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Agenda Item 10

FAO AND ADAPTATION TO CLIMATE CHANGE IN THE EUROPEAN REGION

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I. INTRODUCTION

1. Climate change and adaptation to it are a major challenge that agriculture, forestry, fisheries and rural areas in the European region will face in the coming years. The projected climate changes will affect crop yields, livestock management and location of production, with persistent water shortages, resultant important risks for farm income, and some land abandonment. In the European region, policies in support of agriculture, forestry and rural development manage not only food production but also the maintenance of rural landscapes and the provision of environmental services. Timely adjustments to these policies will be required to better integrate adaptation to climate change into agriculture and rural areas support programmes, for instance to promote good farming practices compatible with the new climatic conditions and to contribute to preserving and protecting the environment.

2. The High-Level Conference on World Food Security: the Challenges of Climate Change and Bioenergy that took place from 3 to 5 June 2008 in Rome addressed the nexus between food security, climate change and bioenergy, identified the process for institutional action for the integration of food security safeguards into multilateral climate-related agreements and defined FAO's response through field interventions, partnerships and multilateral and regional cooperation. The 26th Regional Conference for Europe (ERC) in turn will address these issues in the European region with a focus on the Central and Eastern Europe and Central Asian subregions.

3. Climate change is expected to directly affect present and future food availability; concurrently, the transition to biofuels, converting agricultural and forestry origin biomass into fuel will give agriculture and forestry a new role in climate change adaptation and mitigation. This new role may compete with food supply, in particular for the rural and urban poor. The possible negative impact of weather conditions on the 2008 cereals and oilcrops harvest could further aggravate the unfavourable food security situation resulting from the 2007 and 2008 sharp increases in prices of staple farm and food products and depleted stocks [1].

4. This paper makes reference to selected recent and ongoing research, analytical work and discussions on the manifold impacts of climate change, considered relevant to the 26th ERC Ministerial Round Table debate, and to the formulation of policy recommendations for the attention of Member Governments, civil society and Non-Governmental Organizations (NGOs) and FAO. Attention is given to the situation in the Central and Eastern Europe and Central Asian subregions, as data availability permits, since in Western Europe both research and policy debates began earlier and are now well advanced.

5. Adaptation measures and options for FAO activities are proposed in the Annex to this paper, based on a short overview of past FAO activities, with a focus on areas where FAO has a comparative advantage; that is support to rural areas and household livelihoods; national policies regarding agriculture, forestry and fisheries and national and regional assessments for food security. This Annex also includes a summary of selected research and methodology supplementary data, and information regarding sources and reports referred to in the main paper.

[1] FAO Crop Prospects and Food Situation, No. 2, April 2008.

II. CLIMATE CHANGE PROJECTIONS

6. According to the most recent Intergovernmental Panel on Climate Change (IPCC, 2007) Fourth Assessment Report (AR-4)[2], the warming of the globe's climate is unequivocal as evidenced by observations of increases in global average air and ocean temperatures, widespread melting of snow and ice, and rising global mean sea level. The linear warming trend over the last 50 years is nearly twice that observed for the last 100 years. As oceans are absorbing more than 80 percent of the heat added by climate change, the volume of sea water is increasing.

7. The 2007 report indicates that temperature increases in the region over the last decades are within or even slightly above the predicted ranges of previous IPCC reports, heightening confidence in AR-4 climate change projections for the future. Box 1 provides other projections for this century for the principal climatic parameters. Average summer temperatures will increase by between about 2 and 4 degrees centigrade throughout the region, while simultaneously summer precipitation will decrease by up to 50 percent in southern Europe and the Mediterranean. Droughts will be common and today's 100-year droughts, comparable to the 2003 extreme drought affecting Central Europe, are likely to reoccur every 50 years from the south-eastern Mediterranean to the Ukraine. Extreme events such as warmer and hot days and nights are generally likely to become more frequent.

[2] As IPCC organized its climate projections according to different spatial subdivisions; observations and projections from the Northern Europe, Southern Europe and Mediterranean, and Central Asia subregions apply.

BOX 1: PROJECTED CLIMATIC CHANGES UP TO 2100[3] FOR COUNTRIES IN THE REGION

IPCC-Region	Southern Europe and Mediterranean	Central Europe	Central Asia
Increase of average annual temperature ^{0}C	2.2 to 5.1/3.5	2.3 to 5.3/3.2	2.6 to 5.2/3.7
Increase of summer temperature ^{0}C	3.5 to 4	2.5 to 4	3.5 to 4
Increase of winter temperature ^{0}C	2 to 3.5	3 to 4	3.5 to 5
Change in summer rain %	-25 to -50	0 to -20	-10 to -30
Change in winter precipitation %	+5 to -20	+5 to +20	0 to + 20
Other parameters	Early/late frost; 50% dry summer seasons; torrential rains; soil desiccation; fire season intense, long, frequent; less windy longer growing season.	Increase in evapotranspiration; reduced summer moisture; increase in temperature variability; frequent drought, heat waves more frequent, intense and longer torrential rain in summer; increased wind speeds probable; shorter snow season, lower snow depth.	> 96% extremely warm seasons 10-20% extremely dry seasons.

8. Projections for Europe indicate a 1–2% increase per decade in annual precipitation in northern Europe and an up to 1% per decade decrease in southern Europe (in summer, decreases of 5% per decade is projected). The reduction in southern Europe is expected to have severe effects, e.g. more frequent droughts, with considerable impacts on agriculture and water resources.

9. Anticipating future climatic trends can help governments and society to adapt to potential changes and implement relevant policy measures. The IPCC has developed a range of alternative emissions scenarios, based on different socio-economic development pathways for the

[3] A range and median of predictions are provided for the applicable IPCC spatial subdivisions for average annual temperature. Summer and winter projections were approximated from maps covering the FAO Central and Eastern Europe and Central Asian regions.

21st century, set out in the Special Report on Emissions Scenarios (SRES) (Nakicenovic et al. 2000). These scenarios provide a comprehensive set of narratives that define the local, regional and global socio-economic driving forces of environmental change (e.g. demography, economy, technology, energy and agriculture). The selected method used for projections and a general description of emission scenarios of the IPCC Special Report on Emission Scenarios (SRES) are presented in Box 2.

