ECONOMY-WIDE ANALYSIS OF WATER RESOURCE MANAGEMENT: A CGE MODEL FOR TURKEY

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ABSTRACT

ECONOMY-WIDE ANALYSIS OF WATER RESOURCE MANAGEMENT:
A CGE MODEL FOR TURKEY

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Water-related issues are gaining importance at both national and global level. Water resources are becoming insufficient in meeting the rising needs. As resources are distributed unevenly throughout the world, supply and demand correspondence is difficult to meet. The analysis of water related issues should be addressed within a comprehensive framework. CGE models offer this possibility. This study aims to construct a CGE model for Turkey which includes water as a factor of production. It relates water issues with another troublesome debate that is important for Turkey: trade liberalization in agriculture. Turkey as a member of WTO and a candidate country for the EU has to consider the effects of a further liberalization in agriculture on its economy. In this study a trade liberalization scenario and a water-policy scenario have been discussed. Additional simulations are conducted in the case of a productivity increase in agriculture. Results show that, trade liberalization in agriculture leads to an increase in GDP and income levels, but had a negative impact on the trade balance in agricultural products. Applying a "selective water tax" will result in a decrease in production and consumption in water-intensive sectors, as well as in the private income. For the first simulation, productivity increase in agriculture leads to a further increase in both GDP level and incomes, and it compensates the trade distortions resulting from the tariff reduction. In water simulation, private income increases with productivity increase and depletion in production and consumption of agricultural products reversed. Moreover, the net exports in agriculture improve significantly.

Keywords: CGE, water resource management, Turkey.

ÖZ

SU KAYNAKLARI YÖNETİMİNİN EKONOMİK ANALİZİ: TÜRKİYE İÇİN BİR HESAPLANABİLİR GENEL DENGE MODELLEMESİ

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Su konusu ulusal ve uluslararası düzeyde önem kazanmıştır. Mevcut su kaynakları artan ihtiyacı karşılayamaz hale gelmektedir. Dünya üzerindeki su kaynakları dengesiz bir şekilde dağılmış olduğundan arz ve talep dengesini bulmak zorlaşmıştır. Su konusunun kapsamlı ve çok yönlü bir şekilde ele alınması gerekmektedir. HGD modelleri bu imkanı sunmaktadırlar. Bu çalışmada Türkiye için su içeren bir HGD modeli kurulmuştur. Model, su konusunu Türkiye için sıkıntılı tartışmalara sebep olan bir başka konuyla, tarımda ticaret serbestisi konusuyla ilişkilendirmektedir. Türkiye, DTÖ üyesi olması ve aynı zamanda AB'ye üyelik için aday olması sebebiyle, tarım sektöründe yapılacak bir liberalizasyon durumunda ekonomisinin nasıl etkileneceğini gözetmek durumundadır. Bu çalışmada, bir ticaret serbestleştirilmesi ve bir de su politikası senaryosu incelenmiştir. Daha sonra bu senaryolar tarımda bir verimlilik artışı olması durumunda tekrar değerlendirilmiştir. Sonuçlar göstermiştir ki tarımda ticaret serbestisi GSYİH ve gelir düzeylerini arttırmakta ancak tarım ürünleri ticaret dengesi üzerinde negatif etki yaratmaktadır. "selektif bir su vergisi" konulması, su kullanımı fazla olan sektörlerdeki üretim ve tüketim ile özel kesimin gelirlerin düşmesine neden olmaktadır. Tarımda verimlik artışı, ilk betimleme için GSYİH ve gelir seviyelerinde daha fazla artış getirmekte, aynı zamanda tarife indiriminden kaynaklanan dış ticaretteki bozulmaları telafi etmektedir. Su betimlemesinde, verimlilik artışı ile özel gelirler artmış, tarım ürünleri üretim ve tüketimdeki düşüş tersine dönmüştür. Bunun yanında tarım ürünleri net ihracatı önemli ölçüde artmıştır.

Anahtar Kelimeler: HGD, su kaynakları yönetimi, Türkiye.

To my beloved family

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CHAPTER 1

INTRODUCTION

Computable general equilibrium (CGE) models are effective in making economy-wide policy analysis. CGE models cover the interrelationship between production activities, factors of production, households, government and rest of the world. Therefore, it is possible to analyze both the direct and indirect effects of a policy change or an economic shock throughout the economy. These features make CGE modeling a suitable method for analyzing water-related issues.

Water is an indispensable part of our lives. Water resources that are being used for various purposes, such as drinking, domestic use, agriculture, industry and recreation, are becoming inadequate in meeting rising needs. Use of scarce resources in a proper way becomes increasingly important. In this respect, developing a comprehensive water management strategy and at the same time, considering the effects of policy changes on these scarce resources becomes essential.

The aim of this study is to construct a water extended CGE model for Turkey. The model consists of nine sectors from which four are agricultural (growing cereals and other crops, growing vegetables, horticultural specialties and nursery products, growing fruit, nuts, beverage and spice crops and other agriculture sectors). Five non-agricultural sectors consist of food, beverage and tobacco, textile, chemical products, metals and other non-agriculture sectors. The choice of the sectoral decomposition is determined in terms of availability of data.

There are four factors of production: labor, capital, land and water. They are mobile across sectors. Total supply of factors is fixed exogenously. Full utilization of labor, capital and land are assumed. While, it is supposed that a certain amount of water is not consumed. A nested production structure is applied with a Leontief Production function to combine water and land inputs, while a Cobb-Douglas production function is implemented to combine the water-land composite with capital and labor.

Armington specification on the trade structure is applied. Accordingly, domestic and traded goods are taken to be imperfect substitutes.

Protective trade policies in major crops together with government subsidies curtails the productivity growth and with the tax burden associated with them, harm the taxpayers and consumers, so the economy as a whole (Çakmak, 2004). In fact, there is an ongoing debate on an international scale for liberalizing agricultural trade. Although WTO countries seem to agree on the need for liberalization in agriculture, no agreement has been achieved so far on further liberalization of trade in agricultural products. Turkey implemented the necessary decreases in its agricultural tariff rates committed in Agreement on Agriculture of WTO. However, this did not lead to a real overall average tariff reduction. In this study, a trade simulation examines a situation in which Turkey decreases its agricultural tariff rates leading to a real decrease in its overall average applied tariffs.

Besides the trade simulations, a water policy scenario is also examined. Water is mostly priced below its marginal cost. Especially, low charges for irrigation water cause huge amounts of water to be wasted. In this study, the possible affects of an implementation of a selective water tax is analyzed.

Same simulations are repeated under the assumption of productivity increase in agriculture. This is important for Turkey in order for it to increase its comparative advantage in the international arena. This is mostly indicated in the studies concerning the EU-Turkey trade relations. Turkey has nearly half of both its imports and exports with the EU. Several studies indicate that Turkey can not benefit from Customs Union (CU) enlargement or from an accession with the EU unless it does not apply the necessary structural change policies. This is true even for the sectors that Turkey has a competitive advantage in, namely fruit and vegetable sectors. In fact, Abay (2005) states that without enhancing the quality and standards, Turkey can not benefit from this advantage. He also indicates that for the products which Turkey is short in supply (such as cereals and oil seeds) it is important to increase the productivity. Also, Çakmak and Kasnakoğlu (2002) showed that even a small increase in the productivity in the livestock sector can eliminate the negative impact of a possible accession on livestock production.

In order to display the necessity and the importance of the construction of a model involving water, it is important to discuss the present situation of water resources and the threats they are faced with, and also the misuse of them. Therefore, in the following chapter, the water resources in the world and in Turkey are examined. It is necessary to adopt an effective water management policy in order to protect and use properly the present water resources. Thus, in Chapter 2, also information on water resource management is presented.

An example of a huge water resource development project has been started in the south-eastern part of Turkey. The Southeastern Anatolia Project (GAP) aimed not only in the construction of new dams, hydroelectric power plants and irrigation systems, but also to affect the whole economic and social life of the region. For this reason, it will be treated separately in Chapter 2.

Different modeling choices for water-related issues are discussed in Chapter 3. A brief history of CGE modeling, its advantages and disadvantages are also discussed here. Finally, in Chapter 3 a literature on water-extended CGE models is discussed. Chapter 4 presents the general features of the CGE models and the structure of the CGE model used in this study. The results obtained from the simulations are discussed in Chapter 5. Finally, in the last chapter concluding remarks are given.

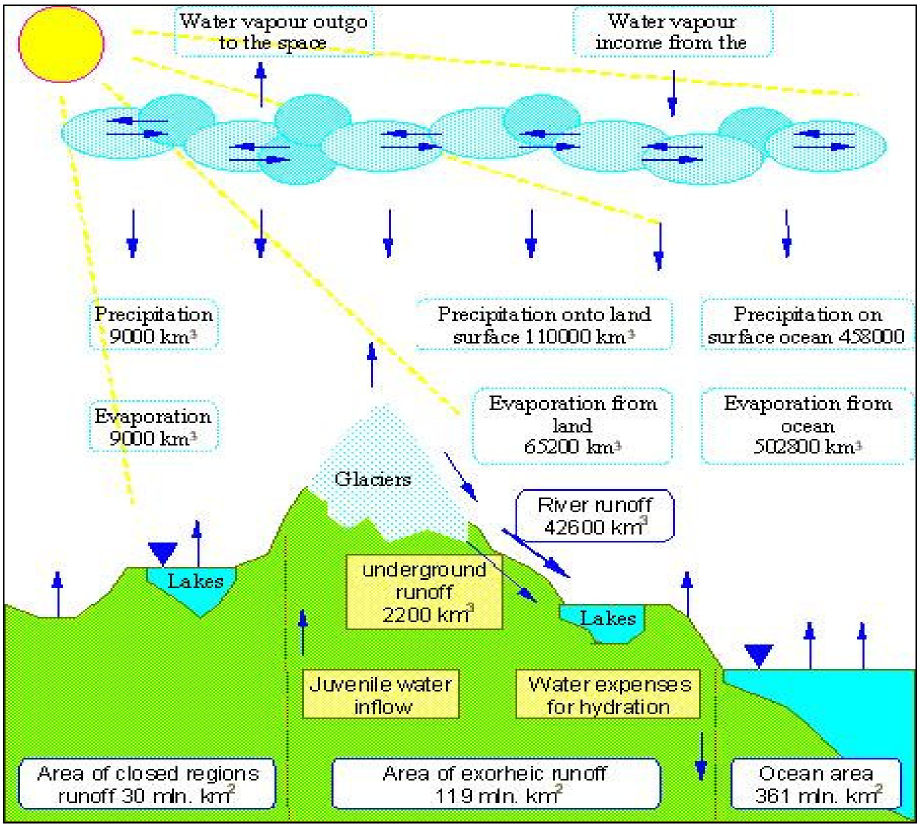
CHAPTER 2

WATER RESOURCES AND WATER MANAGEMENT

2.1 The Hydrological Cycle

The water on earth is distributed in various places such as atmosphere, biosphere, lithosphere and hydrosphere, and in various forms such as vapor, liquid and solid. Water from one natural form is converted to another through the process which is called the hydrological cycle (Figure 2.1). The ground and ocean water evaporates into the atmosphere. After water vapors in the atmosphere reaches to a certain concentration and a proper temperature, it precipitates as rain, snow, hail, sleet back to the earth by atmospheric conditions.

The water which precipitates on earth may go to oceans, seas, underground water reservoirs or mix with the surface water. The surface water eventually reaches to the sea after being used by humans, animals or plants or in some cases without being used at all. The underground water either surfaces out by itself or is drawn out by humans. Thus, this is a natural cycle that provides fresh water for the earth on a continual basis. This cycle is a dynamic process. For many centuries, the fresh water provided by the hydrological cycle was quite sufficient for the living organisms on earth. Unfortunately, the increase in population and the use of water by industries make the demands for the fresh water (mostly from rain, ground water, and surface water) great and it is increasing at an accelerated rate. Also, the construction of dams or changing the course of rivers aids the modifications in the distribution of water on earth.



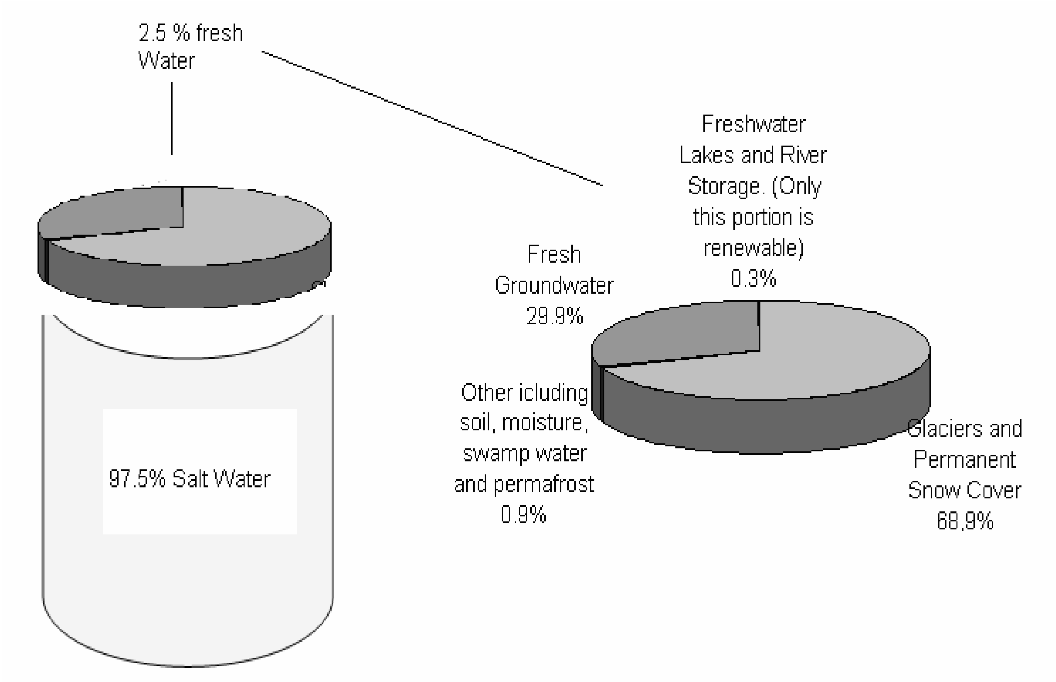
Source: SHI/UNESCO (1999).

Figure 2.1: The Hydrological Cycle

2.2 World Water

Modern estimates show that Earth's hydrosphere contains a huge amount of water (about 1386 million cubic kilometers). Unfortunately, 97.5% of this is saline water and only 2.5% is fresh water. About 68.7% of this fresh water is in the form of ice and permanent snow covers in the Antarctic, the Arctic, and mountainous regions. Only 0.3% is economically usable resources (Figure 2.2).

The renewable water resources include yearly replenished water in the process of water turnover on the earth. It is mainly the river runoff estimated in the volume referred to a unit of time (m^3/s, km^3/year, etc.). In the process of turnover, the river runoff is not only recharged quantitatively, but also its quality is restored. If human contamination of the rivers can be stopped, water can return to its natural purity. So the river runoff is actually representing the renewable water resources, and is the most important component in the hydrological cycle. It provides the major volume of water consumption in the world (SHI/UNESCO, 1999).



Source: SHI/UNESCO (1999).

Figure 2.2: Total Global Water

According to SHI/UNESCO (1999) the regional distribution of river runoff and water use is extremely uneven. While in some regions water resource use is large, in others water is used less when compared to the available resources. Modern water withdrawal is 24-30% of water resources in Southern and Central Europe. It is between 1.5% and 3.0% in the north. This value is 1% for North America, but 28% for US territory. In Africa, the northern part is using 95% of the available water resources, while in other regions (especially in Central Africa) water withdrawal is negligibly small when compared with the amount of water resources. In southern, western, and central Asia and Kazakhstan, the use of water resources is about 42-84%. But, in Siberia and the Far East, this use is not above 1%. In all regions of

South America, the use of water is only between 2-4% of the available quantities. It is estimated that by 2025, the unevenness in the distribution of water resources and water use will increase.

Analyses show that water resources are fully depleted in many countries. Besides using all local water resources, some of the countries also use a great part of the fresh water inflow coming from neighboring territories. About 75% of the Earth's population lives in the countries and regions where 20% of water resources being used (SHI/UNESCO, 1999).

Various indices are used to measure water stress. One is the ratio of water withdrawals for human use to renewable resources, which is called the 'criticality ratio'. It has been estimated globally and projected to 2025 (Alcamo et al., 1999). This measure shows that by 2025, four billion people, more than half of the world's population, will be living in countries facing high water stress (corresponding to criticality ratio that is greater than 40 percent) (Rosegrant et al., 2002).

Over the period 1995-2025, total global water withdrawals are expected to increase by 23 percent (Rosegrant et al., 2002). For developing countries, this increase may go up to 28 percent. Water use is expected to increase by 75 percent in the domestic sector, 72 percent in livestock and 42 percent in industry. Irrigators' water consumption is assumed to increase at a lower rate of 4 percent over the period, but due to the dominance of the irrigation sector in total water use, the absolute increase is similar to that of the other sectors (Rosegrant et al., 2002).

Water resources are rapidly depleting. Currently available resources are becoming insufficient in meeting this growing demand. Unfortunately, these scarce resources are under threat. Half of the world's wetlands have been lost due to the diversion of water and the conversion into agricultural and other land uses (Bos and Bergkamp, 2001). Moreover, world's rivers, lakes and groundwater aquifers are being severely contaminated by human, industrial and agricultural wastes. Humans have been harmed by waterborne illness and by consumption of food from contaminated ecosystems (UN, 1997). Water-related diseases are becoming a serious problem, especially in developing countries (WHO, 2000). According to the UN, annually 3.3 billion illnesses and 5.3 million deaths are caused by unsafe water on a global scale (UN, 1997). Worldwide, one billion people are living without clean drinking water and 1.7 billion have inadequate sanitation facilities.

As the water resources which can be used easily become insufficient to meet the increasing needs, new methods, such as desalinization, groundwater withdrawals, treating used water etc., have been introduced to increase the supply. In many cities, water has to be brought in from far away areas due to the shortage of groundwater. In India and Indonesia, since the late 1960s and the early 1970s, the real costs of water in new irrigation schemes have more than doubled. While in the Philippines, costs have increased by more than 50 percent, they have tripled in Sri Lanka, and have increased by 40 percent in Thailand (Rosegrant et.al., 2002).

Rosegrant et.al (2002) indicate that irrigation construction costs in Africa are higher than in Asia, due to physical and technical constraints. While the average investment cost for medium and large-scale irrigation estimated to be US$8,300/ha in 1992 dollars (FAO, 1992), in Sub-Saharan Africa this increases to US$18,300 if the infrastructure costs as roads, houses, electric grids, and public service facilities are also included (Jones, 1995).

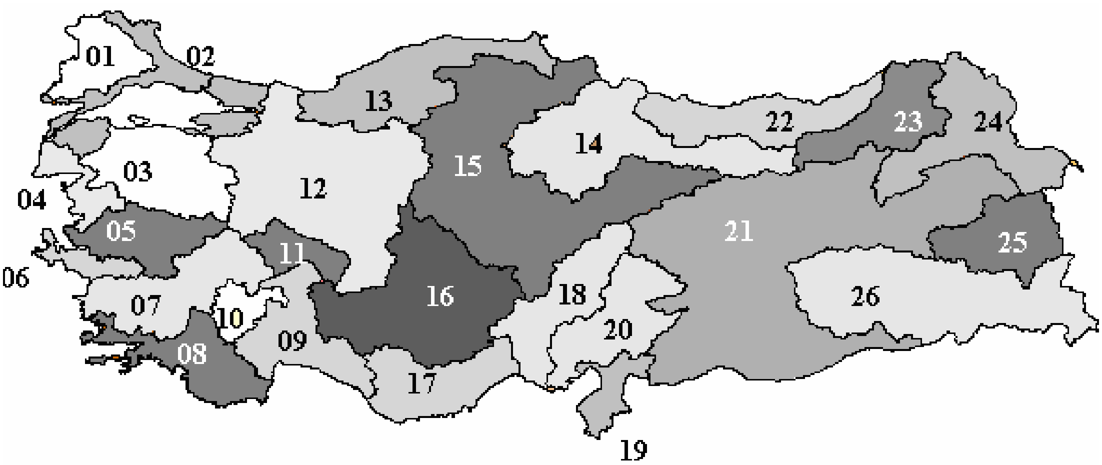
Constructing large dams may be essential, but it requires huge financial resources which are scarce especially in the developing countries. Furthermore, the development of new dams may impose high environmental and social costs, such as dislocation of people displaced from dam and reservoir sites. "Assessment of large-scale dams should include a comprehensive accounting of costs and benefits, and if projects proceed they must employ equitable, realistic and practical methods for compensating those who are negatively affected" (Rosegrant et.al, 2002; p. 165).

2.3 Turkey's Water Supply

The total area of Turkey is 779.452 km^2 of which 280.5 km^2 is agricultural area. Irrigable area is 258.5 km^2. Three sides of Turkey are surrounded by seas. Mountain chains are parallel to the north and south coasts while on the west coast, the mountain chains are perpendicular to the sea allowing the temperate climate to go further inland. There are sudden height changes. All these, together with the distance from the sea, cause the climate to vary within short distances. Precipitation also varies accordingly.

The climate is mostly continental, with hot, dry summers and long, cold winters. On the Black Sea coast, the summer temperatures are cooler and the winters are warmer. Other coastal areas have a Mediterranean type climate with hot, dry summers, mild, wet winters and a rainfall of up to 800 mm. In some specific micro climates there are some exceptions to these rules.

Water resources are mostly located in Eastern Turkey, while the demand is highest in the West. Turkey can be divided into 26 basins (Figure 2.3). Water resources are unevenly distributed among them. The 21 of 26 basins contain about 51% of the water. The remaining part is drawn together in 5 basins: Antalya, Eastern Mediterranean, Eastern Black Sea, Fırat (Euphrates) and Dicle (Tigris) (Ünver, 2003).



Source: DSİ (2005).

Figure 2.3: River basins in Turkey

Annual precipitation is between 220 mm and 3000 mm. According to long term measurements, the average annual precipitation is 643 mm. This corresponds to $501x10^9$ m^3 annual precipitation volume. The average annual evaporation loss is approximately $274x10^9$ m^3. It is estimated that $41x10^9$ m^3 water feeds the underground water and $186x10^9$ m^3 flows into the seas by rivers. $7x10^9$ m^3 water is coming from rivers that have their sources in neighboring countries. Total disposable water potential becomes $234x10^9$ m^3. It has been shown that $110x10^9$ m^3 of this potential can be used economically (SPO, 2001).

Precipitation differs largely between basins and even within short distances. The highest annual precipitation is in the East Black Sea region with 1198 mm and the lowest one is in Konya closed basin with 417 mm (Burak et. al., 1997).

Ünver (2003) gives two interesting examples concerning the varying precipitation rates. When Bodrum (north of Gökova Gulf) is compared with Marmaris (south of the gulf), the precipitation rates differ between 300-400 mm. The air distance between a district of Sinop, Bozkurt, and centre of Sinop is about 50-60 kilometers, but precipitation difference is high. Generally in Sinop, the average precipitation on the sea shore is about 679-1077 mm, but midland it is about 388-473 mm.

Water flows differ as well. Runoffs in the Antalya basin are about 75 percent of the rainfall flows. On the other hand, just north of it, in the Burdur Göller Basin this rate falls to 10 percent. In the Black Sea region, runoffs amount to 60-65 percent, but can not be used due to the mountainous structure of the region (Ünver, 2003).

Table 2.1: Per Capita Disposable Water (m^3)

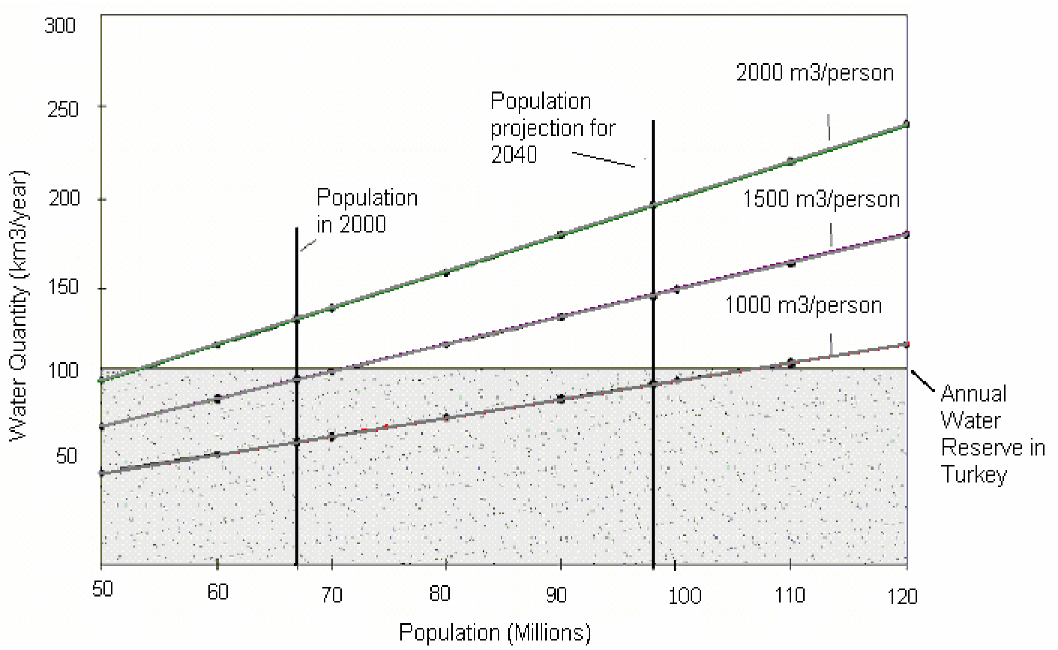
IRAQ	2020
LEBENON	1300
TURKEY	1735
SYRIA	1200
ASIAN AVERAGE	3000
WEST EUROPIAN AVERAGE	5000
AFRICAN AVERAGE	7000
SOUTH AMERICAN AVERAGE	23000
WORLD AVERAGE	7600

Source: SPO (2001).

Per capita disposable water is 1735 m^3 while the potential is approximately 3690 m^3. Values in Table 2.1 show that compared to other countries, Turkey is one of the countries which faces water shortages (SPO, 2001).

Falkenmark (1997) calculated the minimum annual per capita water requirement as 1000 m^3/capita/year. Considering basic needs, water availability as 1000-2000 m^3 per capita means there exists water stress. Annually, over 2000 m^3 water availability corresponds to very little or no water stress.

