Climate Risk Case Study

Pilot Climate Change Adaptation Market Study: Turkey

European Bank
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Acknowledgments

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1. Introduction

This market study took place between January 2012 and June 2013 with the aim of understanding the needs of the Turkish private sector in order to improve climate resilience. It was funded jointly by the European Bank for Reconstruction and Development (EBRD) and the International Finance Corporation (IFC).

The study was undertaken in collaboration with the Union of Chambers and Commodity Exchanges of Turkey (TOBB) and the Ministry of Environment and Urbanisation (MoEU). Key information and insight was also provided by a range of public and private sector organisations across Turkey, who provided both feedback to the national adaptation questionnaire, and attended a series of one day workshops in Istanbul, Ankara, Bursa, Gaziantep and Anatolia.

Across the world interest and action by the private sector to understand and manage the risks of climate change is growing significantly. Climate change may challenge all areas of business performance, including operational, financial and environmental performance, social interactions, regulatory compliance, contractual obligations and legal constraints. However, for those businesses that take on this challenge, there are potentially significant commercial and competitive advantages to be gained[1].

The market study aimed to develop new approaches to help businesses understand and manage the risks, and identify technological and investment needs and opportunities caused by a changing climate. It also sought to prioritise specific, innovative, market-based interventions, services and products to support the climate resilience of businesses in Turkey. Moreover, the study aimed to identify ways of creating an enabling environment for promoting climate resilience through market transformation and private sector engagement in adaptation.

This Public Summary Report describes the study outcomes. It documents a number of pro-adaptation opportunities for the private sector, identified through the course of the assignment. An initial 'long-list' of over 20 potential financial interventions were developed through extensive research, a series of sectoral workshops in-country, focused stakeholder interviews, professional judgement and best practice review. Additional consultations followed on the 'long-list' interventions, with the aim of creating a 'short-list' of potential priority investments. Further market analysis was then applied to these 'short-list' interventions, as described in Chapter 4. Finally, Appendix 1 contains the main figures and tables referred to in the main report text. Appendix 2 contains the 'long-list' of potential financial interventions, with supporting information.

2. Background

2.1. Climate challenges for Turkey

The Mediterranean region is identified as one of the future climate change "hotspots"[2]. Climate models (General Circulation Model, GCM) largely agree on a basin-wide precipitation reduction in the Mediterranean[3] and, in line with this, a number of studies indicate future drying of the Mediterranean and Aegean coastal regions of Turkey, and wetting for Black Sea coastal areas[4, 5 & 6]. There is a consistent message of precipitation decreases, of the order of 5 – 25%, along the western coasts of Turkey during the first-half of the 21st century[7].

Reductions in precipitation are likely to have major impacts on trans-boundary river basins. A number of studies point to substantial decreases in annual discharge for the Euphrates River (between 30 – 70%) by the end of the century[8]. A detailed hydrological study for Seyhan River Basin, which covers the large downstream Çukurova Plain, found that annual runoff decreased by 50 – 60%

for the entire basin by the end of the century[9]. Sensitivity studies have also been conducted to understand the climatic effects on the seas surrounding Turkey. These indicate that warmer summer and autumn sea surface temperatures probably enhance the formation of extreme precipitation events and associated flash floods[10]. A severe precipitation event that occurred in Istanbul in September 2009 resulted in the loss of more than 30 lives and a great deal of property.

Climatic changes are already being seen in Turkey and will intensify over coming decades. To summarise, Turkey is projected to experience:

- Temperature increases everywhere in all seasons, but the increases are larger in summer than winter (Figure 8 in Appendix 1),
- Decreases in annual precipitation amounts in southern parts of Turkey, and possible slight increases in the northeast (Figure 9 in Appendix 1),
- More intense precipitation events, increasing the risks of fluvial and pluvial flooding, together with landslides (Figure 10 in Appendix 1),
- Increased intensity and duration of droughts and hot spells (Figure 11 in Appendix 1), leading to increased water stress (Figure 12 in Appendix 1), and
- Rising sea levels, increasing the risks of flooding in low-lying areas of river deltas and coastal cities (Figure 13 in Appendix 1).

Changes in climate will have significant impacts on Turkey's economic sectors. Table 1 provides a range of example impacts associated with the private sector in Turkey.

Table 1: Illustrative examples of some of the potential climate change impacts for the private sector in Turkey (- equals risks; + equals opportunities).

Projected changes in climate for Turkey	Possible impacts for the private sector
Increase in temperatures in all seasons, although more pronounced in summer than winter	- Heatstress for workforce, particularly those working outdoors or in un-ventilated buildings. This has the potential to impact business continuity and health and safety procedures. - Increased demand for cooling technology and energy, resulting in an increase in operational costs and potential non-compliance with energy / emissions reduction targets. + Decrease in winter heating costs, resulting in a reduction in operational costs. + Increased growing seasons in some parts of the country leading to potential increased productivity in 'shoulder' months before and after typical growing season. + Expansion of the tourist season into shoulder months, with the consequence that visitor numbers are sustained throughout the year and the tourism industry faces new opportunities.
Decrease in precipitation in the southern parts of the country	- Decline in agricultural productivity, with the consequence that agribusinesses are faced with declining profits and increased operational costs. - Increase in water stress, particularly in Gediz and Sakarya basins in the west and Euphrates and Tigris in the east. This may result in restrictions on water use for commercial, industrial and public users.

Projected changes in climate for Turkey	Possible impacts for the private sector
Increase in intensity and duration of droughts and hot spells	- Restrictions are imposed on water use for commercial, industrial and public users. - Damage to infrastructure from increasing frequency of heatwaves on which the private sector relies (e.g. road and rail).
Sea level rise	- Flooding of low-lying areas of the river deltas and coastal cities, resulting in damage to physical assets and disruption to operations. - Insurance premiums may increase or insurance may become unavailable and the value of exposed assets decreases. - Disruption to agricultural activities in the low-lying parts of the coastal plains. - Damage to historical and cultural sites along the Bosphorous Strait, including Dolmabahçe Palace and mosque, Beylerbeyi Palace and Ortaköy Mosque, which will have detrimental impacts on the tourism industry.

2.2. Snapshot adaptation survey for Turkey

This market study undertook one of the first adaptation-focused surveys in Turkey. An online adaptation questionnaire was published on TOBB's website in May 2012 and the responses were collected over a period of three weeks. This time period was sufficient to gather responses from 128 individuals representing businesses from different regions of Turkey, operating in numerous sectors and ranging in size from micro to large-scale enterprises. The size of the sample responding to such a specific and new topic was surprisingly high. The majority of the respondents were high-level managers or owners (shareholders) of their companies, which was important as these decision-makers are the ones who are likely to handle climate change issues.

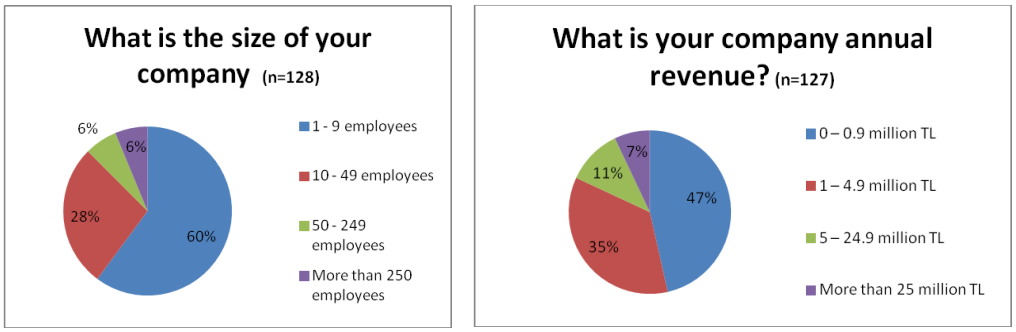

Figure 1: Characteristics of responding organisations.

The questionnaire achieved its objective of reaching Turkish SMEs. In line with the EU average, micro and small/ medium enterprises account for more than nine out of every ten enterprises in Turkey[11]. It was therefore crucial that the questionnaire reached SMEs; 60% of micro and 28% of small businesses responded (Figure 1). It indicates that the content and online survey method employed were effective in reaching the target audience, which was initially a concern as it was perceived that SMEs might be more reachable with traditional media (e.g. letters). The partner institution, TOBB, successfully facilitated the delivery of the messages to its network.

Up to 45% of respondents said that their company had been significantly affected in the last three years by a climate-related event. The majority of the events that affected these businesses were

water-related, including extreme rainfall events (45%), droughts and water shortages (42%) and decreasing rainfall (37%).

Climate change impacts were considered to be an important issue for business. Regarding the business and market-related concerns of the respondent companies, the most interesting finding was that concerns about the effects of climate change and/or extreme weather events were rated higher by respondents than those related to economic downturn, domestic and international competition or market regulations. Some 20% of respondents answered that their company is 'very concerned' and 48% answered that their company was 'fairly concerned' about 'the effect of climate change in Turkey'. Similar figures were obtained about 'being prepared in case of extreme weather', with 21% of respondents 'very concerned' and a further 49% 'fairly concerned'. (It must be acknowledged, however, that the respondents may have been more likely than the general population to be concerned about the topic). Similarly, 95% of respondents believe that climate change will cause drastic to moderate changes in the next 10 years (Figure 2).

The study identified a need to communicate to business the facts about the risks and opportunities of climate change. Despite the high levels of concern expressed, climate change remains an area that the majority of respondents (65%) admit they know 'not very much' about (Figure 2). A similar result was the response to the question 'Do you feel that your organisation has enough information to know whether you should change any of your plans because of a changing climate in Turkey?' where 58% felt they 'probably' or 'definitely' did not have enough information (Figure 3). Among this sample, respondents from large companies (8 responses) were most likely to feel they had enough information. The low level of knowledge and high level of concern expressed indicate that there are significant needs for information and guidance about climate change. The vast majority of responses (76%) stated that most businesses do not have enough information about the consequences of climate change, either in their region (46%) or their sector (21%), or both (9%) (Figure 4).

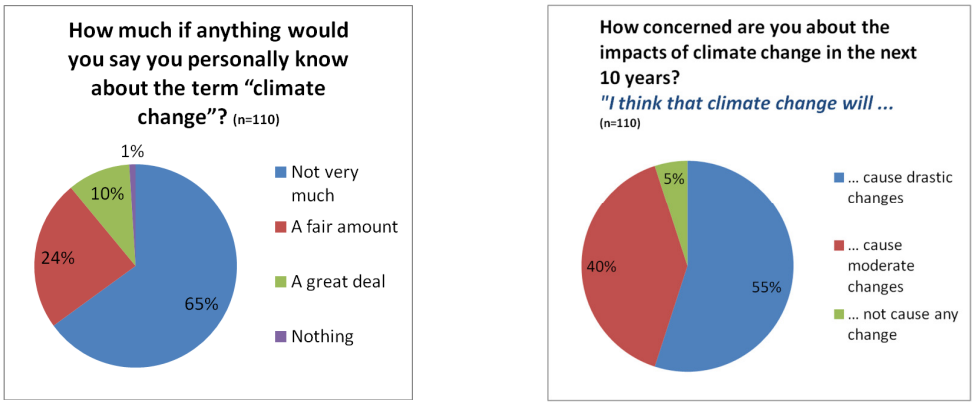

Figure 2: Awareness level on climate change and related level of concern.

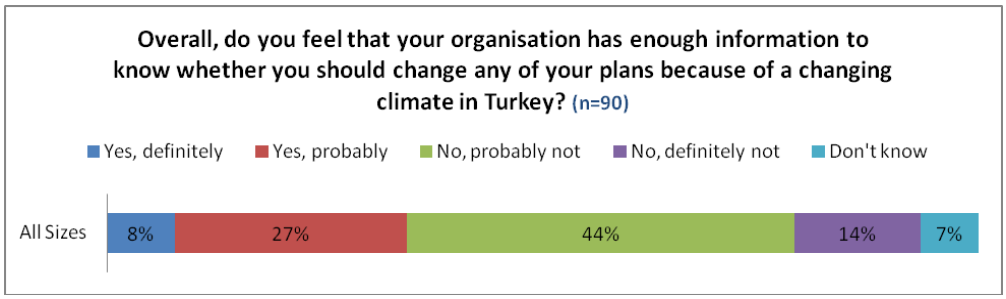

Figure 3: Access to information for business planning.

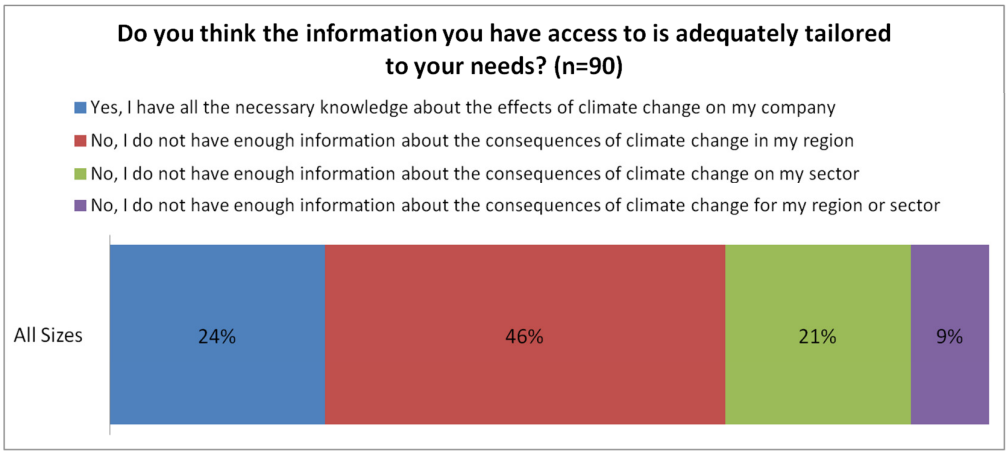

Figure 4: Adequacy and scope of climate change related information.

Another important result from the questionnaire was the variation between business-related information sources and those concerning climate change impacts and solutions. The response rates were highly divergent; TV programs, radio and news were seen as the main sources of information about climate change impacts and solutions (27%), whereas the same sources had the lowest percentage of importance (0.9%) when it came to getting relevant business information (Figure 5). The second and third most popular information sources about climate change were governmental institutions (such as Ministry of Environment and Urbanization and State Meteorological Service) and business association events.

