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Drought trends and impacts on agricultural production and natural resources in the context of climate change

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Abstract. Every single day, scientific evidence of climate change mounts all around the world and in Turkey. In the 20th century, the average temperature increased by 0.6°C all around the world and by 0.95°C in Europe. According to the latest developments, the consequences in the Mediterranean Basin would be more severe compared to the world. It is expected that the global warming would be 1°C in 2025. In such a case, the temperatures would increase by 0.7-1.6°C in the Mediterranean Basin and the increase would even reach to 2°C in 20 to 50 years. Global climate change will hit the Mediterranean Region with a severe drought. It is seen that in the Mediterranean Basin, the precipitation had dropped by 20% over the past 25 years. The sea level will increase by 20-40 cm in 2050 and this will mostly affect Turkey. In Turkey, especially in arid and semi-arid regions such as the Mediterranean, Aegean and Central Anatolia regions, significant declines are foreseen in the precipitation levels. It can also be said that the most obvious reflections of climate to our daily lives are the unexpected weather events. "Too much or too little rain at the wrong time and at the wrong place" just summarizes the case. According to the report of Union of Turkish Agricultural Chambers, the total cost of the drought for the agricultural sector is estimated to be 2.5 billion €. Imports of agricultural products increased by up to 60%, with serious economic consequences. In order to manage increasing water demand and consume water more efficiently, it is necessary to change the existing management approaches and policies. The agricultural policy has to be essentially revaluated while encouraging modern and efficient irrigation systems and defining correct crop patterns. Illegal water use must also be brought to an end. The impacts on natural resources have to be considered when water investments take place and they have to ground on integrated and sustainable water management. Long term and basin wise planning has to be done depending on the population, housing and industry projections in the cities. Within this planning context, climate change factor has to be play a key role and any risks should be anticipated ahead.

Keywords. Temperature increase – Precipitation – Extreme events – Agricultural losses – Adaptation.

Tendances de la sécheresse et impacts sur la production agricole et les ressources naturelles dans le contexte du changement climatique

Résumé. *Les preuves scientifiques du changement climatique augmentent jour après jour dans le monde entier, et en Turquie également. Au cours du XXe siècle, les températures moyennes ont augmenté de 0,6°C dans le monde entier et de 0,95°C en Europe. Selon les dernìers travaux, les conséquences dans le bassin méditerranéen seraient plus fortes qu'au niveau mondial. Il est attendu que le réchauffement global atteigne 1°C en 2025. En tel cas, les températures augmenteraient de 0,7-1,6°C dans le bassin méditerranéen et cette augmentation atteindrait même 2°C dans 20 à 50 ans. Le changement global du climat frappera la région méditerranéenne d'uné sécheresse sévère. On a déjà constaté que dans le bassin méditerranéen les précipitations ont diminué de 20% sur les 25 dernières années. Le niveau de la mer montera de 20-40 cm pour 2050 et ceci affectera fortement la Turquie. En Turquie, en particulier dans les régions arides et semi-arides telles que les régions de la Méditerranée, l'Égée et l'Anatolie centrale, des baisses significatives sont prévues pour les niveaux de précipitations. On peut dire également que les retombées les plus évidentes du climat dans notre vie quotidienne seront les événements météorologiques inattendus. "Trop de pluie ou trop peu au mauvais moment et au mauvais endroit" en résumé. Selon le rapport de l'Union des Chambres d'Agriculture de Turquie, le coût total de la sécheresse pour le secteur agricole est estimé à 2,5 milliards €. Les importations de produits agricoles pourraient augmenter jusqu'à 60%, avec des conséquences économiques graves. Afin de gérer une demande d'eau grandissante et de la consommer de façon plus efficace, il est nécessaire de modifier les approches et politiques de gestion existantes. La politique agricole doit être essentiellement réévaluée tandis que seraient encouragés des systèmes modernes et efficaces d'irrigation et définis des modèles culturaux adéquats. Il faudra également*

en finir avec l'utilisation anti-réglementaire de l'eau. Les impacts sur les ressources naturelles doivent être considérés lorsque l'on investit dans le domaine de l'eau, en se fondant sur une gestion intégrée et durable de l'eau. Un aménagement à long terme concernant le bassin doit être mené en fonction de la population, et des projections de construction d'habitations et pour l'industrie dans les villes. Dans le cadre de ce contexte d'aménagement, le facteur changement climatique doit jouer un rôle clé et tout risque devrait être anticipé bien à l'avance.