10. The scenarios are structured under four major 'families' labelled A1, A2, B1 and B2, each of which emphasizes a different set of social and economic assumptions, organized along two axes. The vertical axis represents a distinction between more economically (A) and more environmentally and equity (B) oriented futures. The horizontal axis represents the range between increased globalization (1) and more regionally oriented developments (2). A2 is characterized by a continuous increase in emissions; A1 and B2 have a slower increase in emissions that levels off towards 2100; B1 reaches maximum emissions around 2050 after which they decrease.

11. The emissions scenarios are used as input to General Circulation Models (GCMs), as summarized in the Annex. These models indicate that global mean temperature is likely to rise by between 1.1 and 6.4^{o} C by the end of the century (IPCC 2007a). The best estimates for the low scenario (B1) is 1.8^{o} C (likely range is 1.1^{o} C to 2.9^{o} C), and the best estimate for the high scenario (A1F1) is 4^{o} C (likely range is 2.4^{o} C to 6.4^{o} C). The temperatures above land will increase faster than above oceans, and that temperatures in high latitude regions will increase more than in tropical regions. Changes in precipitation manifest less comprehensive patterns, but currently wet areas will get wetter and arid areas will become dryer. Globally, precipitation will increase, but this will be mainly from intense precipitation events in the winter season and will only negligibly increase water availability for agriculture.

12. Seasonal changes in temperature and precipitation were calculated for three groups of countries selected for the purpose of the paper: (i) south-eastern Europe: Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia and TFYR Macedonia, (ii) eastern Europe: Armenia, Belarus, Georgia, Moldova, Russian Federation and Ukraine and (iii) central Asia: Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan, using the four IPCC SRES scenarios (Figure 1). The A2 scenario, with the highest emissions and thus also temperature increase, was analysed for four different GCMs to allow for analysis of the variability between GCMs. This variability replicates the major uncertainties in determining future climate change.

Box 2: The Emission Scenarios of the IPCC Special Report on Emission Scenarios (SRES)

A1. The A1 storyline and scenario family describes a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. Major underlying themes are convergence among regions, capacity-building and increased cultural and social interactions, with a substantial reduction in regional differences in per capita income. The A1 scenario family develops into three groups that describe alternative directions of technological change in the energy system. The three A1 groups are distinguished by their technological emphasis: fossil intensive (A1FI), non-fossil energy sources (A1T), or a balance across all sources (A1B) (where balanced is defined as not relying too heavily on one particular energy source, on the assumption that similar improvement rates apply to all energy supply and end use technologies).

A2. The A2 storyline and scenario family describes a very heterogeneous world. The underlying theme is self reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is primarily regionally oriented and per capita economic growth and technological change more fragmented and slower than other storylines.

B1. The B1 storyline and scenario family describes a convergent world with the same global population, that peaks in mid-century and declines thereafter, as in the A1 storyline, but with rapid change in economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

B2. The B2 storyline and scenario family describes a world in which the emphasis is on local solutions to economic, social and environmental sustainability. It is a world with continuously increasing global population, at a rate lower than A2, intermediate levels of economic development, and less rapid and more diverse technological change than in the B1 and A1 storylines. While the scenario is also oriented towards environmental protection and social equity, it focuses on local and regional levels.

An illustrative scenario was chosen for each of the six scenario groups A1B, A1FI, A1T, A2, B1 and B2. All should be considered equally sound.

The SRES scenarios do not include additional climate initiatives, which means that no scenarios are included that explicitly assume implementation of the United Nations Framework Convention on Climate Change or the emissions targets of the Kyoto Protocol.

Note: The box summarizing the SRES scenarios is taken from IPCC (2007) Summary Report for Policymakers in Climate Change 2007

