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**EFFECTS OF ADVERSE CLIMATOLOGICAL CONDITIONS
ON FOOD PRODUCTION AND TRADE**

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Natural phenomena affecting agriculture in Latin America

Introduction

1. Agricultural land makes up about 19% of the 19.93 million km² of the Region, which has a total population of 446.2 million inhabitants. About 21% of the active population are directly involved in agriculture which accounts for about 7% of regional GDP. Despite its importance, agriculture is particularly exposed to natural phenomena and market fluctuations. The greatest natural threats to agriculture are drought, flooding, cyclones, volcanic eruption and climate change. While the first four are catastrophic in nature, climate change represents a risk that could lead to modified land use and implementation of adjustment measures whose cost would fall upon the producers. Such a situation poses a threat to development and food security in countries, and was one of the thematic areas referred to in the Rome Declaration on World Food Security and the Plan of Action of the World Food Summit (1996).

Analysis of the regional situation

2. The Latin America and Caribbean Region is one of the richest sources of biodiversity in the world and has potential for carbon sequestering (WRI, 1990-91, LAC CDE, 1992). One third of its surface area is covered with grassland where productivity depends on rainfall. Significant tracts of grassland are subjected to overgrazing, rendering them vulnerable to the periodic droughts.

3. Latin America and the Caribbean account for approximately 35% of the world's inland freshwater supplies and 23% of its potential arable land. The projections are that water availability in several countries of the Region will become critical in the forthcoming years¹. Global warming is threatening to significantly reduce snow and ice reserves in high mountain areas². Hydrological changes could be a source of conflict in river basins with international waters³.

4. There is evidence to suggest that there has been a 35% increase in rainfall in the Humid Pampa, extending as far as southern Brazil⁴. In contrast, historical rainfall data for 1500 kilometres of Chile's Pacific coastline indicate a steady fall in rainfall of up to 25% during the twentieth century⁵.

Different types of natural phenomena

The natural phenomena affecting agriculture include climate change, drought, flooding, hurricanes, landslides and volcanic eruptions.

¹ Mexico, Peru and Chile, whose major urban agglomerations are situated in dry regions.

² Constituting a risk factor in regions where agriculture is heavily dependent on surface waters.

³ Such a situation applies to the three major river basins of the Orinoco, La Plata and Amazon, as well as to the high Andean plateaux of Peru, Bolivia and Chile.

⁴ Forte-Lay, 1987; Castañeda and Barros, 1996.

⁵ Santibañez, 1997.

Global climate change

6. The impact of expected change⁶ on yield is uncertain, as this can be both positive and negative. An increase in temperature in cold climates is positive, as is fertilization with atmospheric CO₂. On the other hand, an increase in temperature in warmer climates may be detrimental because of higher thermal stress and inappropriate acceleration of crop growth cycles. A lower rainfall in arid, semi-arid and dry sub-humid areas may reduce crop yields, but be beneficial in humid areas with excessive rainfall.

The El Niño – La Niña phenomena and climate variability

7. One of the factors disrupting climate patterns is the El Niño phenomenon which raises temperatures in the western rim of the Pacific Ocean⁷ and modifies atmospheric circulation patterns, pressures, rainfall, river flows and level of lakes^{8 9}.

8. El Niño has produced abnormally heavy rainfall¹⁰ but at the same time drought in other areas¹¹. Its presence facilitates the generation of typhoons in the Equatorial Pacific, threatening the coasts of Mexico and Central America. It has also produced droughts on the Pacific coast, from Mexico to Chile and intensive rainfall in Indonesia, Australia, and Northeast Brazil. La Niña, on the other hand, strengthens the trade winds which push the hurricanes that form in the Atlantic towards the western coast of Central and North America.

9. El Niño has affected the Pacific coast of the Central American isthmus with inadequate rainfall and distribution of rainfall, prolongation of dry season, early arrival of dry season and sometimes late arrival of rains. The Caribbean has experienced heavy rainfall and frequent flooding. There have been about ten El Niño events in the last 40 years, each different from the other in terms of impact on regional rainfall. The droughts are cyclical but have no definite periodicity. There is on average one drought every five to seven years in the countries of the Region¹².

Tropical storms, hurricanes and cyclones

10. The average duration of these events is 6 to 9 days, but they can vary from a few hours to a number of weeks. They move at a speed of 330 km per day or more and can cover 2000 to 3500 km before dying out. Each year some eight cyclones pass over the Caribbean or the American

⁶ Based on Atmospheric General Circulation Models.

⁷ Ecuador, Peru, Chile.

⁸ Aceituno, 1987.

⁹ El Niño episodes have produced intensive rainfall and flooding on the coasts of Ecuador and Peru and in central Chile (Rasmuson and Carpenter, 1982; Pittock, 1980). At the same time these events have produced droughts in Northeast Brazil and in Central America, particularly along the Pacific coast with significant social and economic consequences (Hastenrath, 1976; Kousky et al, 1984; Campos et al, 1996).