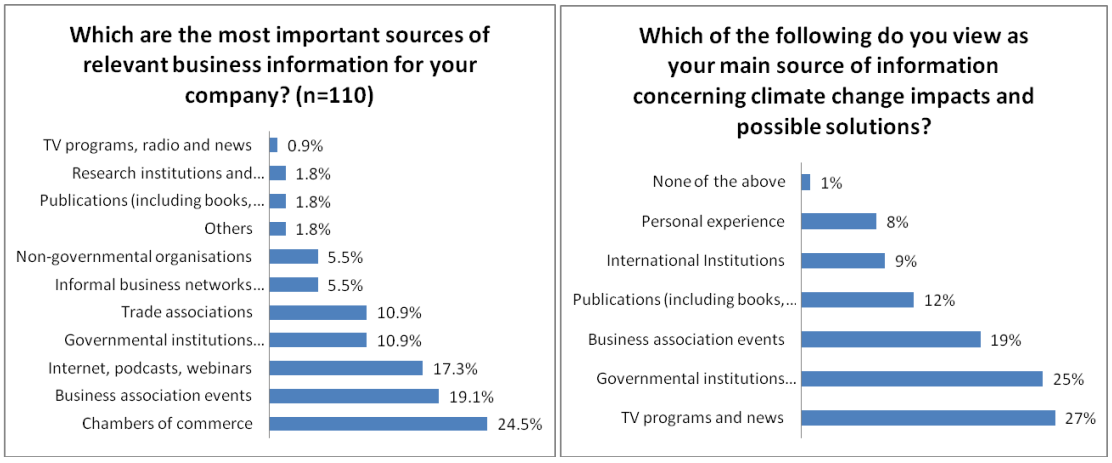

Figure 5: Sources of information - comparison between business information and information on climate change impacts and possible solutions.

Most of the respondents stated that their organisations were at very early stages of adapting to climate change. Among the respondents, 61% of the companies 'hadn't thought about climate change, but plan to in the future'. Of the same sample, 21% 'had looked at present and future risks and opportunities and thought about what to do'. Only six companies, out of 90 responses received to this question, had started taking action related to climate change.

2.1. Current barriers to action on adaptation

One of the most important findings from the questionnaire results was that respondents identified a number of 'very significant' and 'significant' barriers preventing businesses from understanding and taking action to adapt to a changing climate. These are detailed in Figure 6.

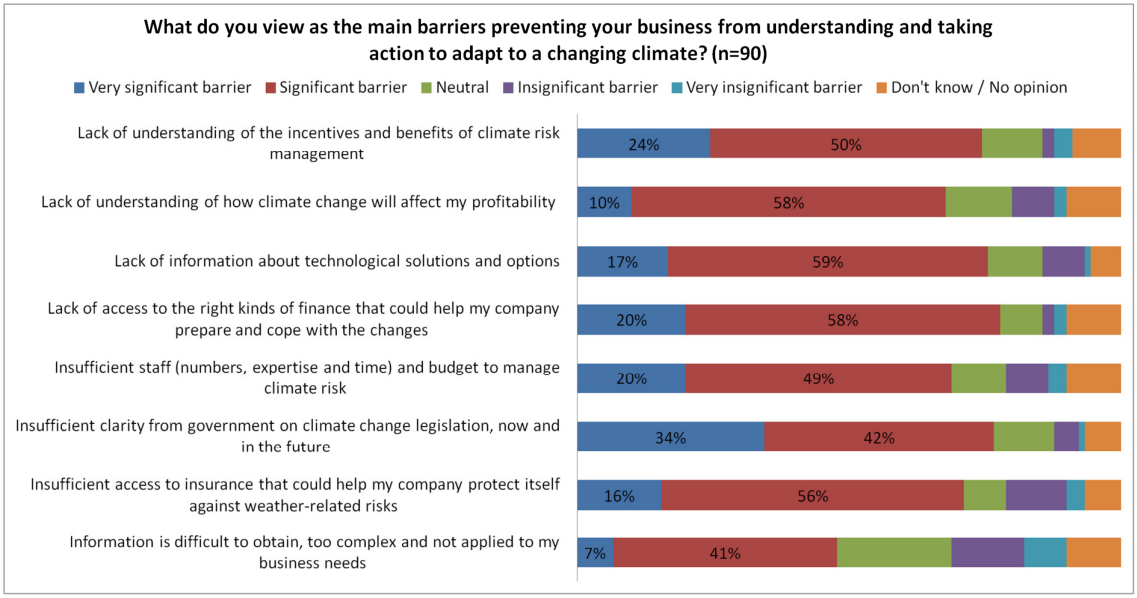

Figure 6: Gaps and barriers to adapt to a changing climate.

Despite the high levels of concern expressed, climate change was an area that the majority (65%) of private sector respondents admitted they know very little about. Based on the survey results, over half of the businesses that responded (58%) felt that their organisation did not have enough information to know whether they should change any of their plans because of climate change. This is not a surprising result; a lack of awareness and knowledge of climate change risks for business is a perennial barrier for private sector adaptation around the world[12].

Beyond the findings of the questionnaire, research and consultation with a range of stakeholders revealed a number of other important barriers. These are described in the remainder of this section.

There is a predominance of SMEs in the Turkish private sector. Turkey's economy relies heavily on SMEs to provide growth and jobs. With respect to employment, almost four-fifths of all Turks working in the non-financial business economy are employed by an SME[13]. The predominance of SMEs creates a number of challenges in making progress on adaptation as there is often considerable effort required to encourage each business that takes action on climate change, which multiples considerably in country contexts where a large number of SMEs exist. SMEs typically have shorter planning horizons than those over which the worst climate change impacts will be felt. The questionnaire conducted for this assignment revealed that 92% of respondents have decision-making and planning horizons of less than 5 years, with 55% not looking beyond one year.

SMEs do not have the capacity to prepare project designs and implementation[14]. As an example, it is reported that this lack of capacity results in difficulty for SMEs to take advantage of funds available from KOSGEB (Small and Medium Enterprises Development Organisation) and TÜBİTAK (Scientific and Technological Research Council of Turkey)[14], which require detailed applications to unlock funding. By its very nature, adaptation action requires future foresight, planning and design, and SMEs' difficulty to operate in this way may be a significant barrier to the uptake of opportunities in adaptation. KOSGEB has been implementing policies to assist in increasing the performance of SMEs, as well as provide credit programmes to allow for investment and growth to try and reduce the scale of this barrier[15].

Access to finance is limited. According to the Ministry of Industry and Trade, the weakness of Turkish SMEs compared to large-sized companies is due in large part to lack of operating capital, risks caused by dependence on one person (founder/entrepreneur), insufficient guarantees, absence of corporate governance, family-owned enterprise structures and non-strategic management processes[14].

High discount rates undervalue future adaptation. Short-term returns dominate investment decision-making. The private sector will apply private sector discount rates when evaluating the potential future benefits of investments. For the majority of businesses in Turkey, this will be a barrier to investments in adaptation actions that go beyond solving the immediate problems of today, (i.e. actions with very short payback periods). There are exceptions, such as adaptation investments associated with large fixed infrastructure where operational lifetimes are several decades; however for the majority of enterprises in Turkey, this will not be relevant.

There is an opportunity to increase the efficiency of Turkish utilities to unlock the full potential of the private sector. Underinvestment in utilities that support the private sector, notably water, power (thermal power plants) and transport (rail) could, in turn, make businesses more vulnerable to the effects of climate change. Climate resilient investment in existing and new infrastructure is critical to ensure the continued performance of the Turkish private sector in a changing climate.

Increased efficiency in the private sector would also help build climate resilience. For instance, although Turkey is an important producer of grains, with wheat yield of 1.95 tons per hectare, it is lagging significantly behind the EU-27 average yield of 5.66 tons per hectare. This is recognised by Government to be a function of operational inefficiency and production in small farms[16]. However, the Ministry of Industry and Trade is taking steps to reform industrial and regional development policies that will aim to increase productivity and competitiveness[17]. This is a strong theme within their current Turkish Industrial Strategy Document (2011 – 2014)[17].

2.2. Current status of adaptation

2.2.1. Private sector organisations

The Union of Chambers and Commodity Exchanges (TOBB) was a leading counterpart in this market study. To date, TOBB's climate change adaptation activities have largely focused on awareness raising initiatives, for instance in September 2010, TOBB in collaboration with EBRD and IFC held a workshop on *"Adaptation, Risks and Opportunities in Turkey"*. In this informative event, relevant public and private stakeholders discussed climate change impacts relevant to business, observed gaps and barriers towards adaptation, as well as opportunities related to climate investments.

However, despite the initiative of TOBB, the Turkish private sector to date has not yet actively engaged with climate change adaptation. Even though key Turkish private sector associations, including TOBB and the Turkish Industrialists' and Businessmen's Association (TUSIAD), are cognizant of the risks and opportunities that climate change poses to its members, the private sector needs to place more efforts in addressing climate change. A very limited number of large Turkish enterprises demonstrate awareness and action on climate change risk. Beyond a few examples, tangible adaptation actions by Turkish businesses need to be increased.

The current focus of climate change activity is on greenhouse gas (GHG) emission reduction (mitigation). There are a number of formal and informal climate change networks developing in Turkey working towards mitigation objectives, involving international organisations, government, research institutions and the private sector, as depicted in Figure 15 in Appendix 1. There is evidence of activities among some in the Turkish private sector that will help to build climate resilience, such as investments in water efficiency. However, the drivers for these are financial, environmental or

sustainable development, and the justification for action remains focused on solving existing, rather than, future climate-related problems.

Similarly, providers of technologies and services to the private sector are not designing for climate change, and there are very few references on company websites to the need to address physical climate risks through adaptation. Technologies to improve water and energy efficiency are increasingly being marketed in Turkey[i]. While these clearly bring benefits in terms of climate resilience, the technologies are not being designed taking account of the changing climatic conditions that they will experience over their lifetimes. This means they risk underperforming. Without demand from their clients and/or incentives from Government policy, it will take time for these providers to see the benefits of developing and marketing climate resilience products.

Example private sector action on climate change: ETI Burcak[18]

One of the leaders in the private sector openly addressing climate change adaptation is the crackers and biscuits producer ETİ Burcak[ii]. In collaboration with WWF, ETİ Burcak have set-out to train 3,000 farmers in the Konya region, in the Inner Anatolia area, to teach them modern irrigation methods as part of an effort to raise awareness about water conservation and to develop a more sustainable system for water usage. To establish the most effective methods of training, the project team created different climate scenarios for the years 2015, 2030 and 2050. Climate projections for these dates show that the temperature in the Konya closed basin will increase by 2 or 3 °C, and up to 4 or 6°C by 2030, according to WWF Turkey's projections. The project's first target was to promote modern, water-conserving irrigation methods, first in the Konya area and then to expand them gradually to other agricultural centres throughout Turkey. Such technologies will help to combat the effects of decreasing precipitation in the region. The partnership has also helped raise awareness of climate change amongst the wider Turkish public.

2.2.2. Government

Key institutions

The Ministry of Environment and Urbanization (MoEU) leads on coordination efforts for climate change related policies and regulations. Under the General Directorate of Environmental Management, MoEU has a "Department for Climate Change and Air Management". MoEU is the National Focal Point of the UN Framework Convention on Climate Change (UNFCCC). The Ministry is also the responsible institution that coordinates high-level activities for climate change mitigation and adaptation actions at the Coordination Board of Climate Change (CBCC). In this role, the Ministry works alongside other relevant ministries, institutions, organisations and NGOs indirectly responsible and / or relevant for adaptation activities[19].

State Hydrological Works (DSI) is responsible for development of water resources for energy use, drinking and irrigation. Being affiliated to the Ministry of Forest and Water Affairs, DSI has an important role in the climate change adaptation efforts since it is the responsible authority for the "Adaptation to Climate Change Working Group" in CBCC. DSI has created an internal working group focused on climate change related issues, including adaptation and the impact of climate change on their activities[20]. The group is formed of 15 professionals from a range of departments including, study and planning, operational and maintenance, geotechnical services and groundwater, surface water and wastewater.

The Ministry of Forest and Water Affairs' (MoFW) operations is responsible for overall policy and regulatory arrangements for water resource management, as well as forest-related activities, such

[i] For example, see http://www.uevf.com.tr/uevf4/UEVF_2013_Bildiriler_Kitabi.pdf

[ii] For more information on this initiative, see:
http://www.iklimeuyumseferberligi.com.tr and http://www.wwf.org.tr/page.php?ID=232&mID=225

as development, rehabilitation and maintenance. It also deals with relevant consequences of climate change, such as desertification and soil erosion. In this context, the ministry is an important stakeholder for the successful implementation of adaptation related measures, since it has responsibilities also for biodiversity and wildlife conservation and, more importantly, water management and meteorological findings.

The Turkish State Meteorological Service (TSMS) provides key input into the scientific evidence base regarding climate change in Turkey and in the wider region. It is affiliated to MoFW. The TSMS is also one of the founders of the Eastern Mediterranean Climate Centre, which includes the national meteorological institutes from Cyprus, Egypt, Greece, Israel, Jordan, Lebanon and Syria. Key projects involving TSMS include, in 2008, a study of "Climate Forecasts for Turkey by using PRECIS Regional Climate: HadAMP3 SRES A2 Scenario" and in April 2010, the US Trade and Development Agency (USTDA) provided a grant to TSMS for "Flood Forecasting and Early Warning System" feasibility study.

Ministry of Food, Agriculture and Livestock (MoFAL) is responsible for development of the agriculture sector and overall rural development, together with food security in the country. Agricultural research, training and extension services are under the responsibilities of the ministry. The Ministry's capacity to build policies on the knowledge of the local needs and opportunities is relatively high which is important for developing policies with respect to climate change adaptation. In the "Turkey Strategy for Combating Agricultural Drought and Action Plan" carried out by MoFAL, a number of goals and actions are determined in an attempt to prevent the pressure of climate change impacts on agriculture with regard to water resources.

The Scientific and Technological Research Council of Turkey (TÜBİTAK) oversees the management, funding and conduct of cross-sectoral climate change-related research in Turkey. TÜBİTAK acts as an advisory agency to the government on science and research issues. They have funded the development of detailed regional climate projections (under the "*Climate Change Scenarios for Turkey*" Project, conducted in conjunction with the General Directorate of Meteorology); collaborated with DSI Coordination Board of Climate Change to provide additional research on the effects climate change on water resources; and supported research in the agriculture sector (e.g. "*The Impact of Climate Change on Agricultural Production Systems in Arid Areas*" project implemented in the Seyhan Basin between 2001 – 2007).