Mots-clés. *Élévation des températures – Précipitations – Événements extrêmes – Pertes agricoles – Adapatation.*

I – Introduction

The recent economic downturn is a severe notice forecasting the consequences of surpassing our capacity. However, the current economic recession is less devastating when compared to the upcoming ecological credit crunch. Today, our global footprint surpasses the world's capacity to renew itself by 30%. If our demand on the planet increases at the same rate, by mid-2030, we will need resources equal to two planets in order to continue the same lifestyles.

Climate change is considered as the biggest threat for the coming years on natural life. The consequences of climate change are already apparent in polar and mountainous regions as well as the land and marine ecosystems and more particularly on coral reefs. Even if it is not possible to anticipate the impacts of climate change on a local scale, every ecosystem may become vulnerable due to the changing temperatures and climate systems. Every single day, scientific evidence of climate change mounts all around the world and in Turkey. In the 20th century, the average temperature increased by 0.6°C all around the world and by 0.95°C in Europe. According to the latest developments, the consequences in the Mediterranean Basin would be more severe compared to the world. It is expected that the global warming would be 1°C in 2025. In such a case, the temperatures would increase by 0.7-1.6°C in the Mediterranean Basin and the increase would even reach to 2°C in 20 to 50 years.

1. What does a 2°C increase in temperature refer to in the Mediterranean Basin? (WWF, 2007)

A. Drought

All the factors such as a more arid climate, decrease in the rainfall, increase of water use in agriculture, and loss of surface water have already created stressful conditions in the region. For instance, a recent study in Spain shows that an increase of 1°C would decrease the water resources by 5-14% in that country. In Algeria, where such a temperature increase has been experienced, the water demand is 0.8 trillion m^3 more than the available resources.

B. Heat waves

If the temperature in the Mediterranean Basin increases and exceeds the levels before the industrial revolution by 2°C, Mediterranean climate will heat up and drought will have larger impact and changes will appear in the climatic conditions. The temperatures will rise 1-2°C compared to the current situation in the region. However, in several inland areas such as in Northern Italy or Turkey where the marital influence is relatively less than the other regions, the increase may even reach up to 5°C. It is also foreseen that the heat waves and the number of extremely hot days would also increase especially in the continental parts of the Mediterranean. It is expected the number of extremely hot days would increase to two weeks even in the windy Greek islands situated in Northern Aegean Sea.

C. Less rain

The rainfalls in the Northern Mediterranean would drop by 30% and the duration of the dry season would be changed and prolonged.

D. Forest fires

A 2°C temperature increase brings along the risk of forest fires and for the other regions of the Mediterranean, the duration of forest fires are expected to be prolonged to around six weeks.

E. Loss of productivity in agriculture

The increase in temperatures and drought would lead to a loss of productivity in agriculture. This condition will mainly affect crops grown in summer and require regular irrigation.

F. Loss of tourism income

The increase in the heat waves and forest fires would cause a drop in the number of tourists visiting the Mediterranean Region during summer. Even if the springs and autumns would be tempting for the tourists, families would prefer to spend their summer vacation in other destinations. Many of the Northern Europeans may stop travelling to the Mediterranean Sea.

G. Loss of biodiversity

The recent studies demonstrate that an increase of 2°C in the Northern Mediterranean would lead to a loss of 50% of the plants in the region. This loss may even reach to 80% in Northern Spain, the mountainous regions and especially in France. The invasive species and the forest fires may spread to a vast area.

II – Drought trends and impacts on agricultural production and natural resources

As it is stated in the Drought in the Mediterranean Report of WWF published in 2006, global climate change will hit the Mediterranean Region with a severe drought. It is seen that in the Mediterranean Basin, the precipitation had dropped by 20% over the past 25 years. The sea level will increase by 20-40 cm in 2050 and this will mostly affect countries such as Turkey and Algeria and the deltas in these regions. In Turkey, especially in arid and semi-arid regions such as the Mediterranean, Aegean and Central Anatolia regions, significant declines are foreseen in the precipitation levels. It can also be said that the most obvious reflections of climate to our daily lives are the unexpected weather events. "Too much or too little rain at the wrong time and at the wrong place" just summarizes the case. Likewise, European Environment Agency shows that Mediterranean Basin is the part that will be affected the most with the climate change. As for Turkey, the expectations show that a part of the Black Sea and Marmara Regions will face water problems, and the Aegean and Central Anatolian Regions (particularly Konya closed basin) will have to struggle with serious water shortages. Moderate water problems are expected to appear in the Eastern Anatolian Region.