¹⁰ In California and Northeast Argentina

¹¹ Indonesia, Australia, South Africa and Northeast Brazil.

¹² ECLAC, 1987.

coast, causing the flooding of agricultural land which can remain under water for many weeks, thus acting as a breeding ground for vectors of dengue and malaria¹³.

Floods

11. Floods in Latin America and the Caribbean are also associated with El Niño. A rainfall event (>50 mm/day over an extended area) causes drainage systems to collapse as they cannot cope with the volumes of water deposited¹⁴. Flooding in the agricultural sector is basically caused by riverbeds breaking their banks, again due to a lack of investment in riverbed protection and maintenance works and the failure to consider the sheer scale of extreme events¹⁵.

Volcanic eruptions

12. The Andes Mountains constitute a “line of fire” that extends from South America, through Central America, to North America. There have been a dozen or so eruptions in the past 10 years that have endangered inhabited areas and agricultural activity¹⁶.

13. The emissions of sulphurous gasses that then convert into sulphuric acid in the air block solar radiation, causing a lowering of temperature and a reduction in luminosity. This, coupled with the deposit of high concentrations of minerals toxic to animals (fluorine, silicon and others) cause serious harm to agriculture and livestock, with consequences that can last for a number of years¹⁷. There is generally one volcanic eruption each year in the Region requiring emergency planning.

Vulnerability and impact of natural phenomena on agriculture

Factors of vulnerability: land use, land management, poverty, land tenure

14. The vulnerability of agricultural systems in the Region is exacerbated by the location of activities in risk areas and by the excessive pressure brought to bear on natural resources by marginalization, poverty, lack of social organization, absence of environmental and land management policies, excessive centralization and bureaucracy of national bodies, limited technical modernization of agriculture, and lack of general awareness of how to forestall and tackle the risks¹⁸.

¹³ In 1982 Honduras was devastated by a cyclone that produced 600 mm of rainfall in three days, while Nicaragua received 860 mm in the same period. Similar episodes were repeated in 1998 with hurricane Mitch.

¹⁴ This frequently occurs in poorly planned urban areas where drainage is non-existent or has only been designed, for reasons of cost, for average but not extreme events.

¹⁵ The most typical situation is that of bridges collapsing under the pressure of high waters for which allowances were not made. In many cases the swollen rivers cause unusually severe water flow that destroys infrastructure such as roads, communication links, irrigation canals and even inhabited areas.

¹⁶ The most important have been: Pacaya (Guatemala, 1987), Guagua Pichincha (Ecuador, 1987), Galeras (Colombia, 1989), Sabancaya (Peru, 1990), Hudson (Chile, 1991), Popocatepetl (Mexico, 1994-95), Montserrat (Island of Montserrat, 1997), Tungurahua (Ecuador, 1999).

¹⁷ Aerosols have costly consequences for the broncho-pulmonary health of local populations.

¹⁸ Many of these reasons were included in the Rome Declaration on World Food Security in 1996, <http://www.fao.org/WFS/final/rd-s.htm>.

15. The term “vulnerability” refers to potential damage that a natural phenomenon can inflict on production, infrastructure, housing or trade, as well as to the ability of society or ecosystems to respond to the resulting impact.

Vulnerability of the main agro-forest ecosystems of the Region

Natural forests

16. The tropical rainforest regulates the climate in the Amazon Region. Its reduction in size therefore alters the hydrological cycle, leading to lower rainfall because of reduced evapo-transpiration and shorter water retention in catchments (Molion, 1975; Salati and Nobre, 1991). Average annual deforestation in Latin America and the Caribbean has been estimated at 7.6 million hectares (FAO, 1993) which, for example, has eroded Brazil's 100 million hectares of Atlantic forest. In tropical regions where higher rainfall is expected from the greenhouse effect, the cleared areas will have lost almost all their vegetative protection against a more aggressive climate, rendering them more vulnerable to flooding. In the subtropical areas bordering deserts, where a reduction in rainfall is expected, the loss in plant cover could cause irreversible desertification, thus marginalizing local populations and driving them towards urban areas.

Grasslands

17. Grazing lands (bushland, savannah and semi-desert formations) account for about 33% of the Region's land area (IPCC, 1996). The spontaneous vegetation of these ecosystems is highly dependent on rainfall, but primary production is often unpredictable, varying by as much as a factor of 10 from one year to another, which places extensive livestock production under permanent condition of risk. Rainfall variability is high in Northeast Brazil and in the arid, semi-arid and dry sub-humid zones of the Pacific coast in Mexico, Central America, Peru and Chile. Overgrazing and inappropriate management practices have caused intensive desertification in parts of Argentine Patagonia (Soriano and Movia, 1986) and Chile. A similar situation exists in the dry regions of Mexico and Central America.