In Figure 2.4, Turkey's annual water reserves, annual per capita water needs together with the Turkish Statistical Institute's (TURKSTAT) population prediction for Turkey are depicted. It has been predicted that when Turkey's population reaches 100 million (it is predicted to reach this value in 2050) it will be one of the countries which faces water shortages.



Source: Köksal et. al. (2003).

Figure 2.4: Water Need and Scarcity in Turkey

2.3.1 Water Resources

Rivers in Turkey mostly have irregular flow regimes. The average inclination of the basins is high and they are not suitable for water use without necessary arrangements (Burak et. al., 1997).

Table 2.2: Basins' Annual Average Water Potentials

Basin's Name	Average Annual Flow (km3)	Potential Percentage (%)	Average Annual Return (1/s/km2)
Fırat Basin	31.61	17.0	8.3
Dicle Basin	21.33	11.5	13.1
East Black Sea Basin	14.90	8.0	19.5
East Mediterranean Basin	11.07	6.0	15.6
Antalya Basin	11.06	5.9	24.2
West Black Sea Basin	9.93	5.3	10.6
West Mediterranean Basin	8.93	4.8	12.4
Marmara Basin	8.33	4.5	11.0
Seyhan Basin	8.01	4.3	12.3
Ceyhan Basin	7.18	3.9	10.7
Kızılırmak Basin	6.48	3.5	2.6
Sakarya Basin	6.40	3.4	3.6
Çoruh Basin	6.30	3.4	10.1
Yeşilırmak Basin	5.80	3.1	5.1
Susurluk Basin	5.43	2.9	7.2
Aras Basin	4.63	2.5	5.3
Konya Closed Basin	4.52	2.4	2.5
Büyük Menderes Basin	3.03	1.6	3.9
Van Lake Basin	2.39	1.3	5.0
North Aegean Basin	2.09	1.1	7.4
Gediz Basin	1.95	1.1	3.6
Meriç - Ergene Basin	1.33	0.7	2.9
Küçük Menderes Basin	1.19	0.6	5.3
Asi Basin	1.17	0.6	3.4
Burdur Lakes Basin	0.50	0.3	1.8
Akarçay Basin	0.49	0.3	1.9
TOTAL	186.05	100.0	

Source: DSİ (2005)

Water in Turkey is not evenly distributed over time and space. The country is divided into 26 river basins. The basins' average annual water potentials are given in Table 2.2.

The annual surface flow is around 186.05 km^3. Economically and technically usable water is 95.00 km^3/year, actual consumption is 33.90 km^3/year (DSİ, 2005).

Annual usable underground water potential is 13.66 km^3. Actual consumption is 6.23 km^3. The use of underground water is increasing. It is used for irrigation and also for drinking in many cities and towns. 20 percent of the irrigation made by DSİ is met by underground water.

Geothermal waters are reserved deep under the ground. They are close to magma so their temperatures are high. Temperatures range from 30^{o}C (Ankara-Ayaş) to 232^{o}C (Aydın-Germencik) (Burak et. al., 1997). They may contain minerals. Near the ground, they may mix with underground water and this will affect their quality.

In Turkey, there are more than 600 geothermal sources. The ones which have a high temperature suitable for energy productions are in the West, while low or medium temperature ones are in Middle and East Anatolia and on the North Anatolia fault (Burak et. al., 1997).

2.3.2 Water Use

The irrigation strategy was declared in the 1990-1994 five-year development plan. The strategy intended to decrease the dependence of agricultural production on climate by introducing modernized irrigation techniques. To achieve its objectives with respect to food security and exports, Turkish agriculture needs to grow at 4 percent annually. Irrigation is indispensable because of the uneven temporal distribution of rainfall. About 8.5 million hectares of land are estimated to be economically irrigable; 4.5 million hectares are presently being irrigated.

From Table 2.3 it can be seen that the largest share of water consumption is for irrigation purposes. It is followed by drinking and utility, and this is followed by industrial use.

Table 2.3: Water Consumption, 1990-2000 (billions m^3)

Use	1990	1995	2000	2003
Drinking and utility	5.9	7.4	9	6.2
Irrigation	32.3	37	41.8	29.6
Industry	5.1	6.2	7.3	4.30
Total	43.3	50.6	58.1	40.1

Source: DSİ (2007).

The level of energy consumption indicates the level of industrialization and the prosperity of countries. As can be seen in Table 2.4, per capita electric energy consumption in Turkey is below world's average and far below the developed countries' average. While average annual consumption in developed countries is 8900 kWh, in Turkey it is 2150 kWh.

Table 2.4: Per Capita Annual Electric Energy Consumption

Countries	**Per capita consumption (kWh)**
World's average	2500
Developed countries' average	8900
USA	12322
Turkey	2150

Source: Eroğlu (2006).

Hydropower is regarded as a major national energy resource, and its development is supported. Turkey shifted its energy strategy from dependence on imported oil to indigenous resource development, including hydropower following the oil crisis of the 1970s. There are several advantages of hydropower energy. It is able to respond to unexpected demand fluctuations. It is fairly clean, and renewable, involves no fuel cost, has a long life- span (200 years), its cost recovery is short (5-10 years), and its operational costs are low, (approximately 0.2 cent/kWh) (DSİ, 2007). Though, as mentioned before, its benefits and costs should be considered carefully in the final decision making.

The production of hydroelectric plants depends on precipitation conditions. Therefore, the share of them in total electric energy production may vary from year to year (Table 2.5).

Table 2.5: Hydroelectric Energy Share

		2003	2004	2005
Production of hydroelectric energy	(Billion kWh)	35.3	47.6	42
Share of hydroelectric energy to total energy	(%)	25	32	27

Source: Eroğlu (2006).

There are three basic concepts concerning hydroelectric potential: "gross potential"[1], "technical potential"[2] and "economic potential"[3] (EİE, 2007). The gross theoretical hydroelectric potential of Turkey is about 433 billion kWh. This corresponds to 1 percent of the gross hydroelectric potential of the world and 16 percent of the potential of Europe (DSİ, 2007). The technically viable water power potential is calculated to be about 216 billion kWh for Turkey. Finally, Turkey has about 127 billion kWh of economically viable hydroelectric potential (Table 2.6).

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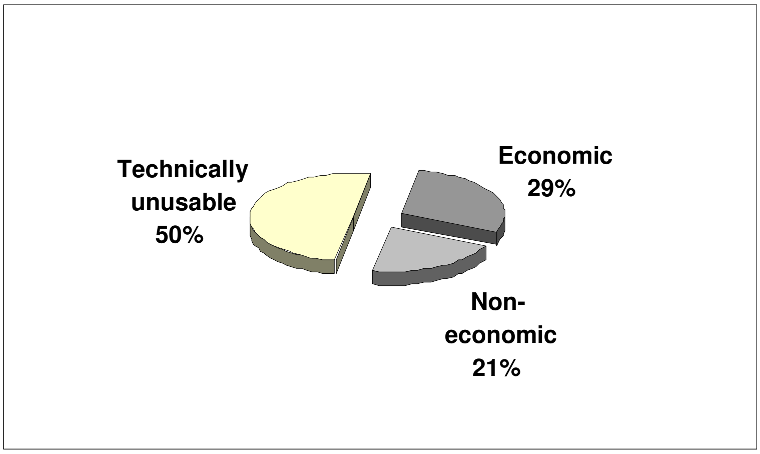
[1] Gross potential: Theoretical upper limit of hydroelectric energy production in a country. It is calculated under the assumption of all natural flows, until the country's borders or until the sea, to be used with 100% efficiency.
[2] Technical potential: Technological upper limit of hydroelectric production. It shows the energy that can be produced when all technically possible projects are realized.
[3] Economic potential: The economically optimum energy production. In other words, it shows the production of water power projects of which their expected yields exceed their costs.

Table 2.6: Hydroelectric Potential in the World and Turkey

	Gross Theoretical Potential of HEPP (GWh/year)	Technically Viable Potential of HEPP (GWh/year)	Economically Viable Potential of HEPP (GWh/year)
WORLD	40150	14060	8905
EUROPE	3150	1225	800
TURKEY	433	216	127381

Source: DSİ (2007).

Among theoretically available hydroelectric potential in Turkey, 50 percent is technically unusable. While 29 percent can be used economically, the remaining 21 percent is non-economical. (Figure 2.5).



Source: Eroğlu (2006).

Figure 2.5: Hydroelectric Potential

In 2005, 26 percent of the realized energy production capacity was met by hydroelectric energy and 90 percent of the hydroelectric production capacity was used (Table 2.7).

Table 2.7: Installed Capacity and Annual Energy Production (2005)

	Installed Capacity (MW)	Production Capacity (Billion kWh/year)	Actual Production Capacity (Billion kWh/year)	Capacity Use (%)
Coal	10076	67.7	44	65
Fuel	3110	20.5	8.5	41
Natural gas	13484	102.3	66.5	65
Hydroelectric	**12941**	**46.5**	**42**	**90**
Total	39611	237	161	68

Source: Eroğlu (2006).

According to the standards of ICOLD (International Committee on Large Dams), "large dam" is defined to be a dam having more than 15 m height from foundation and having a reservoir volume of more than 3 hm^3. There are 544 "large dams" constructed by DSİ and 11 by other institutions adding up to 555 large dams (Table 2.8).

Table 2.8: Dams and Hydropower Plants in Turkey, 2005

	IN OPERATION			UNDER CONSTRUCTION OR IN PROGRAM		
	By DSİ	Other	Total	By DSİ	Other	Total
DAM (unit)	544	11	555	209	1	210
HEPP (unit)	53	82	135	53	17	70
Small Dams (unit)	47	617*	664	1	43*	44

Note: Small dams built by the General Directorate of Rural Services (GDRS abrogated now) for irrigation.
Source: DSİ (2005).

"Water Usage Rights Regulation" came into effect in 2003. This provided the private investors the opportunity to build HPPs. By this way, water that can not be used before could be developed, and water costs for industrial producers could be decreased. The total number of applications for the HPP projects from the private sector reached 646 adding up to a total installed capacity of 10594 MW. This is greater than the total capacity of six big HPP (Atatürk, Karakaya, Keban, Altınkaya, Birecik, and Oymapınar HPP) which is 7442 MW (Eroğlu, 2006).

2.3.3 Water Quality

The quality of water depends on the place for the end use of water. The water used for irrigation needs not be the same quality as that used for drinking. Defining the cleanliness for water therefore is more difficult than for the conventional meaning of cleanliness. Clean water from the ocean, for instance, is not the same as clean water from a freshwater a lake or a river. There are always some dissolved or suspended materials in natural water since when water runs along or through the earth's surface, it dissolves many minerals and carries them as impurities. Some of these impurities may be beneficial for most water use (Usanmaz, 2004).

The total amount of fresh water is limited to those in underground and surface water, and water in living species. This type of water is quite limited and it is usually polluted continually by nature and man.

2.3.4 The Southeastern Anatolia Project (GAP)

GAP is an integrated multi-sectoral development project based on the development of water resources. It includes the southern part of the rivers Dicle (Tigris) and Fırat (Euphrates), and the plains between these rivers. The cities Gaziantep, Adıyaman, Şanlıurfa, Diyarbakır, Mardin, Siirt, Batman, Kilis and Şırnak define the borders of the project region. It covers a land area of 73.863 km^2 corresponding to 9.5 percent of the total national land area. The project region is the least developed region of Turkey. The project aims to improve the living standards and raise the income levels of the people in order to eliminate regional development disparities and contribute to such national goals as social stability and economic growth by enhancing the productivity and the employment opportunities in the rural sector.

The share of the region in GDP was around 4 % in 1985, and it rose to 5.5 % in 2001 accompanied by the rate of per capita income rise from 47 % to 55 % (GAP, 2007).

There are 2 free trade zones in the region in Gaziantep and Mardin. As of the early 2006, there are 10 organized industrial districts (OIDs) and 25 small industrial sites (SISs) operating in the region. 12 more SISs are in progress with relevant construction works.

The GAP had originally been planned in the 1970s, consisting of projects for irrigation and hydraulic energy production on the Euphrates and Tigris, but was transformed into a multi-sector social and economic development program for the region in the 1980s. The development program concerns such sectors as irrigation, hydraulic energy, agriculture, rural and urban infrastructure, forestry, education and health. Upon completion of the project, through facilities over the rivers Euphrates and Tigris together total more than 50 billion cubic meters of water a year. That amount corresponds to 28 percent of the total water potential of Turkey. The water resources development component of the program envisages the construction of 22 dams and 19 hydraulic power plants and the irrigation of 1.7 million hectares of land (20 percent of the total irrigable area of 8.5 million hectares). The total cost of the project is estimated as US $32 billion. The total installed capacity of power plants is 7476 MW and projected annual energy production reaches up to 27 billion kWh.

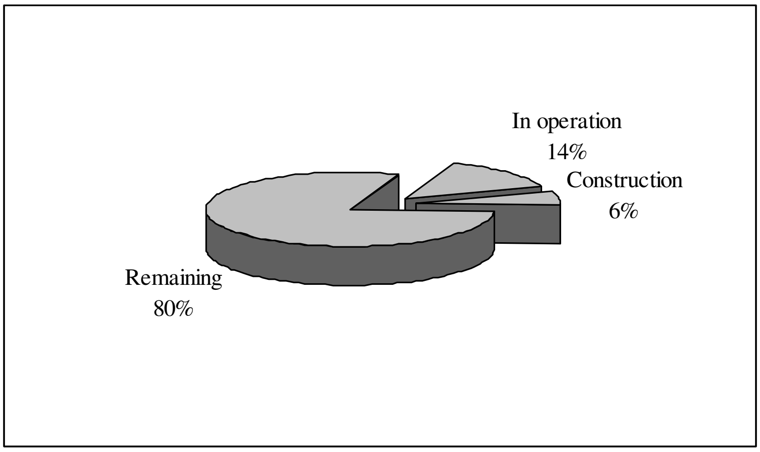
By the end of 2005, 8 hydraulic power plants were completed in the region corresponding to 74 % of envisaged energy projects. Following the operation of Karakaya, Atatürk, Batman, Kralkızı, Dicle, Birecik and Karkamış power plants, total electricity production in Turkey at the end of 2005 increased to 253 billion kWh. The monetary equivalent of this total production is about 15.18 billion US Dollars (1 kWh = 6 cents). Within the total hydraulic energy output of 39.6 billion kWh, GAP's share was 47.2 % (with billion 18.7 kWh) corresponding to 1.1 billion US $ in monetary terms (Table 2.9).

Table 2.9: GAP's Hydropower Energy Revenues, 2006

	Billion kWh	**Value Equivalent (million $)**
Karakaya	8.6	516
Atatürk	8.9	533
Kralkızı	0.1	7
Karkamış	0.4	28
Dicle	0.2	13
Birecik	2.7	160
Batman	0.5	31
GAP	21.4	2188
TURKEY	44	
GAP's Share	% 48.5	

Source: GAP (2007).

The region is the hottest region in Turkey. Evaporation is very high. Therefore, irrigation is very important. Irrigation started on the Şanlıurfa-Harran Plain in 1995, first covering an area of 30,000 hectares. As of the end of 2001, 215,080 hectares of land has been brought under irrigation by the DSİ. In 2006, this increased to 260,955 hectares. Construction of irrigation schemes is in progress on 114,067 hectares of land. Shares of these values are shown in Figure 2.6. Considering the potential of 1.7 million hectares to be irrigated, there is still long way to go. Yet, per capita value added in the agricultural production before irrigation was US$ 596 while it increased to US$ 859 in 2006 (GAP, 2007).



Source: GAP (2007).

Figure 2.6: GAP Irrigation Projects (2006)

In the areas with limited irrigation possibility, wheat, barley, lentils, tobacco and grapes are grown, while in other areas cotton is produced. The production areas of cotton, vegetables, corn, soybean and rice are expected to increase with the completion of the projects (Forum, 2007). Before the public irrigation network, farmers were irrigating 23 percent of the total area with well water. 91 percent of the irrigated land was used for cotton production and in the remaining 9 percent, vegetables were planted. In 2004, 83 percent of the irrigated land was used for cotton production while 3 percent was used for vegetable production. Although the share of vegetable production declined, the total area of vegetable cultivation was increased about 6 times to 3500 hectares (GAP, 2006). Studies show that Turkey has a competitive advantage in vegetable and fruit production in international markets. This makes the developments in irrigation schemes in GAP more important.

Significant developments have been realized in the industry of the region following the start of irrigated farming. The number of industrial enterprises in the region has almost doubled from 1995 to 2001. At the end of 2006, there were 1,834 enterprises in the region each employing more than 10 workers. The total number of people employed by these enterprises was 80,776 (GAP, 2007).

Playing such an important role in the Project, irrigation planning must be done with careful consideration. Especially, it is very important to make farmers conscious of implementing correct irrigation techniques. In fact, it has been predicted that, if the necessary precautions are not taken, in Harran, 5 thousand hectares of land will become unusable due to the salinity of the soil (Zeyrek, 2001).

According to the GAP Enterprise Support Center, the project region has great potential in three areas: renewable energy, organic textile and tourism. In this respect, publicity of the region's tourist attractions, consideration of the energy potential (hydroelectric, sun, wind, bio-energy and jeothermal energies), and starting with cotton production, configuration of organic textiles are planned.

2.4 The Concept of Water Resource Management

Increasing population, rapidly developing industrial and agricultural activities, and increasing pollution point out the importance for the proper management of water. Water management is the efficient and the systematic use of water. While planning was made only for economic purposes, nowadays one must consider various problems, such as protection of environment, recreation and water pollution. Also, the interaction between water systems are increasing and management becomes more complicated.

The basic elements of water management may be considered under the following topics (Burak et. al., 1997):

1) Short-run and long-run water demand
2) River basin management
3) Groundwater and underground water use
4) Interaction between water, land and forests
5) Water quantity and quality management

Berkoff (1994) considers management in two perspectives: supply management and demand management. Supply management covers activities required to locate, develop, and manage new sources, while demand management means to develop mechanisms to promote more desirable levels and patterns of water use. Planning requires consideration of both together with environmental concerns.

Since new water sources have become increasingly inaccessible, demand management should be considered. It covers both direct measures to control water use as regulation and implementing new technology, and indirect measures that affect voluntary behavior as market mechanisms, financial incentives and public education (Berkoff, 1994). Applying new technologies is very important. Especially new irrigation systems are much more efficient than the old classical systems. Also, new techniques used in industry enabling water to be recycled several times and special techniques used for cleaning recycled water must be implemented.

Opportunity cost pricing would provide appropriate incentives for the efficient use of water. However, in practice, water charges usually fall below its financial costs. In fact, in some countries, irrigation water is free and in all countries there is strong resistance to effective water pricing. Private interests can control particular water supplies in local water markets, but it will be difficult to achieve the water allocation through market mechanisms over longer distances or between major sectors (Berkoff, 1994).

For efficient management of water resources, planning at the basin level is very crucial. Although the problem should be approached from a broader perspective, a detailed and proper examination of a hydrological system can only be made at the basin level (Meriç, 2004). A basin is an area that is bounded by natural borders which controls the hydrological system. It is a region of land where water from rain or melting snow drains downhill into a body of water, such as a river, lake, sea or ocean. It includes both the streams and rivers that convey the water as well as the land surfaces from which water drains into those channels. Each drainage basin is separated topographically from adjacent basins by a ridge, hill or mountain, which is known as a water divide.

The most relevant characteristics of the basin-based management can be summarized as follows (Meriç, 2004):

1) Since the basin is bounded by natural borders, it is easier to consider it as a whole and enable us to examine the process that affects the hydrologic system.

2) Considering the different sectors and the users together, examining the threats in the long-term and observing the positive and negative effects of an intervention, the best scale is the basin-based (WWF).

3) Considering scales smaller than basins will limit the success of the management plans, since the plans will be unable to characterize the whole system. Moreover, since the processes within the systems are interrelated to each other, using smaller scales will curtail greatly the sustainability of the projects. On a basin level it would be easier to observe the changes in the water quantity and the quality and take necessary precautions

4) Something that does not cause a problem in one part of the basin may in time effect another part. Therefore, in order to protect the resource, the system must be considered as a whole.

5) Basins are also ecologic boundaries for many species. Therefore, basin-based water management enables us to consider many interactions of natural resources and species.

2.5. Water Management in Turkey

Water resource management in Turkey differs from those implemented in countries targeting sustainable development. Basically supply management strategy dominates. Therefore, the water management strategies needed to be reformed. Of course, this requires a careful consideration of the issues related to the sector (Burak et. al, 1997).

The present system and the defects in water management in Turkey can be attributed to:

1) Misuse of water in the agricultural sector
2) Water subsidies
3) Illegal water use
4) System leakages
5) Pollution
6) Institutional defectiveness

In Turkey, 8.5 million hectares can be irrigated economically. At the end of 2005, 58 percent of this area was irrigated. About 60 percent of the irrigated area was developed by DSİ. About 75 percent of the water consumption is in the agricultural sector. Unfortunately, due to the inefficient use of water in irrigation, the greatest loss of water is also in this sector. Since the present water resources are inefficient in meeting the increasing food demand, preventing the use of inefficient techniques in irrigation is very crucial.

Using more efficient methods of irrigation and the quantity of water being used are very important. There are various irrigation techniques. Recent technological developments increase water productivity by using much less water.

With classical methods, irrigation water is released either randomly to the field (surface or rude irrigation) or is dump into the furrows (furrow irrigation). In either way large amounts of water is used. These are very inefficient methods. The second method is using closed systems, water is transferred in the pipes that are either pressurized or not. In non-pressurized pipe lines, the water flows slowly. Therefore, large-diameter pipes have to be used and this increases the cost (Akıncı, 2007).

The most efficient way of irrigation is to use pressurized pipe lines. Sprinkling systems and drip lines are examples of such systems. In the former, sprinklers are placed in the field with proper spacing and pressured water is pumped into the air. Water reaches the roots by infiltration. In trickle (drip) irrigation, small pipes are laid all the way to the plant and filtered water is dripped into the stubble. Only certain parts of the field will be wet. As a result, irrigation water will be used in the most efficient way.

Classical methods are very common in Turkey. 92 percent of irrigation systems constructed by DSİ uses surface irrigation. The remaining 7 percent is sprinkling systems and only 1 percent is dripping systems (DSİ, 2007). In order to improve efficiency, it is important to make the farmers aware of the efficiency gains of the modern techniques.

The efficiency measures, irrigation rates and irrigation performances, are very low in Turkey. Irrigation performance is calculated as the ratio of irrigation water needed to the water used. In 2001, this ratio was 38.2 percent and 62.4 percent for irrigation by DSİ and others respectively. These low values are mostly due to excess water use in agriculture. The irrigation rate in 2001 was 38 percent in DSİ irrigation, while it was 48 percent in others (Çakmak et. al., 2005).

Low charges for irrigation water cause the farmers to be careless about the amount of water they use. This leads to a great waste of water in this sector. Farmers do not look for more efficient ways of irrigation. This causes not only great water loss, but also threatens the quality of soil. Using too much water causes the salt deep in the soil to dissolve and rise to the surface. This results in impoverishment of the soil.

Water pricing in Turkey varies among the sectors. While volumetric charges are common in domestic and industrial use, there is almost no volumetric system in irrigation. Water pricing does not cover the full economic costs of water and this increases the financial burden on the state (Çakmak, 2002). Cost recovery in Turkey, currently covers a fraction of the actual total costs and no allowance is made for depreciation of the infrastructure (Ünver and Gupta, 2002).

Table 2.10: Length of Different Channel Types (1981-2003)

	1981		**1993**		**2000**		**2003**	
Channel Type	**Length (km)**	**%**	**Length (km)**	**%**	**Length (km)**	**%**	**Length (km)**	**%**
Concrete Channels	16000	37.79	24020	46.62	28117.9	46.79	28596.6	47.44
Small Channels	8500	20.08	21384	41.50	25974.5	43.22	25500.7	42.30
Pipe Systems	600	1.42	1902	3.69	2761.3	4.60	2577.2	4.28
Soil Channel	17235	40.71	4222	8.19	3242.7	5.40	3610.4	5.99
Total	42335	100	51528	100	60096.4	100	60284.9	100

Source: DSİ (2003).

Water transfer and distribution for irrigation are made by the use of soil channels, classic concrete channels, small channels and pipe systems. As seen in Table 2.10, between 1981- 2003, the length of the soil channel declined from 40.71 percent to 6 percent while the length of the concrete channel and the small channel increased from 37.70 percent to 47.44 percent and from 20.08 percent to 42.30 percent respectively. Pipe system use is very low with a rate of 4.28 percent in 2003 (Çakmak et. al., 2005).

Operation loss is officially stated to be 10 percent, but in practice it reaches too much higher percentages (Beyribey et. al., 2003). Therefore, pressurized pipe systems must be encouraged.

Water pollution is a serious problem. In Turkey, because of the population growth, industrialization, growing cities and pesticide and fertilizers used in agriculture, rivers, lakes and seas are rapidly being polluted (Yıldırım and Çakmak 1999).

Pollutants can be grouped into two: point-wise and pervasive sources. If pollutants interfuse in a controlled and measurable manner they will be called point-wise sources, while if they spread widely then they are called pervasive sources (Orhon et. al., 2002).

Point-wise pollutants come from the discharge of domestic and industrial wastewater. The sources of pervasive pollutants are more diverse. They come from the surface water flows, agricultural and forest fields, atmosphere, uncontrolled rain flows coming from settling areas, solid waste depots, metal fields and wastes filtrated into the soil from septic tanks and polluted rivers.

In Turkey, uncontrolled agricultural, domestic and industrial discharges cause many basins to be highly polluted. Porsuk, Simav, Nilüfer, İznik, Eber, Karamuk, River and Burdur Lake are those most seriously polluted by industrial wastes (Burak et. al, 1997).

Leakages from solid waste tanks are not a problem in developed countries but are still an important issue in Turkey. Similarly, domestic wastewaters that are considered as point-wise pollutants in developed countries are of significance in Turkey because of the use of septic tanks in rural areas.

Turkey is far behind in the cleaning of domestic and industrial wastewaters. In the manufacturing sector, only 9 percent of the enterprises have waste treatment facilities. Among those which do not have this system 16 percent are privately owned, while 84 percent is public. Among the 3215 municipalities, only 141 have sewage systems and among them only 43 have waste treatment plants. This means that 98.67 percent of the drains are poured into the rivers, lakes and seas without treatment (ÇOB, 2004). Only 2 percent of the Industrial enterprises have waste treatment plants and only some of them are functioning properly. Only 22 percent of industrial wastes are being treated (Çakmak et. al., 2005).