KOSGEB (Small and Medium Enterprises Development Organisation) provides support to SMEs, by upgrading their technological and innovation capacity, improving their competitiveness and increasing their efficiency and productivity. KOSGEB is a governmental institution affiliated to the Ministry of Industry and Trade and is one of the major organisations executing SME policy in Turkey.

Policy initiatives related to climate change adaptation

In 2011, the Turkish Government adopted a *National Climate Change Action Plan (NCCAP)*[21], covering the period up to 2023. This contains lists of mitigation and adaptation actions, organised by sector.

In 2012, a second edition of Turkey's *National Climate Change Adaptation Strategy and Action Plan (NCCASAP)*[22] was published. The aim of the NCCASAP is to integrate climate change adaptation into national, regional and local policies. The action plan provides a series of high-level themed activities towards adaptation, under which individual actions are described with associated desirable time periods over which actions should be undertaken, key deliverables, performance indicators and identification of the responsible / coordinating government institution(s) and other partners.

There has been limited progress to date on policy development regarding climate change adaptation. There is significant need to increase recognition of the imperative to integrate adaptation across Government policy areas, at all levels[23]. The NCCASAP states that the three main reasons for limited governmental progress are (i) limited understanding of the existence of a series

of mal-adaptation policies and implementations; (ii) limited co-ordination among public institutions; and (iii) limited institutional and technical capacities to ensure the sustainability of the initiatives required[22].

2.2.3. International organisations

Through the Millennium Development Goal Achievement Fund (MDG-F) programme, UNEP, UNDP, FAO and UNIDO have been working on a joint programme entitled *"Enhancing the Capacity of Turkey to Adapt to Climate Change"*. The programme was launched in June 2008 and ended in February 2012, with the following recent highlights[24]:

- Turkey's *National Climate Change Adaptation Strategy and Action Plan (NCCASAP)*[25] has been developed and endorsed by the Ministry of Environment and Urbanisation, and approved by the Climate Change Coordination Board.
- A Capacity Development Programme was developed, and a number of training sessions were provided covering areas such as Climate Data Analysis, Early Warning and Monitoring Systems. Capacity was increased among government officials, civil society and universities to make efficient use of current policies to and develop new ones in the context of climate change.
- Eighteen community-based climate change adaptation projects in the Seyhan River Basin were finalised and lessons learned are being captured.
- A *National Cleaner Production and Eco-Efficiency Centre*[iii] was established to promote efficient water use, and six companies in the Seyhan River Basin are achieving water savings. A number of these companies feature as best practice case studies in the accompanying supplementary information (separate report).

3. Identification of priority sectors for climate resilience in Turkey

3.1. Introduction

To understand which sectors of Turkey's economy could be priorities for investments in climate resilience, analysis was undertaken to identify sectors that were most economically important and climatically vulnerable. The priority sectors were identified by combining and ranking economic indicators describing the significance of sectors to the national economy (i.e. sector production value and employment numbers per sector)[iv] with a climate vulnerability index (based on a sector's use, or dependency on, climatically sensitive infrastructure and systems). The methodology employed is described in this Chapter.

3.2. Economic metrics and ranking

Calculations of economic 'importance' are based on the combined ranking of two metrics: production value in Turkish Lira (TL) and employment numbers per 'division' level subsector. Of the 99 'division' level sectors listed in the European Communities NACE Rev. 2 nomenclature, Turkstat hold available economic data on 76 of these divisions. The detailed output from the economic metrics and ranking, ranked in order of most 'important' (# 1), as shown in Table 6, Appendix 1.

It should be noted that the NACE Rev. 2 'Section' level called 'agriculture, fisheries and forestry' is not accounted for by Turkstat in the same way as the other 76 sectors included in this analysis. Gross Domestic Product (GDP) figures are available for agriculture, forestry and fisheries, but no

[iii] See: http://www.ttgv.org.tr/en/unido-eco-efficiency-programme

[iv] Economic data were obtained from the Turkish Statistical Institute, using 'division' level sectors listed in the European Communities NACE Rev. 2 nomenclature.

production value data (in TL) are available and therefore no direct comparison between GDP and production value can be made. Employment numbers are available; however scrutiny of the national and regional data provided by Turkstat suggests that these data are erroneous, with exceptionally low numbers of employees stated. Notwithstanding these issues, 'agriculture' represented 9% of total GDP in 2009, making it the fifth largest contributor, compared to 17% for manufacturing, 12% for wholesale and retail trade and 15% for transport, storage and communication[26].

NACE Rev. 2 codes do not explicitly include a code for 'tourism'. Two 'Division' level NACE codes, called 'accommodation' (code 55) and 'food and beverage service activities' (code 56) can reasonably be assumed to constitute key aspects of 'tourism'. These two 'division' level codes have therefore been combined in our analysis, to form a new 'tourism' sector. This new 'tourism' sector would rank 6th in the list above, between 'construction of buildings' and 'manufacture of wearing apparel' sectors.

'Financial services' is the final sector of the economy not included in the Turkstat data using the NACE Rev. 2 nomenclature. However, as this study has an important focus on the role of financial institutions in providing financing modalities for private (and public sector enabling environment) adaptation, the inclusion of the role of this important sector will be implicit in our overall project analysis and recommendations for Turkey.

3.3. Climate change metrics and ranking

Scoring and ranking for each NACE Rev. 2 'Division' level sub-sector was based upon its use of, or dependency on, Climatically Sensitive Infrastructure and Systems (CSIS). The CSIS include large fixed assets, transport, water, other (climatically sensitive) raw materials, market demand, energy and ecosystems. The initial output from the scoring and ranking suggest that the following 20 sectors/ subsectors are most dependent on CSIS in Turkey (# 1 is the most dependant), as shown in Table 7, Appendix 1.

3.4. Selection of initial set of sectors and sub-sectors

Draft priority sectors were identified by combining economic indicators with the climate vulnerability index. Table 8, Appendix 1 summarises the most important sectors in Turkey on the combined basis of economic analysis (i.e. production value[v] expressed in Turkish Lira, TL and employment numbers per sector[vi]) and the level of use of, or dependency on, CSIS. The table rows are listed by their economic importance, however when the CSIS scores are applied, the scores depicted in column 2 show the overall score when the economic and CSIS rankings are combined.

In summary, based on the combined economic and CSIS ranking, the preliminary list of priority sectors identified in Table 8 are:

1. Manufacture of food products;
2. Tourism;
3. Wholesale trade, except of motor vehicles and motorcycles;
4. Manufacture of textiles; and
5. Electricity, gas, steam and air conditioning.

[v] Structural Statistics for Industry and Services, Standard definitions (Update: 14-Oct-05): The value of production corresponds to the sum of the value of all finished products (including intermediary products sold in the same condition as received), of the net change of the value of work in progress and stocks of goods to be shipped in the same condition as received, of the variation of stocks of finished products and of those in progress, of the value of goods or services rendered to others, of the value of goods shipped in the same condition as received less the amount paid for these goods and of the value of fixed assets produced by the unit for its own use.

[vi] Ibid. The number of salaried employees includes all persons, workers and employees, covered by a contractual arrangement and working in the enterprise and who receive compensation for their work, whether full-time or part-time.

It is noted, that both 'Wholesale trade, except motor vehicles and motorcycles' and 'Electricity, gas, steam and air conditioning' have very broad sector descriptions, and so the important sub-sectors (NACE code 'group' level) within these sectors have been identified on the basis of further economic considerations as follows:

- *'Wholesale trade, except motor vehicles and motorcycles'*:
  - The 'Whole sale of household goods' subsector is selected from a range of subsectors including: sale of textiles, clothing and footwear, electrical household appliances, china and glassware and cleaning materials, perfume and cosmetics, pharmaceutical goods, furniture, carpets and lighting equipment, watches and jewellery, and other household goods.
- *'Electricity, gas, steam and air conditioning'*:
  - *The* 'Electric power generation, transmission and distribution' subsector is selected from a range of subsectors including: production, transmission, distribution and trade of electricity.

3.5. Selection of final priority sectors

The preliminary list of priority sectors was reviewed and, following consultations, finalized. This final list comprised five sectors, in line with the available budget for in-country engagement for the study. The justification for the choice of these sectors is provided in Table 2. These sectors face a wide range of climate risks (see Figure 14 and

Table 5 in Appendix 1), which is largely a function of their reliance on natural assets and climatically-sensitive raw materials, secure supplies of energy and water, complex supply chains, and large fixed assets.

Table 2: Justification for final priority sectors

Sector name	Justification
Manufacturing of food products and agricultural supply chains	The manufacturing of food products is identified as the highest-ranking sector when considering a combination of economic 'importance' and dependency on CSIS. Agriculture is a significant sector not included in a comparative format in the available Turkstat data; however agriculture is the 5th largest contribution to GDP in Turkey. As such, agriculture has been merged with the manufacturing of food products, as there is a clear and important link in terms of supply chains and the provisions of raw materials.
Tourism	Tourism will be included as a composite of 'accommodation' and 'food and beverage service' activities.
Retail and wholesale trade of household goods, except of motor vehicles and motorcycles	The wholesale trade of household goods accounts for 34% and 36% of production value and employment respectively in Turkey. This is therefore the focus of the analysis. Retail trade was also the second highest-ranking sector in terms of economic 'importance' and therefore has been added to this sector, as the interaction between retail and wholesale markets is an important area of consideration for the management of climate risks.
Manufacture of textiles and wearing apparel	The manufacture of wearing apparel was the 6th highest-ranking sector in terms of economic 'importance', just ahead of 'manufacture of textiles'. As these two sectors are strongly related, both will be amalgamated for the purposes of this study.

Electric power production, distribution and transmission	The subsector 'Electric power production, transmission and distribution' accounts for 91% and 90% of employment and production value respectively in the sector 'Electricity, gas, steam and air conditioning'. This subsector is therefore the focus of the analysis. Although there is a strong public-sector aspect to this subsector (including both national ownership and operation), recognition of its on-going privatisation makes it a useful element of this study, where consideration of adaptation in the context of privatisation can be explored.

It should be appreciated that the final list of priority sectors were not considered to be the absolute focus of this study, but rather the sectors through which climate change adaptation can be understood in the regional and country context. It should be appreciated that the priority sectors in Table 2 cover primary, secondary and tertiary private sector dimensions. As such, they will provide a useful proxy for challenges and solutions for other sectors within these private sector dimensions. For example, many of the challenges facing the manufacture of textiles and wearing apparel may also resonate with other light manufacturing sectors, where common solutions may also exist.

3.6. Identification of potential adaptation actions and investment opportunities

Through a combination of stakeholder engagement and desk-based research, a comprehensive list of potential adaptation actions was developed. Climate change vulnerability data was mapping using GIS to determine the location of sectoral 'hotspot'[vii], which then formed the target regions for sector-themed stakeholder workshops. At these events, vulnerabilities were discussed in more detail, along with businesses' needs to build climate resilience, and consequent adaptation actions. This initial 'long-list' of actions was supplemented by a comprehensive literature review, drawing on international examples and best practice.

To identify investment opportunities, the adaptation needs identified in the priority sectors were aligned with IFI banking divisions. Further consultation with EBRD and IFC led to the selection of banking sectors where climate resilience investments will be most relevant in Turkey. These are agriculture, manufacturing, built environment, energy and transport. These sectors became the focus for the 'long-list' of adaptation actions, or interventions, which contain the full suite of investment opportunities that may provide benefit to the private sector, and in some cases local and national government. 'Long-list' opportunities are provided in Appendix 2.

Adaptation actions (interventions) eligible and suitable for potential IFI funding were selected for further development and taken forward for high-level market analysis. An internal consultation process with EBRD and IFC banking teams resulted in the elimination of 'lower priority' initiatives. This led to the development of a 'short-list' of interventions, which are presented in the following chapter, and comprise:

- Water efficiency in agriculture through the application of water efficient irrigation technology and use of drought resistant seeds;
- Water efficiency in agri-processing /manufacturing by improving process water efficiency and the reuse/ recycling of process and grey water; and
- Climate resilience in buildings through the adoption of a range of technologies and practices to improve water efficiency, reduce overheating risks and minimise flood damage.

[vii] A 'hotspot' is defined as a region where a sector/ subsector cluster (LQ >1) exists and where the sector is vulnerable to a high number of climate hazards.

4. Sector opportunities in Turkey

4.1. Introduction

This chapter comprises the core results of the market adaptation study. It provides an overview of the characteristics of the sector and associated climate change risks, description of the potential 'short-list' interventions and the overall potential scale of the market opportunities, together with the potential economic returns associated with various 'technological' adaptation solutions.

Market analysis was used to provide an indication of technological and investment needs and opportunities for invest in climate resilience in Turkey. The outcomes of the market analysis are both an estimation of the market size, in million USD. (Note: all market size/ investment potential figures shown in this section are gross totals, however figures relating to the investments in drought-resistant seeds in agriculture and passive ventilation in buildings are annual figures). Furthermore the market analysis also provides a brief assessment of the economic viability of each of the analysed climate adaptation investments, as net present value (NPV) and internal rate of return (IRR). The assumptions used in the market analysis are summarised in Table 3 and the market analysis methodology is presented in text box below.

Table 3: Assumptions used in financial analysis of pro-adaptation investments

Factor	Assumption
Intermediated lending	
Loan proportion	60%
Equity proportion (the company)	40%
Equity return	10%
Grant / subsidy proportion	0%
Interest rate	5.2%
Maturity	7 years
Grace period	0
Fees: – up-front – commitment	 1% 0.5%
Residual amount	Financed by borrower or other investors
Investment lifetimes – Agriculture: Irrigation equipment – Agri-processing / manufacturing: Efficient processes and recycling / reuse of water – Buildings: Various climate resilience measures	 5 years 7 years 20 years
Water price	Varied according to investment type
Differences in assumptions for direct lending	
– Loan proportion may require syndications or club deals with other IFIs or the financial intermediary – Interest rate may be slightly lower as there may not be a margin for the financial intermediary	

Method for estimating market potential for adaptation investments

The method used for estimating the market potential for different investment for improvement in water and energy efficiency in the Turkish agricultural sector, food processing and manufacturing sector and the building sector is summarised as follows:

Estimation of the market potential

Total market size (number)	×	Market share (%)	×	Share financing (%)	×	Unit costs (USD)	=	Market potential (USD)

This method is applied to estimate the market potential for all the investment options discussed in this report.

Note: the market potential presented within this chapter, are based on total number of enterprises or buildings in Turkey and the investments are assumed to last between 5 year (drip irrigation) and 20 years (buildings). The only exceptions are investments in drought resistant seeds and passive ventilation of new buildings, for which the market potential figures presented are on an annual basis.

