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National communications from Parties not included in Annex I to the Convention

Compilation and synthesis of initial national communications

**Sixth compilation and synthesis of initial national communications from
Parties not included in Annex I to the Convention**

Note by the secretariat*

Addendum

Climate change impacts, adaptation measures and response strategies

Summary

This document compiles and summarizes information on climate change impacts, adaptation measures and response strategies in Parties not included in Annex I to the Convention. It highlights Parties' key vulnerable sectors, priorities and needs for adaptation and also difficulties/gaps and constraints. Parties have reported that they are already experiencing stresses from climate-related events and phenomena that could be exacerbated by future climate change, and that this makes them highly vulnerable.

* This document is submitted after the due date because all the necessary information was not available on time.

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I. Introduction

1. The guidelines for the preparation of the initial national communications by Parties not included in Annex I to the Convention (non-Annex I Parties) contained in the annex to decision 10/CP.2¹ outlined the information to be provided by Parties. In accordance with Article 12, paragraph 1, of the Convention, each Party should communicate a general description of steps taken or envisaged by the Party to implement the Convention. The guidelines state that, taking into account the chapeau of Article 4, paragraph 1, of the Convention, the initial communication should seek to include, as appropriate:

- (a) Policy options for adequate monitoring systems and response strategies for climate change impacts on terrestrial and marine ecosystems;
- (b) Policy frameworks for implementing adaptation measures and response strategies in the context of coastal zone management, disaster preparedness, agriculture, fisheries, and forestry, with a view to integrating climate change impact information into national planning processes.

II. Reporting

2. Non-Annex I Parties generally followed the UNFCCC guidelines in reporting impacts, vulnerability and adaptation. Although the information centred on Parties' current and future vulnerability and adaptation options, measures and strategies, information was also provided on the methods and approaches used in vulnerability and adaptation assessments, limitations of methods and tools, problems and difficulties encountered, sectors studied, methods for analysing and evaluating adaptation needs and priorities for financial and technical support, and institutional arrangements and networking.

3. The scope and level of detail of reporting varied considerably among Parties. Almost all non-Annex I Parties that submitted an initial national communication provided information on their needs and concerns relating to assessment of climate change impacts, vulnerability and adaptation. They regard climate change impacts, vulnerability and adaptation as critical sustainable development issues.

4. Most of the reporting Parties used both internationally developed methodologies and national models, ranging from sophisticated computer models to qualitative assessments based on expert judgement and literature review. Additionally, many Parties applied statistical analysis and spatial/temporal analogues to develop climate change scenarios for various time horizons up to 2100, which they used to infer relationships between mean climate change and extreme events.

5. Parties used a wide range of sea-level-rise scenarios for different time horizons up to the year 2100. They carried out sensitivity analyses by projecting high- and low-emission scenarios on future sea-level changes and their impacts on coastal zones and resources. Parties also used biophysical and process-based models to simulate impacts on agriculture, water resources, coastal zones and marine ecosystems, forests and terrestrial ecosystems, human health, fisheries, settlements, energy and tourism.

6. Parties highlighted the limitations of using general circulation models (GCMs) for developing regional climate change scenarios, due mainly to the large spatial scale and low resolution of the GCM output. Many Parties did not clearly indicate the methods they used in assessing and analysing adaptation options, measures and strategies. Most of the adaptation options were identified using the Intergovernmental Panel on Climate Change (IPCC) *IPCC Technical Guidelines for Assessing Climate*

¹ FCCC/CP/1996/15/Add.1.

Change Impacts and Adaptation (hereinafter referred to as the IPCC Guidelines) and the GCMs to evaluate and/or determine the cost of specific adaptation strategies and measures.

7. Most Parties presented only a list of possible adaptation options without evaluating, prioritizing and/or costing them, and some Parties used statistical methods and screening matrices to assess selected options.

III. Overview of information

A. Climate change impacts and vulnerability

8. Most Parties reported in various degrees of detail on baselines (climate and socio-economic) and climate change scenarios, although many Parties indicated difficulties in using socio-economic scenarios. Thus, in most national communications climate change scenarios were presented in greater detail than the results of impact assessments.

9. Most Parties stressed that they already are experiencing stresses from climate-related events and phenomena that could be exacerbated by future climate change, and that this makes them highly vulnerable. Small island developing States, and countries with long coastlines and low-lying areas, pointed out their experiences with severe floods and drought, adverse effects from changes in the El Niño Southern Oscillation (ENSO) phenomenon, tropical storms and changes in their patterns, saltwater intrusion, storm surges, coral reef damage, and changes in migratory patterns of important fish. Some countries stated that they are concerned about the long-term sustainability of their arid and marginal regions.

10. Almost all Parties are concerned that future climate change would lead to an increase in frequency and intensity of extreme events, such as droughts, floods, hurricanes and El Niño effects. However, further understanding of the relationships between climate change and the frequency and intensity of extreme events is hampered by high levels of uncertainty surrounding the magnitude of the changes that have been projected using GCMs. Many Parties also reported that future changes in their socio-economic situation would most likely exacerbate vulnerability to the adverse effects of climate change. The socio-economic changes cited included rapid population growth, high food demand, and land and ecological degradation.