Pollutants are also moved to water basins by wind and rain. During winter 16 cities suffer from air pollution in Turkey. Especially pollution on the highways is transferred to the water resources. For example, Fatih Sultan Mehmet Bridge in İstanbul is in the Ömerli Water Basin (Orhon et. al., 2002).

Industrial fertilizers and pesticides used in agriculture together with pollutants coming from forests and residential areas cause nitrogen and phosphate to mix with water resources. Therefore, it is very important to use pesticides at a minimum and to fertilize at the correct times and in the correct amounts.

2.6 Water Sector Organizations in Turkey

Water sector public institutions in Turkey can be grouped into two (Burak et. al., 1997), according to their responsibilities:

1- Practical- Investor
2- Follower- Controller Institutions

Most important technical institutions are:

1- General Directorate of State Hydraulic Works (DSİ)
2- General Directorate of the Bank of Provinces (İller Bank)
3- General Directorate of Electric Power Resources Survey (EİEİ)

Follower- Controller Institutions are:

1- Ministry of Environment and Forestry
2- Ministry of Health
3- State Planning Organization (SPO)

The responsibility of water resources management and nationwide water planning is centralized within the DSİ, which was established under the Ministry of Public Works in 1954. Based on the economic factors and emergency situations identified by the Council of Ministers, the DSİ establishes priorities for the development and the implementation of irrigation, power generation, flood control, and river training. The DSİ is the only legal authority responsible for the exploitation, use and allocation of groundwater.

The General Directorate of the Bank of Provinces, under the Ministry of Public Works, provides credit to finance and implement urban infrastructure. The General Directorate of Electric Power Resources Survey, under the Ministry of Energy and Natural Resources, is responsible for carrying out hydrological studies, geotechnical investigations, and mapping activities to evaluate national hydroelectric power and is also involved in the planning and design of hydropower projects (Burak et.al., 1997).

The Ministry of Environment and Forestry deal with water pollution problems. The Ministry of Health is responsible for water quality control, performing the chemical, physical and microbiological analysis, chlorine measurements and licensing. The State Planning Organization controls and supervises the investment decisions.

Unfortunately, there is a coordination problem among these organizations. Without corporation, similar works are done by different institutions or different plans are designed for the same area. These result in wasting resources (SPO, 2001). Institutions that are in charge of the drinking water sector, DSİ, KHGM (currently abolished) and The Bank of Provinces, are not coordinated properly.

During the planning process, there are no monitoring or examination systems and these raises the costs of the investments. There is no easily reachable or reliable data base. Maintenance and repair of infrastructure are not done regularly or sufficiently. Therefore, systems can not be used to their full capacities. (Burak et.al., 1997).

60 – 80% of the investments of The Bank of Provinces to municipalities are financed through non-recourse funds. Therefore, municipalities prefer to use these funds instead of considering other alternatives as build-operate-transfer models (Burak et.al., 1997).

Due to illegal water use, the real water demand can not be computed. Therefore, consumed water can not be priced.

In Turkey, there is no comprehensive national policy for sectoral and inter-sectoral water use. Plans are usually made on a project base when it is demanded. Long-term targets are not of concern (Burak et.al., 1997).

Users are not encouraged to participate in the planning and the application stages so, projects are not accepted and objectives can not be realized.

Water rights are also very important. Good quality water that can be used as drinking water can also be used as irrigation or portable water. State has the sole ownership of all waters. Priorities in basin based projects are not determined. These cause water to be wasted. Legal arrangements for water rights are necessary.

The necessary finances for establishing foundations for drinking water, solid waste, sewerage systems and their treatment plants either can not be found or only small annual funds are found so that construction takes long time (SPO, 2000).

Modeling the water-related issues gain importance especially in 1990's. Different modeling tools can be used for this purpose. These are discussed in the next chapter together with a literature survey on CGE models involving water as a factor of production.

CHAPTER 3

WATER IN CGE MODELS

Different methods are being applied in analyzing water-related issues. Water demand literature relies mostly on econometric estimation methods (Mukherjee, 1995). Models consist of sets of equations whose parameters are estimated econometrically. Examination of groundwater storage and their depletion is mostly analyzed by the use of optimal control techniques. Some studies that apply this method are, Cembrano et. al. (1988), Brdys and Ulanicki (1994), Cembrano and Quevedo (1999) and Cembrano et. al. (2000). Saleth et. al. (1991) use game theoretical techniques to examine the bargaining rules which will facilitate the efficient operation of a "thin"[4] water market across a variety of bargaining environments[5] (Mukherjee, 1995). Sheehan et. al. (1981) and Carraro et. al. (2005) are some other examples of game theoretic approaches to the water issues.

Input-output (I-O) models are also used to analyze the water demand issues. They consist of linear equation systems which represent each of the sectors' productions and consumptions (Güneş, 2007). The economy is displayed in matrix notation representing the interrelations among sectors. Output of one industry is used as an input for another. Each column of the input-output matrix reports the monetary value of an industry's inputs and each row represents the value of an industry's outputs. I-O Model determines the necessary output change in each sector in order to fulfill an economy's final demand. Thus, it can be used to analyze, for example, a

[4] "thin" market: a market with few eligible participants.
[5] Bargaining environment is defined by institutional features such as the size of the water market, the water rights system, the distribution of farm sizes, and the level of participants' information.

change in water demand resulting from a change in the final demand (Mukherjee, 1995).

A Leontief production function is assumed. Output levels are determined endogenously. Factor of production use is determined by the level of output of the corresponding sector. Factors are not substitutable and they are fully utilized. Prices are fixed exogenously and are independent of demand. Therefore, the model is quite rigid (Mukherjee, 1995).

Another methodology used, is the linear programming (LP) models. It is primarily used in irrigated agriculture and farm models. Linear programming problems involve the optimization of a linear objective function, subject to linear equality and inequality constraints. While in I-O models, factor inputs must be used fully, for the LP models the constraints need not to be binding (Mukherjee, 1995).

3.1. CGE Models

Computable General Equilibrium (CGE) models are powerful economic tools for multidimensional/multi-sectoral analysis. They improve traditional input-output analysis by generating quantities and prices endogenously and reflecting market incentives.

CGE models are based on the Walrasian general equilibrium structure, which was formalized in the 1950s by Kenneth Arrow and Gerard Debreu. The models explicitly incorporate supply constrains, identify prices and quantities separately, and have smooth, twicely differentiable production and preference surfaces. Thus, substitution effects in production and in consumption are allowed in the CGE models. Factor and commodity markets attain their equilibrium through the adjustment of prices.

CGE models are used to analyze wide economic impacts of changes in the external environment and in economic policies. The first basic characteristic of these types of models is that they generate a set of prices consistent with the equilibrium in an economy. These prices are based on production and consumption decisions, which in turn determine employment and incomes in the various sectors of the economy. Second, the model specifies interactions and linkages between markets. Third, the

CGE model is based on a specification of the economic structure which is critical for tracing the impact of an external shock or policy change (Dixon and Parmenter, 1996).

Up to the 1960's, empirical research in economics was mainly partial equilibrium analysis. Johansen introduced a computable equilibrium model with 20 cost-minimizing industries and a utility-maximizing household sector in 1960. Following Johansen's contribution, there was no significant progress in the development of CGE modeling until 1970s. Though, large-scale, economy-wide econometric models were mostly used (Dixon and Parmenter, 1996).

Scarf (1967a, 1967b and 1973) designed an algorithm for computing solutions to numerically specified general equilibrium models. In the early 1970s, his students John Shoven and John Whalley made contributions improving the modeling structure (Shoven and Whalley, 1972).

Oil crisis, sharp change in the international monetary system and rapid growth in real wage rates occurred in the 1970’s. The econometric models were not capable of examining the effects of such a shock not seen before since they relied on time-series data. For the oil crisis, for example, regression equations based on pre-1973 time-series data, will have an insignificant or zero coefficient price of oil. It was realized that CGE models were able to deal with such shocks with no historical experience (Dixon and Parmenter, 1996).

It was also observed that much more detailed models could be formed with CGE modeling techniques. Especially after the developments in applied mathematics, larger-scale CGE models were formed in 1980's. Software programs only became available in the 1990’s. The software developed in USA is represented by the GAMS/MPSGE program. The corresponding Australian CGE modeling program is GEMPACK.

3.2 Advantages and Disadvantages of the CGE Modeling

There are many advantages of using CGE models. Since they allow modeling the whole economy, it is possible to observe the total effects of a policy change or a shock on the economy. They also enable the modeler to make predictions about further changes in the economy. Moreover, the modeler can analyze the feedback effects on income and the prices of policy changes as well. Another advantage of including all sectors is that it reduces the danger of bias through omission. The partial equilibrium approach suffers from this danger as they omit certain sectors and intersectoral linkages (Mukherjee, 1995).

CGE models allow the use of non-linear equations. This provides a more realistic representation of the real economy. As mentioned above, the availability of software which can solve non-linear equation systems enhances the CGE model.

There are some disadvantages of the CGE models. The main deficiency of the models is that they are sensitive to the parameters used in the model. The primary parameters, which will be explained in the next chapter, such as import, export or factor elasticities are provided from econometric analysis or determined by the modeler. Unfortunately, different studies that analyze these parameters may lead to different results. Therefore, it would not be easy to find reliable primary parameters. The choice of parameters will probably affect the results of the models. Also, one must be aware of the choices of the functional forms as they are chosen by the modeler and may not display the true structure of the economy. It may be useful to perform a sensitivity analysis by comparing the model results for different parameters and functional forms in order to test the robustness of the parameters used and accordingly the function choices (Güneş, 2007).

CGE models are more complex than the IO and LP models. They give a much larger range of opportunities to the modelers as they can serve greater disaggregation possibilities and more elaborate behavioral and technical relationships, and also allow for the use of non-linear functional forms. But, this requires a larger data set and this data set must display a balanced economy in the base year. But these requirements are difficult to satisfy, especially for developing countries (Güneş, 2007).

3.3 A Review of Literature of CGE Models with Water

One of the first Applied General Equilibrium (AGE) models to analyze water management policies is presented by Berck, Robinson and Goldman (1991). They used the model to find the effects of reducing water inputs in the San Joaquin Valley of California on the GDP of the Valley, on sectoral output, employment and land use. The model is disaggregated into fourteen sectors six of which are agricultural sectors. The agricultural production function comprises of 4 primary factors: water, land, labor and capital. Water is defined as an exogenous stock and it is only used by the agricultural sector. They propose two alternatives for the agricultural sector. First, with strong elasticity of substitution, where agricultural land, labor and capital are connected by a Cobb-Douglas function. Second, with low elasticity of substitution where capital and land are used in fixed proportions and labor is combined with this aggregate by a Cobb-Douglas function. They conclude that a reduction in water endowments generates a substitution from the agriculture to the livestock sector with a decrease in GDP and a reduction in agricultural income and labor demand. Thabet (2003) argues that this kind of model specification limits the substitution possibilities between the primary factors and the intermediate inputs.

Goldin and Roland-Holst (1995) study the relationship between trade reform and water management policies in Morocco. There are four sectors, two of which are agricultural sectors. Utilizing their model, Goldin and Roland-Holst simulate three scenarios. The first scenario is an increase in water tariffs for agriculture and the second is a reduction in import duties. As the third scenario, they combine the previous two and these result in an increase in GDP and an improvement in household income. Goldin and Roland-Holst use a production function for agricultural sectors that does not allow for substitution between water and other intermediate consumption or primary factors. They assume the existence of a perfectly elastic offer of water, which is able to answer any request. There is no production of water in the model, a fixed endowment of water is assumed.

Löfgren (1996) examines the impact of alternative water allocation mechanisms and different choices for charging the operation and management costs of the irrigation and the drainage system. He finds that, when water is abundant, the easiest way to achieve cost recovery is by taxing the land. On the other hand, if water is scarce, a volumetric water charge or a "crop-water" charge (based on crop water consumption per land unit) is better for discouraging water consumption. While the latter charging system is easier to implement, the former has the advantage of encouraging long-run water-saving technical change.

Löfgren also examines a 15-30% cut in the water supply while permitting a 79-158% increase in water use in the rest of the economy. He concludes that by cutting agricultural water use by 15% does not decrease aggregate farmer incomes, but decreases the real value-added, employment and consumer surplus by 3 to 7%. If the same reduction is 30% instead, negative effects would be larger and there would be a large agricultural trade deficit.

When he made a comparison with an inefficient alternative (half of the farmers being forced to cut water uses) he observes that the efficient alternative yields a much higher output level while he avoids the inequity associated with access to water. However, when the government charges prices sufficient to reduce water consumption by 15-30% it increases the government revenue by 11-18%, while reducing the farmer's income by 20-35%. So, Löfgren concludes that there is a need for institutional reforms endowing the farmers with tradable water rights.

In all three studies mentioned so far, one can see that water is taken to be an exogenous stock variable. Moreover, substitution between inputs was not allowed. However, Just (1991) argues that allowing possibilities of substitution between entrants into the agricultural production function is very important for studies concerning the water problem. In fact, Decaluwe et. al. (1998, 1999) introduce water production sectors into their models. Their model is more flexible than the standard models, since they allow for substitution among the factors of production.

Decaluwe et. al. (1998), explicitly model the water production with various technologies according to whether water is extracted from the stopping or the underground tablecloths. The model allows for substitution between the intermediate agricultural inputs. Moreover, there are also possibilities of simulating exogenous rainfall variation. Decaluwe et. al. simulate the affects of an arbitrary increase in water price, a reduction in subsidies to water management authorities (WMA) and a decrease in average rainfall. They conclude that a 10% increase in water prices results in an approximately 8% reduction in water demand, 0.13% reduction in GDP and subsidies to WMA.

Decaluwe et. al. further modify their model so as to compare different water pricing schemes. The CGE model presented by Decaluwe et. al. (1999), called Aquam Model, analyzes the impact of irrigation water tariffing at the marginal cost and at the average cost to the Moroccan economy. Two regions are represented in the model: the North with abundant water and the South slightly short of water. Both regions produce similar commodities linked by a constant elasticity of substitution (CES) functions which are sold on the national and the international markets as composite commodities. Agricultural production function is a CES function based on the argument of Just (1991). CES specification makes it possible to postulate substitutability between the factors of production and the intermediate consumption.

Three pricing policies are simulated, Boiteux-Ramsey Pricing (BRP), Marginal Cost Pricing (MCP) and an arbitrary increase in agricultural water prices. Results reveal that BRP combined with a reduction in distorted production taxes was the most efficient in reducing water consumption with a positive impact on equivalent variation (EV) and eliminating WMA subsidies. MCP has a more positive impact on the EV but is not as efficient in reducing water consumption and does not eliminate subsidies (natural monopoly). Finally, the arbitrary increase in agricultural water prices generated negative effects on EV and only small reductions in water consumption and subsidies to WMA. Hence, considering welfare criteria and water conservation objectives, Boiteux-Ramsey pricing seems to be the best alternative. Moreover, they show that as an economy becomes more rigid, BRP becomes more advantageous whereas the efficiency of MCP decreases.

Tirado et. al. (2003) introduced the idea of allocation of water rights. They presented a CGE model for the Balearic Islands to analyze the welfare gains associated with an improvement in the allocation of water rights through voluntary water transfers.

There are ten sectors in the model. Two of them are water production sectors (traditional drinking water sector and desalinization of sea water). There are five production factors: land, capital, labor, soft water and sea water, and four agents, consumers, firms, government and rest of the world (ROW).

In agriculture, it is possible to change the irrigated and the non-irrigated crops composition. To include these adjustment alternatives, they model both irrigated and non-irrigated crop production technologies as nested multilevel CES functions.

At the status quo, water supply is assumed to be fixed and water rights are not tradable, drinking water is produced and distributed by using other production factors and is used as a final good by consumers or as an intermediate good by other sectors of the economy. Sea water supply is assumed to be fixed and determined by the available desalinization capacity.

With the introduction of transfer water rights, agricultural production decreases. But, tradable water rights would lead to an efficient institutional setting so that the overall efficiency in the economy increases.

They also conclude that water markets would bring substantial savings by avoiding the construction of some water regulation infrastructures such as dams, desalinization plants, and water transfer facilities. Moreover, the economic distortions which may result from the operation of these redundant infrastructures would be eliminated.

Decaluwe et. al. (1999) and Tirado et al. (2003) do not take the distribution of drinking water under consideration. Thabet (2003) integrates a drinking water production/distribution sector into CGE, but with no distinction between production and distribution. This distinction is introduced by Briand (2004) in her CGE model for Senegal. In addition, to separate production and distribution of water sectors, the distribution of water is divided into two groups: formal and informal. Briand argues that the informal drinking water distribution operators serve the low income group and their services must be regarded as a true complement of the public company. Consumers' low and/or irregular incomes and bad locations lead them to these informal operators. In fact, a large number of the consumers that prefer these informal operators are located in peripheral distrincts, secondary centers or in difficult access points. In order to have a minimal quantity of drinking water each day, households split their expenditures in accordance with their daily and irregular incomes. Briand, aims at analyzing the effects of water pricing policy on the development of both formal and informal water distribution and tries to determine a policy which enables all households to use water services and also analyze the effects on the income distribution of the three consumers categories that is defined in the model, namely the consumers in rural areas, Dakar and other urban areas.

There are many studies concerning the effects of tax and subsidy removals. Stringer and Wittwer (2001) model “water policy reforms” in Australia. Australia is the largest wine exporter after the European Union. Grape growers depend on reliable supplies of good quality water at specific times. Rainfall and irrigation influence the grape quality and vine health. The policies and management practices that effect the future water availability, access, use and quality have a strong affect on Australia’s wine industry (Stringer and Wittwer, 2001).

In their paper, Stringer and Wittwer explore the key factors motivating change in national, regional and local water institutions and examine the effects of the resulting policy reforms on water markets, water use and the profitability. They examine two policy affects: removal of implicit subsidies and taxes on water usage in certain areas and taxing producers for salinity.

The water pricing reform scenario indicates that, there is a redistribution of irrigation activity to South Australia. Overall agricultural output declines but the benefit in terms of reduced salinity damage outweighs this. When producers are taxed for the full cost of salinity damage, the reduction in national income is outweighed by the benefit from the reduced salinity.

In their study, Kraybill et. al. (2002) form a CGE model for the Dominican Republic in order to analyze the consequences of a reduction in irrigation subsidies and elimination the tariff on rice imports. Model results show that applying either of these reforms separately causes GDP to rise. Even implementing both policy changes together is more efficient. But, the distributional consequences differ. For the poor, who spend a large share of their earnings on rice, the benefits of price reductions resulting from free trade are beneficial. But, lower prices also diminish the incomes of the rice producers, who comprise an important segment of the rural population. Moreover, decreasing subsidies will harm the farmers and also the consumers since it will result in higher food prices due to increased agricultural production costs.

Robinson and Gehlhar (1995) use an eleven-sector CGE model to analyze the policies in Egypt in 1986-88. There are large output taxes and subsidies varying across the sectors. In agriculture, there are major input subsidies and no charges for water. Robinson and Gehlhar perform three different series of experiments: in the first series, they explore the impact of removing agricultural taxes and subsidies sector by sector. In the second series, they examine the impact of eliminating both agricultural and non-agricultural distortions due to the tax, subsidy and tariff system. In the final series, they estimate the agricultural water demand curve. Here, they reduce the aggregate supply of water progressively to observe how the price of water and the use of water change. All three series are done using different model variants: migration versus no migration and constraint water versus unconstraint water.

Robinson and Gehlhar find that under the 1986-88 policy regime land, not water, was the binding constraint for farmers. Even if Egypt had introduced a market for water, the equilibrium price would have been close to zero.

Results indicate that, eliminating the ad valorem taxes and subsidies leads to an increase in the demand for water and a significant increase in the market price of water that would prevail if there were an open water market. Demand curve analysis shows that the water demand is quite inelastic. Robinson and Gehlhar argue that a policy reform on the output side would have great influence on the water distribution system. Also, reducing water consumption or managing water distribution when water supply remains fixed while agriculture is growing, will cause water to cost too much for the farmers. In order to be successful in a policy reform, Egypt must ensure that the water is allocated efficiently so that it is used where its potential market value is greatest.

Cabral (2005), using a nineteen-sector CGE model based on 1996 SAM, examine the impact of subsidy removal in north countries on Senegal. He finds that the elimination of agricultural subsidies in developed countries leads to a shift in agricultural supply toward external markets. This, in turn, results in an increase in the cost of imported cereals, particularly in rice. Since the cereals occupy a significant weight in the consumption basket of poor households, their well-being worsens, except those of the Delta rural households.

Azdan (2001) analyzes the economy-wide impact of water policy reform in Jakarta, especially among different-income households and within the industrial sector. They apply three scenarios. First, there is an additional tax on the municipal water company (PAM) to increase capital for the company. Second, the same tax is used to subsidize access by low-income households to PAM water. Finally they examine the elimination of cross subsidization between households and industry and collection of fees on ground water extraction.

They conclude that elimination of cross subsidization would contribute to economic efficiency. Also, they show that fees needed to be increased substantially in order to reduce the excess extraction of the ground water. It would be equitable and efficient to eliminate the subsidy to households currently connected to the municipal system and transfer the revenues created by this subsidy cut to connect more households.

Mukherjee (1995) analyzes the economy-wide linkages among all water users in the watershed and simulated water and land policy reforms. Here, there are four factors of production: labor, capital, land and water. Water and land are forming a composite good by Leontief function. This in turn, links with labor and capital through the CES function. She concludes that there was a tendency towards inefficient use of water in both agricultural and non-agricultural sectors. With a suitable scarcity price charge for water, the sectors using water relatively less intensively are considerably less disadvantaged when compared to those with more intensive use. The system is very sensitive to the scarcity water price changes. Modest water and land reform policies could lead to dramatic and positive changes in the homeland agricultural sector.

Diaz-Rodriguez (2000), investigate the effects on markets, of liberalizing the rice market and reducing water subsidies for agricultural production, economic welfare, and water use in the Dominican Republic. Results show that, as imported rice becomes cheaper, domestic rice production declines. But, as the increase in imports outweighs the decrease in domestic outputs, rice consumption increases. Total water use in agriculture is reduced and the factors of production are diverted to other crops' production. Liberalization leads to an improvement in the net welfare. The poor, who spend a larger share of their earnings on rice when compared to other income groups, benefit the most.

Diao and Roe (2003) examine the linkages between water and trade policies in Morocco. They present a dynamic AGE model. They create simulations in order to examine both the short-run and the long-run dynamic effects of trade reforms and a water user rights market. Results of the trade reform alone show that the shadow price of water falls in the sector that produce pre-reform protected crops. Farmers who are worse-off after the reform could earn income from renting out some of their water to others. Also, they show that creating a water user-rights market compensates the losses of farmers due to the trade reform, and also raises the efficiency of water allocation thus, benefits the whole economy.

Some studies consider inter-regional relations. Two examples are Vaux and Howitt (1984), and Diao et. el. (2002).

Vaux and Howitt (1984) develop a GE approach for inter-regional water trade. They examine the interregional equilibrium supply and the demand relationship for California. They estimate that if trade is not allowed and the development of new water sources is exclusively used to meet increasing demand, the resulting prices for all regions are dramatically higher. The increasing demand can be met at much lower social costs with a market-based interregional trade of water supplies.

Diao et. al. (2002) construct a model for Morocco. Seven major irrigation regions and perimeters within each region are considered. Each of the regions is linked to up and down stream markets, and they compete with the rest of the economy for economy-wide resources. In their study, Diao et. al. aim at estimating the shadow price of water in each perimeter of these seven major agricultural development authorities (ORMVAs), and at conducting an analysis of a water user-rights market among farmers in each region.

The results suggest that a decentralized water trading mechanism could increase agricultural output by 8.3 percent, affect the rental rates of other agricultural inputs at the national level, including labor, and have economy-wide effects that entail modest declines in the cost of living, an increase in aggregate consumption, and expansion of international trade.

In addition to the above studies: Seung et. al. (1998) study the welfare gains associated with the transfer of water uses from agricultural to recreative uses in the Walker River Basin. Seung et. al. (2000), combine a dynamic CGE model with a recreative demand model to analyze the temporal effects of water reallocation in Churchill County (Nevada). Diao and Roe (2000) provide a CGE model to analyze the consequences of a protectionist agricultural policy in Morroco and show how the liberalization of agricultural markets creates the necessary conditions for the implementation of efficient water pricing (particularly through the possibility of a market for water in the rural sector). Goodman (2000), by using an applied CGE, shows how temporary water transfers provide a lower cost option than does the construction of new dams by enlarging the existing water storage facilities.

Although there are many CGE models for Turkey neither includes water. The model constructed in this study is a multisectoral, single country, and static, CGE model which includes water as a factor of production together with capital, labor and land. Its production structure is similar to Mukherjee (1995) with a Cobb-Douglas production function instead of a CES function. The details of the model are presented in the next chapter.

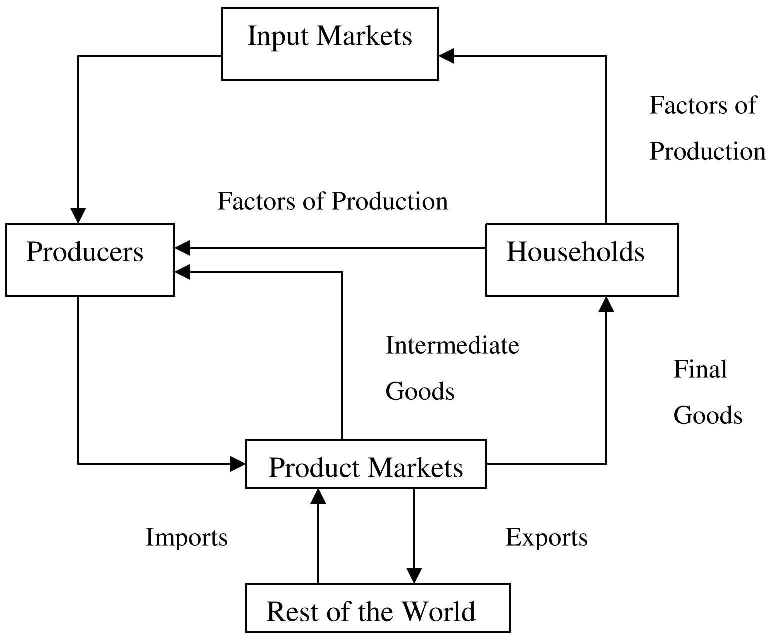
CHAPTER 4

STRUCTURE OF THE TURKISH WATER-CGE MODEL

CGE models are represented in the form of a non-linear equation system. They are computable in the sense that they display numerical solutions and they are general since they contain all the economic agents, all flow of factors and all markets in the economy. They display equilibrium since every market in the economy is assumed to be in equilibrium.