Mountain ecosystems

18. Mountain ecosystems play an important role in Latin America. In many regions they are the sites of ancestral human settlements, as in the high plateaux of Peru, Bolivia and Chile. They regulate the hydrological regime in virtually all of South America, while the altitude gradient of the Andes Mountains is a rich source of biodiversity. The reserves of snow and ice are now threatened by global warming which could cause them to diminish (IPCC, 1996) thereby slightly changing river flows and exposing large areas of irrigated land in Peru, Bolivia, Mexico, Chile and Argentina to the threat of drought¹⁹.

Agriculture

19. The Region has a total of 134 million hectares under cultivation, 75% of which are under some form of degradation (UNEP, 1992)²⁰. A total of 14 040 000 hectares are irrigated (UNEP,

¹⁹ Almost all the glaciers are now receding because their lower limits are melting (Schubert, 1992; Hastenrath and Ames, 1995; Aniya et al., 1992; Kadota et al., 1992).

²⁰ Land degradation is mainly due to erosion of slopeland, overgrazing and salt build-up and alkalization on irrigated land.

1992). Productivity of rainfed agriculture is closely linked to rainfall (Viggliozzo et al., 1995). Although agriculture only accounts for some 7% of GDP, it is nevertheless pivotal to the economies of all countries, not only because it employs an average of 40% of the population, but also because it provides a large share of the Region's exports (Baethgen, 1994).

Inappropriate technological use of natural resources

20. Economic and social marginalization in some areas has led to the use of systems that are not environmentally friendly; nor do the capitalization and modernization of agriculture necessarily guarantee the existence of sustainable production systems. This has been well illustrated by the farming of extensive areas of the Amazon where productivity declines in a few years and by the salinization of large irrigated areas because of the failure to adopt a long-term view when programming irrigation works.

21. The technological aspect that has caused the most environmental damage in the Region²¹ has been the tillage of soil in areas that are too fragile for such a practice. In virtually all countries this has produced widespread erosion which is irreversible in terms of agricultural productivity. The failure to treat waste waters from industry, mining and human settlements has resulted in critical levels of water pollution in surrounding areas. Poor irrigation systems have caused salinization in lower reaches of rivers and the silting of riverbeds, reservoirs and agricultural land. All these practices are damaging the resource base and exacerbating the vulnerability of the agricultural environment.

Impact on production and trade infrastructure

22. According to ECLAC estimates, the natural disasters that have occurred in the five countries of the Central American Common Market²² represent losses equivalent to 2-3% of GDP²³. The damage in each country depends on its economic and geographic situation but the smaller countries tend to suffer disproportionately more.

Impact of El Niño (Annex 1)

23. The impact depends on the intensity of the El Niño event, on the degree of infrastructural preparation and on the climatic characteristics of each region. The impact can be both negative and positive:

- **Negative:** Floods, soil erosion, destruction of crops, increase in pests and disease, destruction of infrastructure, lower crop yields.
- **Positive:** Recovery of reservoir and groundwater levels, increased grassland productivity, enhanced conditions for reforestation, temporary recovery of biodiversity.

²¹ Reference to the Region means Latin America and the Caribbean.

²² Costa Rica, El Salvador, Guatemala, Honduras and Nicaragua.

²³ ECLAC, 1987

24. Where El Niño produces droughts, the impact is only negative: reduction in water availability for irrigation, delayed sowing and lower yields, reduced productivity of natural grasslands and rainfed crops, increased wind erosion in flat and highland areas, environmental stress of hydromorphic communities²⁴, salt build-up in the soil because of the lower volumes of irrigation water and the drying up of humid areas²⁵, the consequences of frost because of delayed rainfed sowing, the lowering of water tables and the drying up of wells, and the advance of desertification in arid, semi-arid and sub-humid ecosystems²⁶.

Social and economic impact of drought

(Annex 1, boxes 1 to 5)

25. The reduction in supply of agricultural and forest products affects the chain of input and service providers and intermediaries, the financial system, tax revenues and employment. The increase in food prices means that food has to be imported from other regions or countries. In some countries there is a reduction in hydro-electric power which affects the whole economy.

26. Drought is the longest-lasting form of natural disaster, occurring gradually and silently. Many countries of the Region have been affected by droughts that have persisted for five or more years. Between 1979 and 1984 Northeast Brazil was hit by a devastating drought that affected more than 10 million people and caused many to migrate. The drought of 1977 in Mexico affected 1 million hectares of cropland, half of which were almost totally destroyed, and caused the death of some 45 000 head of cattle. The drought of 1982-83 in Bolivia affected 1.6 million peasant farmers (Annex1).

27. Droughts widen social inequalities as the economically stronger sectors have the capital and technology to deal with the crisis. This can lead to disputes between users, reducing their quality of life and indirectly fuelling urban poverty.

Impact of hurricanes

(Annex 1, box 6)

28. This is perhaps one of the most devastating phenomena, especially in small countries. The damage caused by the wind is compounded by the heavy rains that cause strong surface runoff which in many cases leads to erosion, silting and flooding. There are a few active protection measures that can be taken with regard to agriculture, the best form of defence being to adopt a production strategy whereby as little cropland as possible is exposed to hurricanes.