B. Methods and approaches used in vulnerability and adaptation assessments

11. Almost all Parties reported on the use of various impact and vulnerability assessment methodologies and approaches, ranging from sophisticated computer models to qualitative assessments based on expert judgement and literature review. The methodological approaches used by Parties were generally consistent with the analytical framework provided in the IPCC Guidelines and the United Nations Environment Programme (UNEP) *UNEP Handbook on Assessing Vulnerability and Adaptation to Climate Change* and the *UNEP Handbook on Vulnerability and Adaptation Assessment*.

12. Most Parties reported on developing climate change scenarios with time horizons extending through 2050, 2075 and 2100. They created the scenarios using outputs from equilibrium and/or transient GCMs. Many Parties also reported on the use of the MAGICC–SCENGEN² for generating regional climate change scenarios as a first step in their vulnerability and adaptation assessments.

13. Many Parties also applied statistical and analogue methods based on regionally developed methods and/or historical records for developing scenarios covering periods of less than 100 years, and

² Model for the Assessment of Greenhouse-Gas Induced Climate Change (MAGICC) and Global and Regional Climate Change Scenario Generator (SCENGEN).

some reported on using a statistical analysis to infer relationships between mean climate change and extreme events. Various methods and approaches were used by Parties to assess impacts, vulnerability and adaptation (see table 1).

Table 1. Models and approaches used to assess impacts of, and vulnerability and adaptation to, climate change in key sectors in non-Annex I Parties

Methods/tools techniques	Agriculture and food security	Water resources	Coastal zones and marine ecosystems	Forests and terrestrial ecosystems	Human health	Fisheries
Biophysical/process models						
CERES ^a crop	x					
CLIRUN	x	x				
DSSAT	x			x		
Gap Analysis				x		
Holdridge Life Zones Classification				x		
SPUR				x		
				Rangelands and livestock		
Others						
Adaptation decision matrix and/or adaptation strategy evaluator	x	x	x			
Integrated models and analysis	x	x	x			
IPCC common methodology			x			
National models ^b	x	x	x	x	x	x
		WATBAL	Aerial-video assisted assessment		Health indices and disease vectors	ENSO
Qualitative/expert judgement	x	x	x	x	x	x

^a Crop Environment Resources Synthesis model.

^b National models were used with the water balance model (WATBAL) and aerial-video assisted assessment of risk taking into account health indices, disease vectors and the effect of the El Niño Southern Oscillation (ENSO) on oceanic circulation.

14. Most coastal countries analysed impacts on coastal zones using the IPCC scenarios of sea-level rise, which assume a 0.5 and/or 1.0 m rise in sea level by 2100. Some Parties (e.g. Argentina) used historical data analysis for developing sea-level-rise scenarios, whereas others (e.g. Mauritius, Mexico, Uruguay) applied aerial videotape-assisted vulnerability analysis, which uses detailed field data to identify vulnerable land and infrastructure.

15. Many Parties used models such as DSSAT,³ SPUR2,⁴ CLIRUN,⁵ and the Holdridge Life Zones Classification,⁶ and the WATBAL.⁷ Others used national models for impact assessment, particularly in agriculture (e.g. Armenia, Kazakhstan, Republic of Korea), water resources (e.g. Egypt, Philippines), and terrestrial ecosystems (e.g. Chile, China, Gambia, Malawi, United Republic of Tanzania). In a number of national communications, use of models was not specified, but a matrix and flow charts were used to depict the effects of storm surges and cyclones on coastal infrastructure, health, soils and water supply (e.g. Lesotho, Samoa).

16. Some Parties used vulnerability indices which took into account changes in socio-economic and environmental conditions under doubled carbon dioxide, population distribution and growth, urbanization, mortality, and water consumption, to evaluate vulnerability and adaptation to climate change (e.g. Chile, Mexico).

17. Almost all Parties highlighted the limitations of using GCMs. Common methodological problems in impact assessment were: lack or inadequacy of local, specific environmental and socio-economic data and methodologies; lack of methodologies for integrated and socio-economic assessments; and lack of understanding of the magnitude of climate change impacts on water resources, human health, fisheries, coral reefs, some local ecosystems, etc.

18. Other limitations included unsuitability of methods and tools, lack of national capacity, lack of data, lack of financial resources and lack of appropriate institutional frameworks which contributed to the difficulties in applying the IPCC Guidelines.

19. Some Parties attributed the difficulties relating to vulnerability and adaptation assessment to the lack of country-specific socio-economic scenarios, the lack of collection, quality control, archiving, retrieval, preparation and analysis of data, and the lack of comprehensive studies on possible adaptation measures and cost-benefit analysis of adaptation options (e.g. Brazil, China, India, South Africa).

20. Despite the large uncertainties associated with climate predictions a number of Parties provided information about how they dealt with the uncertainties inherent in climate change and emission scenarios.