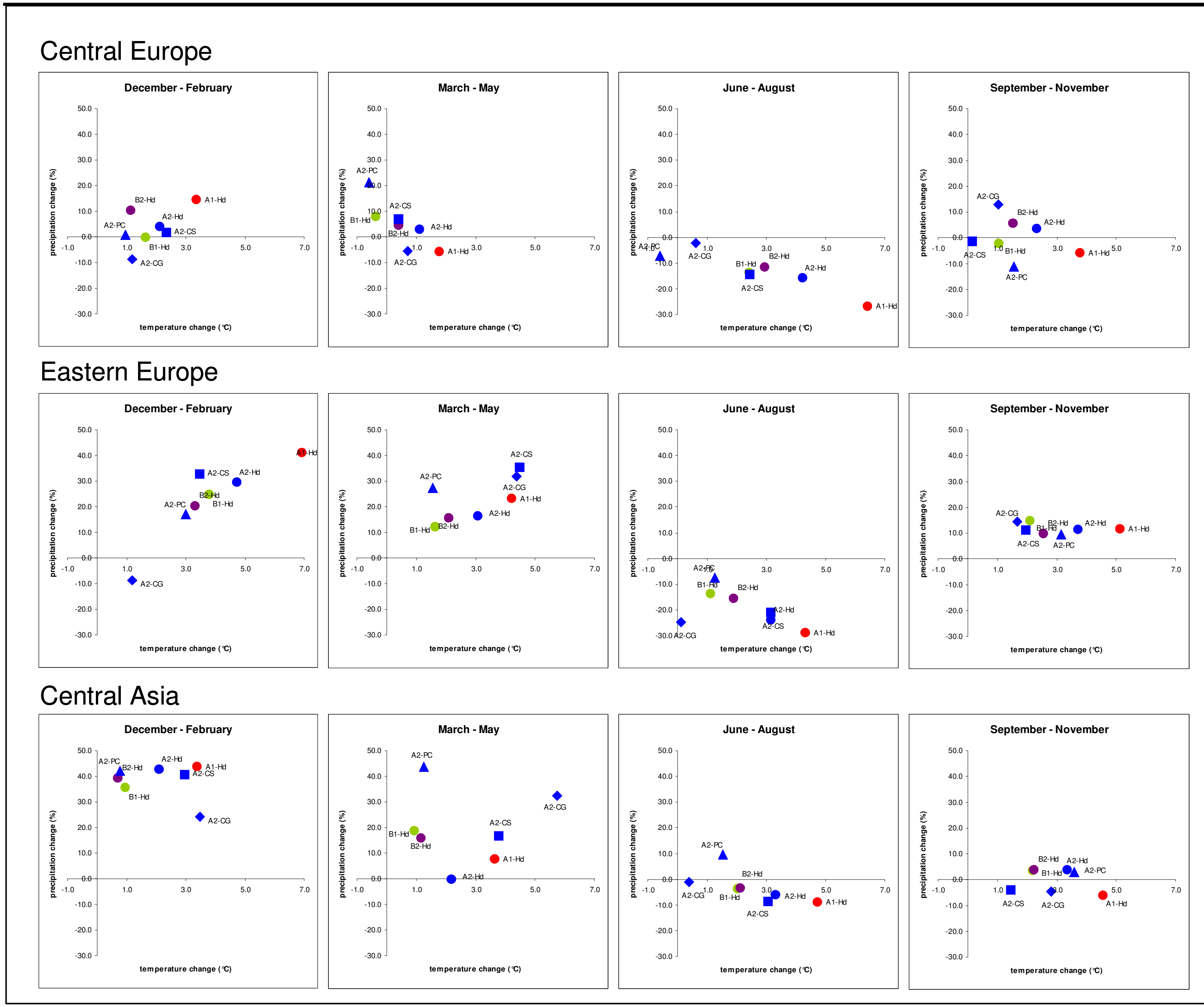

Figure 1. Projected mean seasonal temperature and precipitation change in the 2080s compared to 1969-1990 mean climate, based on the TYN SC2.3 dataset (http://www.cru.uea.ac.uk/cru/data/hrg/) for the four IPCC SRES scenarios (A1,A2,B1,B2) and 4 GCMs (Hd = HadCM3; CS = Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO2); PC = National Center for Atmospheric Research (NCAR) Parallel Climate Model (PCM); CG = the Second Generation Coupled Global Climate Model (CGCM2)). For the eastern Europe countries group, only the Russian Federation domain west of the Ural Mountains was taken into account

13. There is some variance between GCMs concerning the level of warming and in some cases also in the precipitation change (e.g. for spring in Central Asia and winter in eastern Europe countries). The most modest changes are projected for the south-eastern Europe group, with a maximum increase in precipitation of 20% and a few degrees of warming. Winter and spring in eastern Europe are projected to become much wetter (up to +40%) and warmer (up to +7°), while summer will be considerably drier (up to -30%). Although there is a spread in projections between GCMs (Figure 1), temperature is projected to increase considerably in all seasons. The greatest differences relate to precipitation, but there is general agreement that winter and spring will become wetter. This is consistent with observations over the last few decades. Summers become drier, while there is little change in autumn weather conditions. This trend towards drier conditions is most obvious in the eastern Europe and south-eastern Europe country groups. When combined with higher temperatures, which will increase evapotranspiration, this will result in less water being available for plant growth. This will be an important main driver affecting agricultural productivity.

14. While some differences between the country groups analysed could be discerned, it should be noted that climate change can vary considerably within these groups, especially across long latitudinal gradients (e.g. in the Russian Federation) and in mountainous regions, e.g. the Urals, the Caucasus and the Balkans. This variability in climate change impacts should be taken into account when defining subregions for future climate change impact assessment.

III. IMPACT OF CLIMATE CHANGE ON AGRICULTURE IN THE EUROPEAN REGION

15. Agricultural productivity will be directly affected by climate change. In mid- to high-latitude regions, moderate to medium warming (an increase of 1-3°C), along with an associated CO2 carbon dioxide increase can have small beneficial effects on crop yields, while in low latitude regions even moderate temperature increases (1-2°C) are likely to have negative impacts (IPCC 2007b).

16. Furthermore, it is important to remember that social and economic factors will ultimately determine both food demand and the technological capability to cope with potential climate change impacts (Ewert et al, 2005; Rounsevell et al. 2006). For developing countries, which tend to rely more heavily on primary sectors and attract comparatively low levels of investment, the potential impacts of climate change will greatly depend on the scenario assumptions for possible future development pathways.

17. A recent analysis of the spatial impacts of climate and market changes on agriculture in Europe (Hermans et al., 2008) extended the methods developed by Ewert et al. (2005) to assess potential climate change impacts on cereals (i.e. wheat) and tubers (i.e. potato) productivity in Europe. The analysis is based on the A1 (global economic) and B2 (regional sustainability) scenarios, the HadCM3 GCM, and includes assumptions on technological development. Results are available for the south-eastern Europe and eastern Europe country groups (data for the Russian Federation is only available west of the Urals). Figure 2 indicates that in the south-eastern Europe group climate change has a slightly negative impact, but when the effect of raised CO_2 concentrations are taken into account, the impacts are slightly positive, as suggested by the IPCC (2007b). However, technology is the most important driver, with far greater effects than climate change. Figure 3 gives a summary of the results for both south-eastern and eastern Europe country groups.

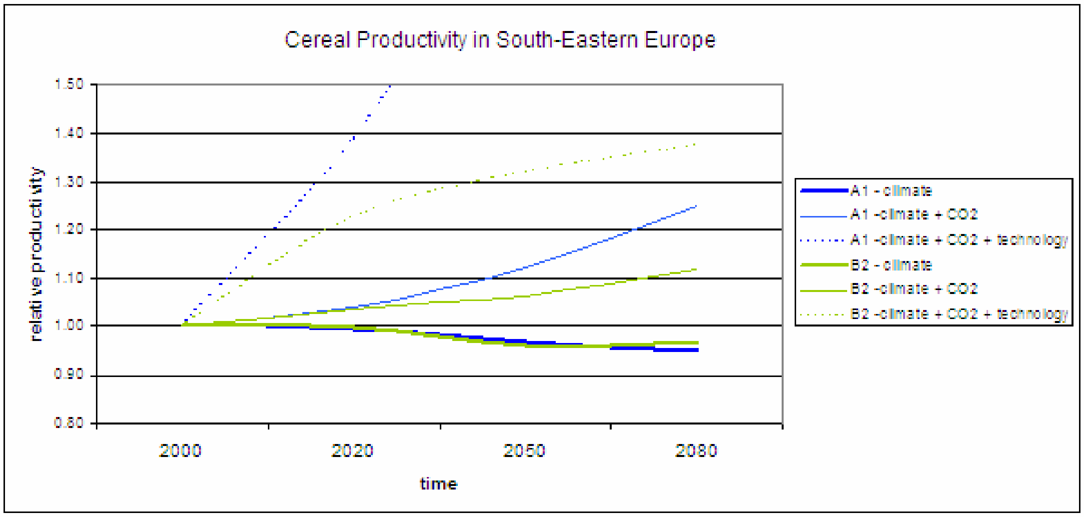

Figure 2. The effect on relative cereal productivity in the selected south-eastern and eastern Europe country groups based on six different scenarios. Data derived from Hermans et al. (2008).