CGE models can be classified according to different criteria. One is the regional aggregation decision, since they are concerned with only one country or several countries or they may be regional. They can also be classified as static or dynamic, real or financial, fully or partially competitive. Sectors, factors of productions, and household groups are all disaggregated according to the aim of the model (Güneş, 2007).

A typical CGE model contains supply and demand equations based on the optimization problems of the agents. Consumers maximize their utility under their budget constraints while producers maximize their profits under technology constraints. The representative consumer's decision determines the demand for goods and supply of labor. Consumers purchase final goods from the product markets and sell their labor in the factor and product markets in return for wages. On the other hand, the representative producer's decision determines the supply of goods and the demand for production factors. Producers purchase inputs from input markets and intermediate goods from product markets, and use them to produce goods in the product markets (Mukherjee, 1995). All the countries, other than those of concern are named as the 'rest of the world'. Goods are exported to the rest of the world, and imported goods are also sold in the domestic product market (ESCAP, 2003). For the flow of goods and services see Figure 4.1.



Source: ESCAP (2003)

Figure 4.1: Economy-Wide Circular Flow of Goods and Services

Often, the public sector is also included in these models in order to analyze the affects of a policy change. The government collects taxes and tariffs, provide monetary transfers, subsidies and services. Factor incomes are distributed among households and these together with public and foreign transfers (in an open economy) make up the aggregate income of households (Mukherjee, 1995). Households then use their incomes less taxes for consumption and saving.

Domestic supply and demand, together with the incomes are all determined simultaneously within the model. The solution of the general equilibrium model turns out to be a vector of commodity and factor prices that satisfies the supply and demand decisions.

First CGE studies were considering models with pure neoclassical thinking. But in further studies some market distortions are added to the models. Especially, models constructed for developing countries may include macroeconomic imbalances and rigidities as unemployment, factor immobility, enter-exit barriers, and fixed prices (Güneş, 2007).

In order to ensure the macroeconomic balances closure rules are introduced. Robinson (1989) defines the closure as assuming some of the macroeconomic variables as exogenous. Closures determine the way of achieving the balances in public account, saving-investment and trade (Güneş, 2007). Exogenous and endogenous variable decisions are made accordingly and this determines the causalities within the model. Possible closure choices are given in Table 4.1. Modelers decide on the closure rules suitable for the structure of their model.

Table 4.1: Closure Rules:

■ Public Account
Public revenue is the sum of public savings and public consumption.
➢ Endogenous public saving, exogenous tax rates
➢ Exogenous public saving, endogenous tax rates
➢ Exogenous public saving, public expenditures, endogenous compulsory savings
■ Rest of the world
National account balance.
➢ Exogenous foreign savings, endogenous exchange rate
➢ Endogenous foreign savings, exogenous exchange rate
➢ Exogenous exchange rate, endogenous import rationing
➢ Exogenous exchange rate, endogenous import quotas
■ Saving-investment
(Private+ Public + Foreign) Savings = Investments.
➢ • Exogenous investments, endogenous private savings
➢ • Endogenous investments, exogenous private savings

Source: TEPAV/MOD (2007).

In public accounts, if the tax rates are given exogenously, public income will be determined accordingly and public savings will be calculated endogenously by the difference of the public revenue and the public expenditures. On the other hand, if public savings are taken to be exogenous, either the tax rates or directly the public expenditures will be determined within the model.

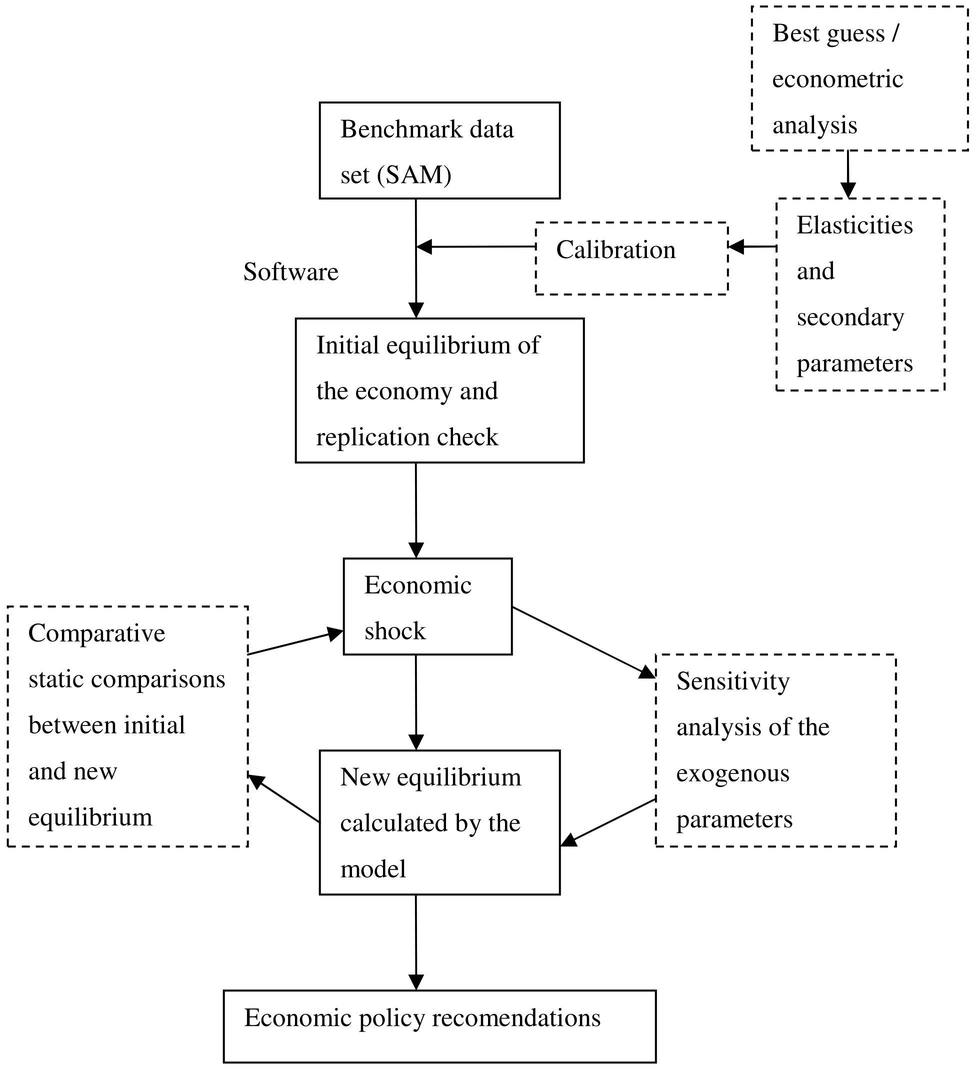
The first debates on closure rules mainly focused on saving-investment closure and four different approaches were introduced (Dewatripont, Michel, 1987; Robinson, 1989). The first is the “neoclassical closure” which is a saving-driven approach that considers the savings to be exogenous and the investments are calculated. On the other hand, in “Keynesian closure”, savings are determined endogenously. In the other two approaches, total consumption is also considered. The so called “Johansen closure” which is investment driven, the necessary saving level for the exogenously given investment level is determined from changes in consumption expenditures. Finally, the “Fisher closure” takes savings, investments, and total consumption as exogenous and interest rate is the balancing factor (Güneş, 2007).

If the exchange rates are fixed exogenously, it can balance the foreign trade. Then, foreign savings will be determined endogenously. Conversely, foreign savings may be taken as exogenous and exchange rates will be calculated endogenously within the model.

CGE models require a balanced data set representing the whole economy. The best way to form such a comprehensive set is to construct a Social Accounting Matrix (SAM)[6]. Two kinds of parameters are specified. The primary parameters are typically different substitution elasticities. They are taken to be “best guess” values or estimated by the use of econometric methods. The secondary parameters are the other parameters in the model such as the efficiency and distribution parameters. They are calibrated to a level that reproduces the benchmark data (Törmä, 2003). Equation systems are formed by the exogenous variables and calibrated parameters. Once the model replicates the initial data (base run) modeler can pass on to the next step. Model will be used for examining the affects of policy changes and economic

[6] SAM is explained in detail in Section 4.2.

shocks. The analysis is completed with the comparison of the simulation results with the base run solutions. The computational steps of a CGE model are represented in Figure 4.2.



Source: Törmä (2003)

Figure 4.2: Computational Structure of the CGE Modeling

The next section presents the details of the water-related CGE Model for Turkey.

4.1 Water-CGE Model for Turkey, TURKWAT

TURKWAT is a single-country, 9-sector with four factors of production, saving-driven, small-open, and static CGE model for Turkey. It is the first model for Turkey that includes water as a factor of production. Different from the other CGE models for Turkey, it has a nested production structure. Land and water form a composite good. This, together with capital and labor, comprises the total agricultural production. This structure is similar to the work of Mukherjee (1995), except she used CES production function in the second stage, while here Cobb-Douglas production function is preferred. The only model for Turkey having the same agricultural disaggregation is the one by Güneş (2007). Though the non-agricultural sector decisions differ.

4.1.1 Model Specifications

Production Structure:

The model disaggregates the whole economy into nine different sectors. Four of these sectors are agricultural sectors: Growing of cereals and other crops n.e.c., growing vegetables, horticultural specialties and nursery products, growing fruit, nuts, beverage and spice crops and other agricultural sectors. The remaining five sectors are non-agricultural sectors: food, beverage and tobacco, textile, chemical products, metal and other non-agricultural sectors. One can find the details of sectoral decomposition in the I/O Table in Appendix A.

Agricultural sectors are decomposed according to the Input-Output Table's detail. Within the non-agricultural sectors, food, textile, chemistry and metal sectors use water intensively. Other sectors are aggregated as "other non-agricultural sectors". Within these sectors, manufacture of paper and paper products uses relatively more water. However, due to lack of data it is not treated separately.

In manufacture of paper and paper products, production is carried out in two stages: pulping[7] and paper making. The former requires large amount of water.

[7] Extraction of cellulose fibers from wood.

However, in Turkey, this procedure is not carried on much, most cellulose fibers are imported. Another source of cellulose fibers is recycling of paper. This also requires a considerable amount of water but not as much as used in pulping.

In the second stage of the production, namely, the paper production water also used, but in much smaller amount compared to pulping. As an overall, the amount of water used in paper industry in Turkey is not considerably large amount compared to the other non-agricultural uses such as in chemical and metal industry. Therefore, ignoring the amount of water in this sector does not make much difference in our calculations.

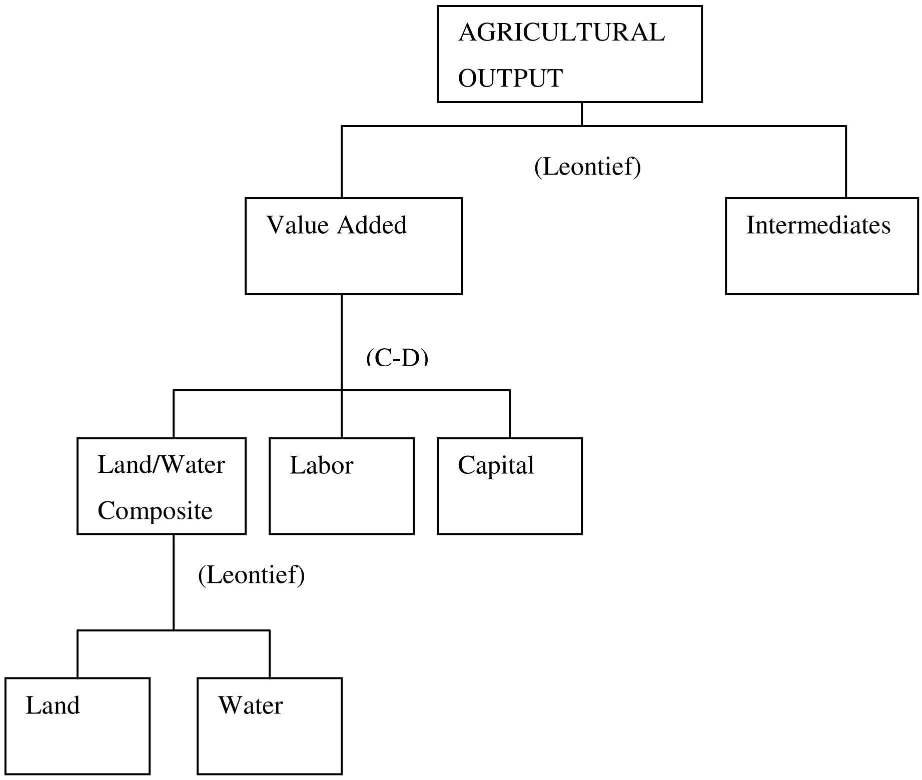


Figure 4.3.a: Structure of Agricultural Output

Agricultural production has a nested structure (Figure 4.3.a). It is assumed that there are four factors of production: Labor, capital, water and land. As in the model by Mukherjee (1995), land and water comprise a composite good. This composite input in turn, is linked with capital and labor through a constant returns to scale Cobb-Douglas (C-D) Production Function given in Equation 4.1.

$$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} TW_i^{(1-\alpha_i-\beta_i)} \tag{4.1}$$

Here, K_i is capital, L_i is labor and TW_i is the land/water composite.

Sectoral output is assumed to be a Leontief function of sectoral value-added and intermediate inputs. Thus, no substitution is allowed between the primary factors and intermediates. Intermediate input demand in each sector, *i*, is determined by the fixed Leontief coefficients a_{ij}'s.

$$INT_i = \sum_j a_{ij} XS_j \tag{4.2}$$

Land is not applied to non-agricultural production. For non-agricultural sectors, labor, capital, and water inputs are aggregated through a C-D Production function:

$$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} H_i^{(1-\alpha_i-\beta_i)} \tag{4.3}$$

Here, K_i and L_i represent capital and labor respectively and H_i represents the water input.

Value-added and intermediate inputs are combined in a Leontief function to form the sectoral output (See Figure 4.3.b).

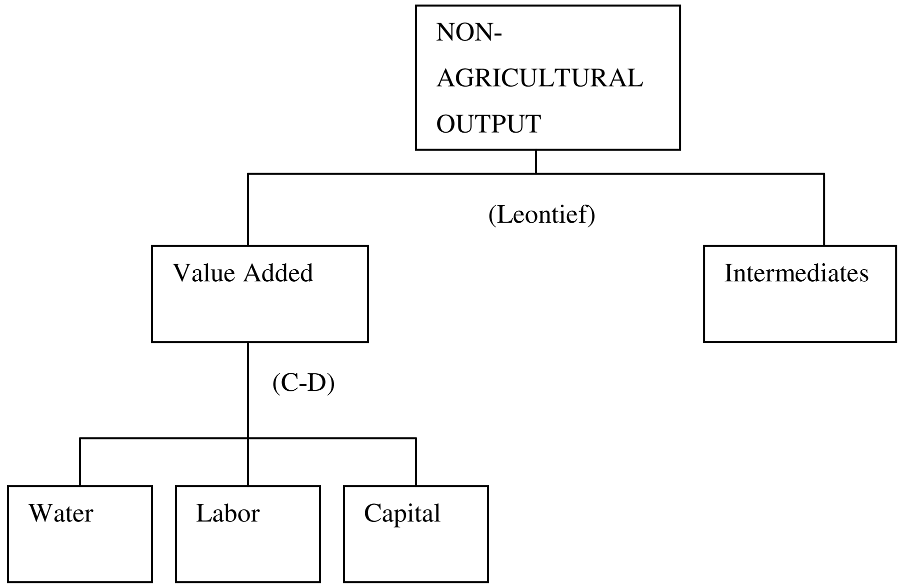


Figure 4.3.b: Structure of Non-Agricultural Output

Aggregate supplies of factors of production in each sector are fixed and given exogenously. Labor and capital inputs are assumed to be fully utilized. Since not all water resources can be used at once, water input is assumed to be consumed partly, the remaining is allowed to flow. There is no separate production sector for water. Sectoral water usage is assumed to be determined in a competitive market as are the other factors of production.

Income Generation:

Two different agents are assumed in the model. The private and the public. The public agents represent all the state owned enterprises and the private agent represents the households.

Public revenues consist of tax revenues and income from abroad.

$$GREV = TACTTAX + TCOMTAX + PYRTAX + CAPTAX + REMTAX + HTAX + PFTR \quad (4.4)$$

Tax revenues consist of activity taxes (*TACTTAX*), commodity taxes (*TCOMTAX*), payroll taxes (*PYRTAX*) and capital taxes (*CAPTAX*). The remaining taxes (*REMTAX*) are defined so as to contain all other public revenue. *HTAX* is water tariff collection according to water use. It is taken as the income received from water distribution obtained from TURKSTAT (2004). Data is available for 2001. The proportion of it to the public revenue is applied for 2003. Accordingly, public "water income" is calculated from the public revenue of 2003. *PFTR* represents public foreign transfers.

Private income is composed of income from factor ownership less taxes, and domestic and foreign transfers.

$$
\begin{aligned}
Y = & \sum [(1-tpyr).W.WDIST_i.L_i + (1-tcap).RK.RKDIST_i.K_i] \\
& + VWATER - HTAX + \sum_{ia} STW_{la,ia}.QT_{ia} \\
& + TRANS + NPFI - NPFE
\end{aligned} \tag{4.5}
$$

In Equation 4.5 above, $WDIST_i$ are sectoral wage difference coefficients and $RKDIST_i$ are sectoral profit rate differentials; *W* and *RK* are the average nominal wage rate and the average profit rate respectively. *VWATER* represents the total water factor income. This less of public water tariff collection is supposed to give the water factor income of the farm organizations and added to the private incomes as the "water income" of the private sector. $STW_{la,ia}$ is the average price of land and the index *ia* corresponds to the agricultural sectors, *TRANS* represents the public transfers to households, *NPFI* is the net private factor income from abroad and *NPFE* is the net private factor payments to abroad.

Expenditures:

Public expenditure composes of the sum of aggregate public consumption, public transfers and interest payments on public foreign debt. Sectoral public consumptions are taken as proportions of the total public consumption. Each proportion is calibrated as a ratio of sectoral public consumption to aggregate public consumption, which is taken to be a fixed proportion of public revenue. Public transfers are calculated as a proportion of public revenue.

Private expenditures are composed of private consumption in the model, other public revenue and foreign transfers. Private consumptions are calculated to be one minus marginal propensity to save (MPS) multiplied by disposable private income.

Rest of the world (ROW):

The "small country" assumption is applied. Namely, world prices of imports and exports are assumed to be given exogenously and import and export prices within the country are calculated from these world prices. So, the domestic price of imports is the import tariff inclusive world price times the exchange rate:

$$Pm_i = Pwm_i ER(1+tm_i) \tag{4.6}$$

Domestic price of exports is calculated as world export price multiplied by the exchange rate:

$$Pe_i = Pwe_i ER \tag{4.7}$$

The Armington specification is used: imported and domestically produced goods are assumed to be imperfect substitutes. Households consume a composite good composed of domestic and foreign products. Subject to their current incomes, households minimize their costs. As a result, the households decide on the composition of domestic and imported goods in their consumption bundle. Accordingly, sectoral composite good, CC_i, is formulated as a *Constant Elasticity of Substitution* (CES) aggregation of the domestic commodity, DC_i, and the imported foreign good, M_i:

$$CC_i = ac_i (bc_i M_i^{-\gamma_i} + (1-bc_i) DC_i^{-\gamma})^{-1/\gamma_i} \tag{4.8}$$

Here, γ_i is the elasticity of substitution parameter and is given exogenously to the model.

According to the Armington specification, households minimize a cost function:

$$Pd_i.DC_i + Pm_i.M_i \tag{4.9}$$

subject to the CES composite commodity. Pd_i and Pm_i are sectoral domestic and imported goods' prices respectively.
The first order condition of the cost minimization problem gives:

$$\frac{M_i}{DC_i} = \left(\frac{bc_i}{1-bc_i}\right)^{\sigma_{m_i}} \left(\frac{Pd_i}{Pm_i}\right)^{\sigma_{m_i}} \text{ where } \sigma_{m_i} = \frac{1}{1+\gamma_i} \tag{4.10}$$

The representative producer in each sector is assumed to maximize its total revenue from domestic and foreign sales:

$$XS_i = at_i(bt_i E_i^{-\mu_i} + (1-bt_i)DC_i^{-\mu})^{1/\mu_i} \tag{4.11}$$

The producer's problem is to maximize profit

$$Pd_i.DC_i + Pe_i.EX_i \tag{4.12}$$

subject to total output and first order condition gives:

$$\frac{EX}{DC} = \left(\frac{1-bt}{bt}\right)^{\sigma_{e_i}} \left(\frac{Pe}{Pd}\right)^{\sigma_{e_i}} \text{ where } \sigma_{e_i} = \frac{1}{1-\mu_i} \tag{4.13}$$

De Santis (2002) provides estimated elasticities for Turkey. Accordingly, both σ_{m_i} and σ_{e_i} are taken to be equal to 2. In order to reflect the comparative advantage of Turkey in foreign trade, it is further assumed that the response of the vegetable and fruit sectors should be lower than this rate. Therefore, elasticities for these sectors are taken to be 0.5.

Equilibrium Conditions:

Public saving is the difference between public revenues and public expenditures. Private saving is calculated as MPS multiplied by disposable private income, and MPS is taken to be fixed. Thus, the model closure is “saving driven”. Private saving calculated from the exogenous saving rate is assumed to determine the investment level through the saving-investment balance. Total private investment is distributed to the sectors in fixed shares. Total public investment (*TOTGINV*) is calculated from government primary balance (*GPRMBAL*) equation:

$$GPRMBAL = GREV - TGCON - TOTGINV - INTRSRAT * TRANS \qquad (4.14)$$

In accordance with the economic program of 2003, *GPRMBAL* is taken to be as a proportion of *GDP*. *INTRSRAT*[8] is the ratio of interest payments to domestic banks in government transfers.

Total saving (public, private and foreign) is equal to the total investment:

$$GSAV + PRSAV + FSAV = TINV \qquad (4.15)$$

Commodity balance, describing the supply and demand equivalence of composite commodities, is given below. The sum of private and public consumption demands, $PRCON_i$ and $GCON_i$ respectively, investment demand, INV_i, and the intermediate demand, INT_i, has to be equal to the sectoral absorption, namely to the supply of the composite good, CC_i.

$$CC_i = INT_i + PRCON_i + GCON_i + INV_i \qquad (4.16)$$

[8] Is calculated to be equal to 0.484 as the proportion of public domestic interest payments within public transfers.

Current account balance implies

$$\sum PM_i IM_i + NPFE + FIP = \sum PE_i EX_i + FSAV + NPFI + PFTR \qquad (4.17)$$

Here, *NPFE* is the net private factor payments to row; *FIP* is the foreign interest payments; *NPFI* is the net private factor income from row; *PFTR* is the public foreign transfers, and *FSAV* is the foreign savings.

4.2 Data Set

This section explains the construction of the data set required for CGE modeling. First, the general structure of the social accounting matrices is being presented. In the next subsection, the construction of the data set used in this model, namely the 2003 SAM for Turkey is being analyzed.

4.2.1 Social Accounting Matrices

SAM's which are essential for CGE modeling are comprehensive, balanced data sets. They simply record all of the transactions that take place in a national economy during one year[9]. The SAM is basically the synthesis of two tools or methods of economic analysis: the input-output table and the national income accounting. So, it comprises information on income and expenditure flows of the economy as well as socio-economic indices, such as income distribution, unemployment, gender differences, and poverty. The construction of a SAM, therefore, requires combining data from three different sources, i.e., national income and expenditure accounts, I-O tables, and socioeconomic surveys (Kumar and Young, 1996).

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[9] The guiding works for social accounts, in the twentieth century, were those by Kuznets (1937) (on national accounts) and by Leontief (1941) (on input-output matrices). The SAMs used today are based on the work by Meade and Stone (1941). In this study, they developed the first logically complete set of double-entry national income accounts (Kehoe, 1996).

There are several SAM constructed for the Turkish economy. Günlük-Şenesen (1991) presents a SAM for the economy for the year 1973. Her study stands as a straightforward enlargement of the 1973 I-O table. Özhan (1989) constructs a SAM for 1983 that has proven to be very useful for analyzing the income distribution effect of stabilization policies employed in Turkey during 1980's. There are other studies by Adelman et al. (1989), Yeldan (1989), and Harrison et al. (1992) to study various particular aspects of Turkish economy. Yet, none of these SAMs have yet incorporated household survey information and hence have no income-distributional dimension (De Santis and Özhan, 1995).

There are several studies concerning SAM for Turkey for the year 1990. One of them is a study by De Santis and Özhan (1995). This study gives a highly disaggregated SAM containing 281 accounts. Another is a study by Köse and Yeldan (1996). This study aims to establish a macroeconomic base for a computable general equilibrium model. The model employs a 14-sector SAM together with a capital composition[10] matrix. Tunç (1999) presents a SAM that contains not only the real accounts but also capital accounts and financial assets and liabilities. Atıcı (2003) reorganizes the SAM constructed by De Santis and Özhan (1995, 1997) in order to analyze income distribution on a factor base. It is a 6-sector SAM containing 8 different labor forces, 5 different capital stocks, and 6 different factor incomes. There are 20 households identified according to their incomes; government and private enterprises.

Usanmaz (2001) constructs SAMs for the years 1963, 1968, 1973, 1979, 1985 and 1990 in order to examine the intersectoral resource flow between agricultural and non-agricultural sectors in Turkey.

For our purpose, the only officially published SAMs are the ones constructed by Telli (2004). In his study, Telli constructs a series of SAMs between the years 1996-2003. This study is important in the sense that it introduces a systematic approach which produces a series of SAMs. He decomposes the labor force into

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[10] A matrix whose elements, *bij*, describes the amount of capital good originating from sector "*i*" that will be used to make up one unit of real capital in sector "*j*". Thus each column of the matrix adds up to one.

formal and informal labor and adds a detailed analysis of social security institutions. The SAM constructed for 2003 was later extended to a 9-sector SAM (Telli et. al., 2005).