C. Key vulnerable sectors

21. Information provided by Parties on current and future key vulnerable sectors was dependent on the relative importance to their economy. The key vulnerable sectors/areas included agriculture and food security, water resources, coastal zones and marine ecosystems, terrestrial ecosystems (forests, rangelands, etc.), human health and human settlements, fisheries, and others (biodiversity, infrastructure, coral reefs, tourism and energy, etc.) (see figure 1).

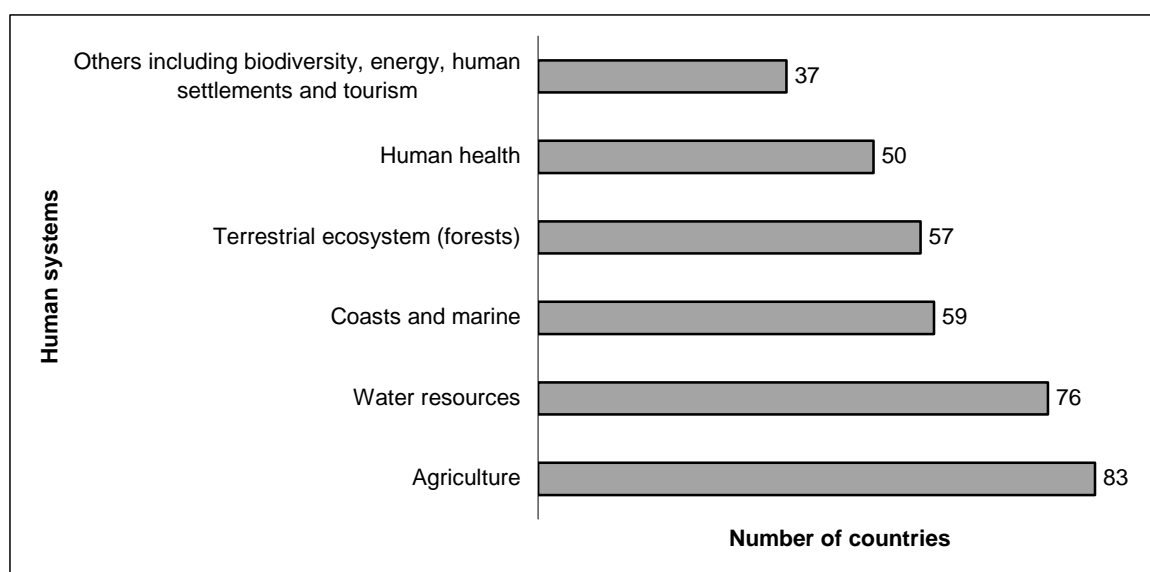
³ Decision Support System for Agrotechnology Transfer (DSSAT) is a software system that integrates crop growth models with crop, weather and soil data and estimates potential changes in crop yields and water use. It is provided to countries within the United States Country Study Program and the Global Environment Facility support programme.

⁴ The SPUR2 suite of models simulates the effects of climate change on grassland ecosystems and cattle production. The package includes submodels for plant growth, hydrology/soils, animal production and grasshopper infestation.

⁵ CLIRUN is a Microsoft Excel spreadsheet-based integrated water balance model developed for climate change impact assessment of river basin runoff.

⁶ This model relates the distribution of major ecosystems ("life zones") to the climate variables of biotemperature, mean precipitation, and the ratio of potential evapotranspiration to precipitation (PET ratio).

⁷ Water balance model.

Figure 1. Number of Parties reporting on key vulnerable sectors

1. Agriculture and food security

22. The issues relating to vulnerability presented for agriculture and food security were generally more detailed and extensive than those for other sectors/areas, although the level of detail and the presentation of the methods and results varied considerably.

23. The number and types of impacts in this sector included productivity/yield of crops, effects on soil moisture, and incidence of pests and spread of infectious diseases, as well as effects on the length of the growing season, carbon fertilization and productivity of pastures and livestock.

24. Most Parties reported that future climate change would affect the production/yield of common crops such as grains, cotton, fruits, vegetables, sugar cane and grapes, under various climate change scenarios. Some countries predicted a reduction of soil humidity by up to 30 per cent, thus increasing the arid areas by 33 per cent (e.g. Armenia), whereas others expected a decline in wheat production by 27 per cent (e.g. Kazakhstan) and land degradation from saltwater intrusion (e.g. Mauritius).

25. Some countries reported on the fertilization effect of increased atmospheric concentration of CO₂. Small island developing States reported on possible agricultural losses as a consequence of sea-level rise.

26. Many Parties, especially those that rely heavily on a single agricultural system, such as nomadic livestock husbandry (e.g. Mongolia) and atoll agriculture (e.g. Maldives), stated that the low productivity of their agricultural system will be exacerbated by the increased erosion and loss of soil fertility resulting from climate change and its adverse impact on groundwater.

2. Coastal zones and marine ecosystems

27. Vulnerability assessments of coastal zones and marine ecosystems were based on both qualitative and quantitative analyses of the impacts of climate change and sea-level rise. Many Parties were concerned most about the economic impacts in the coastal zones, and about loss of land and infrastructure. More specifically, many reporting Parties identified the following negative impacts: erosion and setback of coastlines, increase in salinity in estuaries and wetlands, degradation of mangrove ecosystem, saltwater intrusion into aquifers, beach and land losses, decrease in productivity of coastal

fisheries and devastating effects on species of coral. For example, Dominica estimated that 15 per cent of its coral reef is already under stress from bleaching, and Papua New Guinea predicted that 25 per cent of its existing shoreline could be inundated.