The various calculation segments are defined as follows:

- 'Total market size' is the initial market for adaptation investment without any reductions made.
- 'Market share' is the assumed share of the total market that will invest in the adaptation measure.
- 'Share financing' is the share of the needed adaptation investment that can be financed through loans. The share financing percentages used in the financial analyses are assumed to apply to all investment cases. A figure of 40% contribution from the enterprise and 60% from the FI has been selected, in line with a typical capitalisation structure, as described in the 2013 EBRD guide to financing[27].
- 'Unit costs' are the unit cost of the adaptation investments.

4.2. Investments in water efficiency in agriculture

4.2.1. Overview

Globally, agriculture is widely regarded as one of the sectors likely to be most impacted by climate change[28], and agricultural production in Turkey is no different. Agriculture is inherently extremely vulnerable to climate variability and change, due to the natural connections and dependencies that exist between climatic conditions and plant development. There are a variety of climate drivers that can impact agricultural productivity, both directly and indirectly. In Turkey, higher temperatures are likely to directly impact crop yields, while encouraging invasion of alien species and proliferation of pests, which will indirectly affect productivity. Higher temperatures will also cause thermal stress of livestock, with implications for animal productivity and health[29]. Changes in precipitation patterns increase the likelihood of short-term crop failures and long-term production declines.

Under a changing climate, the agriculture sector will need to increase their water efficiency, build resilience to droughts and avoid overheating for crops grown outdoors and indoors. This presents a series of opportunities to invest in a range of technologies available to deal with these climate-related risks including water efficient drip-, sprinkler-, or micro-sprinkler irrigation systems, rainwater harvesting systems, drought-resistant or salinity-tolerant seed varieties, or those that can use lower quality water (i.e. treated wastewater), natural ventilation and shading for buildings; underground cooling pipes and ground heat sink pumps[30].

The majority of Turkish agricultural producers are SMEs, operating on holdings smaller than the EU average and with modest incomes. More than 90% of farm households have no more than 20

hectares (ha) of land, and 66% of all holdings are less than 5 ha in size[31]. Incomes for the majority of households (92%) are in the small economic size group (<TRY 13,000 p.a./ EUR 7,222 p.a.)[31]. As such, access to finance remains limited for small businesses in the agricultural sector[32] and the majority are highly dependent on government subsidies to survive[33]. Due to their limited capacity to deal with climate shocks, small-scale farms can be severely impacted by climate and weather events.

Agriculture is the largest water user in Turkey, consuming ca. 75% of the country's available resources for agricultural irrigation. There are approximately 39,100,000 hectares[34] of agricultural land in Turkey, of which 5,200,000 hectares is equipped for irrigation[35]. The largest concentration of irrigated land is associated with the Southeastern Anatolia Project (GAP), which comprises more than half the presently irrigated land in Turkey[36].

Drought-resistant crops are currently not widely used in Turkey[37]. However, Provincial and District Agricultural Offices and individual farming cooperatives are increasingly guiding farmers about crop choices. The development and application of new crop strains is an expanding research area in Turkey, through the establishment of the *Agricultural Drought Test Centre* in Konya, however, understanding and modelling of the physiological traits that limit productivity in each crop and in each environment where it is grown is a time-consuming task.

4.2.2. Investment potential and financial performance

Literature suggests that maintaining the current agricultural production will require an increase in irrigation by up to 45% within the next 30 years, and up to 60% at the end of the century. This increase suggests that the current market could potentially expand, providing increasing opportunities for on-going and future investments in water efficient technologies[38].

Without adaptation, crop yield in Turkey will decrease significantly from 2015 onwards due to climate change[39]. There are two key potential appropriate technologies that could reduce climate change risk relating to water scarcity. These are the installation of water efficient irrigation (e.g. drip, sprinkler and micro-sprinkler irrigation systems), and the introduction of drought-resistant seed varieties. In 2009, the Turkish seed market posted a total annual value of USD 650 million[40].

The potential beneficiaries of investments include large-scale commercial farms, small-scale enterprises and agricultural cooperatives. One group are commercially orientated farms seeking to raise finance to purchase new equipment or retrofit existing assets, of which there are only 57 greater than 500 hectares[41], and large-scale poultry farms. Small-scale farms seeking to make improvements in agricultural productivity include another important and sizeable potential group of beneficiaries, including over 10,000 agricultural cooperatives.

The investment potential for water efficient irrigation and drought-resistant seeds is estimated to be USD 2,520 million and USD 234 million/ annum[viii] respectively. A more detailed set of figures is shown in Table 9, Appendix 1. The financial performance of water efficient irrigation and the use of drought-resistant seeds are calculated using a simple generic model that provides estimates for project IRR, loan IRR, and NPV.

Investments in irrigation and drought-resistant seeds are estimated to have IRRs of 57.3 to 64.4% (depending on the assumed cost of water scenario) and 29.9% respectively. These investments could potentially provide a very strong return on investment, as presented in Table 12, Appendix 1.

4.3. Investments in water efficiency in agri-processing/ manufacturing

4.3.1. Overview

The agri-processing sector needs a secure supply of water in order to operate effectively. Increasing the climate resilience of the agri-processing sector should focus on issues associated with

[viii] The market estimate for seeds is per annum, reflecting the need to sow seeds annually.

water scarcity. Areas of Turkey identified as being exposed to 'extreme' or 'high' water stress by the 2020s are Inner, Eastern and Southern Anatolia, the eastern Mediterranean region and the western Black Sea. Businesses that manufacture food products containing water and, in the case of the beverage industry, those where freshwater is the primary and most important ingredient of the product, are particularly vulnerable to projected climate impacts on water availability and quality.

A number of Turkish businesses in the agri-processing are already taking action to address water efficiency. This activity suggests that there is market demand for a range of water efficient technologies and the potential for investment, however this is likely to be demand driven by considerations of sustainability rather than adaptation. More than 99% of all businesses in Turkey are SMEs[42] and within this group, there is limited awareness of water efficiency in terms of adaptation[43].

Over 99.5% of the businesses manufacturing food products are SMEs and collectively they generate over half of the sub-sector's total production value (TRY 33.6 trillion in 2009)[44]. The remaining half of the sub-sector's total production value is generated by 0.5% of businesses, highlighting that there are a number of large market players (in sugar and molasses production, chocolate, canned food and vegetables, and meat and dairy production)[45].

Equally, over 98% of businesses manufacturing beverages are SMEs and collectively they generate approximately one quarter of the sub-sector's total production value (TRY 1.2 trillion in 2009). The remaining 2% of businesses play a very significant role in the sub-sector by generating three quarters of total production value.

In terms of market dominance, for every beverage manufacturing business, there were 80 food product manufacturers in 2009. The market is primarily food manufacturers, however beverage manufacturers are particularly sensitive to water scarcity.

As a result of pressure and impacts on water resources, the currently low cost of water may change in the future. Studies have shown that water pricing can be a very effective way to encourage water efficiency[46]. The EU's Water Framework Directive obliges Member States to use economic instruments as an effective way to promote water efficiency. This is marked, in part, by a general trend to increase water prices in Europe, which has had an effect on consumption[47]. Although not yet implemented in Turkey, the EU *acquis* may also bring this obligation to bear and is a potential market driver. Should water price increases occur by any means, the opportunity to invest in businesses wishing to manage increasing water costs is likely to grow.

The MoFAL is supporting greater integration between agriculture and industry through its *Rural Development Plan (2010-2013)*[48]. As part of the *Rural Development Support Programme*, the MoFAL has made a number of financial investments in the processing, packaging, wrapping and storing of agricultural products and purchase of machinery-equipment. Between 2006 – 2011 this programme provided TRY 575 million in grants to support the construction of 3,203 new processing facilities. The motivation behind such actions is likely to be driven by the EU accession process and the need to align standards with the EU. As retailers require higher standards from food manufacturers, it is expected that the food and beverage sector will become more sophisticated. Although these actions are not driven by climate change, they are useful policy drivers to engage the private sector and highlight best practice in the agri-processing sector.

4.3.1. Investment potential and financial performance

Agri-processing and manufacturing require secure water supplies. Sector activity in four areas of Turkey is already facing increased water stress, including southern Marmara, southern Central Anatolia, eastern Black Sea and Southeastern Anatolia.

There is a range of potential technological solutions to increase water efficiency in the agri-processing/ manufacturing sector. These solutions can be grouped into two broad categories:

changing a range of technologies to improve process efficiency; and recycling and reusing process and grey water.

The potential beneficiaries for these two technology types are a broad range of agri-processing/ manufacturing enterprises (including more than ten large breweries) in Turkey. Access to water efficiency should be available nationally, but there are regions where a more targeted offering may be effective.

The investment potential for water efficient process systems and the use of recycling and reusing of process water is estimated to be USD 75 million and USD 180 million respectively. A more detailed set of figures is shown in Table 11, Appendix 1.

Investments in water efficient process systems and the recycling and reuse of process water are estimated to have IRRs of -7.3 to +7.2% and +7.2% to +30.1% (depending on the assumed cost of water) respectively. For comparison, two case examples of Turkish agri-processing companies (Pakyürek and Gülsan[49]) who have both invested in water efficiency are included in Table 12, Appendix 1.

Both water efficiency measures are potentially viable, but not under all water price scenarios. For process water efficiency, investment has positive NPV where a water price of approximately USD 0.29/m^3 or more exists. Even so, however the IRR is still only marginal at 7.2%. This is not the same for recycling/ reuse of process and grey water, which appears to provide a more robust IRR, although only at a water price of above USD 0.11/m^3.

4.4. Investments in climate resilience in buildings

4.4.1. Overview

Climate change presents opportunities for property developers, designers, architects and planners to create or remodel buildings and their surrounding open spaces that are resilient in the face of future change. There are many actions that can be taken at the building scale to improve climate resilience. To be most effective, however, these need to be coupled with adaptation actions at the neighbourhood scale (i.e. developments of groups of dwellings, including a mix of uses, from an individual block to a large estate) and the conurbation or catchment scale (through spatial planning).

Increased risk of overheating will drive the need for additional cooling of buildings and investments should be targeted at the property sub-sectors in Turkey that use significant amounts of energy for summertime cooling. Detailed information on energy used for space cooling in commercial buildings is unavailable for Turkey, however studies in the United States show that cooling energy use is highest for office buildings, warehouse and storage buildings, hotels, schools and universities, hospitals, and the retail sector[50]. Higher temperatures have the potential to lead to increased energy use and greenhouse gas emissions, unless low-energy cooling designs and technologies are used, which are capable of coping with the increased temperatures which buildings will experience over their lifetimes.

At present, the hottest summertime temperatures in Turkey are experienced on the Mediterranean and Aegean coastlines and the southeast of the country. All parts of Turkey are projected to experience summertime temperature increases, with the increases being slightly higher in the eastern half of the country. In general, it is in urban areas, where the urban heat island (UHI) effect will compound the rising temperatures caused by climate change, that the need for cooling will be most strongly felt. The cities with the highest current temperatures which are expected see the greatest temperature increases from climate change are: Izmir on the Aegean coast, Adana, Antalya and Mersin on the Mediterranean, and Gaziantep, Dikarbakir, Urfa and Malatya in the southeast. Cooling demand in Istanbul and Ankara will also be significant.

According to the Turkish Association of Real Estate Investment Companies, sustainability and green building objectives are leading to changes in building design and materials. Projects are making more use of natural heat and light, natural ventilation instead of mechanical air conditioning, and improved insulation[51]. However, if advanced, naturally ventilated buildings are designed and built without taking account of rising temperatures that will be experienced over the lifespan of the building, it could prove necessary to add mechanical cooling as other adaptation measures, such as adding mass, may not be technically feasible[52].

A combination of low quality existing buildings and rapidly rising urban populations creates a significant need for new building construction in Turkish cities[53]. For new developments, investment opportunities in climate resilience exist at both the building and the neighbourhood scale. For instance, large-scale developments can improve space cooling through the provision of green and blue infrastructure (such as trees and fountains). Many such technologies are already in place in pilot projects in the city of Gaziantep[54], which highlights the ability of adaptation actions at these different scales to become mutually supportive.

New build housing and regeneration of residential stock offer excellent opportunities to build in climate resilience measures at lower capital cost. According to a building count carried out by TURKSTAT, the total number of buildings in Turkey in 2007 was 8.5 million[55]. Around 670,000 new buildings are constructed each year. Most dwellings are owner-occupied (68%), with 26% rented from private owners and 2% from social owners or government[56]. High levels of migration from rural to urban areas over the last 30 years, together with population growth have led to a steep climb in demand for land and housing in urban areas, particularly amongst low and middle-income groups. This has led to affordability problems for these groups, who are unable to buy or rent property, and hence to a significant increase in unauthorised housing developments, known as 'gecekondu'. According to the Chairman of the Urban Land Institute of Turkey, it is estimated that these unlicensed buildings account for 55% of Turkey's housing stock and some 40% of the housing stock should be refitted or demolished due to age, quality and earthquake risk[57].

The major urban regeneration requirements offer significant opportunities for investments that seek to incorporate climate resilience measures. The government agency that oversees regeneration nationally, the Housing Development Administration of Turkey, TOKİ, has stated its ambition to increase construction of new build residential property creating "*financial opportunities to finance social housing projects through innovative structures such as revenue sharing projects under public-private partnerships*". It should be noted that where such residential development are of a large scale, then they might equally be suitable for direct investments.

I**ncreased water resource stress, coupled with government policy on water efficiency, will drive investments in water efficiency in buildings.** Outside the residential sector, water intensive buildings with the highest opportunity for investment in water-saving mechanisms include hotels, hospitals, schools, offices and shopping centres[58]. Investment in water efficiency will be driven by both government regulation and price. Turkey's *National Climate Change Adaptation Strategy and Action Plan* includes explicit objectives around addressing water management in urban areas, and includes an action to develop a pricing policy to encourage efficient water use in cities.

Increased water scarcity in Turkey is likely to exert upward pressure on tariffs and potentially drive further demand for the uptake of water efficient technology in buildings. Currently, local governments set tariffs for water in Turkish cities, with commercial users charged a linear tariff. In 2009, the highest water tariffs were charged in Istanbul, and the lowest was in Diyarbakir[59].

4.4.1. Investment potential and financial performance

Buildings are facing increased risks of overheating, water shortages and flooding under a changing climate and the risks are likely to intensify over the coming decades. To combat these dynamic and

increasingly prominent issues, there is a significant opportunity for cities, and particularly those seeing rapid expansion, to integrate climate resilience measures into their building stock.