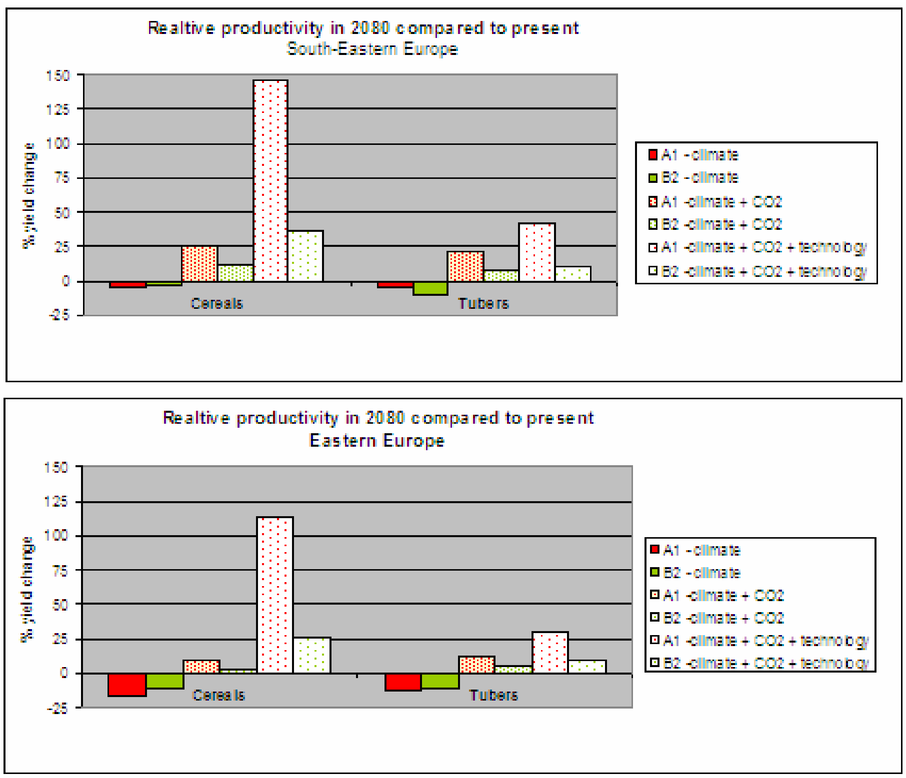

Figure 3. Summary of the cereal and tuber productivity in 2080 compared to 2000 in south-eastern and eastern Europe country groups, based on six different scenarios. Data derived from Hermans et al. (2008).

18. Agriculture is especially sensitive to climate change, since shifts in environmental conditions and changes in climate variability will directly influence agricultural productivity. As such, climate change can have serious impacts on food security and on economies and people dependent on the agricultural sector (IPCC 2007b). However, climate change and its impacts are highly location specific, which makes it difficult to generalize. The residual impacts of climate change on a region or sector depends on both projected climate change and its potential impacts and on the ability to cope with these changes (IPCC 2007b). It is therefore important to develop

an adequate understanding of the region as a coupled human-environment system where humans (e.g. the agricultural sector or the population) are seen in relation to the environment that provides the boundary conditions for agricultural production (Schröter et al, 2005; Metzger & Schröter 2006).

19. This section explores impacts and adaptation strategies for the three selected groups of countries in the Europe region, grouped taking into account geographical and climate characteristics, thus:

- south-eastern Europe: Albania, Bosnia and Herzegovina, Croatia, Montenegro, Serbia and TFYR Macedonia
- eastern Europe: Armenia, Belarus, Georgia, Moldova, Russian Federation and Ukraine
- central Asia: Azerbaijan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan

20. A brief analysis of these groups of countries shows that while agriculture has retained an important role in the economy and social structure in all three, providing employment for more than one fourth of the population and generating approximately the same share of GDP, there are considerable differences. The countries in south-eastern Europe countries have the highest agricultural productivity, the least irrigated cropland, the greatest fertilizer use and the lowest yearly variation in cereal production. In contrast, Central Asia has the lowest yields, relies heavily on irrigation and has the largest inter-annual variation of cereal yields. Clearly, within the groups there is considerable variation between countries.

21. Narratives were formulated, based on the major characteristics, for alternative future development pathways for relevant socio-economic and biophysical drivers influencing agriculture. Insights obtained from such modelling exercises can be used as a tool to develop and discuss adaptation measures to cope with the potential impacts of climate change (Metzger et al. 2008). For the projections, climate change scenarios from various General Circulation Models (GCMs) have been summarized and the potential impact on agricultural productivity is assessed according to different scenarios. On this basis, alternative adaptation strategies are discussed as well as methods and resources to improve future impact assessments. A draft list of proposed priorities for response through FAO activities is provided in the Annex.

IV. PROJECTED IMPACTS OF CLIMATE CHANGE ON GROSS DOMESTIC PRODUCT (GDP) AND FOOD SECURITY

22. The most comprehensive study on the effect of climate change on agricultural Gross Domestic Product (GDP) (Tol, 2002), which covers nine regions of the world draws on previous studies between 1992 and 1995, that estimate the impact of climate change on gross agricultural product on a regional basis, as shown in Table 1 (for Notes on Methodology, etc, see the Annex).

TABLE 1: **GLOBAL IMPACTS ON AGRICULTURE* FOR A 2.5 DEGREE CELSIUS INCREASE IN GLOBAL MEAN TEMPERATURE**

REGIONS	WITHOUT ADAPTATION		WITH ADAPTATION		MEAN
	Best Guess	SD	Best Guess	SD	
Latin America	-0,8	0,6	0,6	0,7	-0,1
South & South-east Asia	-0,7	0,3	0,6	0,3	0,0
Middle East	-0,4	0,4	0,6	0,5	0,1
Africa	-0,2	0,2	0,5	0,3	0,1
OECD-P	-0,2	1,6	0,8	1,6	0,3
OECD-A	-0,3	1,3	1,0	1,3	0,4
OECD-E	0,6	1,0	2,1	1,1	1,3
Eastern Europe & Former SU	0,9	1,2	2,7	1,1	1,8
Centrally planned Asia	1,7	1,0	3,1	1,0	2,4

* expressed in percent change from reference projection of GDP

Source: Tol (2002)

SD – Standard Deviation
SU – Soviet Union

23. Without adaptation to climate change, it is estimated that GDP will decline in seven of the nine regions with only Eastern Europe and the former Soviet Union (SU) and Central Asian countries benefiting from climate change. With adaptation, it is estimated that GDP will increase in all nine regions with Organisation for Economic Co-operation and Development (OECD)-Europe, Europe, the former Soviet Union countries and the Central Asian countries benefiting the most. There are likely to be major differences in GDP variations due to climate change between countries within a single region; thus, climate change mitigation and adaptation policies must not only be regional but should be country specific.