Impact of flooding

(Annex 1, box 1)

29. Flooding is especially intense in the warm and cold events that are associated with Southern Oscillation. Large areas of land remain under water for several days causing crop losses.

²⁴ Especially in the high plateau regions of Peru, Bolivia and Chile (marshlands).

²⁵ Wetlands

²⁶ As a result of overgrazing, forest fires and natural plant mortality.

Impact of climate change on agriculture

30. The expected changes involve increases or reductions in rainfall, depending on area. An increase in rainfall in subtropical areas could be beneficial for rainfed crops so long as change remains within manageable limits. In the middle latitudes with Mediterranean temperate climates, an increase in winter temperatures could mean earlier sowing to take advantage of the cold season rains and reduce the need for irrigation.

31. Most studies anticipate falls in crop yield as a result of global warming and changes in rainfall, in some cases by more than 50%²⁷. Work carried out in Chile with simulation models has indicated that some crops there will benefit from global warming while others will be adversely affected²⁸.

Food vulnerability monitoring and early warning systems

32. Natural climatic events can seriously affect world food vulnerability, making this an area of concern for governments and international bodies. There are a number of information systems monitoring the regions of the world where food insecurity exceeds critical levels. Countries have made an important commitment to develop such instruments, most of which seek to draw upon national data compilation and processing capacities. The governments made a commitment at the World Food Summit (Rome, 1996) to develop the Food Insecurity and Vulnerability Information and Mapping System (FIVIMS) which is based on existing national capacities for the assembly, processing and analysis of data²⁹. FAO has also implemented the Global Information and Early Warning System (GIEWS) to monitor general market conditions and the occurrence of food and agriculture emergency situations. The GIEWS issues regular reports on the crop situation, the impact of natural phenomena on the output of major commodities in different regions and countries, the food outlook, trade information and alerts and information for El Niño, hurricanes and other specific climate threats

(<http://www.fao.org/WAICENT/faoinfo/economic/giews/spanish/smia.htm>).

Impact of natural phenomena on biodiversity

33. Biological degradation can be disastrous or gradual. It is disastrous mainly in the case of fires that completely or partially destroy plant cover and cause the displacement of living species. Floods are not as catastrophic as fires but can also displace entire animal populations or cause serious mortality among relatively immobile local species. Whatever the case, the affected area needs to be repopulated after the event in a natural manner, either by drawing upon the resilience of the biological system³⁰, or artificially through ecosystem rehabilitation programmes. As there are generally no funds for such programmes³¹, the impact can only be healed through ecosystem resilience, so the outcome is gradual biological erosion.

²⁷ Rosenzweig et al., 1993; Siqueria et al., 1994; Liverman and O'Brien, 1991.

²⁸ CONAMA, 1999

²⁹ A number of bilateral cooperation and international agencies are providing technical and financial assistance in support of this initiative (<http://www.fivims.net>).

³⁰ Capacity of recovery to an original state following a disturbance.

³¹ Related institutional responsibilities are not clearly defined in most countries.

34. The full resilience of ecosystems generally requires more time than the timespan between one disastrous event and another, which also produces cumulative degradation or regression.

35. National and regional plans are needed to mitigate the threat of these processes to biodiversity, otherwise there will be serious biological depletion in the next 15 and 20 years, especially of invertebrates and valuable endemic plants.

Definition of policies and institutional arrangements to prevent and mitigate the impact of natural events

36. The costs of mitigation fall upon the whole community of a country or indeed on other countries. Changes in commodity supply and demand alter terms of trade beyond national frontiers. Mitigatory actions are therefore the shared responsibility of governments, non-governmental bodies, local authorities and individual citizens.

37. Mitigation of the impact of natural events requires cross-sectoral actions and policies that take stakeholder interlinkages into account and allow for the multiple cause and effect relations that are unleashed by large-scale climate variations.

38. Governments need to accept two basic principles to implement an effective policy of prevention and mitigation. The first is to accept that natural disasters are not “possible” situations, but are part of the “normal” course of events in certain areas, and therefore need to be integral components of national development strategies. The second principle is to accept the wisdom of prevention of impact rather than repair of damage from events that are largely predictable but ignored³².

39. The following elements and players need to be involved in a prevention and mitigation policy:

NGOs

40. These institutions have an important role to play in the transfer of technology, extension, training, community organization and raising of public awareness of the need to mitigate the impact of climate change.

Local authorities

41. Local authorities need to engage in land management programmes that are jointly formulated with the local population and that aim to minimize adverse effects. Catchment management programmes are needed, as are improvement of local water resource infrastructure³³, and the establishment of local communication networks and the coordination of multi-sectoral actions.

³² Application of these principles can save hard currency and above all lives and human suffering.

³³ Canals, drainage, diversion channels, check dams, river embankments.

Producers

42. A land-use strategy needs to be defined based on anticipated risks, with improved irrigation techniques and efficient water use and the adoption of land management systems that will minimize erosion from heavy rain but also drought. Grassland management systems need to be improved and stocking intensity needs to equate with land carrying capacity. There is also a need for actions to rehabilitate degraded ecosystems, with the provision of technical assistance and subsidies.