Increasing the climate resilience of buildings can be achieved through a series of measures. These include improved insulation; installing green roofs to reduce overheating and runoff rates; green and blue infrastructure to provide cooling; installing heat reflective glazing; using passive venting; rainwater harvesting/ recycling; improving surface water drainage systems and introducing building-scale flood protection measures.

The potential beneficiaries include private/commercial property and municipal housing investments to domestic and international property developers, municipalities, hospitality companies and providers of hospitals, healthcare and educational facilities. There may be a natural bias to focus on beneficiaries in urban areas, however the need to adapt to climate change is also a rural issue.

The potential pro-adaptation investment potential for both residential and commercial property is estimated to be significant. Market analyses suggest the following investment potential: building insulation (USD 17,345 million), green roofs (USD 3,035 million), passive ventilation and cooling (USD 4,405 million p.a.), green and blue infrastructure (USD 750 million), heat-reflective glazing (USD 5,760 million), rainwater harvesting (USD 11.5 million), surface water drainage systems (USD 1,500 million) and flood protection (USD 1435.50 million). A more detailed set of figures is shown in Table 13, Appendix 1.

Green and blue infrastructure and insulation represent the highest NPV values at USD 13,882,665 and USD 1,511 respectively. Under the assumptions made in the analysis, the remaining climate resilience measures have negative NPVs.

In terms of IRR, green and blue infrastructure provides the highest IRR at 13.3%. As outlined in Table 14, Appendix 1, insulation has an IRR estimated at a reasonable 9%, whereas passive cooling and flood protection have IRRs of 4% and 7.1% respectively, suggesting that they are potentially below business hurdle rates. In terms of high (USD 2.05/ m^3) and low (USD 0.9/ m^3) scenarios for the cost of water, when these are applied to the financial estimates of IRR for rainwater harvesting/ recycling, even with the high water price the IRR remains at -8% suggesting that a significant increase in water pricing would potentially be required to provide IRRs over business hurdle rates. Flood protection also provides a modest IRR.

5. Conclusions

Climate change is underway and its impacts are intensifying. Key impacts in Turkey include temperature increases, decreases in annual precipitation, increased intensity and duration of droughts and hot spells leading to increased water stress; more intense precipitation events, increasing the risks of flooding, together with landslides; and rising sea levels, increasing the risks of flooding in low-lying areas and coastal cities. These changes in climate will have significant impacts on Turkey's economic sectors.

In Turkey, the main challenges to overcome are low levels of awareness, short-term business planning horizons, limited access to finance and limited government progress on adaptation policy development. In spite of recent exposure to climate-related events and the high levels of concern expressed at future impacts, the majority (65%) of businesses that responded to this market study's survey acknowledged that climate change remains an area that they know very little about.

Water efficiency in agriculture and agri-processing/ manufacture, and climate resilience in buildings were highlighted as priority areas. Internal consultation with EBRD and IFC's banking teams lead to the selection of a 'short-list' of pro-adaptation investments. The sectors that did not make it on to the 'short-list' were deemed lower priorities by EBRD and IFC based on issues

including: high levels of public ownership (as opposed to private), climate resilience aspects and immediate investment opportunities being perceived as minor, and where other EBRD/IFC assignments were already considering the sector or topic.

Considering all the climate resilience investments assessed in market analyses, several potentially attractive commercial opportunities were identified. A summary of the market analyses for all three sectors (Figure 7) demonstrates that the highest IRRs overall were found for investments in the agriculture sector (water-efficient drip irrigation and drought-resistant seeds). Relatively high IRRs were also found for recycling/ reusing process water in agri-processing/ manufacturing (for a high water price), and for green and blue infrastructure and building insulation. The largest market potential, by a significant margin, was for building insulation. It was also apparent that water pricing was an important factor in determining the financial viability of some investment options.

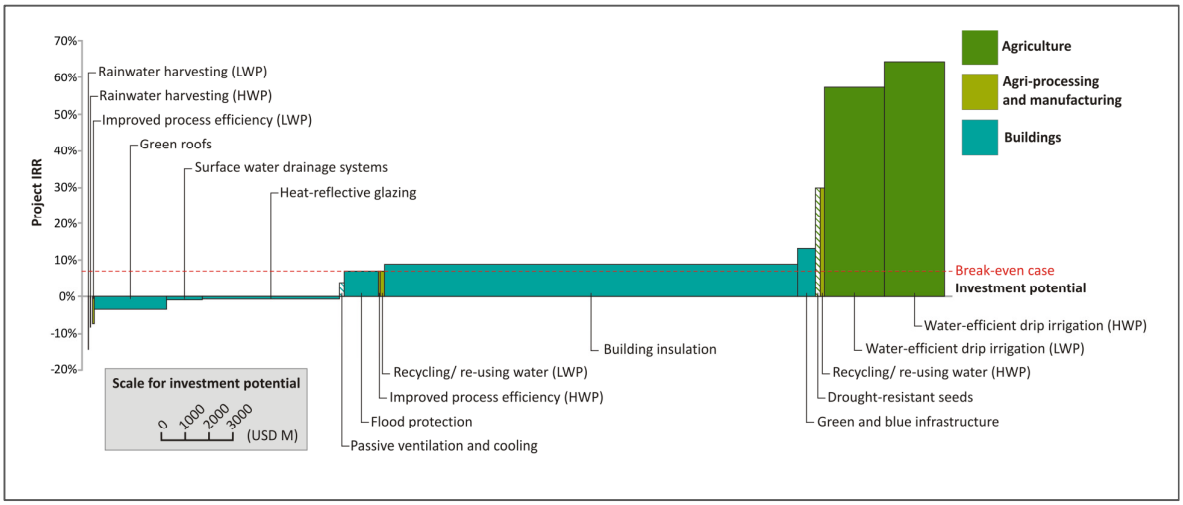

Figure 7: Summary of the indicative investment potential today and project IRR for the set of climate resilience investments included in the market analysis (agriculture, agri-processing and manufacturing, and buildings). The width of each bar represents the total investment potential and the height of the bar is the project IRR. The total investment potential across all three sectors is estimated at more than USD 22 billion.

Notes

The analysis is based on information obtained through a combination of desk studies and in-country consultations, and hence should not be considered to present an accurate estimate of the market potential and associated economic returns.

Investment potential represents the opportunity today. Given the trend in observed impacts, coupled with other pressures on resources, and near-term climate change projections, the investment potential, project IRR and the range of possible climate resilience investments may increase significantly in the coming years. The analysis has focused only on the chosen set of investment areas and is therefore not exhaustive. Inclusion of additional climate resilience measures from other sectors would show a much higher and diverse investment potential.

The 7.1% IRR hurdle rate represents a generic break-even investment scenario, where the investment is set to provide zero NPV. This has been calculated using a series of loan and investment assumptions that provide a basis for comparison across the investments (see Table 3). For agricultural irrigation and agri-processing/ manufacturing, an assumed project lifespan of 10 years would require an annual cost saving of 23% to produce zero NPV under an IRR of 7.1%. For buildings, where a 20 year project lifespan is assumed, an annual cost saving of 16% is required to produce a zero NPV under the same IRR.

Water prices in Turkey vary depending on use and location. Therefore, for water efficiency investments in all three sectors, both high water price (HWP) and low water price (LWP) scenarios are presented to illustrate the influence that water prices play in the project IRR and NPV results (see Table 4). For the agricultural and building sectors, the two water price scenarios were based on published data. Applying the high and low water

prices therefore provides an illustration of the worst- and best-case scenarios for the performance of these investments. For the agri-processing and manufacturing sector, however, only one indicative water price was found in the literature. As such, the second water price scenario was selected to provide an indication of the price that would make the investments in this sector break-even (i.e. zero NPV).

For investments in climate resilience in buildings, investment potential values for commercial and residential properties have been summed in the figure.

For investments in drought-resistant seeds (agriculture) and passive ventilation and cooling (buildings) (denoted by cross-hatching in the figure), investment potential values are *per annum*. As such, the width of the two cross-hatch bars is standardised and does not reflect their true market potential. For all other investments, the values are totals based on the total number of existing enterprises/buildings in Turkey suitable for the investment, and assumptions regarding the proportion that will invest (ranging from 5% to 50%, depending on the investment).

Table 4: High and low water price scenarios used in the market analyses

Climate resilience investment	Low water price	High water price
Agriculture: Drip irrigation	92 USD/ha	322 USD/ha
Agri-processing / manufacturing: Improved process efficiency	0.19 USD/m^3	0.29 USD/m^3
Agri-processing / manufacturing: Recycling /reusing water	0.11 USD/m^3	0.19 USDm^3
Buildings: Rainwater harvesting	0.9 USD/m^3	2.05 USD/m^3

Appendix 1: Figures and tables

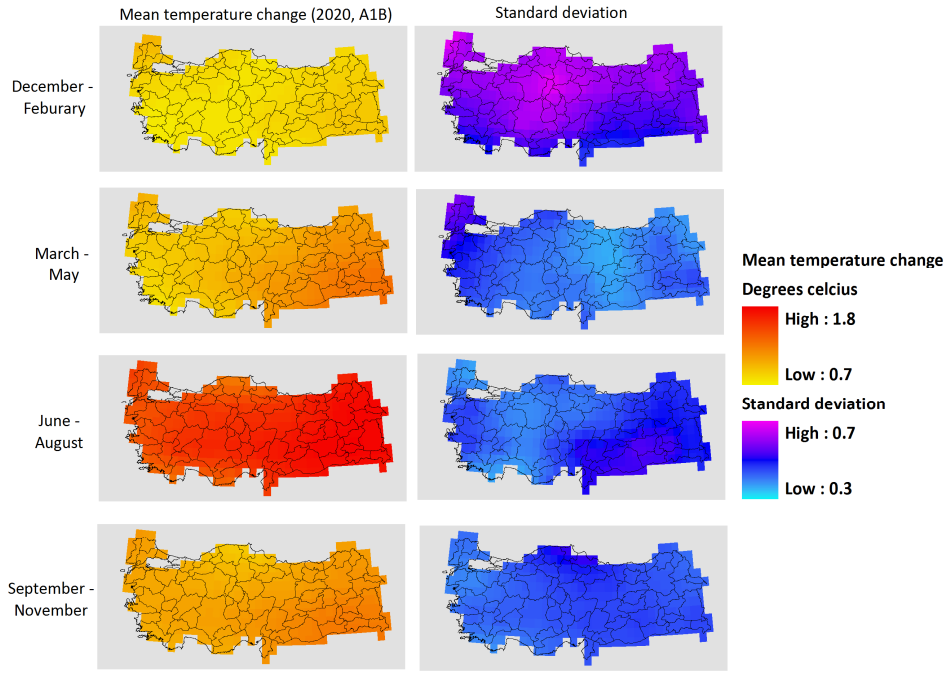

Figure 8: Projected changes in temperature across 16 Global Climate Models (2020s, A1B). (Data source: Climate Wizard, http://www.climatewizard.org; Girvetz *et al.*, 2009).

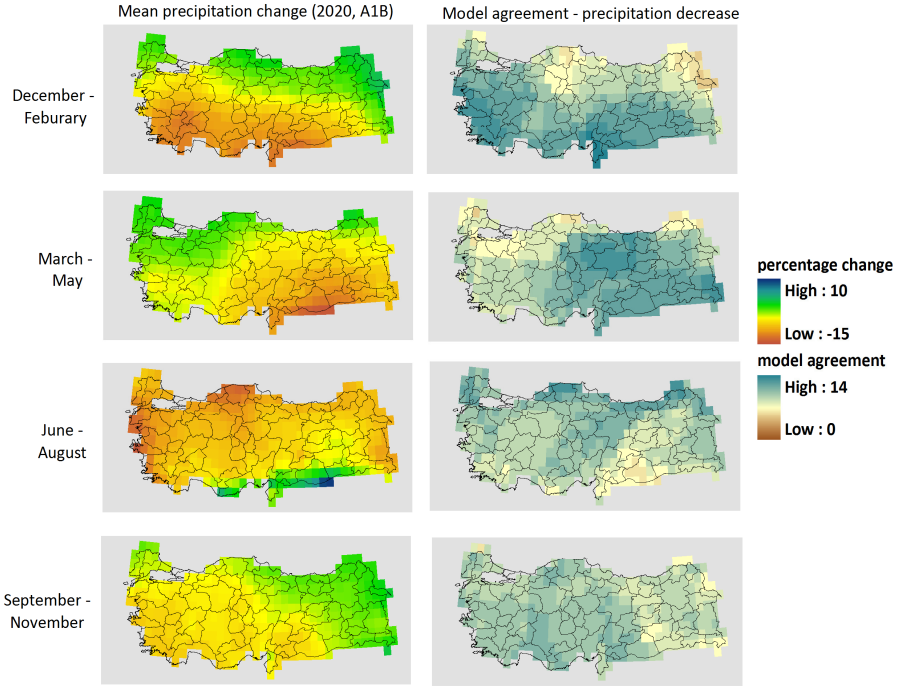

Figure 9: Projected changes in precipitation across 16 Global Climate Models (2020s, A1B). (Data source: Climate Wizard, http://www.climatewizard.org; Girvetz *et al.*, 2009).

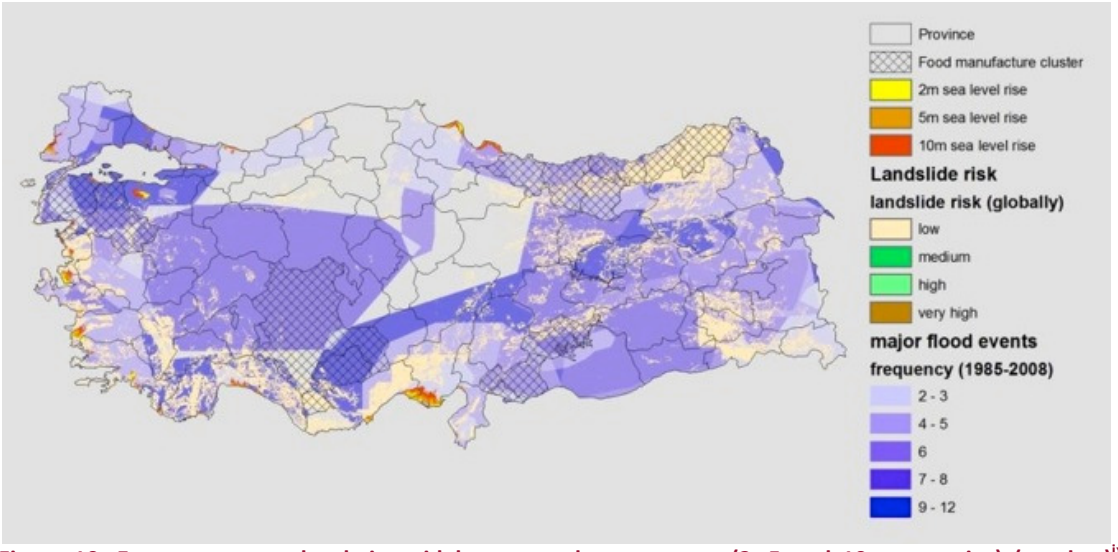

Figure 10: Exposure to sea level rise, tidal range and storm surge (2, 5 and 10m scenarios) (top key)[ix], precipitation induced landslide risk areas (middle key)[x] and the spatial extent of large flood events from 1985-2008 (bottom key)[xi].