Table 4.2: Format of an Aggregated SAM

	Activities	**Commodities**	**Factors**	**Private House-holds**	**Govern-ment**	**Invest-ment**	**ROW**	**Total Receipts**
Activities		Domestic Supply					Exports	Tot. Sales Revenue
Commo-dities	Interme-diate Inputs			Private Consump-tion	Government Consump-tion	Invest-ment		Domestic Absorp-tion
Factors	Factor Payments							Factor Income
Private House-holds			Factor Incomes		Transfers		Private Foreign Transfers	Private Income
Govern-ment	Activity Taxes	Commodity Taxes	Factor Taxes	Remain-der Taxes			Public Foreign Transfers	Public Income
Invest-ment				Private Savings	Public Savings		Foreign Resource	Tot. Invest-ment
Rest of the World		Imports		Private Foreign Transfers	Foreign Interest Payments			Foreign Earnings
Total Expendi-tures	Production Costs	Aggregate Absorption	Factor Costs	Private Hh Expend.	Public Expend.	Tot. Invest-ment	Foreign Expenses	

In this study, a SAM with a base year of 2003 is constructed. A simple 2-sector SAM is formulated at the beginning, and then it is extended to a 9-sector one in order to represent the basic modeling needs of the thesis.

As mentioned above, SAMs are comprehensive data sets which gather different data from different sources. Collecting these data and harmonizing them into a balanced SAM system not a straightforward task. Some data may be published differently by different agencies and/or the data taken from different sources may not be consistent with each other. Therefore, deciding from which source the data is to be taken and trying to achieve consistency is very important.

Table 4.2 illustrates a schematic format of a standard aggregated SAM. Utilizing this table, the treatment of the data is presented first. The rest of the work is to disaggregate the aggregated SAM into different sectors. Disaggregating is carried out in accordance with 1998 I-O coefficients.

SAM is a balanced scheme with all column sums being equal to the corresponding row sums (Köse and Yeldan, 1996). So, all the economic balances related to the data used must be satisfied. These correspond to income-expenditure identities, supply-demand equalities, saving-investment balances and trade balances. SAMs are designed so as to display the expenditures in columns and revenues in the rows. It is an example of single entry book keeping, with every entry appearing in both a row and column. This means that each income item for one party must be an item of expenditure for another so that total receipts equal total outlays (Turner, 2004). Therefore, the sum of each column must be equal to the sum of the correspondent row. For instance, observe that for the public sector, the income consists of tax revenues and public foreign transfers. The correspondent column gives the expenditures containing government consumption, transfers to households and foreign interest payments. Public saving is the difference between public revenues and public expenditures.

4.2.2 2003 SAM for Turkey

In this part, construction of the data set for TURKWAT, namely the 2003 SAM is explained.

Public Account:

Public revenues in the model are composed of public tax revenues, non-tax revenues, social funds[11], factor incomes, privatization revenues, and public foreign income. Four different taxes are defined (commodity taxes, activity taxes, payroll taxes and capital taxes), and the sum of other taxes and domestic public income is defined as 'remainder taxes'. Calculations for the components of the public revenue are given in Table 4.3.

Data of direct and indirect taxes together with wealth tax, non-tax revenues (B), factor income (C), total social funds (D), and privatization revenues (E) and also the total tariff revenues are all taken from SPO (2005).

In the data of Ministry of Finance, General Directorate of Public Account, the shares of income taxes, corporate taxes and value added taxes are given. These are calculated accordingly. 'Commodity taxes' are taken to be the sum of VAT and tariff revenue.

According to the Ministry of Finance, 90 percent of the income taxes are collected as a withholding tax. Among these, 52 percent is taken from employees. So, first the income tax withholding is calculated and 52 percent of this is considered to be income taxes from employees (A.2.a.aa).

Social security premium collections and unemployment security premium collections are taken from SPO. These are decomposed into employees' and employers' premium payments according to the survey by TİSK (2004)[12]. Accordingly, within 100 TL costs to employees 25.2 TL is the premium payments and 14.7 TL is paid by the employers. So, the ration of employers' share in premium payments over total premium payments becomes 0.147/0.252. Hence, the employers' premium payment is found to be this factor times the total payments. The same logic is applied for unemployment security payments.

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[11] The difference between the premium payments of private agents to social security institutions and the wage payments to private agents.

[12] TİSK(2004), "2003 Çalışma İstatistikleri ve İşgücü Maliyeti", TİSK (Türkiye İşveren Sendikaları Konfederasyonu) Publications, No:249,Ankara

Table 4.3: Calculations of Public Revenues

PUBLIC REVENUE
A. TAX REVENUES

- 1. Indirect Taxes
    - a. Value Added Tax (VAT)
    - b. Tariffs
    - c. Other
- 2. Direct Taxes
    - a. Income Taxes
        - aa. Income taxes from employees
        - ab. Other
    - b. Corporate Taxes
- 3. Wealth Tax

B. NON-TAX REVENUES

- 1. Public foreign income
- 2. Other

C. FACTOR INCOME

D. SOCIAL FUNDS

- 1. Social Security Premiums
    - a. Premiums paid by employees
    - b. Premiums paid by employers
- 2. Unemployment Security Payments
    - a. Premiums paid by employees
    - b. Premiums paid by employers
- 3. Other

E. PRIVATIZATION REVENUES

<u>TABLE A.2 GOVERNMET ROW FORMULAS</u>

COMMODITY TAXES	=	A.1.a + A.1.b
ACTIVITY TAXES	=	A.1.c + D.1.b + D.2.b
PAYROLL TAXES	=	A.2.a.aa + D.1.a + D.2.a
CAPITAL TAXES	=	A.2.b + C
OTHER PUBLIC REVENUE	=	A.2.a.ab + B.2 + A.3 + D + E - D.1 – D.2
PUBLIC FOREIGN INCOME	=	B.1

‘Activity taxes (*ACTTAX*)’ are calculated as income taxes less commodity taxes plus employers’ social security and unemployment security payments.

‘Payroll taxes (*PYRTAX*)’ are the sum of income taxes paid by the employees, together with the employees’ social security and the unemployment security payments.

‘Capital taxes (*CAPTAX*)’ are composed of corporate taxes and public factor incomes.

All other public revenues are named as ‘Remainder Taxes (*REMTAX*)’.

Public expenditures are composed of public consumption, public transfers and interest payments on public foreign debt. Public transfers to the private sector in SAM are calculated as public transfer payments taken from SPO, minus public foreign transfers.

<u>Rest of the World:</u>

Import and export values are taken from the SPO (2005). Net foreign factor income and its components (incomes and receipts) are taken from TUKSTAT (2005). These are decomposed into public and private incomes and receipts. Worker remittances from abroad (in SPO data) are considered as public income from abroad and interest payments on public foreign debt are considered as the public payments to abroad. Remainders are private receipts and expenditures. Formulation is displayed in Table 4.4.

Table 4.4: Calculations for Net Factor Income from Abroad

NET FACTOR INCOME FROM THE REST OF THE WORLD		
Income Received		
Public	=	Worker’s Remittances
Private	=	Other
Income paid		
Public	=	Foreign Interest Payments
Private	=	Other

Capital Account:

Investment data is taken from SPO. Savings are calculated as follows: Foreign savings are taken from TURKSTAT, private savings are taken to be residual so that the row and column for ‘private households’ is balanced. Public saving is calculated from the following identity:

PUBLIC SAVING = Total Investment (Public Investment+ Private Investment+ Stock Changes) – Private Saving – Foreign Saving

Factor Markets:

Four factors of production are defined in the model: labor, capital, land and water. Labor and capital payments calculations are shown below. Labor input value is composed of payments to employees and unregistered employment. Capital input value is calculated as operating surplus minus the sum of social security and unemployment security payments by employers.

Payment to employees and operating surplus are taken from GDP-incomes approach data of TURKSTAT. Unregistered employment payment is taken as a residual[13].

FACTOR PAYMENTS TO LABOR INPUT

= Payments to employees + Unregistered employment payments

FACTOR PAYMENTS TO CAPITAL INPUT

= Operating surplus

– Social security payments by employers

– Unemployment security payments by employers

[13] Compared to Telli (2004), our calculations reflect a smaller value of unregistered employment payments. Values are 34,039,632 in Telli and 24,593,383 in this study. The difference is exactly equal to the difference in capital value taken in the two studies. This is due to the different definition of the capital factor incomes. Here, for calculation of this value, operating surplus is taken as (179,960,243) whereas Telli takes capital plus depreciation as 169,553,739.

Land input is taken as the cultivated land and water input is the total water use (sum of the water consumption for irrigation, industry, and drinking and utility purposes) given in Table 2.3. Payments to land and water are dropped from the capital factor payments.

Domestic supply is computed as a residual to balance the corresponding column and the row.

The aggregate SAM constructed, is then extended into a 9-sector one. The sectoral decomposition is formulated according to the data availability. Agricultural sectors are determined according to the 1998 I-O table's detail. The first three agricultural sectors are the same as in I-O table. Other agricultural sectors are gathered under "other agriculture sectors". The non-agricultural sectors details are determined by the data available for sectoral water use in industrial sectors. Intermediate goods, consumption, investment, exports and imports are decomposed according to the quotients obtained from the 1998 I-O Table. Activity and commodity taxes are decomposed so that the corresponding row and column sums are balanced.

Sectoral capital and labor use are determined by the use of I-O coefficients. Land is decomposed into four agricultural sectors according to the land use for the corresponding crop production. Water usages in the agricultural sectors are determined according to the relative water need for the crops produced in each sector. Non-agricultural sector water usage is decomposed according to the sectoral water usage taken from TURKSTAT. Coefficients used for the sectoral decomposition of water and land are given in Table 4.5.

Table 4.5: Water and Land Sectoral Decomposition Coefficients

	C	**V**	**FR**	**OA**	**F**	**TE**	**CH**	**M**	**ONA**
WATER	0.200	0.350	0.350	0.100	0.170	0.115	0.089	0.550	0.077
LAND	0.787	0.089	0.120	0.004					

4.2.3 Model Calibration

As mentioned before, primary parameters are either calculated econometrically or taken as a "best guess" of the modeler. Others are obtained by calibration. Model calibration is a procedure of calculation of the model parameters so as to reproduce the base year data. First, the "steady-state" version of the model is fitted with the base year data. In this study, the "structural" parameters of the model are calibrated using the 2003 data base for Turkey. The base year data has to be generated as a solution of the model with calibrated parameters. Once this procedure is finalized, model can be used for policy analysis. The results of the calibration procedure are given below.

Production function for agricultural and non-agricultural sectors are given as,

$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} TW_i^{(1-\alpha_i-\beta_i)}$, i = C, V, FR, OA and

$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} H_i^{(1-\alpha_i-\beta_i)}$, i = F, TE, CH, M, ONA.

The factor share parameters α_i and β_i are calibrated from the first order conditions representing the equality of marginal revenue product and the value added:

$$\alpha_i = \frac{RK.RKDIST_i K_i}{PVA_i XS_i} \tag{4.18}$$

$$\beta_i = \frac{W.WDIST_i L_i}{PVA_i XS_i} \tag{4.19}$$

The technology parameter A_{ia} is calibrated for agricultural sectors as

$$A_{ia} = \frac{XS_{ia}}{K_{ia}^{\alpha_{ia}} . L_{ia}^{\beta_{ia}} . TW_{ia}^{(1-\alpha_{ia}-\beta_{ia})}} \tag{4.20}$$

and for non-agricultural sectors A_{ina} is calculated as

$$A_{ina} = \frac{XS_{ina}}{K_{ina}^{\alpha_{ina}}.L_{ina}^{\beta_{ina}}.H_{ina}^{(1-\alpha_{ina}-\beta_{ina})}} \tag{4.21}$$

Water and land shares within the composite good TW_i are taken as fixed Leontief coefficients. Water share, $ttwa_i$, is calculated as the proportion of the water factor income within the total factor income of land/water composite.

Activity taxes (*TACTTAX*), commodity taxes (*TCOMTAX*), payroll taxes (*PYRTAX*) and capital taxes (*CAPTAX*) are taken to be fixed proportions of production value, domestic demand, wage income, and profit income respectively. These fixed proportions are calculated as the ratio of 2003 data of value of production, domestic demand, wage and profit incomes to the corresponding tax values. Model equations for the tax revenues are formed using these parameter values. Accordingly, the tax revenues are calculated form the equations:

$$TACTTAX = \sum tac_i PX_i XS_i \tag{4.22}$$

$$TCOMTAX = \sum tcomr_i (PM_i * IM_i + PD_i * DC_i) \tag{4.23}$$

$$PYRTAX = \sum tpyr.W.WDIST_i L_i \tag{4.24}$$

$$CAPTAX = \sum tcap.RK.RKDIST_i K_i \tag{4.25}$$

Thus, the corresponding parameter values for activity taxes, commodity taxes, payroll taxes and capital taxes are tac_i, $tcomr_i$, *tpyr* and *tcap*, respectively. The first two are given in Table 4.1, and *tpyr* and *tcap* are equal to 0.172 and 0.183 respectively.

Water tariffs are collected from the non-agricultural water use. Therefore, the tariff rate, *ttw*, is calculated as the ratio of *HTAX* to total non-agricultural water use to be 4.171.

Parameters in the gross output-exports frontier

$$XS_i = at_i(bt_i E_i^{-\mu_i} + (1 - bt_i)DC_i^{-\mu_i})^{1/\mu_i}$$

is calibrated from the first order conditions

$$at_i = \frac{XS_i}{(bt_i.EX_i^{\mu_i} + (1 - bt_i).DC_i^{\mu_i})^{1/\mu_i}} \quad \text{and} \tag{4.26}$$

$$bt_i = \frac{1}{1 + \frac{PD_i}{PE_i}.(\frac{EX_i}{DC_i})^{(\mu_i - 1)}} \tag{4.27}$$

Composite good aggregation function includes two parameters: ac_i and bc_i.

$$CC_i = ac_i(bc_i M_i^{-\gamma_i} + (1 - bc_i)DC_i^{-\gamma_i})^{-1/\gamma_i}$$

They are calibrated from

$$bc_i = \frac{PM_i}{PD_i}.(\frac{IM_i}{DC_i})^{(1+\eta_i)} \tag{4.28}$$

$$bc_i = bc_i/(1 + bc_i) \quad \text{and} \tag{4.29}$$

$$ac_i = \frac{CC_i}{(bc_i.IM_i^{-\eta_i} + (1 - bc_i)DC_i^{-\eta_i})^{(-1/\eta_i)}} \tag{4.30}$$

Sectoral parameter calibration results are given in Table 4.6. Here, the production function parameters, trade parameters and tax parameters are displayed.

Table 4.6: Sectoral Parameters

SECTORS	Production Parameters			
	α	β	A	ttwa
C	0.032	0.509	4.356	0.038
V	0.378	0.455	4.354	0.379
FR	0.597	0.173	4.239	0.310
OA	0.557	0.427	7.509	0.789
F	0.744	0.243	6.986	
TE	0.471	0.515	26.272	
CH	0.805	0.188	8.595	
M	0.209	0.570	131.52	
ONA	0.559	0.441	9.665	

Table 4.6: Sectoral Parameters (Continue)

SECTORS	Armington Parameters				Tax Parameters	
	ac	bc	at	bt	tac	tcomr
C	2.038	0.305	2.592	0.747	0.032	0.509
V	1.265	0.001	3.432	0.840	0.378	0.455
FR	1.152	0.004	2.196	0.651	0.597	0.173
OA	1.713	0.169	4.622	0.899	0.557	0.427
F	0.291	0.261	2.515	0.733	0.744	0.243
TE	0.544	0.330	2.003	0.481	0.471	0.515
CH	0.309	0.541	2.190	0.649	0.805	0.188
M	0.598	0.498	2.019	0.549	0.209	0.570
ONA	0.463	0.273	2.601	0.748	0.559	0.441

Four different cases are examined with TURKWAT. Results of the simulations are given in the next chapter.

CHAPTER 5

SCENARIOS AND SIMULATIONS

Water-CGE Model for Turkey is used to analyze two kinds of simulations. One is a trade simulation while the other is a water simulation. The first one is about the ongoing debate in the international platform, namely the agricultural trade liberalization. Within the relations with WTO, Turkey applied its commitments on the tariff reductions in agriculture. However, decreasing the tariff ceilings did not result in a reduction in applied tariff rates. The first simulation (The WTO simulation) describes the case of Turkey releasing its protections in trade so as to realize a real reduction in its average agricultural tariff rates. Next, the model is utilized to examine the effects of implementing a "selective water tax". Charging water below its opportunity cost leads to wasteful use of it. Moreover, as it is considered to be a public good and most of the times, even the operation and maintenance cost are can not be fully utilized, it becomes costly for the governments to collect and distribute water. Studies concerning water pricing and water user rights (as Stringer and Wittwer (2001), Tirado et. al. (2003) and Diao and Roe (2003)) mostly indicate that increasing the price of water and/or introduce water user rights or water markets can be effective in encouraging water saving.

It is important for Turkey to perform a productivity increase in agriculture for it to increase its comparative advantage in the international arena. In fact, Turkey is far beyond especially its biggest trade partner, EU, in agricultural productivity. Studies on Turkey-EU relations (as Abay (2005), Çakmak and Kasnakoğlu (2002)) mostly show that this will cause Turkey to be worse-off in a case of trade liberalization. Therefore, both the trade and water simulations are analyzed under a general scenario of a total productivity increase in agriculture.

5.1 WTO-Simulation

Tariff reduction in agriculture gives rise to serious debates in the international arena. International trade liberalization has been discussed since the end of World War II. Negotiations which became official with the General Agreement on Tariffs and Trade (GATT) were finally institutionalized with the establishment of the World Trade Organization (WTO) in 1995.

After the economic depression in the 1930's, countries isolated themselves and world trade almost ceased. With the idea that isolation may be damaging for the national economies in the long run, the advantages of free trade started to be discussed in the 1940s. After the negotiations for liberalization of the world trade, construction of an organization named "International Trade Organization (ITO)" was decided upon. Until then, in order to be able to go to a tariff reduction for certain goods, the GATT Agreement was signed. This was supposed to be temporary, but because ITO could not be established, the Agreement replaced the organization and was in operation between 1948- 94.

According to GATT's basic principles, member countries are responsible for eliminating all their protections (with some exceptions), transforming their import restrictions only to tariffs (tariffication) and decreasing these tariffs over time. There are certain bound rates that are determined by each country and in practice, countries can not apply tariffs beyond these rates. In addition, countries are not allowed to discriminate among their trade partners (Most-Favored-Nation (MFN) status). So, every country must treat all countries equally for the same goods. Moreover, countries can not discriminate between imported and domestic goods with respect to domestic market regulations and practices.

After 1948, within GATT four conferences and four rounds were held. Before the last round (so called "Uruguay Round") in 1986-94, agricultural trade was exempted from GATT in practice (Clapp, 2006; p. 10). This was due to the US's persistence in protecting its agriculture in the 1950's (Jawara and Kwa, 2003). The US protected its agriculture primarily in the form of domestic farm supports, while the EU used export subsidies. Plus, both applied high tariffs on certain products. Other countries such as, Japan also protected their agriculture. But, by the 1980's, these protectionist policies became costly. In fact, OECD's (Organization for Economic Co-operation and Development) agricultural subsidies totaled to US$300 billion per year. In the end, it was mainly the US who put pressure on to include agriculture sector formally in GATT (Clapp, 2006; p. 10).

At the end of the Uruguay Round, the Marrakesh Agreement was signed on April 15, 1994. Accordingly, GATT gave up its place to WTO on 01.01.1995. Within this agreement, in addition to 28 other agreements, the Agreement of Agriculture (AoA) was signed. AoA has three basic principals: Market access, export subsidies and domestic support.

1) Market Access: According to this principal**,** non-tariff barriers will be converted to tariffs (tariffication). After tariffication, member countries will reduce their tariff rates starting from the values valid in September 1986.

Developing countries will decrease their tariffs by 10 percent for each commodity and 24 percent on an overall average within ten years. On the other hand, for the developed countries these values are 15 percent and 36 percent, respectively. The time period set for these reductions is six years.

Developing countries are able to offer ceiling-tariff rates in cases where duties were not "bound" (i.e. committed under GATT or WTO regulations) before the Uruguay Round WTO (2007). The least-developed countries (LDC) may not cut their tariffs. Considering a rise in tariff rates due to tariffication, the rule of "minimum entrance" requirement was introduced. With this rule, in the first year, developed countries would import agricultural goods amounting to as much as 3 percent of their domestic consumption based on the 1986-88 period. This percentage would rise to 5 percent after 6 years. For the developing countries, the minimum access rate was 4 percent after 10 years (Sayın et. el., 2002)).

2) Export Subsidies: It is agreed that export subsidies, subsidy payments from the budget and subsidized exports are to be decreased based on the 1986-90 period. Accordingly, in six years, developed countries will decrease the value of their subsidies by 36 percent and their quantities by 21 percent, whereas developing countries will aim for 24 percent and 14 percent reductions, respectively, in ten years.

3) Domestic Support: According to AoA, developed countries will reduce the domestic supports that are subject to the list of commitments by 20 percent within six years. For developing countries, a reduction of 13.33 percent was required within ten years. LDCs are not subjected to make reductions. If the support by a country for each of the products is not above a certain share of its total value of the product, then there is no need for any reduction. This is "de minimis" and it amounts to 5 percent for developed and 10 percent for developing countries (WTO, 1996:1; Ay and Yapar, 2005).

Subsidies are categorized into different 'boxes' according to their potential to distort trade (Figure 1). Three boxes are defined. The "Amber Box" represents the subsidies that are regarded as trade distorting, such as price support for producers. WTO members are committed to making substantial reductions in their Amber box subsidies. The "Blue Box" contains subsidies that are considered to be less trade-distorting than the Amber box subsidies. These are direct payments made under production-limiting programs. The last, is the "Green Box". Items that fall into this box must have no or minimal trade-distorting effects. Green box subsidies are not subject to subsidy reduction (WTO, 2007)[14].

After the Uruguay round, many meetings were held, but no agreement was reached. The main controversy has been focused on tariff reduction and elimination of agricultural subsidies. While the US wants the EU to reduce its tariffs, it insists on giving subsidies itself. Especially the subsidies given to the farmers depress the prices and this harms some other countries. On the other hand, the EU implements high tariff rates. G-10 countries (Japan the most and Israel, Norway, Bulgaria etc.) are opposed to trade liberalization. The group where Turkey is included (G-33) emphasized the opportunity of setting special products. G-90 countries, which are

[14] A summary of the "three pillars" of the AoA –market access, export subsidies, domestic supports- can be found in Çakmak and Akder (1999).

mostly the least developed countries, are those demanding application of the most liberal policies and giving special treatment to the developing countries[15].

At the end of 2001, a declaration was published in the Council of Ministers Conference in Doha, Qatar (The Doha Ministerial (DM) Declaration). Accordingly, member countries were to determine their commitments until the conference in Cancun (Mexico) in September 2003 and up to January 2005 negotiations were to be ended. But, this program was not realized. The situation today suggests that no agreement can be reached until 2013.

5.1.1 Turkey's Position and the WTO-Simulation

Turkey, related all its agricultural commodities to WTO, but did not go to tariffication stating that it has no non-tariff barriers. The reasons for this are that Turkey liberalized its trade primarily in the previous years and also commodities that were not defined in 1986 arose (Çakmak and Akder, 1999). On the other hand, in accordance with its commitments to WTO, Turkey has reduced its tariff rate ceiling by 24 percent on average as of 2004. But, as can be seen in Table 5.1, although this requirement was met, it was not reflected in the applied average tariff rates. In fact, they are to be increased[16]. This is due to Turkey increasing the protections to the highest levels of WTO tariff commitments for many commodities (Ay and Yapar, 2005).

The WTO policies were aiming to have the average tariffs reduced. However, the average applied tariff rates of Turkey did not decrease. WTO-Simulation determines the affects of a real decrease in the average tariffs. This refers to an average of 32 percent tariff rate reduction in 2003.

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[15] For country groups see ICTSD (2004)
[16] For tariff rates for different commodities see Çakmak et. al. (1999).

Table 5.1: Turkey's Average Agricultural Tariff Rates

Years	EU and EFTA	Other Countries	Average
1994	43.64	46.03	44.84
1995	31.23	34.58	32.91
1996	46.93	49.55	48.24
1997	50.60	51.60	51.10
1998	52.90	53.10	53.00
1999	52.00	53.10	52.55
2000	56.50	57.60	57.05
2001	55.60	56.60	56.10
2002	54.70	55.70	55.20
2003	54.40	55.40	54.90
2004	54.60	55.60	55.10

Source: DTM (2004).

5.1.2 Simulation Results

Turkey, according to the AoA, has reduced its agricultural tariff ceiling value by 24 percent (each year 2.4 percent for ten years) from 1994 to 2004. However, as seen in Table 5.2, the applied average tariff rate increased from 44.84 percent to 55.10 percent with fluctuations. Starting from 44.84 percent value in 1994 and reduced by 24 percent more, the tariff value would be 20.84 in 2004. However, the observed value in 2004 was 55.10. Therefore, the difference between the expected value and the applied one is 34.26. When the same calculation is done for 2003, from 1994 to 2003 the reduction should be 2.4x9 = 21.60 which corresponds to a tariff value of 23.24 (= 44.84-21.60) in 2003. However, the applied value in this year was 54.90 percent. The difference between the applied value and the required value of 23.24 is about 32 percent. This simulation tries to answer a "what if" question to understand the situation when the applied tariff value is 23.24 instead of 54.90 percent. In WTO-Simulation, effects of a reduction in tariff rate, tm_i, of a general 32 percent for all agricultural sectors is analyzed. All the values and percentage changes are given in real terms.

Tariff reduction in agriculture leads to a reduction in agricultural import prices. In Table 5.2, the import price, *PM*, in cereal sector decreases from 1.00 to 0.89 which corresponds to an 11 percent decrease. The changes in the other sectors are, 25, 28 and 30 percent for vegetable, fruit and other agriculture sectors, respectively. Turkey has not much comparative advantage in the livestock sector. Therefore, the other agriculture sector displays the largest price decrease (30 percent). Domestic prices, *PD*, slightly decreased for all of the sectors as displayed in the Table except for the fruit and chemical sectors.