24. There appears to be a consensus about the following generalized impacts of climate change, although debate about climate change modeling and impact estimates continues. The extent of the risks and opportunities from climate change depends on the actual mean global temperature rise and the ability of countries, and regions within countries, to adapt to climate change. Developing countries are most at risk and require assistance to adopt appropriate measures. More specifically[4]:

a) Countries in the more temperate and polar regions are likely to benefit substantially from global warming; countries in mid-latitudes will at first benefit and will only begin to be negatively affected if temperatures rise above 2.5°C; countries in tropical regions are likely to be negatively impacted immediately by global warming,

b) Agriculture in most developed countries would likely benefit from climate change (increase in production and agricultural GDP) whereas most developing countries would not benefit due to the predominance of agriculture in their economies and due to technological limitation and low adaptive capacity, and

[4] For detailed discussion see Tol, R.S.J. 2002. Estimates of Damage Costs of Climate Change. Part 1: Benchmark Estimates. Environmental and Resource Economics, 21(1) 47-73 and Adaptation to Climate Change in Agriculture, Forestry and Fisheries, FAO, 2007.

c) Global warming will not have a detrimental effect on aggregate global food supplies over the next century but food imports of developing countries in general and least developed and small island states in particular would increase substantially.

V. ADAPTIVE CAPACITY AND ADAPTATION STRATEGIES

25. Adaptation refers to adjustments in natural or human systems in response to actual or expected climate change, which moderate harm or exploit beneficial opportunities. A general adaptation scheme is provided in the Annex. Adaptation in agriculture varies depending on the climatic stimuli (to which adjustments are made), farm type and location, as well as the economic, political and institutional conditions (Bryant et al., 2000; Smit and Skinner, 2002). Adaptation strategies include a wide range of forms (technical, financial, managerial), scales (global, regional, local) and actors (governments, industries, farmers). Adaptation options can be grouped into four main categories (adapted from Smit and Skinner, 2002):

1. Farm production practice	
Choice of crop species and cultivar	More heat- or drought-resistant varieties
Crop diversification	An increased number of crops can decrease risk
Time of sowing the crop and irrigation management	Can increase yields or reduce water demands or increase water use efficiency
Fertilizer use	Adapt timing and amount of application
Degree of land preparation	Minimum and/or no tillage for water economy
Adjustment of pest and weed control	New problems require new practices
2. Farm financial management	
Crop, farm and income insurance	To cope with extreme conditions
Diversify income and increase off-farm income	Mixed farming, agro tourism, nature and environment services and management, to supplement income and decrease variability
Increase farm size	To cope with per hectare losses
Investment and saving	To increase financial capital for future adaptations
3. Technological developments	
Development of new crop varieties	More heat- or drought-resistant varieties
Improved short-term weather forecasting	For short-term adaptation of management
Resource management innovations	For example to improve the efficiency of water use
4. Government programmes and insurance	
Subsidy, support and incentive programmes	To assist farmers to adjust to change and rural communities to mitigate impacts
Education and information programmes	To increase awareness of all stakeholders
Research and development	To search for new alternatives in production and sustainable farming
Revise water retention policies	To reduce impacts of floods and droughts and improve water use efficiency
Land use policies	For example decisions on biofuels or food crops.

(a) Some issues in adaptation and mitigation

26. In the south-eastern and eastern Europe country groups which have been considered above, intensive irrigation is not common practice. As water availability will likely further decrease, stimulating irrigation is not a good strategy. Improving soil and water management, by, for example, conservation or no tillage cultivation or water retention, will be more efficient. As farms are generally small and the average age of farmers is high, measures that are easy to adopt should be encouraged; the impacts differ per region. Negative effects mainly relate to increased climate variability (heat stress, droughts, frost damage), but positive impacts are projected, especially in colder regions (e.g. reduced frost risk window). In this case, an increase in temperature can increase crop yields and increase the suitability of certain crops.

27. In Central Asia, most crops are irrigated and improving irrigation efficiency and water productivity would be important for this region. This is also the region where the highest temperatures and lowest precipitation are already registered, and hence, where the most severe effects are expected. Crop improvement activities related to development and adoption of drought tolerant varieties would be beneficial in this context.

28. In all areas, strategies to cope with new pests, diseases and weeds will be important. A slight change in climatic conditions can lead to destructive effects on crop yields. For example, if the temperature rises above 25°C for three consecutive days, aphid populations may increase above the economic threshold level and negatively impact the crop yield. In many regions farmers already have problems with an increased incidence of pests and diseases. Farmers need to be prepared for this and be able to evaluate the costs and benefits of improved crop protection.

29. Hence, an integrated approach relevant for local, national and international contexts is needed to improve adaptive capacity. An important first step is raising awareness about climate change and its potential impacts at the regional level. Initially, farmers in Europe were sceptical about climate change, but over the past decade awareness that climate change is already apparent and affecting agricultural production has increased. Recent research in the European Union ADAGIO project (www.adagio-eu.org) indicates that most farmers do link the observed impacts of climatic extremes to projected climate changes. Information on shifting agro-environmental zones is perceived as useful, since farmers understand the problems of neighbouring farmers in other zones and translate projections for their own future.

30. The second step is to inform farmers more explicitly about the risks they face, and the appropriate adaptation strategies they could implement in their own specific circumstances. Regional experiments can be designed to test relatively inexpensive measures, such as shifting sowing dates or switching to another existing crop variety. More expensive strategies, such as the development of new crop varieties and the expansion of irrigation, will require substantial investment by farmers and government. Given the uncertainty in regional climate projections, such investments are a form of risk management. Identifying low cost and no-regret options will be important. Many farmers are conservative and will only change practices when they are convinced that changes are efficient.