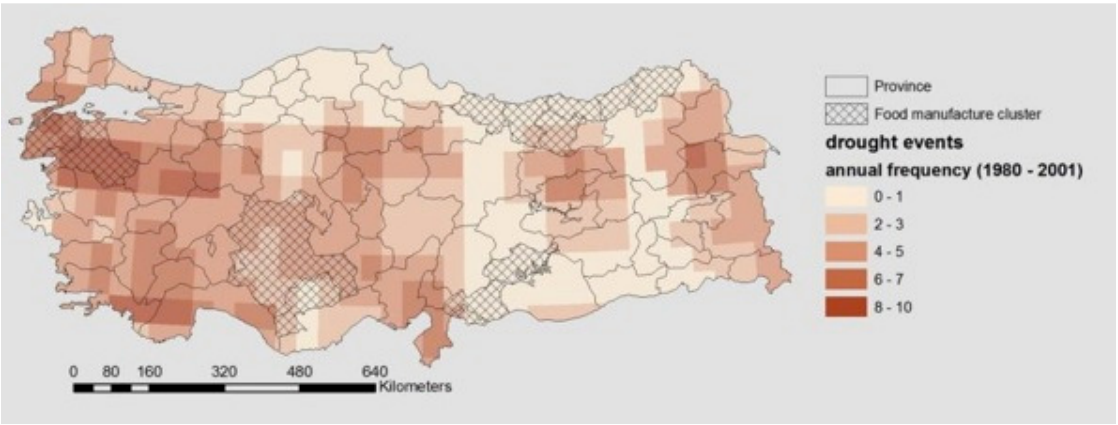

Figure 11: Exposure to drought events[xii].

[ix] Based on topography of Turkey (NASA Shuttle Radar TM 90m). Data source: Jarvis, A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org). GIS spatial analysis by Acclimatise.

[x] Data source: An estimate of the annual frequency of landslide triggered by precipitation. It depends on the combination of trigger and susceptibility defined by six parameters: slope factor, lithological (or geological) conditions, soil moisture condition, vegetation cover, precipitation and seismic conditions. Credit: GIS processing International Centre for Geohazards /NGI.

[xi] Data source: G.R.Brakenridge, "Global Active Archive of Large Flood Events", Dartmouth Flood Observatory, University of Colorado, http://floodobservatory.colorado.edu/Archives/index.html.

[xii] Estimate of global drought annual repartition based on Standardized Precipitation Index. It is based on two data sources: 1) A global monthly gridded precipitation dataset obtained from the Climatic Research Unit (University of East Anglia). 2) A GIS modelling of global Standardized Precipitation Index based on Brad Lyon (IRI, Columbia University) methodology. Credit: UNEP/GRID-Europe.

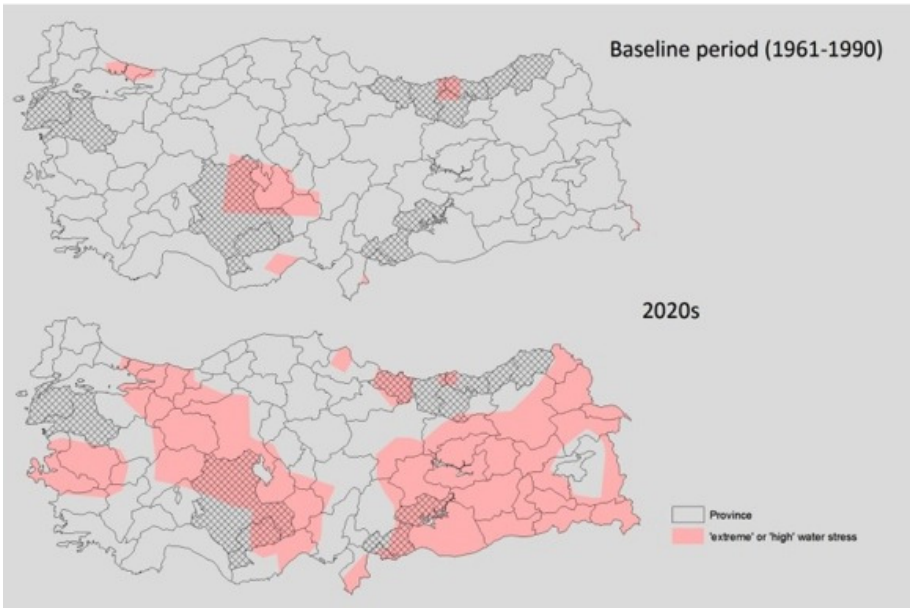

Figure 12: Projected changes in 'extreme' or 'high' water stress regions: Baseline period (top) and the 2020s (bottom)[xiii]

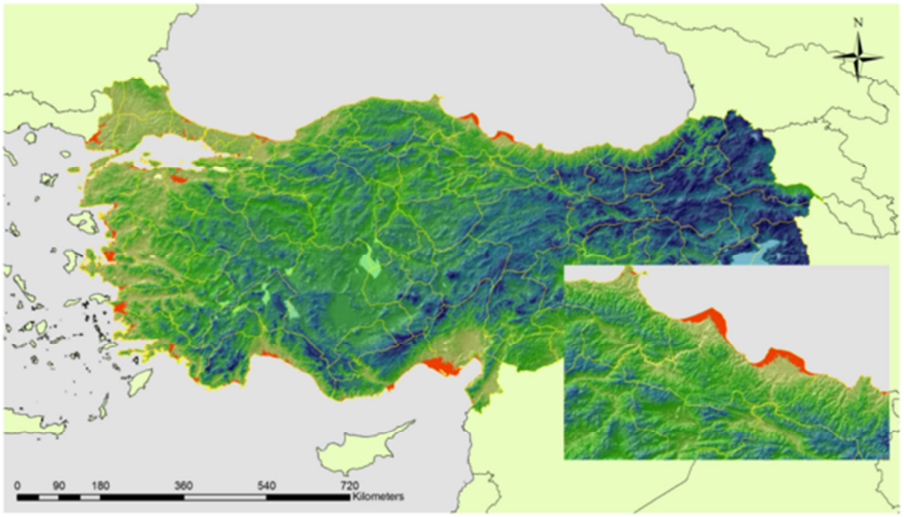

Figure 13: Low lying (coastal) regions at risk from coastal inundation as a result of sea level rise, tidal range and storm surge (10m scenario). Based on topography of Turkey (NASA Shuttle Radar TM 90m). (Data source: Jarvis, A., H.I. Reuter, A. Nelson, E. Guevara, 2008, Hole-filled SRTM for the globe Version 4, available from the CGIAR-CSI SRTM 90m Database (http://srtm.csi.cgiar.org). GIS spatial analysis by Acclimatise.)

[xiii] Data source: Alcamo, Joseph , Flörke, Martina and Märker, Michael (2007) 'Future long-term changes in global water resources driven by socio-economic and climatic changes', Hydrological Sciences Journal, 52: 2, 247 — 275. The index includes the impact of climate change and population, as well as the effects of income, electricity production, water use efficiency and other driving forces on water stress.

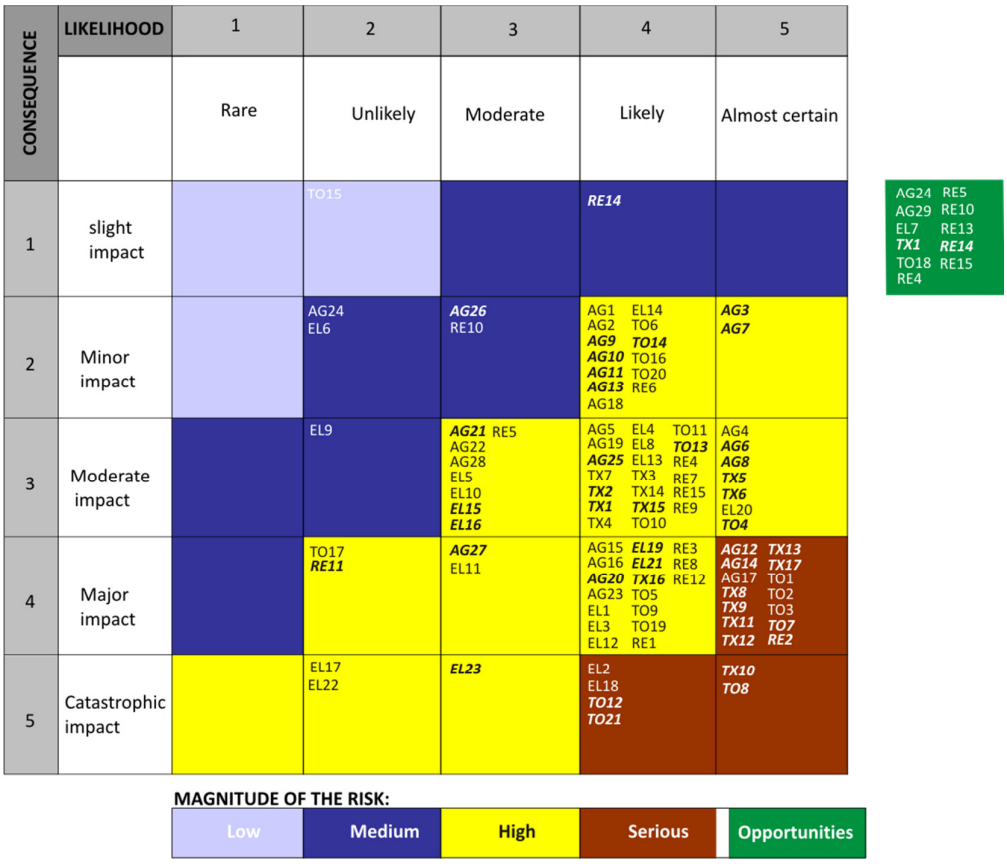

Figure 14: Risk matrix for all priority sectors in Turkey. Cross sectoral risk are highlighted in *italics*.

Table 5: High risks identified per sector in Turkey

ID code	Risk category	Climate driver and process	Consequence for the private sector	Risk (↓) / Opportunity (↑) / Combination (=)	likelihood (1-5)	consequence (1-5)	Significance of risk	Cross sectoral risks
Manufacture of food products								
AG11	Operational performance	Decrease in groundwater recharge due to reduced rainfall and increasing temperatures	Decreasing water quality and groundwater levels	↓	5	4	20	x
AG12	Financial	Decrease in groundwater recharge due to reduced rainfall and increasing temperatures	Increasing CAPEX and OPEX for water supply and treatment	↓	5	4	20	x
AG14	Financial	Increased incidence of heatwaves	Increasing OPEX for workplace cooling	↓	5	4	20	x
AG17	Environmental and social performance	Increased water scarcity	Conflict and disputes arise between farmers and local population	↓	5	4	20	
Tourism								
TO8	Reputation	Decrease in groundwater level and water scarcity	Conflicts with local communities and environment over the use of water	↓	5	5	25	x
TO1	Financial	Increase in temperature and poor building design causes high internal building temperatures	CAPEX due to increased demand for space cooling systems in	↓	5	4	20	

ID code	Risk category	Climate driver and process	Consequence for the private sector	Risk (↓) / Opportunity (↑) / Combination (=)	likelihood (1-5)	consequence (1-5)	Significance of risk	Cross sectoral risks
			the tourism sector					
TO2	Financial	Increase in temperature and poor building design causes high internal building temperatures	OPEX due to increased demand of energy at higher costs	↓	5	4	20	x
TO3	Financial	Decrease in groundwater level	CAPEX and OPEX due to more complex and energy intensive groundwater abstraction processes	↓	5	4	20	x
TO7	Operational performance	Increase in high intensity rainfall events and insufficient drainage capacity at hotels and supporting infrastructure causes flooding	Asset damage and operational disruption	↓	5	4	20	x
TO12	Safety and health	Increase in high intensity rainfall events and lack of climate resilient asset design and infrastructure causes flooding	Workforce and customer health and safety issues	↓	4	5	20	x
TO21	Safety and health	Increasing risk of wildfires	Workforce and customer health and safety issues	↓	4	5	20	x
Wholesale and retail trade of household goods								
RE2	Financial	Increase in temperature and poor building design causes high internal building temperatures	CAPEX due to increased demand for space cooling systems in commercial buildings	↓	5	4	20	x

ID code	Risk category	Climate driver and process	Consequence for the private sector	Risk (↓) / Opportunity (↑) / Combination (=)	likelihood (1-5)	consequence (1-5)	Significance of risk	Cross sectoral risks
Manufacture of textiles and wearing apparel								
TX10	Environmental and social performance	Decreasing ground water levels	Conflict with local environment & communities	↓	5	5	25	x
TX8	Financial	Decreasing ground water levels	Increasing CAPEX and OPEX for improving water efficiency	↓	5	4	20	x
TX9	Reputation	Decreasing ground water levels	Reduction in abstraction licences	↓	5	4	20	x
TX11	Financial	Decreasing ground water levels	Increased OPEX associated with water supply	↓	5	4	20	x
TX12	Financial	Decreasing ground water levels	Increased OPEX and CAPEX due to drilling needs to access ground water	↓	5	4	20	x
TX13	Financial	Increasing climate hazards (e.g. flood, landslide and fire risk) and lack of climate proof asset design and infrastructure	Increased CAPEX, OPEX for protection against climate hazards	↓	5	4	20	x
TX17	Safety and health	Increased heatwaves	Increased heat stress amongst workforce	↓	5	4	20	x
Electricity production, transmission and distribution								

