice a year and millions of saplings are planted. But not much care is taken of these saplings and, thus, survival loss is maximum.

The mountain people need training and technical guidance for planting and tending the young saplings of the newly introduced and the traditional plant species. This aspect needs institutionalization. The reforestation shall provide additional fire-wood for domestic use and timber to earn additional income, in addition to mitigating the negative impact of environmental degradation in the mountains. Also, encouragement in terms of adaptation of new technologies, financial support and training is required to develop and maintain medical botanic resources. Cropping and harvesting should be done carefully to ensure quality products and that populations are sustained in perpetuity. Some countries are earning millions of dollars annually by exporting medicinal plant-products (for example China, India and South Korea). Pakistan has the potential to benefit from cultivating the medicinal plants and processing thereof. Employment avenues and enhancing quality and life have to be explored, to avoid migration of people to the plains. Some other priority-areas for sustainable development is the mountainous regions are summarized below.

9. PRIORITY AREAS FOR SUSTAINABLE DEVELOPMENT IN THE MOUNTAINOUS REGIONS

These are listed below:

- i. Survey of types of soils, forms of forests, commercial plant-species and methods of plantation, availability, distribution and use of water, plant and animal resources of mountain ecosystems be carried out, on priority basis.
- ii. Active cooperation be established with ICIMOD, to identify location of glaciers and their status of melting, to watch the effect of climate change and the related issues.
- iii. Develop national policies that would provide incentives to the local communities to undertake conservation measures and to adopt environment-friendly technologies (for example cultivation and processing of medicinal and aromatic plants).
- iv. Every effort be made to conserve and preserve indigenous plant-species to avoid loss of biodiversity and to utilize local knowledge in the process.

- v. Integrated watershed programmes be launched, through effective participation of the local people to prevent further ecological imbalance.
- vi. Micro-hydel technology is a mature and proven technology and can be adopted with ease in the mountainous regions. The experience gained by PCRET over the last 35 years be availed to provide light & power to the remote areas in the mountains.
- vii. Reforestation needs immediate attention. Provide training to the local community on planting and tending the young plants of fast-growing trees.
- viii. Promote alternate livelihood opportunities, particularly through development of employment schemes that increase the productive base.

BIBLIOGRAPHY

- Daily Dawn, Islamabad, 2010. Erroneous Report about Glacier Melting, Dated 24th January 2010.
- Environment and Urban Affairs Division, Government of Pakistan, and IUCN, 1992. "The Pakistan National Conservation Strategy", pages 278.
- Hussain, T., and Kazi, A.Q., 2007. "Energy Policies for Third World Countries", Science Vision, Vol. 12, No. 1-4, pages 49-59.
- ICIMOD, 2008. "The Next Five Years – Changes and Challenges in the Himalayan Region", p 55, Kathmandu, Nepal.
- Kazi, S.A., 1969. "A Geography of Pakistan", The Inter Service Press Ltd., Karachi, pages 262.
- Ministry of Finance, Government of Pakistan, 2008. "Economic Survey", 2007-08. Chapter 16, on Environment, pages 267-283.
- Sharma, D., 2009. Perils of Denying Glacier Melting, Dawn Daily, December 2009.
- Shearman, D., and Smith, J.W., 2008. "The Climate Change Challenge and the Failure of Democracy", Praeger Publishers, Pentagon Press, New Delhi, page 181.
- United Nations Conference on Environment and Development, Rio de Janeiro, 1992. Earth Summit – Agenda 21, Chapter 13 Managing Fragile Ecosystems: Sustainable Mountain Development, pages 119 and 120.

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- United Nations Millennium Summit 2000.
- United Nations, 2006. "Revision of World Population Estimates Projections", New York, 2007.
- World Commission on Environment and Development, 1987. "Our Common Future".