The main reason that water becomes one of the most important issues of this century originates from its scarcity as a resource. 96% of the water resources on earth are salty, the remaining 4% is freshwater but nearly 70% of freshwater is trapped by ice or ice caps. The remaining 30% of freshwater is found in underground resources. The fresh surface water such as lakes or rivers constitutes less than 1% of the water resources on earth. The constantly increasing world population and rapid increase of water demand in different sectors put heavy pressure on water resources. Unsustainable water management and usage create breakdowns on the hydrological

cycles. More frequent floods and droughts and interruption of ecosystem services are consequences of these breakdowns.

Drought has become a major source of concern in many regions and countries. Therefore, the importance of the concept of "water footprint" introduced as a method of measuring global, regional and national water demand on goods and services is increasing. Although water is not a rare resource, however it is not equally distributed or available on the world. Today, approximately 50 countries suffer from intermediate or severe water shortages. It is also expected that number of people who are exposed to seasonal or all year long shortages will increase with the impact of climate change. Water shortage, decreasing water quality and destruction of ecosystems are the major threats for the integrity of ecosystem which is essential for a stable life span. Diminishing water resources are under great pressure at world-wide level due to rapid population growth, water use habits resulting in losses, lack of efficient management, pollution, insufficient investments or low productivity of sectoral water usage.

III – Turkey's drought trends and impacts on agricultural production in the context of climate change

Water is an essential requisite for the well presence of ecosystems. The health of wetland ecosystems depends on sustainability of natural water regimes as biodiversity, minimum flows required for the function and preservation of wetlands and water quality and quantity. The natural structure of wetlands and environmental services usually disappear or get damaged in time due to the interventions like the constructions blocking water flow or channels carrying water faster than its natural flow. Environmental and social impacts on wetlands have always been neglected during the water infrastructure investments and those changing the natural water flow resulted in changes in the natural structure of wetlands. In the last 40 years in Turkey, almost 1,300,000 hectares of wetland habitats lost their ecological and economical characteristics due to such interventions like drying or filling wetlands or intrusions to water systems. Among these wetlands, there are several lakes and reed fields such as Amik Lake, Avlan Lake, Suğla Lake and Kestel, Gavur, Yarma, Aynaz, Hotamış and Eşmekaya reed fields. In Turkey, the quantity of water per person per year has dropped from 4000 m^3 to 1430 m^3 over the last 20 years. It is also predicted that this figure will decrease to 1000 m^3 with respect to the population growth. Turkey forges ahead on the way of being a water poor country.

In terms of meteorological drought Turkey had the largest decrease in precipitation in the Southeast Anatolian Region, where it dropped by 44%, in Eastern Anatolia Region by 18%, and 15% in Mediterranean part of Turkey. Further to the fact that agriculture is the most important user of water of all sectors (72%), the main problem in agricultural water use is related to the efficiency of irrigation methods. On only 6% of the total irrigation area the water efficient sprinkling and drip irrigation technologies are used, in the majority of fields (94%) there is inefficient and highly water consuming surface irrigation.

The main concern in Turkey regarding water resources is the lack of planning in sectoral water use. In Turkey, agriculture has the biggest share in water use with 72% followed by domestic usage with 18% and industrial usage with 10%. There is a serious productivity problem in water use in agriculture. According to the Turkish Statistical Institute, as of 2001, surface water is used for irrigation in 88.5% of the overall irrigated areas in Turkey. More precisely, 8.5% is done by sprinkler irrigation systems and only 3% by drip irrigation. In other words, agricultural water use is very squandering.