28. Almost all coastal countries, including small island developing States, reported that climate change and its consequent sea-level rise will have a devastating effect on coastal communities and infrastructure.

3. Water resources

29. Almost all reporting Parties provided information on the impacts of climate change on their water resources. Many Parties presented the results of analyses of impacts in run-off for separate river basins, watersheds or lakes, and other Parties presented qualitative considerations on how projected climate change and sea-level rise would affect water availability and quality.

30. Some Parties presented an estimation of the effect of changes in their water resources on the future water supply and demand balance. Supply–demand ratios are expected to be positive for some countries under some climate scenarios and negative for others. Parties indicated adverse effects on their water resources by as much as 30 per cent due to higher evaporation levels, water shortages and droughts, and an increase in water demand for irrigation (e.g. Argentina, Zimbabwe). Other Parties expected an increase in rainfall and flooding, thus affecting hydroelectric power generation. Other negative impacts predicted included increased demand from agriculture, saltwater intrusion into coastal water resources caused by sea-level rise (e.g. Cook Islands, Egypt, Vanuatu), and the degradation of water quality due to pollution, saltwater intrusion and sedimentation.

31. Many Parties stated that they already experience severe water supply problems caused by a rapid increase in population, growing demands from agriculture and industry, expanding urbanization, unabated pollution of water bodies and the effects of climatic variability and extreme events (e.g. Lesotho, Philippines, Uganda).

32. Parties also identified the following impacts: increase in the frequency and intensity of surface run-off; soil erosion; drought; pollution; and decreases in surface water/run-off and groundwater with negative impacts on agricultural lands, grasslands and terrestrial and aquatic ecosystems; and higher rates of evaporation from hydro-reservoirs affecting reserves available for power generation. Some Parties stated that high-intensity rainfall and drought would contribute to biomass degradation and would affect fishing, food production and transport.

4. Human health

33. Many Parties carried out the assessments of climate change impacts on human health, with various levels of detail. Most Parties predicted an increase in the incidence of water- and vector-borne diseases such as malaria, dengue and diarrhoea. Many Parties expressed concern that higher temperatures would lead to increases in the incidence of endemic diseases, exacerbated by population growth and inadequate sanitation.

34. Parties reported information on the likely incidence of diseases such as malaria (e.g. Papua New Guinea, Solomon Islands), cholera (e.g. Armenia, Zimbabwe), and dengue fever (e.g. Argentina). Some Parties also noted the potential for increase in cardiovascular and intestinal diseases, influenza, yellow fever and general morbidity.

35. Parties also mentioned the lack of data on and understanding of the interactions between health conditions and climate. Therefore much of the information presented on climate change impacts on human health was based on qualitative assessments, although a few Parties used statistical correlation to

infer the relationship between climate characteristics, population data and incidence of diseases such as heat stress, cramps, dehydration, rashes, vascular and renal disorders, viral conjunctivitis and influenza.

36. Some Parties indicated that climate change impacts on human health will be exacerbated by existing poor conditions arising from insufficient potable water, low governmental budget for health, and environmental degradation, especially in marginal areas which are home to the poor.

5. Forests and terrestrial ecosystems

37. Most countries evaluated the impacts of projected climate change on their forests and rangelands in terms of changes in biomass, species composition and vegetation types. Impacts were found to be negative in general.

38. Foreseen impacts on forest ecosystems included increased fire hazard, loss of moisture, shifts in forest extent and type, loss of biodiversity, loss of fodder, increased incidence of tree stand mortality due to diseases, and reduction in food production and animal habitats. For example, the Republic of Korea estimated that its forests would begin to decline within 30 years, culminating in severe damage after 100 years, and Azerbaijan indicated that the total area of coniferous forest is expected to decrease by 2.5 per cent under a scenario of doubled CO₂ concentration in the atmosphere. Some Parties estimated loss due to climate change of between 10 and 15 per cent in annual growth of woody biomass (e.g. Armenia, Mexico).

39. Parties expected an increase in hyper-arid, arid or semi-arid areas under all climate change scenarios. For example, in Argentina aridity could expand in subtropical areas (north of latitude 40°S) due to an increase in temperature and evaporation, whereas in Armenia and Kazakhstan the arid area could expand by 20–40 per cent. For many Parties, climate change would reduce land cover, displace/change ecosystems and species composition, and lead to loss of biodiversity. Other Parties reported on the risk of frequent forest fires in the dry season and a related increase in soil erosion.

6. Fishery resources

40. Some Parties examined the possible climate change impacts on fisheries as a part of their vulnerability and adaptation assessments. No common methodologies were used for this sector, and only qualitative considerations were presented.