31. Integrated assessment forms an appropriate tool to explore adaptation options with stakeholders. At the regional level, governmental organizations and NGOs but primarily the private sector agriculture stakeholders can be confronted with potential impacts, using modelling studies to show the benefit of investment in infrastructure or water management (e.g. water retention to cope with drought). Local stakeholders or individual farmers can be confronted with potential impact and adaptation strategies that are specific for their farm type and agri-environmental situation.

(b) Methods and resources to improve impact assessment

32. The priorities and resources required to improve understanding about climate change impacts may be grouped as follows (for detailed discussion methods and resources needed, see the Annex):

1. Raise awareness in the agricultural sector and government	4. Construct regional scenarios and relate to local conditions
2. Discuss with stakeholders across groups and institutions	5. Improve baseline data and develop a meaningful aggregation framework
3. Adopt a local approach to develop and implement adaptation practices	6. Continued investment in scientific methods

VI. IMPACT OF CLIMATE CHANGE ON FORESTRY

33. FAO member countries in the European region differ not only in climate, agricultural resources and forest vegetation but, no less important, in their status under the United Nations Framework Convention on Climate Change (UNFCCC) and Kyoto Protocol. All countries of the region have ratified the UNFCCC and most are also Parties to the Kyoto Protocol, except Kazakhstan, Tajikistan and Turkey. They belong either to the Annex I group of countries (Lakyda et al, 2005) with the possibility of investing in or hosting Joint Implementation (JI) mitigation projects, or to the non-Annex I group of countries (Schoene and Netto) which could benefit from carbon offset projects under the Clean Development Mechanism (CDM) (for additional information see the Annex).

34. Forestry and the use of wood provide the opportunity for carbon sequestration in forest resources as well as through an increased use of timber products; it should be reiterated that forest management decisions taken today (e.g. tree species choice) remain irreversible for decades or even centuries. In many European countries, forests and forest reserves provide the main opportunities for maintaining biodiversity and conserving rare and endangered species. Impacts from climate change might lead to the appearance of exotic tree species in forests or a focus on resistant local species in order to maintain the productivity of forestry. This will threaten biodiversity and reduce the opportunity to implement the national and pan-European conservation programmes (Kellomäki et al, 2000).

35. Climate change impacts will potentially shift the area of tree species native occurrence northwards (Štefančík et al, 2005). In addition, an increase in growth has been recorded in some countries in central and northern Europe, especially in areas where precipitation has increased in combination with an increase of CO2 and nitrogen deposition and changes in management practice (Kellomäki et al, 2000). Stability problems with regard to the current forest cover may become especially serious in countries like Hungary, Moldova, the Russian Federation and Ukraine, which are situated on the border of the closed temperate forest belt (Rasztovits et al, 2005). The tree species structure is also expected to change, as the share of competitive, drought resistant and fast-growing tree species will increase (*Ailanthus altissina, Robinia pseudoacacia*). Due to competitive exclusion beech and sessile oak will disappear from these sites (Rasztovits et al, 2005).

36. In turn, in the Mediterranean sub-region, forest ecosystems or ranges of individual species start to contract in the south and at lower elevations. The southern occurrence of beech (*fagus silvatica*) or Scotch pine (*pinus silvestris*) is declining or dying back (IPCC 2007; Jump et al 2006; Maracchi et al, 2005; Martinez-Vilalta and Pinol 2002). Competitive strength

will increase or decrease by species within ecosystems, changing its composition. Thus, deciduous trees will often replace conifers in Central Europe. Shrubs may increasingly dominate trees in the Mediterranean. More than half the plant species in a large sample from Europe would become vulnerable, endangered or committed to extinction in their native habitat under predicted climatic changes (Thuiller et al, 2005).

37. Many ecosystems will lose stability. Simultaneously, disturbances, such as more intense, more frequent and larger forest fires, pathogens and insect calamities will become more frequent and spread to new areas, particularly in the Mediterranean and Central Europe. The spread of the pine processionary moth to new areas and new host species in the Mediterranean provide an example (Battisti et al 2005). Newly introduced pathogens, such as the pine wilt nematode, might become invasive. In spite of a warmer climate, late and early frost will increasingly damage trees that are not properly hardened. Countries from the region have already reported over 100 000 ha of such disturbances in the last Global Forest Resource Assessment (FAO 2006).

38. Climate change would also have an impact on forest soil vegetation, fauna and landscapes (Kellomäki et al 2000) as well as on insect and fungus populations that will benefit from favourable conditions for growth. Potential threats might include expansion of pests and even cause dieback of an entire forest. At the same time the size of game populations, which are constrained by extreme winters, cold and forage availability in spring, may benefit from higher average temperatures.

39. Increasingly, the change to hotter and drier summer weather results in the incidence of more intense forest fires. The hot weather dehydrates the wood and vegetation on the forest floor, creating favourable conditions for forest fires. The dryness of the weather also prevents soil dampening from rain (David Suzuki Foundation 2007). Torrential rainfalls in areas consumed by fires or affected by dieback will enhance erosion, landslides and rockfalls and contribute to silting of streams and reservoirs. Declining forests lose their ability to regulate surface water flows and mitigate the flooding that has occurred and is projected to increase for Central Europe; their retreat or degradation affects their function in mitigating local or regional drought effects or desertification.

40. With higher concentrations of CO2, longer growing seasons, warmer temperatures in northern and mountain regions, and nitrogen emissions, global Net Primary Productivity, has increased on average by 6 percent over the last two decades of the twentieth century (Nemani et al 2003). Current increases in the region are strongest for Central and Eastern Europe, slight for the Mediterranean and not detectable in Central Asia. However, drastic water deficits and decreased nutrient availability, particularly of phosphorus, will curb productivity in all subregions, particularly in southern and central Europe (Koerner et al 2005).

41. The effects of climate change on forests will have repercussions on market prices, market adaptations with regard to forest management and the wood products industries and may well have significant effects on forest-based outdoor recreation (Irland et al, 2001). Throughout Europe, regular management with shorter rotation enhances the turnover of the current tree populations with a faster introduction of more resistant tree species and trees with other provenances into forests. The supply of timber of pioneer species with a short life span is expected to increase, producing a small-dimensioned timber (e.g. Czech Republic). The general timber supply of other countries such as Slovakia may decrease in the future. But the effect on the dimension and quality of timber very much depends on thinning intensity and the period required for rotation (Kellomäki et al, 2000). The adaptation process in product markets may include the use of alternative species in the manufacturing process, changing the nature or location of capital and machinery, modifying reliance on imports or exports, or adopting new technologies (Irland et al, 2001).