IV – Main environmental and economic implications of drought in Turkey

Currently a coherent monitoring scheme for drought effects on the environment across the

region is missing. Drought records are mainly based on meteorological parameters and hydrological data, such as groundwater level and recharge, eventually flows as well. Impacts and consequences for vegetation patterns, population developments of either mammals, amphibians, birds or others are not directly registered and there is no feedback loop to meteorological and hydrological information. In recent years some report schemes, such as for droughts were developed by the European Union, ministered by the European Environment Agency, but only few countries did support it at all and when, in many cases with poor and incomplete data. Thus it is difficult to assess the direct impact of decreased flows and floods, deterioration of water quality and changes of river dynamics immediately, though some effects are obvious and very tangible, other consequences may occur only after a lag of time. In 2007 Turkey faced temperatures not recorded since 1935. Inadequate precipitation affected the agricultural production and farmers negatively. According to the report of The Turkish Union of Agricultural Chambers (2009), the total cost of the drought for the agricultural sector is estimated to be 2.5 billion €. Imports of agricultural products increased by up to 60%, with serious economic consequences. Productivity in wheat production fell by 13.9%, grain production by 23.5%, maize and paddy production by 7.2 and 6.9% respectively, olive production by 39.1%, pistachio production by 33.3%, fig production by 27.6% and sunflower production by 23.6% as well as pulse and tobacco at lower rates and cotton production and cultivation area by 10.8%. In 2008, the Ministry of Agriculture and Rural Affairs declared that the cost of droughts in 2008 for the agricultural sector amounts to 1.5-2 billion € approximately, with 435,000 farmers being affected severely by the droughts. Major production losses are seen in cereals and lentil production. In Southeastern Anatolia Region, production losses are estimated to be 90% for wheat and grain, and 60% for red lentil. Again, 90% loss in grain production has already by now impacted on the starting conditions for the next season. Droughts in the region do also affect livestock production due to drought affected meadows and thus fodder production. Moreover, breeding is hampered due to fall in grain, wheat and bait production. Some farmers had to sell their livestocks under these circumstances. Besides Southeast Anatolia Region, droughts affected every part of Turkey. Production of grape in Elazig, cherry in Izmir, cereals in Konya, Muş, Polatli and Cankiri, apricot in Malatya are negatively affected due to the droughts. Since drought impacts in 2007 the Turkish Government has taken several decisions to tackle the water-drought subject. Thus provincial drought Commissions were established in June 2007 by decree, which also provides the baseline for possible compensation to farmers affected by the weather conditions depending on area and production. Furthermore, it was decided to set up provincial Drought Commissions and to prepare Drought Action Plans. With new regulations for agricultural credits at the Agricultural Bank, set from the Council of Ministers, new incentives for the development and installation of modern drip irrigation systems were put in practice in spring 2007. Another support towards a better integrated management of water resources was the integration of the State Hydraulic Works (DSI) into the Ministry of Forestry and Environment in August 2007, followed by the preparation for a National Water Law. In February 2008 the Turkish Grand National Assembly (TGNA) agreed on the creation of a "Research Committee for the Effects of Global Warming and Sustainable Water Resources Management", inviting relevant institutions and organizations (including WWF-Turkey) to the Assembly and to work together on the preparation of an comprehensive report to be presented then in the National Assembly. Interest in the use of desalination technologies for drinking water production has increased in Turkey in recent years due to severe drought events experienced in last few years. Desalination technology is mostly used in Aegean coast by touristic facilities. While total capacity of desalination plants had been merely 3600 m^3/day in 2002, today it is nearly 31,000 m^3/d. It is expected that before the end of 2008 total capacity will reach 120,000 m^3/d and this is expected to triple in 5 years.

V – Conclusion

An integrated and sustainable water management in Turkey requires immediate actions from all stakeholders from governments, local decision makers, private sector, farmers and retailers,

water management authorities and individual citizens. In order to manage increasing water demand and consume water more efficiently, it is necessary to change the existing management approaches and policies. The agricultural policy has to be essentially revaluated while encouraging modern and efficient irrigation systems and defining correct crop patterns. Illegal water use must also be brought to an end. The impacts on natural resources have to be considered when water investments take place and they have to ground on integrated and sustainable water management. Long term and basin wise planning has to be done depending on the population, housing and industry projections in the cities. Within this planning context, climate change factor has to be play a key role and any risks should be anticipated ahead.