41. Parties reported that climate change would affect fishery resources by destroying breeding and nursery areas, such as mangrove forests and coral reefs, and by affecting the availability of nutrients. Some Parties indicated a potential for reduction of fishery resources due to ENSO events (e.g. Peru), and others expressed the need to better understand the role of ocean up-welling in relation to tuna migration (e.g. Maldives and Peru).

42. Parties also identified possible adverse effects on fisheries due to changes in temperature and salinity, and loss of productive habitats for many species due to sea-level rise and associated flooding. In some cases the effects could be catastrophic. For example, the Republic of Korea expects the rise in sea-water temperature to lead to the extinction of cold-water fish in the Yellow Sea. However, effects on deep-water fish are likely to depend on whether temperatures change at great depths, which is still uncertain.

7. Other sectors or resources

43. Many Parties also reported on their impact assessments on other sectors or resources. For instance, the effect on livestock production was directly linked to the productivity of the pastures, which was projected to decline. Kazakhstan indicated that a lower nitrogen content of fodder would diminish

the nutritional value of their livestock, and Armenia expected a 30 per cent reduction in the number of cattle.

44. Some Parties presented information on how climate change and sea-level rise might affect settlements along their coastlines, deltaic plains and river deltas. Other Parties used vulnerability indices, such as population distribution and growth, urbanization, mortality and water consumption, to evaluate the vulnerability of human settlements.

45. Some Parties provided information on the vulnerability of tourism, infrastructure, energy systems and biodiversity, which would be affected by increased frequency and intensity of storms and hurricanes.

D. Sectoral adaptation and response measures

46. Most Parties provided information on adaptation options, measures and/or strategies relating to climate change impacts for a wide range of sectors, such as agriculture, water resources, coastal zones and marine ecosystems, forests and terrestrial ecosystems, human health, fisheries, human settlements, tourism, energy and biodiversity. Table 2 presents the priorities and needs for adaptation in key vulnerable sectors in various developing regions.

Table 2. Priorities for adaptation to key vulnerable sectors as reported in the initial communications of non-Annex I Parties

Developing country region	Need to adapt	Key vulnerable sectors
Africa	Very high	<ul style="list-style-type: none"> • Agriculture • Water resources
Asia	High	<ul style="list-style-type: none"> • Agriculture • Terrestrial ecosystems
Latin America and the Caribbean	High	<ul style="list-style-type: none"> • Agriculture • Water resources
Small island developing States	Very high	<ul style="list-style-type: none"> • Water resources • Coastal zone (sea-level rise)

47. Some of the adaptation options included introduction of water policy reforms focusing on water conservation, inter-basin water transfer, desalination, flood management and construction of dams, development of drought-tolerant crops, improvement of early warning systems, enhancement of erosion control, training and assisting farmers, integrated coastal zone management, improvement of health care systems, enhancement of forest management, protection of tourism infrastructure, strengthening of environmental legislation, and promotion of conservation.

48. Parties also highlighted some barriers to implementation of adaptation strategies and measures. These included technological, financial and human resource constraints, which are prevalent in most non-Annex I Parties.

49. Some Parties emphasized their needs for adaptation research, particularly to address key vulnerable sectors, such as water resources management, including use of groundwater resources and development of drought-tolerant and disease-resistant crops and livestock. Other Parties stressed the importance of research in facilitating the protection of forests, reforestation, and conservation of coral reefs.

50. Many Parties also reported on plans to incorporate or integrate climate change concerns and issues into their planning processes as a strategy for adaptation to climate change over the long term. Some Parties have included adaptation measures in their national action plans and/or national

environmental action plans as a first step towards implementation of adaptation, and others have reported that some legislative changes would help facilitate incorporation of climate change adaptation in the future. Table 3 provides a summary of adaptation options, measures and strategies envisaged for key vulnerable sectors in non-Annex I Parties.

Table 3. Examples of types of adaptation to climate change envisaged for key vulnerable sectors in non-Annex I Parties

Key vulnerable sectors	Anticipatory adaptation	Reactive adaptation
Agriculture and food security	<ul style="list-style-type: none"> • Development of tolerant/resistant crops (to drought, salt, insect/pests) • Research and development • Soil-water management • Diversification and intensification of food and plantation crops • Policy measures, tax incentives/subsidies, free market • Development of early warning systems 	<ul style="list-style-type: none"> • Erosion control • Dam construction for irrigation • Changes in fertilizer use and application • Introduction of new crops • Soil fertility maintenance • Changes in planting and harvesting times • Switch to different cultivars • Educational and outreach programmes on conservation and management of soil and water
Coastal zones and marine ecosystems	<ul style="list-style-type: none"> • Integrated coastal zone management • Better coastal planning and zoning • Development of legislation for coastal protection • Research and monitoring of coasts and coastal ecosystems 	<ul style="list-style-type: none"> • Protection of economic infrastructure • Public awareness to enhance protection of coastal and marine ecosystems • Building sea walls and beach reinforcement • Protection and conservation of coral reefs, mangroves, sea grass and littoral vegetation
Water resources	<ul style="list-style-type: none"> • Better use of recycled water • Conservation of water catchment areas • Improved system of water management • Water policy reform including pricing and irrigation policies • Development of flood controls and drought monitoring 	<ul style="list-style-type: none"> • Protection of groundwater resources • Improved management and maintenance of existing water supply systems • Protection of water catchment areas • Improved water supply – groundwater harvesting and desalination
Human health	<ul style="list-style-type: none"> • Development of early warning system • Better and/or improved disease/vector surveillance and monitoring • Improvement of environmental quality • Changes in urban and housing design 	<ul style="list-style-type: none"> • Public health management reform • Improved housing and living conditions • Improved emergency response