Table 5.2: Domestic and Import Price Changes

(Base = 1.00)

	PX	PM
C	0.997	0.891
V	0.998	0.747
FR	1.000	0.716
OA	0.997	0.697
F	0.997	1.000
TE	0.997	1.000
CH	1.000	1.000
M	0.999	1.000
ONA	0.999	1.000

Table 5.3 displays the general results of the WTO-simulation in comparison to the baser-run in real values. There is a real increase in the GDP value by 0.5 percent. Private and public incomes increase by around 0.4 and 1.2 percent, respectively. Total real consumption rises from 656.757 to 660,798. Total production also rises in both value and quantity terms. The share of agriculture in total production decreases while the non-agricultural share increases. The volume of agricultural production decreases from 44,375 to 43,315.

Table 5.3: General Results of WTO-Simulation

(real, million TRY)

	BASE-RUN	WTO-SIM
GDP	358,700	360,455
Value of Production	601,885	605,473
Agriculture	60,216	58,950
Non-agriculture	541,669	546,523
Share of Agriculture (%)	10.0	9.7
Share of Non-Agriculture (%)	90.0	90.3
Volume of Production	281,861	281,877
Agriculture	44,375	43,315
Non-agriculture	237,486	238,562
Share of Agriculture (%)	15.7	15.4
Share of Non-Agriculture (%)	84.3	84.6
Total Consumption	656,757	660,798
Agriculture	70,608	70,946
Non-agriculture	586,149	589,852
Incomes		
Private	308,459	309,697
Public	108,376	109,660
Total Trade		
Imports	110,334	112,996
Exports	98,496	100,093

As agricultural imported goods become cheaper with the reduction of tariff rates, agricultural imports increase (Table 5.4). The largest increase is observed in the other agriculture sector, nearly threefold, as the world prices of livestock product prices are much lower than the domestic prices. Non-agricultural imports also increase, resulting in an overall real increase of about 2.4 percent in total imports.

Table 5.4: Trade-Related Changes

(real, million TRY)

	BASE RUN			SIMULATION		
	IM	**EX**	**NET EXPORTS (NE)**	**IM**	**EX**	**NET EXPORTS (NE)**
C	3,217.7	2,281.8	-935.85	4,346.3	2,204.0	-2,142
V	157.76	301.29	143.53	244.80	303.36	58.559
FR	321.52	2,516.317	2,194.8	528.87	2,507.5	1,978.7
OA	408.56	227.43	-181.13	1,171.4	223.76	-947.64
FR	2,698.5	5,086.4	2,387.8	2,700.7	5,149.0	2,448.3
TE	6,329.2	31,959	25,629	6,388.5	33,140	26,751
CH	42,080	10,128	-31,952	42,244	10,164	-32,080
M	11,619	8,035.8	-3,583.3	11,685	8,139.8	-3,544.9
ONA	43,502	37,961	-5,541.0	43,686	38,262	-5,424.4

Vegetable-sector export increases by 0.7 percent while other agriculture sectors' exports decline. As observed from Table 5.4, although Turkey remains to be a net exporter in fresh fruits and vegetables, its net exports decline. The increase in exports of non-agricultural sectors does not meet the increase in imports and this results in about 9 percent deterioration in overall trade deficit.

The Armington specification makes it possible to decompose the overall consumption into domestic and imported good consumption. Imported agricultural goods become cheaper with the reduction in tariff rates. This leads to an increase in consumption of these goods. Figure 5.1 shows the percentage shares of imported goods in total consumption. It can be seen that the consumption of agricultural goods shifted from domestic to imported goods. In fact, the share of agricultural imported goods in the total agricultural consumption increases from 5.8 percent to 8.9 percent in agricultural sectors. Changes in the percentage shares of the imported goods are significant. Changes are 35, 54 and 63 percent for cereal, vegetable and fruit consumptions, respectively. The largest change is for the other agriculture sector from 1.8 to 5 percent corresponding to a 183 percent increase. On the other hand, for non-agricultural sectors the total share of the imported goods remains almost the same. Changes in the percentage shares are negative, and are less than or equal to 1 percent.

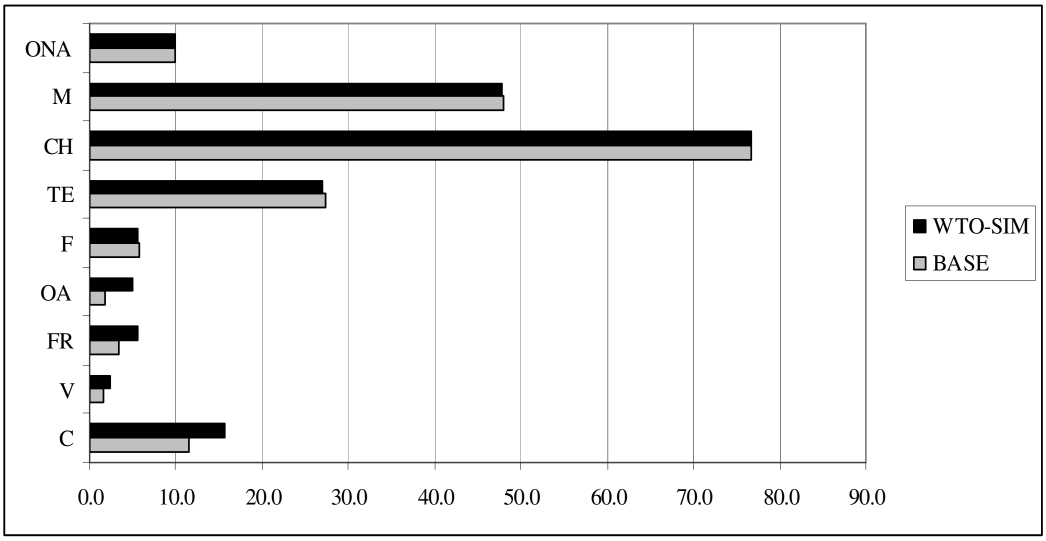

Figure 5.1: Percentage Shares of the Imports within the Total Consumption

On the supply side, domestic agricultural production declines, except for vegetable production, while non-agricultural production increases. One can see the percentage of increases in production in Figure 5.2. As mentioned before, only agricultural sector for which exports increase is the vegetable sector. This results in an increase in production in this sector. Although the shares of imported goods within the total consumption of fruit increase, households do not change their domestic consumption much. This leads to a relatively small decrease in fruit production. On the other hand, changes in domestic consumption in other agricultural sectors are much higher. The largest decline in production is in cereal production, with a 4 percent decrease, as the domestic consumption declines the most for this sector. Textile sector exhibits the largest production increase of about 3 percent as it shows the largest increase in export.

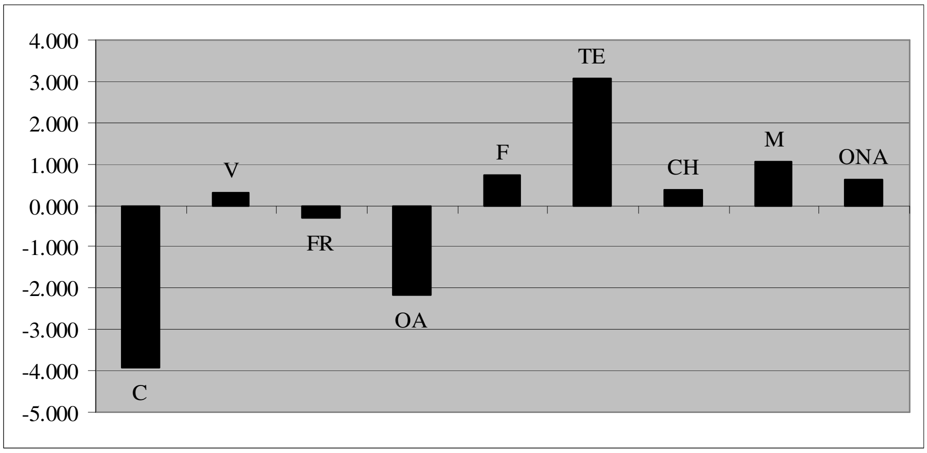

Figure 5.2: Percentage Increase in Domestic Production Compared to Base Run

Changes in the allocation of factors of production in each sector, in comparison to a base-run value of 1 can be seen in Table 5.5. Water and land use in agriculture declines as production reduces. There is a capital flow from agriculture to non-agricultural sectors. Labor use in cereal productions and other agriculture productions decrease. The excess supply of water increases from 95,000 to 109,304 billion m^3.

Table 5.5: Changes in Input Use

(Base = 1.00)

SECTORS	LABOR	CAPITAL	LAND	WATER
C	0.9613	0.9541	0.9566	0.9566
V	1.0049	0.9973	0.9999	0.9999
FR	1.0008	0.9933	0.9959	0.9959
OA	0.9805	0.9732	0.9757	0.9757
FR	1.0109	1.0033		1.0059
TE	1.0322	1.0245		1.0272
CH	1.0078	1.0002		1.0028
M	1.0114	1.0038		1.0065
ONA	1.0085	1.0009		1.0036

To sum up, trade simulation results show that a 32 percent decrease in tariff rates leads to a 0.5 percent increase in GDP, and 0.4 and 1.2 percent increase in private and public income respectively. Consumers benefit from the decreasing prices and increasing incomes. However, the model does not give any information about the possible deteriorations in income distribution. Factors of production mostly flow from agricultural sectors to others only, labor for fruit and vegetable production increases. The vegetable sector is the only sector for which agricultural production and exports increase. The overall foreign trade volume increases, but in the agricultural sectors net export values decline.

5.2 Water-Simulation

Water as a public good plays an important role in the Doha Development Round. One billion people in world do not have access to clean and affordable water and 1.7 billion lack sanitation services (UN, 1997). This essential, but at the same time, scarce resource should be considered carefully. "While the Doha Round talks about access to markets, access to public goods is an even greater priority to hundreds of millions of people in the Global South" (Drache, 2006; p. 9). So, the water issue takes an important place in the international arena. The same is true for Turkey.

Water tariffs are mostly set below its provision cost. This, not only leads to wasteful use of it but also puts burden on the governments as mostly they can not fully utilize even the operation and maintenance cost.

In Turkey, water policies are set by municipalities with various pricing schemes for different cities. Water tariffs are determined by the Metropolitan Municipality Council in accordance with "Tariff Regulations" defined by the Council of each metropolitan municipality. By applying price differentiation, municipalities are trying to ensure water saving (Sogesid, 2005). This may work as applying higher water tariffs is considered to be one of the tools that may lead to more efficient use of water. In fact, studies concerning water pricing and water user rights (as Stringer and Wittwer (2001), Tirado et. al. (2003) and Diao and Roe

(2003)) mostly indicate that increasing the price of water and/or introducing water user rights or water markets can be effective in encouraging water saving.

In water-simulation here, the effects of an implementation of a selective water tax are analyzed. In this respect, the water income of the government is added to the model as some sort of tax collection from the non-agricultural water use. The formulation is given as:

$$HTAX = ttw \sum_{ina} QH_{ina}$$

Here, QH_{ina} is the sectoral water use in non-agricultural sectors. Simulation results are obtained by multiplying *ttw*, which is equal to 4.2, by 3. Results are given below.

5.2.1 Results of Water-Sim

The general results of the simulation are given in Table 5.6. Tripling the water tax results in an increase in GDP from 358,700 to 358,781 which corresponds to an increase of only about 0.02 percent. Increase in public water revenue results in an overall increase in public revenue from 108,376 to 112,904, corresponding to a 4.3 percent increase. Being a constant proportion of the public revenue, public consumption also increases. Private income, on the other hand, declines from 308,459 to 307,025 as a result of increasing tax burden on water usage.

Changes in private and public incomes lead to a decrease in private consumption and an increase in public consumption. The overall effect on the total consumption is a 0.02 percent increase from 656,757 to 656,876. Yet, the decline in agricultural consumption results in a decrease in agricultural production, both in value and volume terms. Sectoral changes in the value of production in comparison to the base-run are displayed in Figure 5.3. It can be seen that production in agricultural sectors and food and textile industries declines while there is smaller increases in chemical, metal and other non-agricultural sectors. As can be seen in Figure 5.4., all these changes can also be traced in the factor usage in these sectors.

Table 5.6: General Results of Water-Simulation

	BASE	WATER-SIM1
GDP	358,700	358,781
Value of Production	601,885	602,003
Agriculture	60,216	60,048
Non-agriculture	541,669	541,955
Volume of Production	281,861	281,895
Agriculture	44,375	44,245
Non-agriculture	237,486	237,650
Total Consumption	656,757	656,876
Agriculture	70,608	70,405
Non-agriculture	586,149	586,471
Incomes		
Private	308,459	307,025
Public	108,376	112,904
Total Trade		
Imports	110,334	110,371
Exports	98,496	98,533

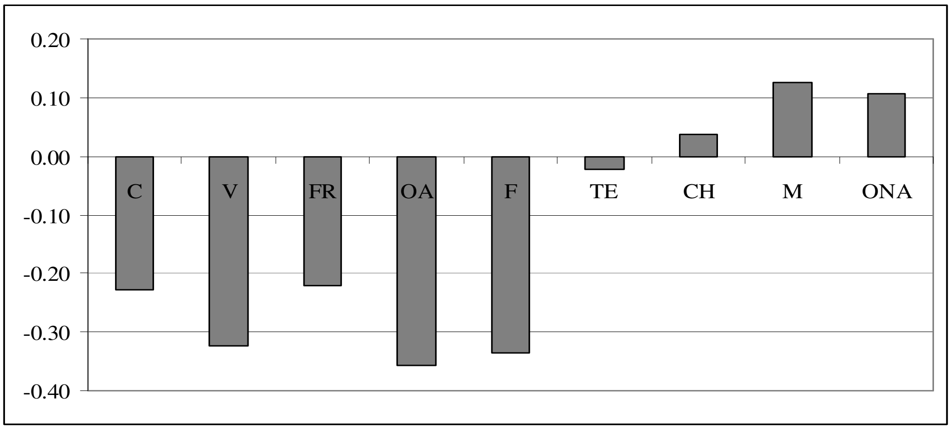

Figure 5.3: Percentage Change in Value of Production with respect to Base Run

Factors are mobile across sectors and substitution is possible. This enables factors of production to move from the sectors in which the production declines to the others. On the other hand, substitution possibilities "smooth" the distribution of factors, therefore, low figures are observed. With production reduction, all factors of productions used in the agricultural sectors are declining with the increase in the water tax. Laborers transfer from the agricultural sectors and from the food industry to other sectors. Capital flows mainly to the metal and other non-agricultural sectors.

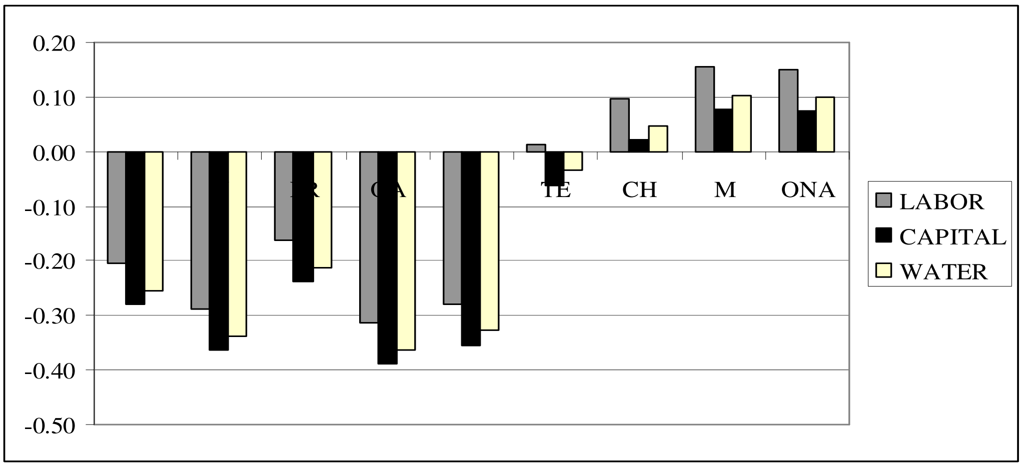

Figure 5.4: Percentage Change in Use of Factors of Production

Water tax increase leads to a decline in water usage in all the agricultural sectors together with food and textile industries. There are small increases in the other sectors' water use. Table 5.7 displays the sectoral water use. Total agricultural water use declines from 296,000 to 295,172. Figure 5.5 displays the change in water use compared to the base run. The largest decline is in the other agriculture sector, from 29,600 to 29,548 and the largest increase is in the metal industry, from 57,769 to 57,800.

Table 5.7: Sectoral Water Use (10^5 m^3)

	BASE	WATER-SIM
C	59,200	59,126
V	103,60	103,43
FR	103,60	103,49
OA	29,600	29,548
F	17,803	17,773
TE	12,046	12,044
CH	9,3400	9,3420
M	57,769	57,800
ONA	8,0430	8,0470

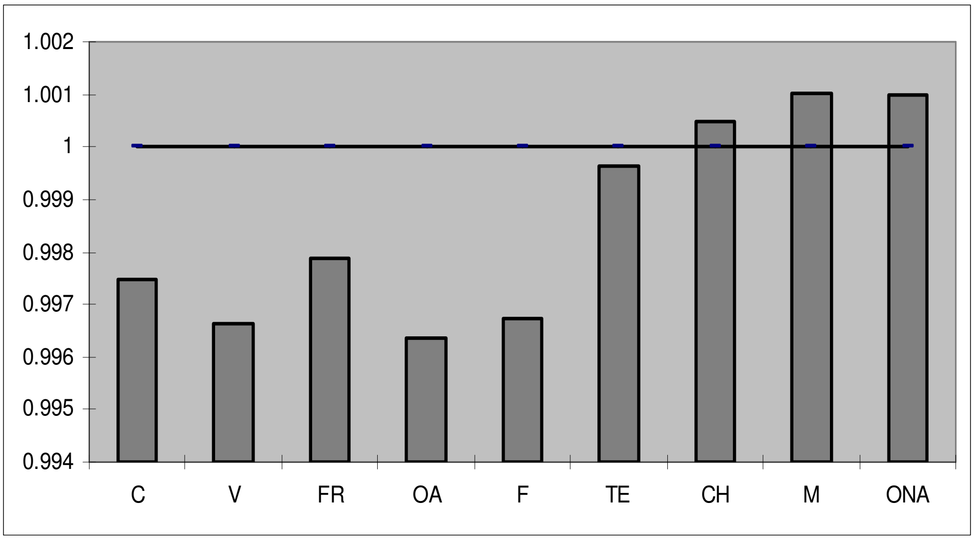

Figure 5.5: Change in Water Use (Base = 1.00)

Exports decline for the agricultural sectors and food sector. Imports decline for these sectors and also for the textile sector (Table 5.8). Agricultural imports decline, but this is offset by the increase in non-agricultural imports leading to an overall increase in total imports value. This increase is balanced by the increase in exports, leaving the overall net exports unchanged.

Table 5.8: Trade Volume

	BASE RUN			SIMULATION		
	IM	EX	NET EXPORTS (NE)	IM	EX	NET EXPORTS (NE)
C	3217.7	2281.8	-935.85	3208.9	2277.4	-931.46
V	157.76	301.29	143.53	157.24	300.38	143.14
FR	321.52	2516.3	2,194.8	320.83	2510.5	2,189.7
OA	408.56	227.43	-181.13	407.02	226.66	-180.36
F	2698.5	5086.4	2,387.8	2689.2	5069.7	2,380.5
TE	6329.2	31959	25,629	6320.5	31962.8	25,642
CH	42080	10128	-31,952	42098	10131	-31,967
M	11619	8035.8	-3,583.3	11628	8048	-3,580.6
ONA	43502	37961	-5,541.0	43541	38007	-5,534.3

In summary, implementing a water tax results in an increase in public income while a decrease in private income. Overall water use decreases for agriculture for about 0.3 while non-agricultural water use increase only about 0.01 percent. Agricultural sectors together with food and textile industry respond to selective water tax by decreasing their water use. Other uses of factors of production and also productions decline for these sectors. Though, in metal and chemical industries water use is not decreasing as production in these sectors require certain amount of water use and water demand is relatively inelastic for these sectors. Trade affect are quite small. Both exports and imports of agricultural products decline while they increase slightly for non-agricultural sectors. In overall, there is no change in total net exports.

5.3 Productivity Analysis

Increasing productivity in agriculture is important for Turkey in order for it to increase its comparative advantage in the international arena. This is mostly indicated in the studies concerning the EU-Turkey trade relations. In fact, Turkey is far beyond EU in agricultural productivity. Studies on Turkey-EU relations (as Abay

(2005), Çakmak and Kasnakoğlu (2002)) mostly indicate that Turkey can not benefit from CU enlargement or from an accession to EU unless it does not apply the necessary structural change policies. This is true even for the sectors that Turkey has a competitive advantage in, namely fruit and vegetable sectors.

In this study, both the trade and water simulations are analyzed for the case of a total productivity increase in agriculture in order to see whether a productivity increase can eliminate the negative effects of the tariff reduction and water tax on the consumption and trade.

The productivity for constant returns to scale the Cobb-Douglas production function in a perfectly competitive economy. Namely,

$$Y = AK^{\alpha} L^{\beta} TW^{\gamma} \text{ with } \alpha + \beta + \gamma = 1.$$

A represents the technology parameter while *K*, *L* and *TW* are the capital, labor and land/water composite used for production. Accordingly, the formulation below is given for productivity growth:

$$\left(\frac{dA}{A}\right)^{SR} = \frac{dY}{Y} - s_K \frac{dK}{K} - s_L \frac{dL}{L} - s_{TW} \frac{dTW}{TW} \quad (5.1)$$

Here, $(dA/A)^{SR}$ is the growth of value added after the contribution of inputs are removed; the term referred to as the Solow Residual. The parameters $s_{K,}$ s_L and s_{TW} are the share of capital and labor inputs in value added respectively. Calculated percentage changes are given in Table 5.9[17].

[17] The capital stock variable is taken from the study of Saygılı et. al. (2005). Labor and land data is obtained from TURKSTAT (2005), water values are taken from DSİ, and finally the agricultural value added is the World Bank, 2007 data. The s_K and s_L and s_{TW} parameters are calculated within the model to be approximately, 0.4, 0.3, and 0.3, respectively. Productivity change for the period of 1993 to 2003 is calculated.

Table 5.9: Results of the Productivity Calculations

	dL/L	dK/K	dTW/TW	dY/Y	dA/A
1993	-9.830	2.565	-0.145	-1.283	2.062
1994	12.10	-0.418	0.494	-0.725	-5.819
1995	3.041	2.209	-3.022	1.965	0.711
1996	1.971	3.883	0.568	4.400	2.151
1997	-4.558	5.193	-0.452	-2.337	-2.004
1998	2.286	4.244	0.391	8.369	5.914
1999	-2.025	-0.365	-0.619	-4.991	-3.862
2000	-12.27	2.709	-1.576	3.857	8.543
2001	4.119	-0.175	-0.115	-6.508	-8.160
2002	-7.801	-0.680	0.869	6.865	10.164
2003	-3.929	-1.764	-2.081	-2.500	0.257

The geometric average of the figures in $(dA/A)^{SR}$ given in the Table is taken as the change to be analyzed. Accordingly, an 18 percent cumulative increase in productivity in agriculture is examined.

The results of WTO simulation with productivity increase are displayed in Table 5.10. Productivity increase leads to a higher increase in both value and volume of the production in the WTO simulation alone. While the value of agricultural production declines with tariff reduction, an increase in productivity in agriculture offsets declines and results in even a higher value than the base run.

Results show that productivity increase leads to a larger increase in GDP values. While GDP increase without productivity to 360,455, it increases to 368,698 with productivity increase. This corresponds to a further about 2 percent increase in GDP with tariff reduction. Comparing the trade simulation alone and the same simulation with productivity, it can be seen that, productivity increase leads to a further 2.4 percent and 1.3 percent increase in private and public incomes, respectively.

Table 5.10: General Results of WTO-Simulation with Productivity Increase

	BASE	WTO-SIM	PROD. INCREASE
GDP	358,700	360,455	368,698
Value of Production	601,885	605,473	624,906
Agriculture	60,216	58,950	70,901
Non-agriculture	541,669	546,523	554,005
Volume of Production	281,861	281,877	284,605
Agriculture	44,375	43,315	43,699
Non-agriculture	237,486	238,562	240,905
Total Consumption	656,757	660,798	682,221
Agriculture	70,608	70,946	80,400
Non-agriculture	586,149	589,852	601,820
Incomes			
Private	308,459	309,697	317,096
Public	108,376	109,660	111,103
Total Trade			
Imports	110,334	112,996	115,904
Exports	98,496	100,093	102,855

As observed in the Table 5.11, productivity increase in agriculture results in a large decrease in agricultural prices. While tariff reduction alone leads to a price decrease at most 1.3 percent for the other non-agricultural sector, with productivity increase price decreases ranging from 0.4 to 17 percent can be observed. The largest decline is observed for fruit products. Non-agricultural prices decline in the WTO simulation while they increase in the productivity increase case except for the food industry. However, both the agricultural and non-agricultural consumption increases with one exception (cereal production in the first case, and metal industry in the second).

Table 5.11: Sectoral Price Changes with Productivity Increase

(Base=1.00)

	PC		PM	
	WTO-SIM	**PROD.**	**WTO-SIM**	**PROD.**
C	0.994	0.897	0.891	0.891
V	0.997	0.882	0.747	0.747
FR	0.998	0.829	0.716	0.716
OA	0.987	0.886	0.697	0.697
F	0.998	0.963	1.000	1.000
TE	0.995	1.004	1.000	1.000
CH	1.000	1.004	1.000	1.000
M	0.999	1.005	1.000	1.000
ONA	0.999	1.007	1.000	1.000

WTO simulation results show that with the reduction in tariff rates, Turkey becomes a net importer for agricultural products, although it is a net exporter of fruit and vegetable. But, productivity increase offsets this trade distortion and further increases the net exports to a higher value than the base run. Results indicate that especially for fruit and vegetable production there is an increase in comparative advantage as the domestic prices decrease significantly and net exports improves (Table 5.12).

Table 5.12: Sectoral Net Exports

	BASE	**WTO**	**PROD**
C	-935.85	-2,142	-656
V	143.53	58.559	184.303
FR	2,194.8	1,978.7	3,869.7
OA	-181.13	-947.64	-736.92
F	2,387.8	2,448.3	3,328.4
TE	25,629	26,751	25,728
CH	-31,952	-32,080	-33,691
M	-3,583.3	-3,544.9	-3,997.4
ONA	-5,541.0	-5,424.4	-7,078.0

Similar to the previous case, for the water simulation, productivity increase leads to a further increase in GDP, total production and consumption (Table 5.13). While water simulation leads to only about 0.1 real increase in GDP, increase in productivity leads to an increase of about 3 percent. Increases in total value of production and consumption rise from about 0.09 to 3.5 and from 0.08 to again 3.5 percent, respectively

As can be seen from the Table 5.13, import and export values also increase further. Agricultural imports declines to even below the base run value. Though, non-agricultural imports further increase, resulting in an overall increase in imports. Total imports increase from 110,334 to 110,371 with water tax and it further increases to 113,613, corresponding to about 3 percent increase compared to base run.