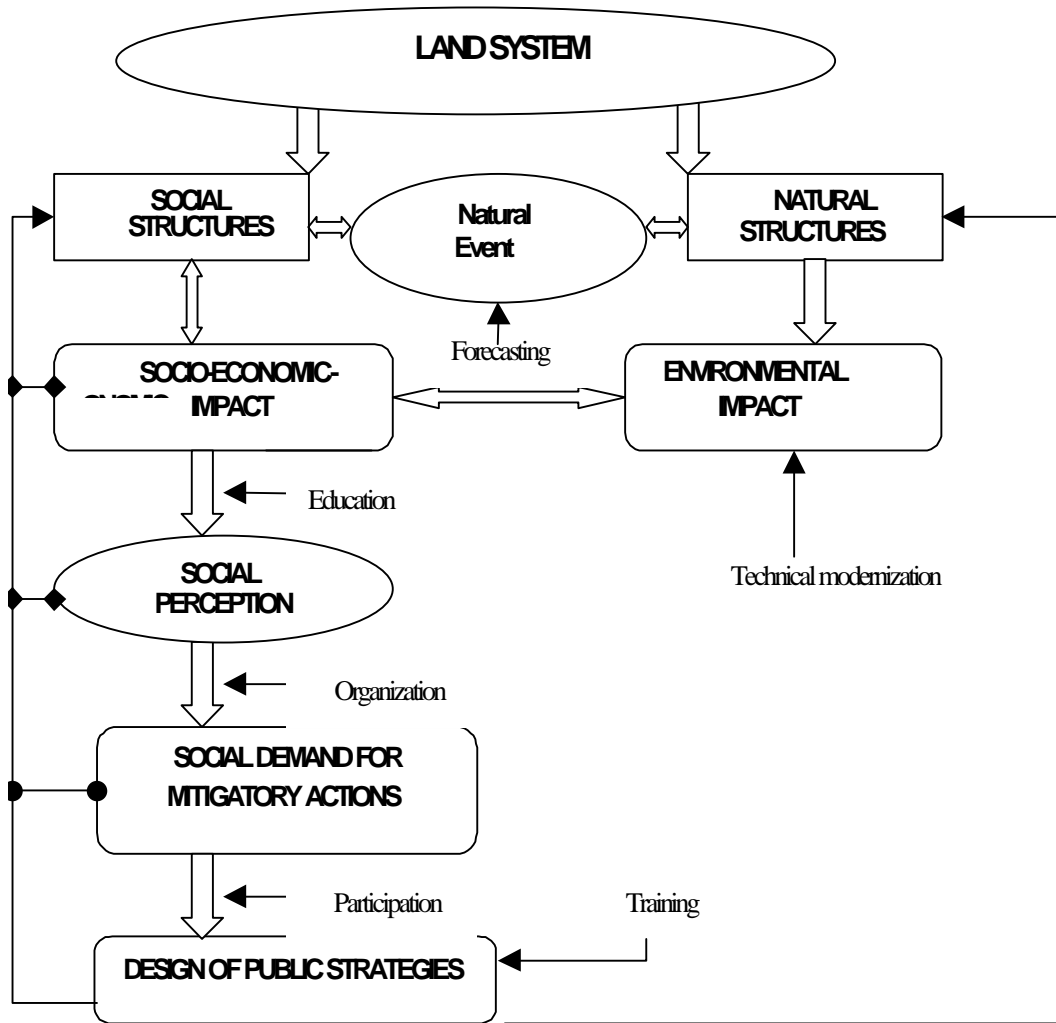


Figure 1. Land areas are made up of natural and social structures. The catastrophic events disturb these systems and produce structural or functional change, referred to as impact. When this impact is seen as negative by the population, pressure is placed on government bodies which need to respond by implementing strategies to prevent and mitigate such impact at social system level (assistance, training, education and research actions) and at natural system levels (rehabilitation of ecosystems, land management, prevention works, protection). A related programme of action needs to include:

Forecasting: to develop the ability to predict such events.

Education: to form a proper perception on the part of society.

Organization: to present demands in an appropriate context.

Participation: to contribute to the design of action strategies.

Training: to strengthen the capacity of government officials responsible for designing and implementing action plans.

Technical modernization: to modify production systems and their interaction with nature so as to reduce vulnerability and risk.

Central Government

43. Central Government should provide an appropriate drainage and defence infrastructure against flooding; implement national water policy that promotes the identification of water resources and their efficient use; implement a policy of agrarian reform to counter the proliferation of micro- and mini-holdings in environmentally sensitive areas; reforest areas at risk from flooding; decentralize decision making; encourage adjustment and defence actions through information, subsidy and credit policies; promote the creation of early warning systems for natural disasters³⁴; evaluate risk areas and divide them into zones, applying land management plans that minimize the exposure of local populations to natural disasters; draw up appropriate building regulations³⁵; implement contingency or mitigation programmes prepared in a participatory manner; and adapt curricula at primary and secondary school and university level.