Silvicultural, managerial and policy options for adapting forests

42. Numerous and detailed technical and managerial options for adaptation exist in all phases of forest development and management and are listed in detail in the Annex. These relate respectively to: (i) regeneration phase adjustment and matching species and provenance to changes in climate and competing vegetation; (ii) the tending of stands, the adjustment of stands and thinning and stocking as well as monitoring of pathogens and insects; (iii) the harvesting stage, avoiding large clearcuts, adjusting harvest equipment and methods and evaluating conversion to uneven-age stands and, finally (iv) raising the awareness of owners and forestry staff, including training for calamities and monitoring climate change-related impacts.

43. The trend towards a reduction in forestry staff and managing and monitoring forests less intensively may need to be reconsidered. Fuelwood from logging slash, forest thinning and forest products conversion is rapidly developing as a renewable, carbon neutral source of energy that has none of the undesirable side effects of agricultural bio-fuels. Intensive, periodic national forest inventories are the best tool for assessing the impacts of climate change on forests and the vulnerability of forests to these modifications and for planning for adaptation and maintenance of forest socio-economic and environmental services.

VII. IMPACT OF CLIMATE CHANGE ON FISHERIES

44. Climate change will slow down oceanic currents vital for marine production cycles and will particularly affect primary production and the migration of fish larvae and plankton. The vertical stratification of water layers will be stabilized and it is likely that, for instance, the Baltic will be impacted by this and by declining salinity due to increased precipitation and reduced inflow from the Skagerrak. There is also likely to be a reduction in the flushing of the deep sea with a decrease in deep sea fish production and, as a consequence, a decline in the deep sea catches in the Mediterranean. The European region is expected to experience more frequent flooding and drought in some areas and high temperatures may jeopardize existing inland aquaculture. Changes in marine fish and plankton distribution occur much faster than changes in terrestrial flora and fauna, and many people in northern and central Europe will have noticed the increase in locally caught southern species at the fishmonger’s counter.

45. There are basic differences in the possible effects of global warming on marine and inland fisheries and aquaculture. Marine fish have large populations, high fecundity, and often planktonic stages; migration is less restricted. Marine populations undergo large population fluctuations (Brander 2005). They generally have a small egg size and early fish larval stages are very vulnerable to even minor changes in the availability of planktonic food. Inland and aquaculture fish will have markedly less opportunity to temporarily escape warm or oxygen poor water.

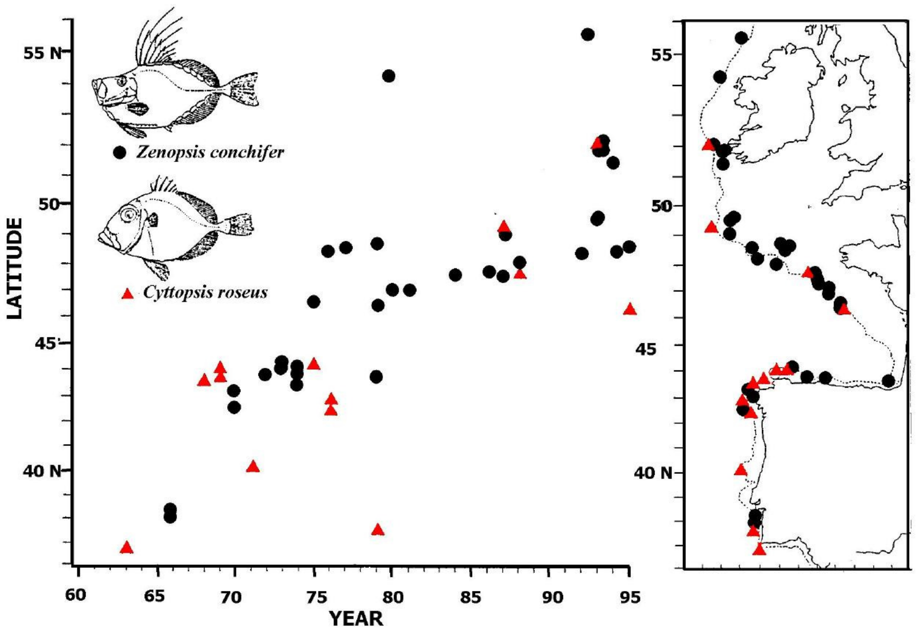

Figure 4. Changes in the distribution of warm water species generated by increased Atlantic water temperatures in Western Europe (Quero, Du Buit and Vayne, 1998).

46. Prediction of the consequences of climate change on the marine population is complex and effects will depend on species, geographical area and distribution. Climate change is already affecting aquatic habitats and fishing resources. Studies document impact on a variety of marine organisms such as tuna, cod, sardine, anchovy, krill, photo- and zooplankton. Warm water species spread to the north and local extinctions have occurred at the boundaries of the current range for salmon and sturgeon. For many salmonids increased winter temperature will increase growth but at the same time will increase the risk of infectious diseases. An increase in summer high temperatures will result in high mortality. The influence on primary production will vary geographically but most model projections predict a moderate global increase of less than 10 percent (Brander, 2006). However major changes in algae species composition can be expected and this may affect growth in higher trophic levels particularly in sea waters. In addition, the slow down in oceanic currents (Curry and Mauritzen, 2005) will reduce the vital upwelling of nutrients and thus ultimately lower the primary production in some areas. The expected major changes in ocean currents are thus likely to influence the distribution and migration of fish larvae (for further details with regard to the impact of climate change on a specific fish population – cod stocks in West Greenland - see the Annex).

(a) Estimates of the effect of climate change on inland fisheries and aquaculture

47. A 2006 comprehensive report (Handisyde, Badjeck and Allison) applied 23 distinctly different layers of information in a GIS (Geographic Information System) model in order to identify the most climate change vulnerable countries and areas. These layers are based on information from FAO FISHSTAT and World Bank GDP data and a broad range of social and climate data and include among others the sensitivity of world freshwater and brackish water aquaculture, mariculture, cyclone-, flood- and drought risk. Each layer can predict a catastrophic situation for a country (i.e. drought, flooding, food security and combinations of such factors) and could be a valuable preliminary tool for governments to guide precautionary planning.