Table 5.13: General Results of Water-Simulation with Productivity Increase

	BASE	**WATER-SIM**	**PROD. INCREASE**
GDP	358,700	358,781	367,572
Value of Production	601,885	602,003	622,472
Agriculture	60,216	60,048	72,137
Non-agriculture	541,669	541,955	550,334
Volume of Production	281,861	281,895	284,995
Agriculture	44,375	44,245	44,585
Non-agriculture	237,486	237,650	240,410
Total Consumption	656,757	656,876	679,206
Agriculture	70,608	70,405	79,899
Non-agriculture	586,149	586,471	599,307
Incomes			
Private	308,459	307,025	314,835
Public	108,376	112,904	114,659
Total Trade			
Imports	110,334	110,371	113,613
Exports	98,496	98,533	101,570

Non-agricultural exports are lower for the case of productivity increase then the water simulation alone, but increase in agricultural exports are much higher than this leading to an increase in overall exports of about 3 percent compared to the base run. Large increase in exports of the agricultural products, in the case of productivity increase, leads net exports to increase about two times while the net exports in non-agricultural products declines (Table 5.14).

Table 5.14: Trade Values

	Exports		
	Base	**Water-Sim**	**Prod.**
Agr.	5,327	5,315	8,620
Non-Agr	93,170	93,218	92,951
	Imports		
	Base	**Water-Sim**	**Prod.**
Agr	4,105	4,094	3,795
Non-Agr	106,229	106,277	109,818
	Net Exports		
	Base	**Water-Sim**	**Prod.**
Agr	1,221	1,221	4,824
Non-Agr	-13,059	-13,059	-16,867

Simulation results show that a 18 percent productivity increase in agricultural productivity leads to an increase in GDP and income values in both trade and water simulations. Also, productivity improvement increases the value of production in agriculture and leads to a significant improvement in agricultural net exports.

CHAPTER 6

CONCLUSION

Water-related issues gain more and more importance over time in the economy. Above all, water is an important economic asset. As a public good, water is being sold below its provision cost and therefore it is usually used wastefully.

The production and management of usable water as a subject in economic analysis is becoming more important. Therefore, in this thesis a model called TURKWAT is developed as an attempt to build up a water-CGE model for Turkey. The model is used to analyze two kinds of issues. The first is trade liberalization in agriculture, which has given rise to a serious debate on the international platform.

Turkey is participating in these debates since it is a member of WTO and a candidate country for the EU. In accordance to the WTO AoA, Turkey has made commitments for tariff reduction in agriculture and has implemented them. Nevertheless, utilization of the advantages of some specifications of the Agreement has kept the applied average tariff rates high. In this first simulation, the consequences of a reduction of applied average tariff rates are analyzed.

Trade simulation results in an increase in GDP and private income. Cheaper imported goods, having access to the domestic market, lead to a price decrease and an increase in total consumption.

Tariff reduction leads to an increase in imports of all sectors and a decrease in exports for agricultural sectors except for vegetable production. Although Turkey remains to be a net exporter for fruit and vegetable production, net exports for these sectors are also in decline. The highest trade distortion is observed in the other agriculture sector. This is due to the livestock sector for which Turkey is far beyond especially the EU in pricing, quality and productivity.

Water is mostly priced even below its provision cost. This leads to wasteful use of it, especially for irrigation purposes. This also puts a burden on the governments as usually they can not fully collect even the operation and maintenance costs. Studies concerning water pricing and water user rights (as Stringer and Wittwer (2001), Tirado et. al. (2003) and Diao and Roe (2003)) mostly indicate that increasing the price of water and/or introducing water user rights or water markets can be effective in encouraging water saving. In this study, the second issue analyzed is the effects of an implementation of a selective water tax. In this respect, the water income of the government is added to the model as some sort of tax collection from the non-agricultural water use. The income effect of this kind of a tax, together with its effect on the sectoral water use is analyzed.

Implementation of a selective water tax causes the private income to decline. This in turn, results in a decrease in consumption and production in the agricultures, the food and textile sectors. The increase in water prices is reflected in the water usage and production of these "most-dependent" sectors. Water use in agriculture, the food and textile sectors decreases while for metal, chemical and other non-agriculture sectors it does not. The textile industry seems to be responsive to income changes as households can shift their consumption from these products to some others.

For metal and chemical products industries, water is used for various purposes such as (a) raw material, (b) solvent for the reactions, (c) heat exchange, (d) transportation, (e) cleaning etc. Therefore, a cut down in water consumption in these two sectors is not technically feasible. Although water use is high, the cost of it within their total costs is small. These sectors require relatively high investments and their tendency to reduce production is low. Implementing a water tax does not lead them to reduce their water use.

It is important for Turkey to achieve productivity increase in agriculture to increase its competitiveness in the international arena. Turkey is far beyond the level of, especially its biggest trade partner, EU, in agricultural productivity. Therefore, in order the see the impact of productivity increase, the same simulations are repeated under the total productivity increase in agriculture.

Results showed that productivity increase in agriculture leads to a further increase in both GDP level and incomes. At the same time, it compensates the trade distortions in agricultural sectors resulting from both simulations and even improves it significantly in the water simulation case. In fact, with tariff reduction, Turkey becomes a net importer of agricultural products while improvement in productivity increases net exports above the base run value. Water simulation implies no change in net exports, but productivity improves it up to four times of its base run value.

Treating water as an economic value is gaining importance. Beyond the consideration of water as an input, this issue must be extended towards forming a water market, considering the cost of water collection and water pricing. Water uses mostly can not be followed as unconscious well water use and unregistered water use in the cities hamper determining the true water consumptions. Pricing water below its cost results in waste of water and this not only leads to large water use but also harms the soil. Not only for Turkey, but for the whole world, it is necessary to construct models in order to take conscious steps in this vital concept. Modelers are aware of this fact and many studies are performed for different countries. It is very important to build up models that can serve specific policy recommendations. In this respect, collecting water data as for example, the collection and distribution of water and water consumption is very important. Senses of using water in a correct way must be spread throughout the society, especially to the farmers. This must be considered all the time, not just when there is water cuts in the cities. It is necessary to give importance to the water user rights and it should be added to the models. Water production must be explicitly included in the models and the effects of introducing water markets must be analyzed.

It becomes important to analyze the effects of not only a water scarcity scenario but also the climate changes. At the same time, it is important to consider the difference between them. In a climate change scenario, if there is a draught, even when it is possible to use enough water for irrigation, it may not be possible to obtain the desired productivity. It is possible to add a rain parameter to the models in order to analyze climate affects. Also, in foreign trade, it becomes important to save water by importing relatively more water intensive products instead of producing them in the domestic markets. This is considered in Middle East countries. Analyzing the effects of such alternatives will be important in determining the future water policies.

In further studies, water-extended CGE models for Turkey may be extended to analyze the above options. We believe that these models can serve very useful tools for policy makers to perform comprehensive water policies.

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APPENDICES

A. SECTORAL CORRESPONDENCE WITH I/O TABLE AND 2003 SAM FOR TURKEY

Table A1: Sectoral Correspondence with I/O Table

I/O NO:	Sectors in I/O Table	Sectors in this model
01	Growing of cereals and other crops n.e.c.	Growing of cereals and other crops n.e.c.
02	Growing of vegetables, horticultural specialties and nursery products	Growing of vegetables, horticultural specialties and nursery products
03	Growing of fruit, nuts, beverage and spice crops	Growing of fruit, nuts, beverage and spice crops
04	Farming of animals	Other Agriculture
05	Agricultural and animal husbandry service activities, except veterinary activities	
06	Forestry, logging and related service activities	
07	Fishing	
13	Production, processing and preserving of meat and meat products	Food, beverage and tobacco
14	Processing and preserving of fish and fish products	
15	Processing and preserving of fruit and vegetables	
16	Manufacture of vegetable and animal oils and fats	
17	Manufacture of dairy products	
18	Manufacture of grain mill products, starches and starch products	
19	Manufacture of prepared animal feeds	
20	Manufacture of bakery products	
21	Manufacture of sugar	
22	Manufacture of cocoa, chocolate, sugar confert.& other food products n.e.c.	
23	Manufacture of alcoholic beverages	
24	Manufacture of soft drinks; production of mineral waters	
25	Manufacture of tobacco products	

Table A1: Sectoral Correspondence with I/O Table (Continue)

I/O NO:	Sectors in I/O Table	Sectors in this model
26	Manufacture of textiles	Textile
27	Manufacture of other textiles	
28	Manufacture of knitted and crocheted fabrics and articles	
29	Manufacture of wearing apperel, except fur apparel	
30	Dressing and dyeing of fur; manufacture of articles of fur	
31	Tanning and dressing of leather; man.of luggage, handbags, saddlery and harness	
32	Manufacture of footwear	
38	Manufacture of coke, refined petroleum products	Chemical products
39	Manufacture of basic chemicals, plastics & synthetics rubber	
40	Manufacture of fertilizers and nitrogen compounds	
41	Manufacture of pesticides, other agro-chemicals and paints, varnishes	
42	Manufacture of pharmaceuticals, medicinal chemicals &botanical products	
43	Manufacture of cleaning materials, cosmatics & man-made fibres	
44	Manufacture of rubber products	
45	Manufacture of plastic products	
50	Manufacture of basic iron and steel	Metal
51	Manufacture of basic precious and non-ferrous metals	
52	Casting of metals	

Table A1: Sectoral Correspondence with I/O Table (Continue)

I/O NO:	Sectors in I/O Table	Sectors in this model
08	Mining of coal and lignite	Other non-Agriculture
09	Extraction of crude petroleum and natural gas	
10	Mining of metal ores	
11	Quarrying of stone, sand and clay	
12	Mining and quarrying n.e.c.	
33	Sawmilling and planing of wood	
34	Manufacture of wood and of products of wood and cork	
35	Manufacture of paper and paper products	
36	Publishing	
37	Printing and service activities related to printing	
46	Manufacture of glass and glass products	
47	Manufacture of ceramic products	
48	Manufacture of cement, lime and plaster related articles these items	
49	Cutting and finishing of stone and man. of non-metallic mineral products n.e.c.	
53	Manufacture of fabricated metal products, tanks, reservoirs &steam generators	
54	Manufacture of other fabricated metal products; metal working service activities	
55	Manufacture of general purpose machinery	
56	Manufacture of special purpose machinery	
57	Manufacture of domestic appliances n.e.c.	
58	Manufacture of office, accounting and computing machinery	
59	Manufacture of electrical machinery and apparatus n.e.c.	
60	Manufacture of radio, television and communication equipment and apparatus	
61	Manufacture of medical, precision and optical instruments, watches and clocks	
62	Manufacture of motor vehicles, trailers and semi-trailers	
63	Building and repairing of ships, pleasure and sporting boats	
64	Manufacture of railway and tramvay lokomotives and rolling stock	

Table A1: Sectoral Correspondence with I/O Table (Continue)

I/O NO:	Sectors in I/O Table	Sectors in this model
65	Manufacture of aircraft and spacecraft	Other non-Agriculture
66	Manufacture of transport equipment n.e.c.	
67	Manufacture of furniture	
68	Manufacturing n.e.c.	
69	Production, collection and distribution of electricity	
70	Manufacture of gas; distribution of gaseous fuels through mains	
71	Collection, purification and distribution of water	
72	Construction	
73	Sale, maintenance and repair of motor vehicles, motorcycles; retail sale of fuel	
74	Wholesale trade and commission trade, except of motor vehicles and motorcyles	
75	Retail trade, except of motor vehicles and motorcycles; repair of personel&household goods	
76	Hotels;camping sites and other provision of short-stay accommodation	
77	Restaurants, bars and canteens	
78	Transport via railways	
79	Land transport; transport via pipelines	
80	Water transport	
81	Air transport	
82	Supporting and auxiliary transport activities; activities of travel agencies	
83	Post and telecommnications	
84	Financial intermediation, except insurance and pension funding	
85	Insurance and pension funding, except compulsory social security	
86	Real estate activities	
87	Renting of machinery and equip. without operator and of personal & household goods	
88	Computer and related activities	
89	Research and development	
90	Other business activities	
91	Education	
92	Health and social work	
93	Activities of membership organizations n.e.c	
94	Recreational, cultural and sporting activities	
95	Other service activities	
96	Public services	
97	Ownership of dwelling	

Table A2: SAM for Turkey (2003, billion TL)

	Activities C	V	FR	OA	F	TE	CH	M	ONA
C									
V									
FR									
OA									
F									
TE									
CH									
M									
ONA									
C	2365826.149			6459542.678	9725220.652	50722.692	196666.390	1.386	288964.820
V		61581.016		1859.007	302738.150	2257.728	1008.029	1.562	594348.282
FR		0.161	442519.985	13852.842	2330711.242	8098.084	650.587	2.043	224849.383
OA	909070.614	631642.614	66261.617	910656.070	2673709.415	978434.478	9423.121	520.675	1886020.046
F		10.852		1522054.081	8237074.462	385264.902	194599.785	570.129	5260387.022
TE	45220.406	2476.527	25570.744	304550.020	523371.763	12825540.000	317121.198	14583.335	1585668.811
CH	3043094.764	656378.115	227345.242	256889.805	2203993.923	2310059.732	9254120.038	653957.017	19291120.000
M		0.015		307.878	52597.344	8130.180	386337.785	6835592.077	16560720.000
ONA	3508144.231	1320410.691	564552.321	1640714.193	7948533.191	7323330.360	11351600.000	4491474.496	123948500.000
Labor	8707216.236	3711577.071	1251902.532	5063583.150	3220916.193	4373944.027	2388237.781	1491673.404	88362340.000
Capital	545126.346	3081548.865	4334326.798	6599528.464	9852439.454	3994035.473	10230430.000	547689.423	111974700.000
Water	296000.000	518000.000	518000.000	148000.000	178026.052	120459.562	93400.549	577688.162	80425.676
Land	7559245.477	849464.837	1151831.436	39510.590					
Private									
Public	-4802017.469	-2238731.319	2723518.650	-4821891.641	-3715966.502	26919687.055	10408124.639	5311919.523	4020264.731
Savings									
ROW									
Tot Exp	22176926.753	8594359.445	11305829.325	18139157.136	43533365.337	59299965.660	44831719.081	19925673.230	374078278.395

Table A2: SAM for Turkey (2003, billion TL) (Continue)

	Commodities								
	C	**V**	**FR**	**OA**	**F**	**TE**	**CH**	**M**	**ONA**
C	19895124.605								
V		8293067.828							
FR			8789512.237						
OA				17911730.000					
F					38446980.000				
TE						27341250.000			
CH							34703720.000		
M								11889900.000	
ONA									336117600.000
C									
V									
FR									
OA									
F									
TE									
CH									
M									
ONA									
Labor									
Capital									
Water									
Land									
Private									
Public	4743624.078	1743057.720	452817.198	4673195.817	6485510.793	-10476900.000	-21923800.000	728377.451	56607610.000
Savings									
ROW	3217653.501	157764.210	321516.745	408559.226	2698541.427	6329216.570	42080470.000	11619050.000	43501590.000
Tot Exp	27856402.184	10193889.758	9563846.179	22993487.523	47631027.305	23193618.065	54860366.917	24237333.859	436226840.571

Table A2: SAM for Turkey (2003, billion TL) (Continue)

	Factors				Agents		Finan Acco		Tot
	Lab	Cap	Water	Land	Priv	Pub	Inv	ROW	Rec
C								2281802.148	22176926.753
V								301291.616	8594359.445
FR								2516317.088	11305829.325
OA								227424.657	18139157.136
F								5086390.253	43533365.337
TE								31958711.142	59299965.660
CH								10127997.838	44831719.081
M								8035768.358	19925673.230
ONA								37960634.899	374078278.395
C					7305395.061	799464.977	664597.379		27856402.184
V					8942252.340	210221.511	77622.133		10193889.758
FR					6082420.640	409440.702	51300.510		9563846.179
OA					14463673.650	58505.623	405569.600		22993487.523
F					31575356.424	331429.434	124280.214		47631027.305
TE					6742807.865	451321.237	355384.771		23193618.065
CH					15416385.964	1979265.928	-432239.126		54860366.917
M					0.000	16099.845	377552.613		24237333.859
ONA					149057608.055	44748749.742	80323190.000		436226840.571
Labor									118571386.000
Capital									163289826.333
Water									2530000.000
Land									9600052.340
Private	98206548.581	123424878.904	340195.135	9600052.340		69967291.458		7970041.369	309509007.787
Public	20364837.419	27734895.089	2189804.865		-19197560.454			445601.423	108375995.009
Savings					88070696.269	-21043503.991		14920066.722	81947259.000
ROW					1049971.972	10447708.542			121832047.514
Tot Exp	118571386.000	163289826.333	2530000.000	9600052.340	309509007.787	108375995.009	81947259.000	121832047.514	

B. THE MODEL

GLOSSARY:

Sectors:

C	Growing of cereals and other crops n.e.c.
V	Growing of vegetables, horticultural specialties and nursery products
FR	Growing of fruit, nuts, beverage and spice crops
OA	Other agricultural sectors
F	Food, beverage and tobacco
T	Textile
CH	Chemical products
M	Metal
ONA	Other non-agricultural sectors

Parameters:

$cles_i$	SECTORAL CONSUMPTION SHARES
gcr	GOVERNMENT CONSUMPTION RATIO (OF GDP)
$gles_i$	SECTORAL GOVERNMENT CONSUMPTION DEMAND
$idles_i$	INVESTMENT DEMAND SHARES
tac_i	ACTIVITY TAX RATE
tcap	CAPITAL TAX RATE
$tcomr_i$	COMMODITY TAX RATE
tm_i	TARIFF RATE
tpyr	PAYROLL TAX RATE
trem	REMAINDER TAX RATE
ttr	GOVERNMENT TRANSFER EXPENDITURE RATIO(OF GDP)
ttw	WATER TAX RATE
$ttwa_i$	WATER IN L-W

Variables:

CAPTAX	CAPITAL TAXES
CC_i	COMPOSITE GOOD CONSUMPTION
DC_i	DOMESTIC SALES OF DOMESTIC GOOD
ESTW	EXCESS SUPPLY OF LAND/WATER COMPOSITE
ESW	EXCESS SUPPLY OF WATER
EX_i	EXPORTS
FIP	FOREIGN INTEREST PAYMENTS
FSAV	FOREIGN SAVINGS
$GCON_i$	SECTORAL GOV CONSUMPTION
GDP	GROSS DOMESTIC PRODUCT
GPRMBAL	PRIMARY BUDGET BALANCE
GREV	PUBLIC REVENUE
GSAV	PUBLIC SAVING
HTAX	WATER TAX
IM_i	IMPORTS
INT_i	INTERMEDIATES
INV_i	SECTORAL INVESTMENT
K_i	CAPITAL STOCK LEVEL
KSUP	CAPITAL SUPPLY
L_i	LABOR DEMAND
LSUP	LABOR SUPPLY
MPS	PRIVATE SAVINGS RATE
NPFE	NET PRIVATE FACTOR PAYMENTS TO ROW
NPFI	NET PRIVATE FACTOR INCOME FROM ROW
PC_i	COMPOSITE GOOD PRICES
PD_i	DOMESTIC GOODS' PRICE
PE_i	DOMESTIC PRICE OF EXPORTS
PFTR	PUBLIC FOREIGN TRANSFERS
PINDEX	PRICE INDEX
PISB	PUBLIC SAVING INVESTMENT DEFICIT
PM_i	DOMESTIC PRICE OF IMPORTS

$PRCON_i$	SECTORAL PRIVATE CONSUMPTION
PRSAV	PRIVATE SAVING
PTW	AVERAGE PRICE OF LAND/WATER COMPOSITE
PVA_i	VALUE ADDED PRICE
PX_i	GROSS OUTPUT PRICE
PYRTAX	PAYROLL TAX
QH_i	QUANTITY OF WATER
QT_i	QUANTITY OF LAND
REMTAX	OTHER PUBLIC INCOME
RK	NOMINAL PROFIT RATE
$RKDIST_i$	SECTORAL PROFIT RATE DIFFERENTIALS
STW(sf,IA)	AVERAGE SUBFACTOR PRICES
STWN	NON-AGRICULTURAL AVERAGE WATER PRICE
TACTTAX	ACTIVITY TAXES
TARREV	TARIFF REVENUE
TCOMTAX	COMMODITY TAXES
TGCON	TOTAL GOVERNMENT CONSUMPTION
TINV	TOTAL INVESTMENT
TOTGINV	TOTAL PUBLIC INVESTMENT
TRANS	PUBLIC TRANSFERS TO HOUSEHOLDS
$TWDIST_{ia}$	LAND/WATER COEFFICIENT
TW_{ia}	LAND/WATER DEMAND
TWSUP	LAND/WATER SUPPLY
VWATER	TOTAL WATER FACTOR INCOME
W	NOMINAL WAGE RATE
WATSUP	WATER SUPPLY
$WDIST_i$	SECTORAL WAGE DIFFERENCE COEFFICENTS
$WTDIST_i$	SECTORAL WATER COEFFICIENT
XS_i	GROSS OUTPUT
Y	PRIVATE INCOME

MODEL EQUATIONS

DEFINITION OF DOMESTIC IMPORT PRICES

$$Pm_i = Pwm_i ER(1+tm_i)$$

DEFINITION OF DOMESTIC EXPORT PRICES

$$Pe_i = Pwe_i\, ER(1-te_i)$$

VALUE OF DOMESTIC SALES

$$Pc_i \cdot CC_i = (1+tcomr_i)(Pd_i DC_i + Pm_i IM_i)$$

VALUE OF SECTORAL OUTPUT

$$Px_i \cdot XS_i = Pd_i DC_i + Pe_i EX_i$$

VALUE ADDED PRICE

$$PVA_i = Px_i(1-tac_i) - \sum_j Pc_j \frac{IO_{ji}}{XS_i}$$

PRICE INDEX

$$PINDEX = \sum PWTS_i * PC_i$$

SUBFACTOR PRICE

$$PTW.TWDIST_{ia}.TW_{ia} = STW_{wa,ia}.QH_{ia} + STW_{la,ia}.QT_{ia}$$

PRODUCTION FNC

Agricultural Production:

$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} TW_i^{(1-\alpha_i-\beta_i)}$, i = C, V, FR, OA

Non-Agricultural production:

$XS_i = A_i K_i^{\alpha_i} L_i^{\beta_i} H_i^{(1-\alpha_i-\beta_i)}$, i = F, T, CH, M, ONA

LABOR:

$W.WDIST_i.L_i = \beta_i PVA_i XS_i$

CAPITAL:

$RK.RKDIST_i.K_i = \alpha_i PVA_i XS_i$

WATER:

Agricultural:

$QH_i = ttwa_i TW_i$,i = C, V, FR, OA

Non-agricultural:

$STWN.WTDIST_i.QH_i = (1-\alpha_i-\beta_i) PVA_i XS_i$, i = F, T, CH, M, ONA

LAND

$PTW.TWDIST_i.QH_i = (1-\alpha_i-\beta_i) PVA_i XS_i$, i = C, V, FR, OA

AGRICULTURAL LAND DEMAND

$OT_i = TW_i - QH_i$, i = C, V, FR, OA

LABOR MARKET EQUILIBRIUM

$\sum L_i = LSUP$

CAPITAL MARKET EQUILIBRIUM

$\sum K_i = KSUP$

WATER MARKET EQUILIBRIUM

$$ESW = WATSUP - \sum QH_i$$

WATER/LAND COMPOSITE MARKET EQUILIBRIUM

$$ESTW = TWSUP - \sum TW_i \quad \text{, i = C, V, FR, OA}$$

TOTAL WATER FACTOR INCOME

$$VWATER = STW_{wa,ia} QH_{ia} + \sum_{ina} STWN.WTDIST_{ina}.QH_{ina}$$

GROSS OUTPUT-EXPORTS FRONTIER

$$XS_i = AT_i (BT_i EX_i^{\mu_i} + (1 - BT_i) DC_i^{\mu_i})^{(1/\mu_i)}$$

EXPORT SUPPLY

$$\frac{EX_i}{DC_i} = (\frac{Pe_i}{Pd_i} . \frac{1 - BT_i}{BT_i})^{(1/(\mu_i - 1))}$$

COMPOSITE GOOD AGGREGATION FUNCTION (ARMINGTON)

$$CC_i = AC_i \left[BC_i (IM_i + TAR_i)^{-\eta_i} + (1 - BC_i)(DC_i + VAT_i)^{-\eta_i} \right]^{(-1/\eta_i)}$$

F.O.C. FOR COST MINIMIZATION OF COMPOSITE GOOD

$$\frac{IM_i (1 + tm_i)}{DC_i + VAT_i} = (\frac{Pd_i}{Pm_i} \cdot \frac{BC_i}{1 - BC_i})^{1/(1+\eta_i)}$$

GOVERNMENT REVENUE

$$GREV = TACTTAX + TCOMTAX + PYRTAX + CAPTAX + REMTAX + HTAX + PFTR$$

INDIRECT TAXES ON DOMESTIC PRODUCTION

$$TACTTAX = \sum tac_i PX_i XS_i$$

TOTAL COMMODITY TAXES

$$TCOMTAX = \sum tcomr_i (PM_i * IM_i + PD_i * DC_i)$$

TARIFF REVENUE

$$TARREV_i = \sum tm_i PM_i IM_i$$

CORPORATE TAXES

$$CAPTAX = \sum tcap.RK.RKDIST_i K_i$$

PAYROLL TAXES

$$PYRTAX = \sum tpyr.W.WDIST_i L_i$$

REMAINDER TAXES

$$REMTAX = trem.Y$$

WATER TAX

$$HTAX = ttw \sum_{ina} QH_{ina}$$

PRIVATE INCOME

$$Y = \sum [(1 - tpyr).W.WDIST_i.L_i + (1 - tcap).RK.RKDIST_i.K_i]$$
$$+ (VWATER - HTAX)$$
$$+ \sum_{ia} STW_{la,ia}.QT_{ia}$$
$$+ TRANS + NPFI - NPFE$$

TOTAL PUBLIC CONSUMPTION

$$TGCON = GCR * GREV$$

GOVERNMENT CONSUMPTION BY SECTORS

$$PC_i.GCON_i = GLES_i.TGCON$$

PRIVATE CONSUMPTION BY SECTORS

$$PC_i.PRCON_i = CLES_i.(1 - MPS).Y.(1 - trem)$$

TOTAL INTERMEDIATE USES

$$INT_i = \sum_j IO_{ij} XS_j$$

GROSS DOMESTIC PRODUCT

$$GDP = \sum PC_i (PRCON_i + GCON_i + INV_i) + PWE_i EX_i - PWM_i IM_i$$

HOUSEHOLD SAVINGS

$$PRSAV = MPS(1 - trem)Y$$

PUBLIC SAVINGS

$$GSAV = GREV - TGCON - TRANS - FIP$$

PUBLIC TRANSFERS

$$TRANS = ttr.GREV$$

INVESTMENT DEMAND BY SECTOR OF ORIGIN

$$PC_i INV_i = IDLES_i.TINV$$

PUBLIC SAVING INVESTENT BALANCE

$$PISB = TOTGINV - GSAV$$

PRIMARY BALANCE AS A RATIO TO THE GDP

$$GPRMBAL = GPRBR * GDP$$

DEFINITION OF GOV PRIMARY BUDGET BALANCE

$$GPRMBAL = GREV - TGCON - TOTGINV - INTRSRAT * TRANS$$

WALRAS LAW

$$GSAV + PRSAV + FSAV = TINV$$

COMMODITY BALANCE

$$CC_i = INT_i + PRCON_i + GCON_i + INV_i$$

CURRENT ACCOUNT BALANCE

$$\sum PM_i IM_i + NPFE + FIP = \sum PE_i EX_i + FSAV + NPFI + PFTR$$

MODEL RESTRICTIONS:

<u>Fixed Values:</u>

LSUP, KSUP, TWSUP,

WDIST, RKDIST, WTDIST, TDIST,

FIP, NPFI, NPFE, PFTR,

WDIST, RKDIST, WTDIST, TWDIST, STWN

PTW

STW("wa",IA)

<u>Model Closure:</u>

MPS and FSAV are exogenous.