44. Figure 1 summarizes the interlinkages that exist between natural events, ecosystems and society, as well as the types of action that are needed at each stage of this complex system.

Instruments of prevention and mitigation³⁶

45. Many of these actions can benefit from an early warning system for adverse climate events. Early warning helps reduce uncertainties by better assessing the size of risk.

46. There is a wealth of information on the generation and evolution of weather events, generated daily by different bodies³⁷. A number of systems forecast El Niño events, including: NCEP-NOAA (National Ocean Atmosphere Administration) USA; MM5 of UCAR (University Corporation for Atmospheric Research), USA (see boxes in Annex 1).

Forecasting floods

(Annex 1, boxes 7 and 8)

47. The Atlantic Coast of Costa Rica was hit by serious storms in 1997 which caused damage to crops and infrastructure. In February 1996 the worst floods in 30 years had occurred near Puerto Limón, but thanks to an early warning system put in place in 1991, the population was evacuated thus saving lives and goods. A radio network involving the Commission of Emergencies and the Meteorological Institute issues several daily bulletins on water levels, and local bodies and community groups receiving the information can activate plans of action if they note a risk level. Such a system could help with decision making:

At Government level

48. Governments could formulate programmes of mitigatory practices to be applied by the population; implement a water policy for emergency situations; take macro-economic mitigation

³⁴ Including systems to monitor the temperature of sea surface waters, river flows and abnormal rainfall.

³⁵ Including safe location, heights, small defence works, etc.

³⁶ Monitoring, GIS, vulnerability, planning, land management, watershed management, land-use planning, education, communication, training.

³⁷ Especially universities and research institutions.

decisions such as changes in taxation, subsidies, promotion of investment, food prices; prepare emergency plans with budgetary allocations for contingencies, thereby reducing costs; and raise public awareness of risks determined by clear indicators.

At farmer level

49. Farmers could adopt appropriate land use strategies, select seeds and types of crops, change sowing dates to reduce losses, build small works for efficient water management and the prevention of flooding and soil erosion; adjust stocking intensity on grazing land according to forecasts of climatic risk; arrange for booster vaccination against diseases likely to emerge with the possible ecological changes; and store products (seeds, feed and inputs).

Regional and subregional agreements and plans of action to mitigate and tackle climate events

50. A number of subregional agreements have been concluded to deal with natural climate events. The Central American community is perhaps the best organized in this sense, but other agreements also exist, such as that between Peru and Ecuador to monitor El Niño and that of Argentina, Bolivia and Paraguay to protect the Gran Chaco against drought and desertification.

51. Given the disastrous impact of El Niño in Central America, the subregion has established a plan of action to mitigate and deal with its effects. This plan is part of the Regional Plan for the Reduction of Disasters³⁸.

52. The problem has been recognized to be structural rather than transitory, which means that medium- and long-term actions also need to be identified in addition to emergency actions.

53. The objective of the plan is to have a package of strategies that will mitigate and tackle the impact of El Niño in Central America.

Regional strategy

54. This plan forms part of regional policies established under the Alliance for the Sustainable Development of Central America (ALIDES), the Regional Plan for Disaster Reduction (PRRD), the Framework Treaty of Citizen Safety (TMSC) and the Central American Plan of Action for the Integrated Management of Water Resources (PACADIRH).

Scientific monitoring of the phenomenon

55. A monitoring and early warning system for El Niño will be set up. It will be based on upgraded national meteorological services and the use of synoptic and hemispheric atmosphere and ocean indicators, drought indices and climate prediction models to make long-term forecasts for dissemination through the corresponding channels to be established.

³⁸ The coordinating bodies are: SG-SICA and the CEPREDENAC (Centre for the Prevention of Natural Disasters in Central America).

Basic elements of a programme of prevention and mitigation of the impact of natural events

56. Implementation of an action programme needs to recognize that the most important long-term element is prevention. This can be achieved by relocating agricultural activities and providing them with in-built protection against environmental contingencies. The following lines of action are proposed:

Implementation and operation of early warning systems

57. There is a need to strengthen international cooperation in the operation of these systems through terrestrial and satellite communication networks, and the exchange of experiences and experts. A start could be made by reinforcing already existing systems in the world and Region, using national resources and seeking to broaden international cooperation.

Mapping territorial vulnerability

58. This involves developing and applying methodologies to evaluate country-specific vulnerability on the basis of biophysical, socio-economic and historical information, mapping potential risk, vulnerability and impact, and formulating risk reduction strategies.

Cropping and biological resource strategies to counter the risks

59. The environmental risk needs to be taken into account by production systems, by introducing crops that are resistant to stress, using biotechnology products for extreme environments, altering sowing periods to avert risk, changing cultivation and input use plans according to early warning information, and executing small works on agricultural holdings to prevent risks.