ID code	Risk category	Climate driver and process	Consequence for the private sector	Risk (↓) / Opportunity (↑) / Combination (=)	likelihood (1-5)	consequence (1-5)	Significance of risk	Cross sectoral risks
EL2	Financial	Reduction in capacity of hydro power plant	Increasing CAPEX to retrofit and design for changes in seasonal hydrology	↓	4	5	20	
EL18	Operational performance	Increased risk of flooding and landslides	Damage to energy generation sites (including TPP, HPP, solar, wind)	↓	4	5	20	

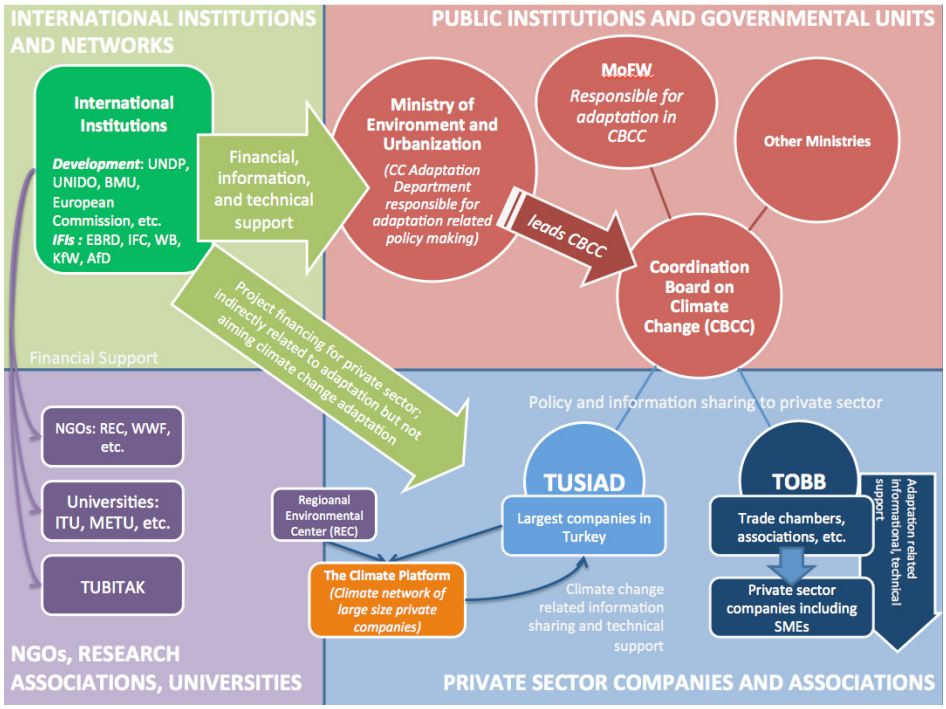

Figure 15: Climate change and private sector networks in Turkey.

Table 6: Sectors ranked based on economic criteria

1. Wholesale trade, except of motor vehicles and motorcycles	9. Manufacture of fabricated metal products, except machinery and equipment
2. Retail trade, except of motor vehicles and motorcycles	10. Manufacture of other non-metallic mineral products
3. Land transport and transport via pipelines	11. Manufacture of motor vehicles, trailers and semi-trailers
4. Manufacture of food products	12. Specialised construction activities
5. Construction of buildings	13. Electricity, gas, steam and air conditioning supply, of which electric power production, transmission and distribution accounts for 91% and 90% of employment and production value in the sector respectively
6. Manufacture of wearing apparel	14. Wholesale and retail trade and repair of motor vehicles and motorcycles
7. Manufacture of textiles	15. Manufacture of basic metals
8. Food and beverage service activities	

Table 7: CSIS sector scores

1. Electricity, gas, steam and air conditioning supply (primarily considering the electric power production, transmission and distribution aspect in this ranking)	11. Mining of coal and lignite
2. Manufacture of food products	12. Manufacture of coke and refined petroleum products
3. Water collection, treatment and supply	13. Civil engineering
4. Manufacture of beverages	14. Manufacture of paper and paper products
5. Sewerage	15. Other mining and quarrying
6. Extraction of crude petroleum and natural gas	16. Water transport
7. Tourism (which is a combination of accommodation and food and beverage service activities)	17. Manufacture of tobacco products
8. Manufacture of textiles	18. Mining of metal ores
9. Manufacture of chemicals and chemical products	19. Wholesale trade, except of motor vehicles and motorcycles
10. Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	20. Manufacture of wearing apparel

Table 8: Priority sectors of the Turkish economy based on economic analysis and climatically sensitive dependencies.

Sector name	Combined economic importance rank	Dependency on Climatically Sensitive Infrastructure and Systems (CSIS)						
		Large fixed assets	Transport	Water	Other (climatically sensitive) raw materials	Market demand	Energy	Ecosystem
Wholesale trade[xiv], except of motor vehicles and motorcycles	1							
Manufacture of food products	4							
Tourism	6							
Manufacture of textiles	8							
Electricity, gas, steam and air conditioning supply[xv]	12							
Agriculture	N/A[xvi]							

Notes on CSIS scoring system used in Table 8

Score 3 (shaded red): Heavily dependent upon a CSIS for the operation of the majority of this sector's core business activities. Sector typified as having large fixed assets, being heavily dependent on transport infrastructure, and a large consumer of raw materials (often with specifically engineered provision of water/ energy, etc.). Likely to be directly supported by ecosystem services. Disruption to CSIS, even for a short period, could cause an interruption in business continuity.

Score 2 (shaded orange): Moderately dependent on CSIS for the operation of the majority of the sector's core business activities.

Score 1 (shaded green): Low dependency on CSIS for the operation of the majority of the sector's core business activities. Although sector may utilise CSIS, business can continue to operate during disruption to CSIS.

[xiv] The subsectors 'wholesale of household goods' account for 34% and 36% of production value and employment respectively. This is therefore the focus of the analysis.

[xv] Due to the very broad sector description, the following sub-sector (NACE code 'group' level) was chosen for further analysis: 'Electric power generation, transmission and distribution'

[xvi] There is no NACE Rev. 2 economic data for the agriculture sector.

Table 9: Market potential: agriculture

		Investment potential	
Climate resilience investment	**Unit cost (USD)**	**Land area or seed market value**	**USD million**
Water-efficient irrigation	2000/ha	2.1million ha	2520
Drought-resistant seeds	Twice the price of conventional seeds	USD 195 million p.a.	234 p.a.

Table 10: IRRs for various water efficiency measures in agriculture

Case	Investment size (USD/ha)	**Annual reduction in costs in relation to investment size**	**Project IRR**	**Loan IRR**	**Weighted Average Costs of Capital (WACC)**	**NPV (USD)**
Irrigation, low water price (64 USD)	1,793	87%	57.3%	7.7%	7.1%	3,474
Irrigation, high water price (USD 322/ha)	1,793	94%	64.4%	7.7%	7.1%	4,016
Drought-resistant seeds (assumes maturity of 12 months)	66	25%	29.9%	7.7%	7.1%	6

Table 11: Market potential: agri-processing/ manufacturing

		Investment potential	
Climate resilience investment	**Unit cost (USD)**	**No. of potential beneficiaries**	**USD million**
Improved process efficiency	50,000/system	2,500 enterprises	75
Recycling and reusing process and grey water	60,000/system	5,000 enterprises	180

Table 12: IRRs at different for various water efficiency measures (including max and min water prices) for agri-processing/ manufacturing

Case	Annual reduction in costs in relation to investment size	Project IRR	Loan IRR	WACC	NPV (USD)	Investment size (USD)
Effective process systems, low water price (USD 0.19/m^3)	20%	-7.3%	7.7%	7.1%	-26,781	50,000
Effective process systems, high water price (USD 0.29/m^3)	30%	7.2%	7.7%	7.1%	42	50,000
Recycling and reusing process and grey water, low water price (USD 0.11/ m^3)	30%	7.2%	7.7%	7.1%	50	60,000
Recycling and reusing process and grey water, high water price (0.19/m^3)	50%	30.1%	7.7%	7.1%	64,425	60,000
Pakyürek	63%	42.4%	7.2%	7.1%	201,230	76,900
Gülsan	1040%	840.7%	6.7%	7.1%	4,014,732	56,900

Table 13: Market potential: buildings

			Investment potential	
Climate resilience investment	**Residential or commercial**	**Unit cost (USD)**	**No. of buildings (unless otherwise stated)**	**USD million**
Building insulation	Residential	12,000/building	662,200	4,790
	Commercial	300,000/building	69,300	12,555
Green roof	Residential	120/m^2	184,000 m^2	1,315
	Commercial	120/m^2	241,000 m^2	1,720

Passive ventilation and cooling	Residential	50,000/building	110,000	3,350 p.a.
	Commercial	150,000/building	11,500	1,055 p.a.
Green and blue infrastructure	Residential	500,000/development	625 developments	187.5
	Commercial	500,000/development	1,875 developments	562.5
Heat-reflective glazing	Residential	5,000/building	645,000	1,935
	Commercial	100,000/building	63,750	3,825
Rainwater harvesting/ recycling	Residential	400/m³	43,000m^3	10.5
	Commercial	400/m³	4,500m^3	1
Surface water drainage	Residential	1,000,000/ development	625 developments	375
	Commercial	1,000,000/ development	1,875 developments	1,125
Flood protection	Residential	2,000/building	329,000	397.5
	Commercial	50,000/building	34,500	1,040

Table 14: IRRs for different adaptation investments: buildings

Case	Savings in relation to investment size	Project IRR	Loan IRR	WACC*	NPV (USD)	Investment size (USD)
Insulation	18%	9.0%	7,7%	7,1%	1511	7445
Green roof	7%	-3.3%	7.7%	7.1%	-6369	6902
Passive ventilation and cooling	8%	4%	7.7%	7.1%	-26969	50,000
Green and blue infrastructure	23%	13.3%	7.7%	7.1%	13,882,665	500,000
Heat-reflective glazing	9%	-0.6%	7.7%	7.1%	-3624	5,000

Water harvesting/ recycling, high water price (USD 2.05/ m^3)	4%	-8.0%	7.7%	7.1%	-17,988	15,000
Water harvesting/ recycling, low water price (USD 0.9/ m^3)	0.01%	-14%	7.7%	7.1%	-21,365	15,000
Surface water drainage systems	8.4%	-0.9%	7.7%	7.1%	-748,870	1,000,000
Flood protection	16%	7.1%	7.7%	7.1%	-9	2,000

Source: Own estimations. All investments are assumed to have a lifetime of 20 years.
*Weighted average costs of capital

Appendix 2: 'Long-list' intervention summary matrices

Energy generation, transmission and distribution[xvii]

Energy Generation, Transmission and Distribution: Summary Matrix	
Priority sub-sector 1	**Hydropower**
Intervention(s)	• The key climate change risks are reduced water availability affecting HPP production, extreme flood events affecting dam safety, increased landslides and sedimentation. • Climate resilience measures can be integrated into investments in HPPs. Opportunities for building climate resilience are greatest for new assets, though improvements can also be made when rehabilitating existing HPP assets. • The potential beneficiaries are typically international and domestic renewable energy companies or conglomerates with power generation operations, seeking to raise finance under PPP concessions. • There will be a range of investment sizes, depending on the scale of the HPPs. Based on the estimations that *"small and medium hydropower plants are likely to cost from US$1 million to US$ 100 million, based on a typical capital cost of around US$2,000 per kW"*[60], SHPPs will generally be better suited to intermediated finance, and MHPPs could benefit from direct or intermediated finance. • Potentially appropriate technologies and practices may include: 1. Turbines, turbine runners and generators designed to cope with projected water flows. 2. Stop, control and shut off valves to reduce water losses. 3. Spillways designed to cope with higher extreme flows. 4. Landslide early warning systems.
Priority sub-sector 2	**Thermal power plants**
Intervention(s)	• The most important climate change impacts are reduced output due to lack of cooling water, warmer cooling water (river- or lake-cooled TPPs), or higher air temperatures (air-cooled TPPs), along with flooding or damage of coastal TPPs. • Climate resilience measures can be integrated into investments in privatised TPPs, or the design and construction of new TPPs. Opportunities for building climate resilience are greatest for new assets. • The potential beneficiaries are international and domestic power generation companies or conglomerates with power generation operations, seeking to raise finance under PPP arrangements. • Potentially appropriate technologies and practices may include: 1. Turbines, turbine runners and generators designed to cope with projected water flows. 2. Stop, control and shut off valves to reduce water losses. 3. Water storage reservoirs.

[xvii] Interventions with energy efficiency dimensions among end-users are covered under other sectors.

	4. Channels dimensioned to reduce head loss or increase discharge capacities.
Priority sub-sector 3	**Electricity transmission and distribution**
Intervention(s)	• The most important climate hazards are heat waves, extreme winds, flooding, landslides and avalanches. • The potential beneficiaries are the Turkish Electricity Transmission Company (TEIAS) and private international and domestic electricity distribution companies. • Potentially appropriate technologies and practices may include: 1. Air-cooling (instead of water cooling) in highly water-stressed areas. 2. Increased cooling water flow rates. 3. Cooling systems (e.g. heat exchangers) designed to cope with higher temperatures. 4. Larger condensers. 5. Combustion turbine inlet air-cooling systems.