1. Agriculture

51. All Parties consider agriculture a key vulnerable sector, as the majority of their populations still depend on this sector for their livelihood. Most of the adaptation options identified for agriculture relate to crop management, land management, and soil and water conservation. In terms of crop management, the options include the development and introduction of tolerant/resistant crops, pest and soil studies, better cropping or farming systems, improved irrigation techniques and crop rotation, as well as changes in the timing of planting of crops. Under land management, adaptation options included afforestation, reforestation of marginal lands and protection of arable land. Regarding soil and water conservation, improved irrigation techniques, introduction of water use policies and monitoring of competing uses and demands for water, soil and water conservation techniques, and flood controls were seen as important.

52. Some Parties indicated that adaptation policies in agriculture should also take into account issues relating to globalization of the world economy (e.g. Dominican Republic) as well as developing early warning systems for crop failure and introduction of new agricultural practices. Improved soil fertility management and insect and pest management are also considered important adaptation options in some countries.

53. Some Parties identified options focusing on educational and outreach activities which provide agriculturists and farmers with information about possible and current climate changes and encourage them to adjust practices, such as by switching to different cultivars. Parties referred to technological options for improving irrigation systems; some other Parties mentioned policy options such as the imposition of standards, reforms in agriculture, development of a free market and promotion of investments in farming.

54. Some Parties considered the following measures: establishment of seed banks and identifying least-cost measures, such as switching crops and/or cultivars, soil improvement, and rainwater management. In contrast, other measures require research and development of new systems, e.g. new drought-resistant varieties or improved systems of water management for efficient or extended irrigation which might not be feasible without financial support from outside sources and from the national government.

2. Water resources

55. The detailed description of water resources by all of the Parties reflected their emphasis on water management, including supply and demand, as a key area for adaptation in the future.

56. Many Parties reported on options to increase domestic water supply; these included prospecting for, and extraction of, deep groundwater, increasing storage capacity by building reservoirs and dams, and improving watershed management. Most Parties highlighted the extraction of groundwater as the most cost-effective measure. Parties also considered outreach and technological options to reduce demand for water. These options involved measures to increase efficiency either by recycling water or restructuring water networks, or by finding ways to decrease demand, such as by changing cropping schedules to reduce the demand for irrigation.

57. Parties mentioned perceived changes in water availability, and the need for redistribution of available supplies between agricultural and industrial uses, as an adaptation option. Parties also mentioned the need to improve and monitor water quality.

58. Parties alluded to the increasing pressure being placed on water resources in their countries, which makes it necessary for them to identify other sources, such as groundwater and desalinated water. Therefore, the use of appropriate technology is an important issue for many Parties. Other options included restructuring and construction of water infrastructure and reduction of leakage and construction of solar desalination systems despite high initial cost, and the implementation of nature and forest conservation measures to stabilize watersheds, and thus water resources.

59. Some Parties proposed measures to reduce/mitigate the risks of floods and drought. The measures included research and outreach activities, such as improvement of monitoring and forecasting systems and promoting awareness of climate change impacts. Some Parties proposed developing national drought policies to mitigate the adverse impacts of periodic droughts and indicated their need for a warning system to monitor the effects of drought.

60. Few Parties considered reducing water pollution as an option for adapting to climate change. Several countries proposed changing water management policies to provide incentives to use water efficiently, or referred to the use of economic incentives through water pricing, taxes and subsidies.

Other Parties indicated the need for institutional development and strengthening relating to water management.

3. Forests and terrestrial ecosystems

61. Forest management and conservation were seen by several Parties as important to protect watersheds, combat land degradation and desertification, preserve species and sequester carbon. Several Parties referred to the need for protection of forest areas, through targeting forests under stress, forest expansion, for example through development of appropriate plantations, and the preservation of genetic resources and biological diversity. Parties also suggested the need for measures to combat mud torrents, forest fires, pests and diseases.

62. Many Parties highlighted the importance of preserving genetic resources and biological diversity, exploring drought-tolerant ecotypes and establishing migration corridors for species. Monitoring and research on terrestrial ecosystems, as well as establishment of adequate environmental standards and management for forests, and improvement and/or proper implementation of existing legislation and plans for forest and land conservation were important measures for future adaptation to climate change.

4. Coastal zone and marine ecosystems

63. Coral reef protection was the most common response option reported by many small island developing States to counter the adverse effects of climate change. Coral reef protection is being promoted through the creation of protected areas, emphasizing indigenous and customary practices relating to harvesting and fishing, and regulating other fishing and shipping practices. Some Parties have already undertaken measures to protect coastal areas, such as building retention walls and sand injections to counteract soil erosion.