New water resources and greater efficiency of water use

60. Efficient irrigation systems need to be encouraged, together with land tillage practices designed to make maximum use of rainfall and to reduce the risk of erosion. Crops need to be managed in such a way as to reduce water loss, using efficient water conservation and delivery systems, and simple methods to regulate water supply. Systems are also needed to harness and store water, which should ideally be used for high-value species.

Monitoring systems based on environmental indicators

61. Systems using biophysical and socio-economic indicators need to be developed to evaluate the status of land systems, the critical points and the priority areas of assistance and research. Environmental indicators need to be applied to analyse vulnerability, risk and potential impact of natural events.

Organizing institutional networks for operations

62. Countries need to be helped to set up institutional networks that will facilitate and streamline the management of programmes to prevent and mitigate disaster impact. These

networks will help define respective institutional roles and interlinkages so as to avoid duplication of effort and wastage of resources. There will also be information sharing mechanisms and institutional cooperation systems at national and regional level.

Safeguarding and optimizing the genetic resource base of countries

63. Biodiversity and its state of conservation need to be evaluated, with programmes to safeguard genetic resources and monitor their condition. Information systems are also needed to track the volume and status of each country's genetic resource base.

Supporting programmes against desertification

64. Desertification increases natural risks, so implementation of national and regional strategies to control desertification is of primary importance, especially the regional plans that have so far failed to get properly off the ground for want of international coordination.

Restoring and rehabilitating ecosystems with a role in water regulation

65. Help needs to be given with training and the implementation of methods to restore and rehabilitate ecosystems in middle and upper catchment areas, with a focus on soil conservation, forestation, water management, land use, retention of run-off waters and other techniques that will help improve the hydrological functioning of degraded watersheds, while at the same time improving productivity in these areas and reducing environmental risks.

Development of land information systems and their application in land-use planning

66. This involves training in the use, application and operation of land information systems using the GIS to identify development options and investment projects, taking into account the notion of environmental risk and the need to safeguard natural resource endowment.

FAO activities aimed at reducing vulnerability in the Region

67. FAO has a number of ongoing activities in the Region that are aimed at reducing vulnerability of individual countries and that also seek to promote the exchange of information on mitigation and prevention actions. Examples include the various Technical Cooperation Networks that operate to this end (see Box 9 in Annex 1). Two important publications have also been issued with policy guidelines and technical advice on reducing the impact of climatic events that cause serious damage to agricultural production³⁹.

68. A number of actions are being conducted to mitigate the impact of natural disasters and to help affected areas recover, including a TCP project in Argentina for the rehabilitation of the rural infrastructure in areas affected by flooding caused by El Niño⁴⁰.

³⁹ AGPC/FAO. Integrated management of crops and soil in slopeland areas of Central America: concepts, strategies and technical alternatives. AGLS/FAO. Management of soil and crops in slopeland areas of Central America, experience gained and farmer-to-farmer transfer of conservation techniques.

⁴⁰ This project helped shape the following investment projects: Establishment of a flood early warning system; Pilot programme for the protection of productive assets, including transfer of livestock and control of pests and disease; pilot

69. The East Caribbean was hit by hurricanes Luis and Marn in September 1996, leading the Economic Organization of the East Caribbean States to request FAO to send a team to evaluate the damage and identify projects for the rehabilitation of the agricultural, livestock and fishery sectors. The team defined a general rehabilitation programme. In 1998, FAO fielded a mission to the countries affected by Hurricane Mitch to assess the crop situation, food needs and the requirements for agricultural recovery.

70. FAO is also encouraging, in the countries affected, the development of agricultural, livestock, forestry and fishery practices that will reduce vulnerability to natural disasters and lessen their impact. By way of example, FAO financed a subregional project in the East Caribbean aimed at promoting and improving capacity to prevent, anticipate and mitigate damage from hurricanes in the Region⁴¹.

programme for the protection of natural resources (through producer organization and training in land and water management). This pilot project could be replicated in other countries of the Region.

⁴¹ This project included in its final stage a regional workshop in Saint Lucia in October 1999, which was attended by government representatives of the project's beneficiary countries, as well as organizations involved in the prevention and repair of damage from natural disasters. This workshop advocated the need to prepare national and regional plans of action to deal with such disasters.

ANNEX I**Box 1. Impact of El Niño in Peru, Ecuador and Bolivia**

The 1982-83 El Niño phenomenon caused losses of 4000 million dollars in Peru (57%), Bolivia (24%) and Ecuador (19%), which corresponds to 10% of the GDP of these countries for the same year. The floods caused damage to transport, clean water and sewerage infrastructure, especially in Piura (Peru). A number of rivers broke their banks in Ecuador. Crops were lost in both countries and renewed sowing was not possible. The heavy rains led to shortages of food and inputs. Meanwhile, other areas were subjected to severe drought which dried grazing land and decimated cattle.

Source: ECLAC, 1998, The El Niño phenomenon: Its nature and the risks associated with its recurring presence, 24 pp.

Box 2. Argentina

Argentina was affected by a severe drought in 1997 causing losses of some 1 500 million dollars to farmers who called on the Government to declare an immediate bank moratorium and open up lines of credit to avoid massive migration towards urban areas. The drought was particularly severe in the provinces of Córdoba, Santa Fe, Entre Ríos and Buenos Aires, affecting cereal and cattle production and some 25 000 farmers.