48. While North Korea displays the highest vulnerability (5 on a scale from 1-5) in terms of food security, several countries in the Central European area obtain a grade 3 (Bosnia and Herzegovina, Bulgaria, Croatia, Moldova, Serbia and Slovakia). Many countries in the Central

and Eastern European area score 3 (Belarus, Bulgaria, Czech Republic, Hungary, Romania, Serbia and Ukraine) in relation to sensitivity of freshwater aquaculture, whereas two countries (Bosnia and Herzegovina and Moldova) are ranked 4. Using a combination of precipitation decrease, temperature increase and population density, a high vulnerability exposure of scale 4 is obtained for Bulgaria and for parts of Romania, and a scale 3 for Serbia and Ukraine. With regard to vulnerability of aquaculture and its impact on food security only Bulgaria and Moldova are ranked 3 in the study. In the summary listing of the 53 most vulnerable countries in the world, Belarus, Czech Republic, Hungary, Romania and Ukraine are classified as vulnerable due to losses in freshwater aquaculture caused by inland flooding, whereas Turkey's freshwater aquaculture is vulnerable to drought impacts.

49. The aquaculture sector is also very reliant on fishmeal and fish oil for the production of fish-feed and less flexible to a shift to other feed products. Peru is the world's largest producer of fishmeal. The country's production of fishmeal has been affected very negatively by the El Niňo developments with the demand for and prices of fishmeal and fish oil on the rise. It is anticipated that a limited or decreasing supply of fishmeal and fish oil will be a problem for aquaculture production during climate change.

50. Just as climate change affects biodiversity, fisheries also have an impact on biodiversity and there appears to be agreement that fishing has a more substantial effect on biodiversity than climate change. The pressure exerted on biodiversity by fishing activities has so far had a greater impact on stocks and ecosystems than climate change. Many fishery resources are heavily overexploited and a change in climatic conditions is very likely to result in the final collapse of some stocks if fishery management does not effect a reduction in exploitation. Precaution is particularly necessary in the border areas of a certain species' distribution where higher stress is expected. So far the EU fisheries policy has not been entirely successful in managing the economically important cod stocks in EU waters. Future fisheries management should take into account the effect of climate change on the resilience of these stocks.

VIII. SELECTED ISSUES PROPOSED FOR THE MINISTERIAL ROUND TABLE

51. FAO, through its multidisciplinary expertise in agriculture, forestry and fisheries, aims to facilitate an integrated approach to climate change adaptation of farmers, scientists and policy makers. Adaptation measures and options, where FAO has a comparative advantage, include rural areas and household livelihoods; national policies in agriculture, forestry and fisheries, and national and regional assessments for food security. A set of core principles are followed in adaptation interventions at national level through field projects (see Box 3). FAO conducts a broad range of activities related to climate change adaptation, as summarized in the Annex that also provides elements of proposed debate of policy options.

Box 3: List of core of principles that forms part of FAO's adaptation interventions

- Demand driven and location specific interventions on climate change adaptation
- Building on existing strengths focusing on food security
- Strengthening institutional and technical capacities
- Climate change adaptation as an ongoing social learning process
- Climate change adaptation interventions at different scales and linking activities
- Inclusion of local perceptions and participatory approaches for prioritizing adaptation practices
- Beyond climate variability targeting future climate change risks and opportunities
- Moving beyond data to decision support to provide opportunities for proactive decision making
- Ecosystem integrity and natural resource management in climate change adaptation
- A multi-disciplinary approach – toward a corporate FAO response
- Integration of climate change adaptation, disaster management and development
- Mainstreaming climate change concerns into development planning
- Learning from the field experience and feedback, advice to policy

52. The Round Table may wish to refer to the region's priorities, as determined by the Twenty-second Regional Conference for Europe, which are:

a) poverty reduction, through support to sustainable rural livelihoods and food security;
b) food safety and quality;
c) sustainable management of natural resources, and
d) institution and capacity-building to facilitate the transition to market economies in the rural sector.

53. Bringing together these priorities that directly address two Millennium Development Goals (MDGs) (poverty and hunger; and the environment - see ERC/06/3) is the challenge facing the Organization.

54. The Round Table is invited to take a strategic view of FAO's contributions to adaptation to the climate change impacts on agriculture, forestry and fisheries, as well as to rural development. Governments are pressured by the immediate problems and emergency issues related to droughts, floods and other extreme weather conditions, potentially linked to climate change. FAO's role may be most useful in encouraging a longer-term perspective and providing strong technical inputs to national or regional debates.

55. While much is known about climate change and how it may affect farmers, forest owners and fishermen in the Central and Eastern European and Central Asian countries, little analysis has been undertaken with regard to how these stakeholder groups are organizing themselves to respond to the new situation and the constraints faced and what specific policies may help them to adapt to climate change challenges.

56. The Round Table is invited to discuss the potential options for FAO's response to meet countries' and regional needs, taking into account the activities of other donors involved in climate change adaptation:

- Strengthen the implementation of the FAO climate programme through fostering the Interdepartmental Working Group (IDWG) on Climate Change; parallel, regional focus groups could be supported, strengthening cross-sectoral coordination among FAO technical departments;
- Develop an integrated climate change programme, within FAO's Regular Programme and Work and Budget provisions, consistent with the legal and political framework of the United Nations Framework Convention on Climate Change (UNFCCC) and the technical work of the Intergovernmental Panel on Climate Change (IPCC) as well as the Global Environmental Facility (GEF);
- Intensify and, where needed, initiate activities within FAO networks of national correspondents to provide technical inputs, focusing on such issues as data and methodologies related to agriculture and climate change;
- Support studies based on empirical data relating to the potential impacts of climate change to reduce uncertainties with regard to the effectiveness of adaptation measures related to agriculture, forestry and fisheries, and support countries in developing tools for the evaluation of the potential impacts of climate change and in assessing options for location specific adaptation and policy mechanisms;
- Focus FAO's field programme, including TCP projects, on the assessment of climate change impacts on food security, agriculture, rural development, forestry and fisheries and required adaptation measures, being mindful of the agriculture sector's emerging role in the protection and conservation of natural resources and the environment, and
- Solicit the creation of an intergovernmental trust fund to finance new FAO activities related to climate change in particular in Central and Eastern Europe and Central Asia, to demonstrate, share and transfer experiences from Western Europe to other parts of the world.