64. Other measures proposed included limiting the development of infrastructure along or near coasts, restoring beach vegetation, waste management, and protection of infrastructure by constructing structures such as sea walls or groynes, and/or by implementing other measures such as beach reinforcement, to counteract coastal erosion.

65. Some Parties discussed and evaluated the costs of adaptation measures for various scenarios of sea-level rise, and estimated the opportunity costs of undertaking no adaptation measures. Other Parties emphasized protection of coral reef and coastal zone ecosystems by the creation of protected areas, comprehensive waste management, and utilizing traditional technologies to promote shoreline stabilization.

66. Measures to adjust to sea-level rise, including through land-use changes, new planning and investment and, more generally, through integrated coastal zone management, research and monitoring of coastal resources, were also considered as important for adaptation.

5. Human health

67. With regard to adaptation in the human health sector, Parties noted such general options as the improvement of living standards, and increase in the awareness about hygiene and strategies to control disease vectors. Specific health sector measures included vaccination and chemical prevention measures, and monitoring of risk groups, especially in exposed areas. Most reporting Parties mentioned the need for further research in the area of human health vulnerability.

68. Many Parties also mentioned measures that would enhance adaptive capacity in general. These measures included: managing population growth, developing and implementing environmental legislation, integrating climate change concerns into national development plans and programmes,

developing appropriate infrastructure to reduce vulnerability, enhancing awareness among the public and policy makers regarding climate change impacts and adaptation, and promoting sustainable development.

6. Fisheries

69. A few countries examined the impacts on fisheries as a part of their climate change and sea-level rise impact assessments. No common methodologies were used for this sector, and only qualitative considerations were presented. Most Parties highlighted the importance of data collection, monitoring and further research in order to improve understanding about impacts and aid in development of appropriate adaptations. For example, many small island developing States considered that better understanding of the impact of climate change on the ENSO phenomenon and its effect on pelagic fishery resources (mainly the tuna fishery) would enable better planning and management.

IV. Needs and constraints

70. A serious constraint to the assessment of vulnerability and adaptation in non-Annex I Parties was the lack of data available to meet the demands of the methodologies for these assessments, as well as Parties' inability to conduct the type of assessments that would generate results reliable enough to be incorporated into national planning processes. Much of the data required as input to impact models and assessments were either not present (uncollected), inaccessible or inappropriate.

71. Many Parties also noted the lack of appropriate institutions and infrastructure to conduct systematic data collection, poor coordination within and/or between government departments and agencies, the absence of universities and/or research centres in smaller, poorer countries, and other cases where existing universities were not engaged in vulnerability and adaptation assessment work.

72. Although many Parties provided information on the institutional arrangements that had been established to carry out vulnerability and adaptation assessment, many of these institutions lacked the capacity and resources to fully engage in such work. In some cases, the participation and involvement of technical teams was hampered by lack of coordination and lack of clarity over roles and responsibilities.

73. The integration of adaptation into long-term planning clearly constituted the next stage for almost all non-Annex I Parties. In some cases adaptation options needed to be considered at the regional level (relating to international waters, for example) and in others adaptation options needed to be considered in a more general context including living standards, demography, legislation and sustainable development at the national level.

74. Many Parties expressed the need for more work to be carried out on integrated assessments, socio-economic assessments, identification of adaptation options and costing implications. Some Parties considered that, where possible, vulnerability and adaptation studies should be conducted at a regional or subregional level, particularly where a number of countries shared natural resources such as coastlines and water resources within major catchments or river systems. Table 4 provides an overview of the needs and constraints relating to vulnerability and adaptation assessments in non-Annex I Parties.

V. Summary

75. Almost all non-Annex I Parties provided information on their needs and concerns relating to the assessment of climate change impacts, vulnerability and adaptation. They also noted that they regard climate change impacts, vulnerability and adaptation as a critical sustainable development issue.

76. Assessments of climate change impacts, vulnerability and adaptation in non-Annex I Parties have provided opportunities for highlighting key vulnerable sectors, priorities and needs for adaptation, and also the difficulties/gaps and constraints. Parties have also highlighted the fact that they are already

Table 4. Overview of needs and constraints relating to vulnerability and adaptation assessments (V and A) from non-Annex I Parties