Box 3. Northwest Brazil

The drought of 1998 affected some 10 million people in 10 states, with 4.8 million people suffering from severe food shortage. Agricultural losses amounted to 80% in some areas. In the state of Bahia alone, the drought affected 271 of the total of 415 districts. This event, which was considered the worst of the century in Northeast Brazil, caused a heavy increase in unemployment and social instability among the landless. Various irrigation projects had to be abandoned because of the lack of water. There were twice as many bushfires as in normal years.

Source: Church World Service (<http://www/nccusa/cws/emre/la073198ap.html>)

Box 4.

- **In Chile** the drought lasted several years causing the loss of at least 8000 hectares of wheat in 1998. A number of other crops couldn't be sown or were sown late because of the lack of rainfall.
- **In Ecuador** the drought produced a severe shortage of electric power in the same year. At the same time, the eastern lowlands of Bolivia were affected by a severe drought which caused a proliferation of fires.
- **In Honduras** the drought devastated the region of Nacaome, where food and water had to be brought in.

Box 5.

- **In Cuba** the drought took a heavy toll in the east of the country (Guantánamo, Holguín, Granma, Las Tunas and Santiago de Cuba) with losses estimated at 267 million dollars, in addition to the loss of 4040 tonnes of meat and 6.2 million litres of milk. Sugar production was down 14% and other food commodities such as bean, banana and rice also suffered losses of up to 42%.
- **Northern Mexico** is experiencing the worst drought in recent years, which has been going on for 5 years. The number of head of cattle have fallen from 22 million to 16 million. It has not been possible to sow 970 000 of the 2.6 million hectares under irrigation. The hardest hit states have been Coahuila, Durango, Nuevo León and Tamaulipas, with 65 000 people affected in Coahuila alone.
- **El Salvador** has had 4 major droughts in the last 21 years. In 1987 there were losses for rice and maize of 83.8% and 65.8% respectively. The droughts have repeatedly led to price increases and poverty.
- **Northern Haiti** suffered intense drought in 1997 which only exacerbated already serious malnutrition problems.

Box 6. Impact of Hurricane Mitch in Honduras in 1998

The official figures for losses in Honduras were as follows:

- Deaths: 6 600
- Homeless: 1 393 669 persons
- Injured: 11 998 persons
- Losses on banana plantations: US\$ 850 million
- Coffee: 800 tonnes
- Livestock: US \$10 million
- Crops: 70% destroyed
- 189 bridges destroyed
- Damage to physical infrastructure: US\$ 1 000 million

Source: Pan-American Health Organization (<http://www.paho-who.hn/mitch0.htm>)

Box 7. Systems of climate forecasting

- After the catastrophic consequences of El Niño 1982-1983, the **Government of Peru** decided to establish a system to predict the phenomenon. The Ministry of Agriculture has included this system in its planning since 1983-84 and in November of each year a forecast is made on the basis of available numerical indications, supplemented with data on ocean surface temperature and winds. The farmers' associations then meet with Government officials to decide on the most appropriate cropping strategy to deal with the situation expected in that particular year.
- Similarly, **Brazil** has a forecasting system that is gradually being perfected in the light of experience gained.
- In the same vein, Mexico (INIFAP) is developing a system, together with the US and Canada, to determine areas vulnerable to El Niño and La Niña.

Box 8. UN Action to Reduce Natural Disasters
(Department of Humanitarian Affairs)

The United Nations declared the 1990s the International Decade for Natural Disaster Reduction (IDNDR, 1990-2000) with the objective of promoting international cooperation to reduce loss of life, economic damage and damage to infrastructure from disasters, especially in developing countries. The Secretariat of the IDNDR in Geneva, acts through the National Committees and Focal Points that have now been set up in 138 countries

<http://www.aber.ac.uk/~jpg/hazards/idndrres.html>).

<i>Box 9. FAO Regional Networks that could help with prevention and mitigation</i>	
Networks	Main objective
Arid and semi-arid zones	To promote the use of technologies for the sustainable use of ecosystems, improving the quality of life of local populations
Conservation of energy and rational use of fuels	To improve energy efficiency and the use of non-traditional energy.
Watershed management	To promote the development of management programmes to prevent environmental degradation and avoid flooding, and increase water resources.
National parks, other protected areas and wildlife	To coordinate institutions involved in the protection of wildlife
Dendroenergy	To promote the use of biomass as a source of renewable energy
Agroforestry systems	To provide training in the use of mixed systems that help restore degraded ecosystems
Systems of food and nutrition surveillance	To disseminate information that will help prevent food crises arising from adverse events
Institutions and organizations of support to rural women	To train women so that they can contribute effectively to the sustainability of household agricultural systems
Institutions involved in economic and agricultural policy training in Latin America and the Caribbean	To network institutions of the Region that can provide training to decision-makers.