VI – Recommendations to Turkish Government

WWF-Turkey urgently asks Turkey to follow up and implement National Policies and work for implementation of environmental acquis in the European Union accession process towards the management of water demands, increasing the efficiency in water use and applying integrated and sustainable water management schemes, based on the availability of their water resources. The following are the main recommendations to the Turkish Government:

(i) Legislation and law enforcement. All efforts should be aimed at maximizing opportunities within the existing legal framework, and giving the highest priority to the ambitious implementation of the European Water Framework Directive (WFD), as well as rigorously integrating water concerns into relevant EU policies. The WFD will only be successful if other policies which have a major impact on freshwater ecosystems, like land-use planning and agriculture, urban and industrial planning, all work towards the same objectives. Laws should be effectively enforced and sanctions applied for those who misuse or illegally use water. Mechanisms for monitoring and control of illegal activities should be established together with regulations being developed to close illegal wells.

(ii) Attention to water scarcity and drought issues in regional consultations and negotiations. Water scarcity needs to be on the top of the priorities in bi- and multilateral relations. The EU should ensure that water scarcity is on top of the priorities of the European Neighbourhood Policy (ENP) regional strategy for the Mediterranean region. Funding for water scarcity and drought under the ENP Regional Strategy for the Mediterranean should be tied to cross compliance with environmental criteria and the wise use of water resources.

(iii) Demand instead of supply management and incentives. The management of water resources has to be developed in a more demand and no longer just supply oriented manner. Turning over the management should also change subsidise mechanisms, e.g. the EU funds via the Common Agricultural Policy towards efficient irrigation agriculture taking into account water availability and climate change impacts. Agriculture policy also needs to ensure effective compliance, excluding for instance those illegally using water from the list of beneficiaries.

(iv) Water pricing. Regulations and a strong enforcement for the implementation for water consumptions recording systems, water user permissions and pricing has to be put in place urgently.

(v) Integration of drought management plans into other regional, sectoral and water management planning. Drought plans should be integrated into normal management plans, in particular the Water Framework Directive implementation plans, to ensure that exceptional situations are taken into account in normal planning. Exceptional and prolonged droughts due to meteorological conditions should be clearly distinguished from structural deficits due to an imbalance between increased water demand and available resources. All developments and planning should adopt an Integrated Water Resource and River Basin management (IWRM & IRBM), which incorporates an integrated, basin-scale and for water transfers also regional attitude towards the most efficient management of water resources.

(vi) Spatial planning and agriculture. An overall framework for economic development in rural areas is needed, which in equal terms takes into account natural conditions, resource availability and social needs as well as economic potentials. Therefore regular land use planning regulations need to be established, which beside the overall framework look particular into the available water resources.

(vii) Development of water infrastructure (dams, reservoirs, inter-basin transfers). Before considering the development and construction of new water infrastructures the natural capacities and values of water ecosystems, but also the potential of water savings through efficiency gains should be evaluated in a consistent manner. Water infrastructure projects should be based on comprehensive demand calculations. All planned projects should have cost-benefit analysis taking into account the environmental, social and economic factors within a comprehensive Environmental Impact Assessment, also considering possible effects from climate change and alternative development options.

(viii) Desalination. Technologies to desalinate either sea or brackish water can neither replace an integrated water management nor compensate structural water deficits or cover up for inefficient water use, which are caused by drought, over-exploitation of natural water resources. Therefore any desalination plant project should be carefully assessed similar to any new water infrastructure planning.

(ix) Working with nature and environmental protection. Authorities should recognize the environmental services nature can offer concerning water quality and quantity, delivered by healthy ecosystems. These are central to delivering "good water status" and are instrumental in mitigating the effects of droughts. Therefore restoring and conserving rivers, wetlands and floodplains should be an integral part of water management plans.

- Impacts caused by water deficits to protected areas should be assessed and monitored, and cases where protected area legislation is violated should be sanctioned; the impacts by water abstraction and use on biodiversity outside designated protected areas (represented through habitats, connectivity, species and population trends) should be equally monitored and measures taken to reverse damages and prevent further deterioration.
- Special restoration and rehabilitation programmes should be provided with sufficient financial support immediately to restore natural ecosystem functions and services.
- Overall the economic activities have to adapt to the amount of water available locally and ensure that environmental flows are considered and secured.

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