	Africa	Asia and the Pacific	Latin America and the Caribbean
Vulnerability and adaptation assessments	<ul style="list-style-type: none"> - Guidance provided by UNFCCC is inadequate 	<ul style="list-style-type: none"> - Vulnerability and adaptation assessment is an ongoing process - Vulnerability and adaptation assessment needs to be explicitly mentioned in the UNFCCC guidelines 	
Methods and approaches – models, tools and data	<ul style="list-style-type: none"> - Use of GCMs and GCM-based scenarios - Improve data availability, quality, archiving and updating - Standardize methodologies and models 	<ul style="list-style-type: none"> - Expand the use of climate models - Improve access and availability of methods - Identify gaps in data and monitoring - Establish new and upgrade existing stations - Enhance expertise to manage stations - Improve access to national climate data 	<ul style="list-style-type: none"> - Standardize methodologies and models - Use of hydrometeorology data to augment, verify and validate GCM outputs
Key vulnerable sectors	<ul style="list-style-type: none"> - Agriculture, water resources, coastal zones, forestry, rangelands, biodiversity, human health. - No cross-sectoral assessments 	<ul style="list-style-type: none"> - Water resources, agriculture, coastal zones, natural ecosystems (forests) 	<ul style="list-style-type: none"> - Water resources, agriculture, coastal zones, fisheries, health/human settlements, LULUCF/ecosystems, desertification/land degradation, industry and energy - Should focus on key sectors
Capacity-building needs (human and institutional)	<ul style="list-style-type: none"> - Climate change issues and longer term training in V and A - Retention of expertise - Establish national climate change committees - Strengthen national institutions to take on work to develop GCMs at appropriate scales - Improve institutional framework for implementation 	<ul style="list-style-type: none"> - Improve capacity for V and A - Establish appropriately skilled and resourced national teams 	<ul style="list-style-type: none"> - Organize workshops in the use of data and application of models and methods - Develop databases - Develop human capacity to archive information and manage databases - Establish national climate change committees - Establish regional climate centres - Strengthen national institutions to take on work to develop GCMs at appropriate scales
Financial and technical support	<ul style="list-style-type: none"> - Adequate funding is required for vulnerability and adaptation work - Financial and technical support from United Nations agencies 	<ul style="list-style-type: none"> - Establish and maintain databases - Integration of V and A with national development planning - Disaster preparedness 	<ul style="list-style-type: none"> - Financial and technical support is crucial for vulnerability and adaptation activities - Establish and maintain databases on population, socio-economics, geomorphology, human health and settlements, risky areas - Develop and disseminate regional climate models
Education, training and public awareness	<ul style="list-style-type: none"> - Vulnerability and adaptation project proposals and negotiations for GEF funding - Integration of climate change issues into national planning - Introduction of GPG for V and A. Encourage participation by stakeholders - Adaptation planning and implementation needs to be integrated 	<ul style="list-style-type: none"> - Regional training where appropriate - Training for both basic and advanced levels - Development of national experts in the use of climate model outputs - Development and application of methods and preparation of scenarios - Use of impact models - Establish and manage databases - Identification and collection of information - Interpretation of results 	<ul style="list-style-type: none"> - Encourage outreach through regional integration units - Identify needs and develop plans - Vulnerability and adaptation project proposals and negotiations for GEF funding - Introduction of GPG for V and A - Provision of equipment, technical support training and information systems
Networking and information	<ul style="list-style-type: none"> - Strengthen collaboration, cooperation among national/regional experts in dealing with trans-national issues, eg: water resources - Guidelines need to be translated into other languages - Cooperation and collaboration with WMO on health issues 	<ul style="list-style-type: none"> - Create, use and maintain Internet services - Regional and national networks of national teams and experts 	<ul style="list-style-type: none"> - Strengthen regional technical information exchange, climate change networks - Cooperation and collaboration with WMO on health issues - Enhance regional exchange of experiences

experiencing stresses from current climate and climate-related events and phenomena that could be exacerbated by future climate change.

77. The current and future key vulnerable sectors/areas identified by Parties in their assessments include the following: agriculture and food security; water resources; coastal zones and marine ecosystems; forests and terrestrial ecosystems; human health; fisheries; human settlements; biodiversity; coral reefs; tourism; and energy.

78. A number of anticipatory and reactive adaptations have been identified in key sectors. Most of these adaptations relate to crop management, land management and soil and water conservation in agriculture and food security; supply-side and demand-side management of water resources; conservation and management of forests and other terrestrial ecosystems; land-use planning and zoning and integrated coastal zone management; improvements in living standards, surveillance, monitoring and early warning systems for outbreak of disease vectors for human health; and improved understanding of climate change effects on the pelagic fishery resources.

79. The small island developing States, and countries with long coastlines and low-lying areas, pointed out that they experience severe floods and drought, adverse effects from changes in the El Niño phenomenon, tropical storms and changes in their patterns, saltwater intrusion, storm surges, coral reef damage, and changes in migratory patterns of important fish. Some countries stated that they are concerned about long-term sustainability of their arid/marginal regions, which are highly vulnerable to the adverse effects of climate change.

80. Many Parties did not provide a clear indication of the methods used in assessing and analysing adaptation options, measures and strategies. Most of the adaptation options were identified using the IPCC Guidelines and global circulation models, which do not adequately address methods for evaluation and/or costing specific adaptation strategies and measures.

81. One of the main constraints in the assessment of vulnerability and adaptation in non-Annex I Parties was the lack of data to meet the demands of the methodologies for these assessments, as well as Parties' inability to conduct the type of vulnerability and adaptation assessments that would generate results reliable enough to be incorporated into national planning processes. Much of the data required as input to impact models and assessments were not present (uncollected), inaccessible or inappropriate. The lack of appropriate institutions and infrastructure to conduct systematic data collection, and poor coordination within and/or between different government departments and agencies, were also areas highlighted for further strengthening.