Transport

Transport sector: Summary Matrix	
Priority sub-sector 1	**Roads**
Intervention(s)	• The dominant climate change impacts are ground instability, flooding from drains and nearby rivers, and overheating damaging road surfaces. • Climate resilience measures can be integrated into investments in privatised roads and associated infrastructure such as bridges and tunnels, or the design and construction of new road assets. The construction of new roads provides the greatest opportunity to build in climate resilience measures at lower capital cost. • The private sector is highly dependent on a robust and efficient transport network and integrating climate resilience in the design and operation of transport infrastructure offers important economic benefits. • A small proportion, 2000 km of Turkish highways, has been privatised under BOT concessions, and the General Directorate of State Highways and the Privatisation Administration is seeking to privatise over 5500 km across the country through 24 schemes (as of September 2012)[61]. • Potential beneficiaries for investment are: ◦ Domestic and international turnkey engineering companies engaged in raising finance under PPP BOT road concessions. ◦ Municipal and central government, which have responsibilities for service provision of roads and drainage in urban areas and state highways respectively. • Potentially appropriate technologies and practices may include:

	1. Heat resistant pavement materials. 2. Reflective surface materials (e.g. light coloured gravel) to reduce road temperature. 3. Surface water drainage, attenuation and outfall systems designed to cope with projected volumes of water. 4. Sustainable drainage systems.
Priority sub-sector 2	**Ports**
Intervention(s)	• The dominant climate change impacts are coastal flooding and erosion, from sea level rise and storm surges, and surface flooding due to overloading of drainage systems. • Climate resilience can be integrated into investments in privatised ports, which may include the construction of new components. Opportunities for building climate resilience are greatest when integrated into the initial design and construction of new infrastructure rather than during retrofit. • The General Directorate of Turkish State Railways (TCDD) is the state entity that has historically owned and operated the largest and most important ports. Since 1997, 17 ports[xviii] have been privatised through 30-year long transfer of rights (TOR) concessions[62] from the General Directorate of Turkish State Railways (TCDD), and others are in the pipeline. • The Government's agenda to privatise ports provides a key opportunity to invest in reducing the risk of flooding (from rising sea level and drainage). • The potential beneficiaries are domestic and international port operator companies engaged in raising finance under PPP BOT/ TOR concessions. • Potentially appropriate technologies and practices may include: 1. Upgrade flood defences. 2. Upgrade infrastructure with height restrictions. 3. Upgrade berthing equipment. 4. Strengthen foundations, stabilise slopes / embankments. 5. Increase drainage system capacity. 6. Fit one-way valves on drainage outlets to sea.
Priority sub-sector 3	**Logistic centres**

[xviii] Tekirdag, Rize, Ordu, Sinop, Giresun, Hopa, Antalya, Alanya, Marmaris, Kuşadası, Çeşme, Trabzon, Dikili, Mersin, Samsun, Bandırma and Iskenderun

Intervention(s)	• Climate change impacts include flooding from drains and nearby rivers, and overheating, which will affect the storage of temperature-sensitive products (e.g. perishable food products and pharmaceutical goods). • Climate resilience can be integrated into investments in the construction of new logistic centres that seeks to reduce principally flood-risk and energy consumption due to the need for increasing space cooling. • 12 logistic centres are planned to be developed under PPP arrangements close to "Organised Industrial Zones" and include Istanbul, Kosekoy (Izmit)xix, Gelemen (Samsun)xx, Hasanbey (Eskisehir)[xix], Bogazkopru (Kayseri)xxi, Gokkoy (Balikesir), Yenice (Mersin), Usak, Palandoken (Erzurum), Kayacik (Konya), Kaklik (Denizli)[xix], Bozuyuk (Bilecik)[63]. The Turkish State Railways (TCDD) forms the public sector component of the PPP arrangements. • The potential beneficiaries are domestic and international logistics companies engaged in raising finance under PPP agreements to develop and operate these logistic centres. • Potentially appropriate technologies and practices may include: 1. Flood defences. 2. Increase drainage system capacity. 3. Increasing the use of natural ventilation and shading; underground cooling pipes and ground heat sink pumps64. 4. Improvements to refrigeration systems, including fans and air conditioning. [Note: such adaptation measures will increase greenhouse gas emissions unless renewable energy sources are used.]

[xix] Under construction (as of 2011)
[xx] Operational since 2007
[xxi] Bidding process ongoing (as of 2011)

Buildings and built environment

Buildings and the Built Environment: Summary Matrix	
Priority sub-sector 1	**Private / commercial property**
Intervention(s)	• The most important climate hazards for property are extreme high temperatures (overheating), water shortages and flooding (from inadequate drainage, rivers or the sea). • Climate resilience measures can be integrated into private/ commercial property/ smaller private/ commercial property investments and individual households investments. New build property and redevelopments/ refurbishments of existing stock offer good opportunities to build in climate resilience measures at lower capital cost. • Potential beneficiaries are domestic and international property developers, hospitality companies and providers of hospitals, healthcare and educational facilities. Smaller investments could also benefit owners/ users of smaller private/ commercial property and individual households. • Potentially appropriate technologies and practices may include: 1. Green and blue infrastructure (e.g. trees and fountains) to provide cooling. 2. External blinds or shutters, heat-reflective glazing and improved insulation to prevent heat penetration. 3. Ventilation. 4. Rainwater harvesting, grey water recycling, low-flush toilets, low-flow taps and showerheads., water meters 5. Surface water drainage systems (including sustainable drainage systems) designed to cope with projected volumes of water taking account of climate change. 6. Low-flush toilets, low-flow taps and showerheads. 7. Non-return valves on drains and sewage pipes, removable flood protection products like flood boards, air-brick covers and flood skirts.
Priority sub-sector 2	**Municipal buildings**
Intervention(s)	• The most important climate change impacts for housing developments are overheating, water shortages and flooding (from inadequate drainage, rivers or the sea). • The potential beneficiaries are the Housing Development Administration, TOKİ, municipalities and their private sector partners in PPP schemes. • Potentially appropriate technologies and practices may include: 1. Green and blue infrastructure (e.g. trees and fountains) to provide cooling. 2. External blinds or shutters, heat-reflective glazing and improved insulation to prevent heat penetration. 3. Ventilation. 4. Green roofs to reduce overheating and runoff rates. 5. Rainwater harvesting, grey water recycling, low-flush toilets, low-flow

	taps and showerheads. 6. Surface water drainage systems (including sustainable drainage systems) designed to cope with projected volumes of water taking account of climate change. 7. Low-flush toilets, low-flow taps and showerheads. 8. Non-return valves on drains and sewage pipes, removable flood protection products like flood boards, air brick covers and flood skirts.
Priority sub-sector 3	**Municipal water supply**
Intervention(s)	• Due to high population and urban growth rates many regions are already facing seasonal or chronic water shortages, necessitating infrastructural development in the sector. The identification and reduction of technical (leakage) and commercial (illicit) losses are critical areas to increase water security. • Increasing water scarcity in urban areas is the highest-ranking climate risk according to the MoEU's National Climate Change Adaptation Action Plan and Strategy[65]. • The potential beneficiaries include over 2,900 municipal governments; or Private developers (i.e. domestic and international turn-key water engineering companies) engaged in raising finance as part of a PPP/ PSP concession. • Potentially appropriate technologies and practices may include: 1. Leakage reduction will require the replacement of ageing pipework with modern PE or PVC piping. 2. Leakage monitoring and reporting technologies will be required as part of on-going operation and maintenance (O&M) programmes, including the setting up of distribution monitoring areas (DMAs) to provide active leakage monitoring and control.
Priority sub-sector 4	**Municipal waste water collection and treatment**
Intervention(s)	• Climate change impacts include flooding of assets, reduced dilution of discharge water during dry periods, and higher air temperatures enhancing the prevalence of biological contaminants in the treatment system and in river discharges. The rehabilitation and construction of climate resilient wastewater collection and treatment systems are critical areas to build climate resilience. • Wastewater treatment works (WWTWs) play a critical role in sustaining and improving future river water quality during low flow/ drought events – currently a critical issue in Turkey. • The potential beneficiaries include over 700 municipal governments without wastewater treatment infrastructure, and extension/ rehabilitation of existing treatment infrastructure for over 2200 municipalities; or private developers (i.e. domestic and international turn-key water engineering companies) engaged in raising finance as part of PPP/ BOT/ O&M agreements. • Potentially appropriate technologies and practices may include: 1. Turkish WWTW currently utilise a range of treatment methods including advanced (37.9%), biological (34.3%), physical (27.6%) and natural (0.2%). It is anticipated that these systems/ technologies will remain relevant and the actual method will be identified as part of the above feasibility studies.

Priority sub-sector 5	**Municipal urban transport infrastructure**
Intervention(s)	• Urban transport infrastructure is susceptible to heat damage, ground instability affecting earthworks and flooding. Coastal transport infrastructure may also be vulnerable to erosion. • Climate resilience measures can be integrated into investments in municipal urban transport systems. Urban transport is likely to see substantial growth in Turkey in the coming years, offering excellent opportunities to address adaptation needs to ensure these long-lived investments perform as intended over their lifetimes. • The potential beneficiaries are the metropolitan municipalities who own urban transport infrastructure. • Potentially appropriate technologies and practices may include: 1. Rail designed to cope with a higher stress free temperature (SFT). 2. Surface water drainage, attenuation and outfall systems designed to cope with projected volumes of water taking account of climate change. 3. Sustainable drainage systems. 4. Strengthened foundations to address under-scouring of quays and piers due to sea level rise and coastal erosion.

Agriculture

Agriculture sector: Summary Matrix	
Priority sub-sector 1	**Agricultural production**
Intervention(s)	• Higher temperatures and changes in precipitation will impact crop yields and cause thermal stress of livestock, with implications for animal productivity and health. • The majority of Turkish farms are SMEs, operating on holdings smaller than the EU average (two-thirds of farms are less than 5 hectares) and with modest incomes (92% of households are in the small economic size group (<TRY 13,000 p.a./ EUR 7,222 p.a.)). • Access to finance remains limited for small farms and the majority are highly dependent on government subsidies to survive. • The exceptions are large-scale commercial farms in the prosperous Aegean and Marmara coastal regions, which produce high value, export crops (e.g. hazelnuts, figs, raisins and tomatoes). • Investments should principally aim to increase water efficiency, build resilience to droughts and avoid overheating for crops and livestock housed indoors. • The potential beneficiaries comprise: 1. Large-scale commercial farms seeking to raise finance to purchase new equipment or retrofit existing assets. 2. Small-scale farms seeking to make improvements in agricultural productivity. • Potentially appropriate technologies and practices may include: 1. Water efficient drip-, sprinkler-, or micro-sprinkler irrigation systems. 2. Rainwater harvesting systems. 3. Drought-resistant or salinity-tolerant seed varieties, or those that can use

	lower quality water (i.e. treated wastewater). 4. Natural ventilation and shading for buildings; underground cooling pipes and ground heat sink pumps[66].
Priority sub-sector 2	**Agri-processing**
Intervention(s)	• The most important climate hazards for agri-processing decreasing water availability and quality, and increased temperatures that will affect product quality and the health and safety of food products – both perishable goods and livestock. • Investments should principally aim to optimising operating conditions through increasing water efficiency and temperature control. • The potential beneficiaries are private domestic food and beverage manufacturers seeking to raise finance to purchase new equipment or retrofit existing assets. • Potentially appropriate technologies and practices may include: 1. Replacement of existing process equipment with technologies that have operational thresholds that encompass predicted future climate-related operating conditions. This may entail the changing of a range of technologies, including motors, generators, computerised control systems, process heating systems, fans, bearings and belts, boilers, HVAC, and compressors. 2. Process technology to reduce water consumption may include recycling and reusing process and grey water, changing production processes.
Intervention(s)	• Innovative finance mechanism for investments in technology to strengthen supply chains. This has the potential to build climate resilience for off-takers[xxii], and their suppliers by allowing off-takers to purchase equipment (see appropriate technologies below) that they loan or sell at subsidised rates to their suppliers to assist in reducing climate risk and building resilience. • The potential beneficiaries are large-scale agri-processing off-takers (i.e. the upper 0.5% and 2% of food and beverage manufacturers, respectively) who are motivated to make their supply chains more resilient by strengthening the climate resilience of their suppliers. • Potentially appropriate technologies and practices may include: 1. Water efficient drip-, sprinkler-, or micro-sprinkler irrigation systems. 2. Rainwater harvesting systems. 3. Drought-resistant or salinity-tolerant seed varieties, or those that can use lower quality water (i.e. treated wastewater).
Intervention(s)	• This innovative financing mechanism has the potential to build climate resilience for off-takers, and their suppliers, through incentivising investments in supplier operations. • Potential beneficiaries include domestic agricultural producers. Local banks will be required to distribute the finance to them, due to their small size and associated low value of investment (< €5 million). • The intervention also involves an off-taker (domestic or international agri-processing company) who is highly dependent on climate-sensitive supply chains, and who is therefore willing to build long-term relationships with their agricultural producers and help them gain improved access to finance.

[xxii] Buyers of a resource, in this case agricultural products from the producer.

Priority sub-sector 3	**Transport and logistics**
Intervention(s)	• Higher temperatures will have impacts for both product quality and health and safety during the storage and transportation of food produce – both perishable goods and livestock. • Climate resilience measures can be integrated into investments in space cooling of storage facilities and vehicles, to help maintain product quality. • There are significantly more licensed firms in national goods transport (172,945) compared to international goods transport (1,634). (Note: These values are not purely for the transport of agricultural products). • The vast majority (95%) of freight transport companies are SMEs • The potential beneficiaries are private domestic and international transport and logistics companies seeking to raise finance to purchase new equipment or retrofit existing assets. • Potentially appropriate technologies and practices may include: 1. Buildings: a. External blinds or shutters, heat-reflective glazing and improved insulation to prevent heat penetration. b. Ventilation. c. Green roofs to reduce overheating. d. Increasing the use of natural ventilation; underground cooling pipes and ground heat sink pumps. 2. Vehicles. 3. Improvements to refrigeration systems, insulation and fans.

Manufacturing

Manufacturing Sector: Summary Matrix	
Priority sub-sector 1	**Heavy and light manufacturing**
Intervention(s)	• The dominant climate change impacts relate to temperature control and increasing water scarcity (there will be 'high' and 'extreme' water stress in some areas of Turkey by the 2020s). • Investments could focus on improving process water efficiency and reducing energy consumption associated with cooling/heating and the temperature control for climate sensitive process equipment[67]. • Potential beneficiaries include: 1. Over 4,000 national and international chemical companies engaged in petrochemicals, fertilizers, pharmaceuticals, paints and coatings, and boron, chrome and soda production. 2. Over 60,000 domestic ferrous and non-ferrous metal manufacturers including iron, steel, aluminium, copper, metal forging and casting companies, some of which are subsidiaries of large international mining/ metal processing companies. 3. Almost 70,000, predominantly domestic SMEs, in the food (see agri-processing

	sector), wearing apparel/ textiles market. • Potentially appropriate technologies and practices may include: 1. Appropriate technology identified by the above audit will comprise of the replacement of existing process equipment with technologies that have operational thresholds that encompass predicted future climatic operating conditions. 2. This may entail the introduction of a range of technologies, including motors, generators, computerised control systems, process heating systems, fans, bearings and belts, boilers, air compressors, condenser coils, refrigeration and HVAC, and compressors. 3. Process technology to reduce water consumption may include recycling and reusing process and grey water (including reverse osmosis), changing production processes, using low water technologies, and reducing leakage.
Intervention(s)	• This innovative financing mechanism has the potential to build climate resilience for off-takers[xxiii], and their suppliers, though assisting investments in supplier operations. • Potential beneficiaries include suppliers of climate-sensitive products to the manufacturing sector, notably to the textile/ wearing apparel manufacturing market. • The intervention also involves an off-taker (manufacturing company) who is highly dependent on climate-sensitive supply chains, and who is therefore willing to build long-term relationships with their suppliers.

[xxiii] Buyers of a resource from a producer

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