C. SIMULATION RESULTS

Table C1: General Outlook of Simulation Results (Base=1.00)

	WTO-SIM	PROD-WTO	WATER-SIM1	PROD-WATER
NOMGDP	1.0049	1.0279	1.0002	1.0247
Y	1.0040	1.0280	0.9953	1.0207
GREV	1.0118	1.0252	1.0418	1.0580
PRIVCON	1.0062	1.0502	0.9954	1.0404
TGCON	1.0118	1.0252	1.0418	1.0580
L .C	0.9613	0.9577	0.9980	0.9923
L .V	1.0049	0.9693	0.9971	0.9649
L .FR	1.0008	1.1112	0.9984	1.1123
L .OA	0.9805	0.9274	0.9969	0.9433
L .F	1.0109	1.0729	0.9972	1.0623
L .TE	1.0322	0.9970	1.0001	0.9718
L .CH	1.0078	1.0031	1.0010	0.9995
L .M	1.0114	0.9737	1.0015	0.9670
L .ONA	1.0085	1.0028	1.0015	0.9990
K .C	0.9541	0.9518	0.9972	0.9899
K .V	0.9973	0.9634	0.9964	0.9625
K .FR	0.9933	1.1045	0.9976	1.1096
K .OA	0.9732	0.9218	0.9961	0.9410
K .F	1.0033	1.0664	0.9965	1.0597
K .TE	1.0245	0.9909	0.9994	0.9694
K .CH	1.0002	0.9970	1.0002	0.9970
K .M	1.0038	0.9677	1.0008	0.9646
K .ONA	1.0009	0.9967	1.0007	0.9966
Qt .C	0.9566	0.9654	0.9975	1.0206
Qt .V	0.9999	0.9771	0.9966	0.9924
Qt .FR	0.9959	1.1203	0.9979	1.1440
Qt .OA	0.9757	0.9350	0.9964	0.9702

Table C1: General Outlook of Simulation Results (Base=1.00) (Continue)

	WTO-SIM	PROD-WTO	WATER-SIM1	PROD-WATER
WT .C	0.9566	0.9654	0.9975	1.0032
WT .V	0.9999	0.9771	0.9966	0.9755
WT .FR	0.9959	1.1203	0.9979	1.1245
WT .OA	0.9757	0.9350	0.9964	0.9537
WT .F	1.0059	1.0816	0.9967	1.0740
WT .TE	1.0272	1.0051	0.9996	0.9825
WT .CH	1.0028	1.0112	1.0005	1.0105
WT .M	1.0065	0.9816	1.0010	0.9776
WT .ONA	1.0036	1.0110	1.0010	1.0101
CC .C	0.9977	1.1163	0.9976	1.1174
CC .V	1.0070	1.1549	0.9967	1.1448
CC .FR	1.0065	1.2021	0.9978	1.1927
CC .OA	1.0117	1.1322	0.9964	1.1175
CC .F	1.0059	1.0665	0.9966	1.0582
CC .TE	1.0204	1.0209	0.9992	1.0032
CC .CH	1.0038	1.0335	1.0004	1.0316
CC .M	1.0075	1.0117	1.0010	1.0067
CC .ONA	1.0059	1.0227	1.0010	1.0193
XS .C	0.9609	1.1560	0.9977	1.1971
XS .V	1.0032	1.1648	0.9968	1.1593
XS .FR	0.9971	1.3343	0.9978	1.3366
XS .OA	0.9783	1.1119	0.9964	1.1310
XS .F	1.0072	1.0888	0.9966	1.0789
XS .TE	1.0306	1.0135	0.9998	0.9876
XS .CH	1.0037	1.0176	1.0004	1.0149
XS .M	1.0108	0.9930	1.0013	0.9856
XS .ONA	1.0063	1.0188	1.0011	1.0149
EX .C	0.9659	1.4454	0.9981	1.4912
EX .V	1.0069	1.4881	0.9970	1.4763
EX .FR	0.9965	1.7667	0.9977	1.7685
EX .OA	0.9839	1.4008	0.9966	1.4173
EX .F	1.0123	1.1771	0.9967	1.1606
EX .TE	1.0370	1.0088	1.0001	0.9779
EX .CH	1.0035	1.0024	1.0003	0.9990
EX .M	1.0129	0.9807	1.0015	0.9716
EX .ONA	1.0079	1.0032	1.0012	0.9976

Table C1: General Outlook of Simulation Results (Base=1.00) (Continue)

	WTO-SIM	WATER-SIM1	PROD-WTO	PROD-WATER
IM .C	1.3508	1.2290	0.9973	0.9041
IM .V	1.5517	1.6736	0.9967	1.0768
IM .FR	1.6449	1.7914	0.9979	1.0890
IM .OA	2.8671	2.5835	0.9962	0.8963
IM .F	1.0008	0.9852	0.9966	0.9825
IM .TE	1.0094	1.0291	0.9986	1.0206
IM .CH	1.0039	1.0419	1.0004	1.0404
IM .M	1.0056	1.0223	1.0008	1.0188
IM .ONA	1.0043	1.0381	1.0009	1.0365

D. CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Çırpıcı, Yasemin Asu
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EDUCATION

Degree	Institution	Year of Graduation
MS	METU, Economics	2001
MS	METU, Mathematics	2000
BS	METU, Mathematics	1997
High School	K. Mimar Kemal Lisesi, Ankara	1993

WORK EXPERIENCE

Year	Place	Enrollment
2006-	YTÜ, Economics Department	Research Assistant
2001- 2006	METU, Economics Department	Research Assistant
1999- 2001	METU, Mathematics Department	Research Assistant

FOREIGN LANGUAGES

Advanced English

PRESENTATION

"*The Turkish CGE Model: Searching for Alternative Specifications*", EcoMod 2005, International Conference, Policy Modeling, İstanbul

HOBBIES

Music, Piano, Puzzle.

E. TURKISH SUMMARY

Bu çalışmanın amacı, Türkiye için suyu bir üretim faktörü olarak ele alan bir Hesaplanabilir Genel Denge (HGD) modeli kurmaktır. Model, üç çeşit benzetim (simulation) yapmak üzere kullanılmıştır. Bunlardan ilki tarımda tarife indiriminin etkilerinin incelendiği DTÖ benzetimi, ikincisi ise su politikaları ile ilgili olan su benzetimidir. Burada, tarım dışı kesime su kullanımları üzerinden alınan bir çeşit su vergisinin uygulanmasının etkileri değerlendirilmiştir. Son olarak, bu iki benzetim tarımda bir verimlilik artışı olması durumunda yeniden analiz edilmiştir.

Hesaplanabilir genel denge (HGD) modelleri tüm ekonomiyi ilgilendiren politika analizleri yapmakta etkindirler. Çok sektörlü bir HGD modeli, üretim aktiviteleri, üretim faktörleri, hanehalkları, kamu kesimi ve dış dünyanın karşılıklı etkileşimlerini kapsar. Bu sayede, politika değişiklikleri ve ekonomik şokların sadece doğrudan değil dolaylı etkilerini de analiz etmemize olanak sağlarlar. Bu özellikleriyle HGD modelleri su ile ilişkili konuların analizi için en uygun yöntemlerden biridir.

Su kaynakları dünya üzerinde dengesiz dağılmışlardır. Bazı bölgelerde mevcut su kaynaklarının küçük bir kısmı su talebini karşılamaya yeterken bazılarında çok ciddi su kıtlığı yaşanmaktadır. Dünya üzerinde bir milyar insanın kaliteli su kaynaklarına erişemediği hesaplanmaktadır. Bu da, bu kısıtlı kaynağın en etkin bir biçimde kullanılmasını zorunlu hale getirmektedir. Bu bağlamda, ekonomik politikalar belirlenirken bunun su kaynakları üzerine olan etkilerinin de göz önünde bulundurulması gün geçtikçe önem kazanmaktadır. Konu uluslararası platformda da önemli yer tutmaktadır. Kaynakların doğru kullanımı ve toplumların refah ve sağlığı bağlamında Doha Kalkınma Gündemi'ne de konu olmuştur.

Doha Kalkınma Gündemi, Dünya Ticaret Örgütü (DTÖ) bünyesinde yürütülen çok taraflı ticaret müzakerelerinin bir parçasıdır. Müzakerelerin temel amacı, uluslararası ticaretin önündeki engelleri kaldırarak karşılıklı olarak ürünlere erişimi kolaylaştırmak, dünya fiyatlarının düşmesine zemin hazırlamak ve bu sayede gelişmiş ülkelerin korumacı politikalarından zarar gören gelişmekte olan ülkelere yardımcı olmak ve özellikle az gelişmiş ülkelerdeki yoksulluğu azaltmaktır. Bu görüşmelerin temel ayaklarından biri de tarım müzakereleridir.

Tarımda tarife indirimi uzun zamandır uluslararası platformda ciddi tartışmalara neden olmaktadır. Genel anlamda uluslararası ticaretin serbestleştirilmesi tartışmalarının içinde değerlendirilen bu konu, ülkeler arasında anlaşmazlıklara neden olmaktadır. Uluslararası ticaretin serbestleştirilmesi, II. Dünya Savaşı sonrasından beri sıklıkla tartışılan bir konudur. GATT anlaşmasıyla resmiyet kazanan müzakereler DTÖ'nün kurulmasıyla kurumsal bir yapıya kavuşmuştur.

1930'lu yıllarda yaşanan ekonomik bunalımın, "Büyük Buhran"'ın ardından ülkeler kendi içlerine kapanmış dünya ticareti durma noktasına gelmiştir. Ülke ekonomilerinin bu durumdan zarar göreceğinin anlaşılması üzerine 1940'ların başında serbest ticaretin yararları üzerinde durulmaya başlanmıştır. Bunun sonucu olarak 1994 yılında ABD'nin Bretton Woods kasabasında bir konferans düzenlenmiştir. Konferansta, dış ödemelerdeki dengesizlikler, uluslararası rezerv sorunları, uluslararası yatırımların yönlendirilmesi gibi mali konuların yanında dünya ticaretinin serbestleştirilmesi üzerinde de durulmuştur. Görüşmeler sonucunda elli ülke temsilcisi tarafından, uluslararası ticaretin serbestleştirilmesi için, "Uluslararası Ticaret Örgütü" (ITO) adında bir örgütün kurulması karara bağlanmış; ancak hayata geçirilmesi mümkün olmamıştır. ITO kurulana kadar belirli mallarda tarife indirimine gidilebilmesi için geçici olarak imzalanan Gümrük Tarifeleri ve Ticaret Genel Anlaşması (GATT) uygulamaya geçirilemeyen örgütün yerini almış, geçici nitelikte düşünülmüş olmasına rağmen 1948- 94 yılları arasında yürürlükte kalmış ve uygulanmıştır.

GATT'ın temel ilkeleri gereği üye ülkeler tarife dışı korumalarını bazı istisnalar dışında tümüyle kaldırmak, ithalat kısıtlamalarını tarifelere dönüştürmek (tarifikasyon) ve bu tarifeleri de zaman içerisinde düşürmekle yükümlüdürler. Her ülkenin belirlediği bağlı oranlar (band rates) bulunmakta ve ülkeler uygulamada bu oranların üstüne çıkamamaktadır. Bunun yanında ülkeler ticari partnerleri arasında ayrım yapamaz. Bir üye ülke herhangi bir ülkeye aynı mal için eşit uygulama yapmak durumundadır; ayrıca ülkeler iç pazara ilişkin düzenleme ve uygulamalar yönünden ithal ve yerli mallar arasında ayrım yapamazlar.

1948 yılından sonra GATT çerçevesinde 4 adet konferans ve 4 adet çok taraflı ticaret müzakeresi (Round) yapılmıştır. Bunların sonuncusu "Uruguay Round" olarak adlandırılan 1986-93 yılları arasındaki görüşmelerdir. Uruguay öncesi görüşmelerde tarifelerin indirilmesi gündemdeyken bu görüşmelerde tarife indirimleri yanında dünya ticaretindeki kural ve disiplinlerin güçlendirilmesine yönelik tüm ülkelerin de taraf olduğu anlaşmalar kabul edilmiştir.

Uruguay Round sonunda 15 Nisan 1994'te Marakesh Şartı imzalanmıştır. Bu anlaşma gereği GATT, 01.01.1995 tarihi itibariyle yerini DTÖ'ye bırakmıştır. Aynı anlaşma kapsamında 28 başka anlaşmanın yanında Tarım Anlaşması (TA) imzalanmıştır. Bu anlaşmanın temel ilkeleri şunlardır:

1) Pazara giriş: Bu ilkeye göre, ülkelerin tarım ürünlerine uygulanan tarife dışı tedbirleri tarifeye dönüştürmesi ve bu işlem sonucunda ortaya çıkan tarifeler göz önünde bulundurularak 1 Eylül 1986 tarihinde geçerli olan tarifeler üzerinde indirim taahhüdünde bulunmaları öngörülmüştür.

Anlaşma gereği gelişmekte olan ülkeler (GOÜ) 10 yıl içinde her bir tarım ürününde en az %10, toplamda ise ortalama %24 indirim taahhüdünde bulunmaktadırlar. Bunun yanı sıra gelişmiş ülkeler (GÜ) içinse bu oranlar sırasıyla %15 ve %36'dır. GÜ'ler indirim süresi 6 yıldır. GOÜ'lere daha önce GATT taviz listesinde yer almayan ürünlerde 1986 yılı tarife hadlerinden daha yüksek oranları konsolide ederek indirime tabii tutma imkanı tanınmıştır. "Tavan konsolidasyon" denen bu imkan GÜ'lere tanınmamıştır. Az gelişmiş ülkeler (AGÜ) ise indirim taahhüdünde bulunmama olanağına sahiptirler. Tarifikasyon sonunda uygulanacak tarifelerin yükseleceği göz önünde bulundurularak pazara giriş kolaylıklarının korunması ve ithal ürünlerin pazara giriş payının iç tüketimin %3'ünden düşük olduğu durumlarda asgari giriş tarife kontenjanlarının (düşürülmüş tarife oranlarından) oluşturulması sağlanmaktadır. Bu asgari giriş tarife kontenjanlarının uygulama döneminde %5'e çıkarılması kabul edilmiştir.

2) İhracat Sübvansiyonları: 1986-90 dönemi esas alınarak ihracat sübvansiyonları, bütçeden ayrılan sübvansiyon harcamaları ve sübvansiyonlu ihracat miktarlarının azaltılması karara bağlanmıştır. Bu bağlamda, 6 yılda GÜ'ler

sübvansiyon değerlerini %36, miktarını ise %21 azaltılırken GYÜ'ler 10 yılda sırasıyla %24 ve %14 indirime gidecektirler.

3) İç Destekler: Tarım Anlaşması'na göre GÜ'ler indirim taahhütlerine konu olan iç desteklerini 6 yıl içinde %10 oranında, GOÜ'ler 10 yıl içinde %13.33 oranında azaltmak durumundadır. AGÜ'ler içinse indirim taahhüdü gerekmemektedir. Bunun yanında, bir ülkenin üreticilerine her bir ürün için sağladığı destek, toplam ürün değerinin belli bir oranını geçmiyorsa destekleme indirim taahhüdü istenmemektedir. Bu uygulamaya "de minimis" denmektedir. Söz konusu oranlar GÜ'ler için %5, GOÜ'ler içinse %10'dur.

Uruguay Turundan sonra pek çok toplantı düzenlenmiş; ancak hiçbirinde bir anlaşmaya varılamamıştır. Bunun temel nedeni ise tarife indirimi ve tarımsal desteklerin kaldırılması konularında uzlaşmaya varılamamış olmasıdır. ABD, AB'nin tarifelerini indirmesini isterken kendisi çiftçilere teşvik vermeye devam etmektedir. Bu teşvikler nedeniyle düşen fiyatlarla diğer bazı ülkeler rekabet edememektedir. Diğer yandan da AB ülkeleri yüksek tarifeler uygulamaya devam etmektedir. G-10[18] ülkeleri tarımda liberalizasyona karşı çıkarken, Türkiye'nin de içinde bulunduğu G-33 ülkeleri özel ürün belirleme opsiyonu üzerinde durmaktadır. Az gelişmiş ülkelerden oluşan G-90 grubu ise daha liberal politikaların uygulanmasını savunmakta ve gelişmekte olan ülkelere özel imkanlar tanınmasını istemektedirler[19].

2001 yılı sonunda Doha'da yapılan Bakanlar Konferansında yayınlanan deklerasyon ile üye ülkeler Eylül 2003'te Cancun (Meksika)'da yapılacak konferansa kadar taahhütlerini belirleyeceklerdi ve 1 Ocak 2005 tarihi itibariyle de müzakerelerin sonuçlanması planlanmaktaydı. Ne var ki bu program gerçekleştirilememiş, görüşmeler günümüze kadar uzlaşma sağlanamadan sürmüştür. Gelinen son noktada, uluslararası gelişmelere bakıldığında olası bir uzlaşmanın 2013 yılından önce olması mümkün görünmemektedir.

Tüm bu sürecin içinde Türkiye de anlaşmalar gereği üzerine düşen sorumlulukları yerine getirmiştir. Tüm tarımsal ürünlerini DTÖ ile ilişkilendirmiş, ancak tarife dışı engellerinin olmadığını belirterek tarifikasyona gitmemiştir. Bunun

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[18] Japonya başta olmak üzere İsrail, Norveç, Bulgaristan'ın da içinde bulunduğu 10 ülkeden oluşan bir gruptur.
[19] Ülke grupları için bakınız ICTSD (2004).

nedeni Türkiye'nin önceki yıllarda dış ticaretini serbestleştirmesi ve 1986'da tanımlanmamış olan malların ortaya çıkmış olmasıdır. Diğer yandan, görüşmeleri en çok çıkmaza sürükleyen konulardan biri olan tarımda tarife indirimi konusunda da gelişmekte olan ülkeler için öngörülen %24'lük indirim taahhüdünü yerine getirmiştir. Ancak bu indirim uygulanan tarifelerde bir gerileme getirmemiştir. Uygulanan tarifeler 1994 yılında 44,84 iken bu 2003'te 54,90 ve 2004'te 55,10 olmuştur.

Bu çalışmada, ilk olarak DTÖ görüşmeleri gereği düşürülen tavan tarifelerin uygulanan ortalama tarifelerde bir düşüşe neden olması durumu incelenmiştir. Uygulanan ortalama tarifelerde, 1994- 2004 yılları arasında her yıl için %2,4 olmak üzere toplamda yüzde 24 olması öngörülen indirim, 2003 yılına gelindiğinde toplam yüzde 21,60 (= 24-2,4) oranında bir indirim yapılmış olması anlamına gelmektedir. Bu durumda, bu indirim tavan tarife oranları için değil uygulanan tarifeler için öngörülmüş olsaydı 2003 yılında uygulanan ortalama tarife 23,24 (= 44,84-21,60) olmalıydı. Oysa yukarda belirtildiği gibi 2003 yılında uygulanan ortalama tarım tarifeleri 54,90 olmuştur. Bu durumda, ortalama uygulanan tarifelerde yüzde 21,60 oranında bir indirim elde etmek, uygulanmış olan 54,90 değeri üzerinden yaklaşık yüzde 32'lik bir indirim yapmaya karşılık gelmektedir. Bu nedenle, DTÖ benzetiminde tarım tarifeleri %32 oranında azaltılmıştır.

Uluslararası düzeyde önem kazanan bir başka konu da su kaynaklarının etkin kullanımı konusudur. Su, kamu malı olarak Doha Kalkınma Turu'nda önemli rol oynamıştır. Dünya üzerinde bir milyar insan temiz su kaynaklarına ulaşamamakta iken 1,7 milyar insan ise sağlık hizmetlerinden faydalanamamaktadır. Hayat için vazgeçilmez olan ancak aynı zamanda da sınırlı olan bu kaynağın doğru şekilde kullanılması bu açılardan çok önemlidir.

Su genellikle maliyetinin altında satılmaktadır. Bu da özellikle tarımda suyun israf edilmesine neden olmaktadır. Sulama suyunun ucuz olması nedeniyle çiftçiler, çok daha az su kullanımına olanak sağlayan gelişmiş sulama yöntemlerine geçme gereği hissetmemekte, klasik yöntemlerle yapılan sulama nedeniyle çok miktarda su israf edilmektedir. Bu durum, suyun boşa kullanılması yanında toprak kayıplarına da neden olmaktadır. Çok miktarda su kullanılmasına bağlı olarak toprağın alt kısımlarında bulunan tuzlar suda çözünerek yüzeye taşınmakta bu da toprağın tuzlulaşmasına neden olmaktadır. Bunların yanı sıra su kullanımları için verilen sübvansiyonlar kamu kesimine de yük getirmektedir.

Türkiye'de belediyeler farklı su fiyatlandırmalarına gidebilmektedirler. Su tarifeleri Büyükşehir Belediye Meclislerinde belirlenmektedir. Fiyat farklılaştırmasına giden belediyeler bu şeklide su tasarrufu sağlamayı amaçlamaktadırlar (Sogesid, 2005). Su fiyatlandırması ve su piyasaları konularında modelleme yapan çalışmalar, su fiyatlarının arttırılması ve/veya su kullanım hakları veya su piyasalarının oluşturulmasının su tasarrufunu özendirebileceğini göstermektedir.

Bu çalışmada uygulanan ikinci benzetim su politikası ile ilgilidir. Burada, tarım dışı kesime uygulanan bir su vergisinin etkileri incelenmiştir. Betimlemelerin sonuçlarını vermeden önce modelde kullanılan metodun seçimi ve modelin temel özelliklerinden bahsedilecektir.

Su kaynaklarının korunması, etkin kullanımı ve kalitesinin korunması gibi su ile ilintili sorunların analizi için değişik yöntemler kullanılabilir. Su talebi literatürü daha çok ekonometrik tahmin yöntemlerine dayanmaktadır (Mukhrjee, 1995). Bu çalışmalarda modeller, parametreleri ekonometrik olarak hesaplanan denklem sistemlerinden oluşmaktadır. Bu çalışmaların dışında, yüzey suları stokları ve yıpranmaları daha ziyade optimal kontrol teknikleri kullanılarak analiz edilmektedirler. Başka bir yöntem de Saleth vd. (1991)'nin çalışmasında olduğu gibi, oyun teorisi tekniklerinin bir su piyasası analizi yapmak üzere kullanılmasıdır.

Su talebi üzerine yapılan çalışmalarda kullanılan bir başka metot da Girdi-Çıktı (I-O) modelleridir. Bunlar, sektörlerin üretim ve tüketim eğilimlerini ifade eden doğrusal denklem sistemlerinden oluşmaktadır. Sektörler arası etkileşimler matris formatında sembolize edilmektedir. Matrisin her sütunu sektörlerin girdilerini parasal değer olarak gösterirken satırlar ise bunlara karşılık gelen sektörel çıktıların değerlerini gösterir. I-O modelleri, ekonominin nihai talebini karşılamak üzere her sektörde olması gereken çıktı değişimini belirlerler. Bu sayede, örneğin, toplam talepteki nihai değişimden kaynaklanan su talebi değişimleri hesaplanabilir.

Bu yöntemde, üretim faaliyetleri, sabit katsayılı üretim fonksiyonları ile ifade edilmektedir. Üretim değerleri içsel olarak hesaplanmaktadır. Üretim faktörleri kullanımı da ilgili sektörün üretim miktarına bağlı olarak belirlenmektedir. Her faktör için arzın tamamı kullanılmaktadır. Fiyatlar dışsaldır ve talepten bağımsızdır. Bu özellikleriyle model oldukça katıdır.

Diğer bir analiz metodu ise doğrusal programlama (DP) yöntemidir. Bu yöntem daha çok sulu tarım ve çiftlik düzeyi modellerinde kullanılmaktadır. Burada, doğrusal bir hedef fonksiyonunun yine doğrusal olan eşitlik veya eşitsizlikler kısıtı altında optimizasyonu yapılmaktadır. I-O modellerinde üretim faktörlerinin tamamı kullanılmak durumunda olunduğu halde DP modellerinde bu koşulun sağlanması gerekmemektedir (Güneş, 2007).

Su meselelerini analiz etmede son derece etkin olan bir diğer yöntem de hesaplanabilir genel denge modelleridir. Bu modeller, I-O analizlerini geliştirerek fiyatları içsel almakta ve doğrusal olmayan denklemlere izin vermektedir. HGD modelleri tüm ekonomiyi içeren kapsamlı analizler yapmak için çok uygun yöntemlerdir. Bu yönleriyle, gün geçtikçe önem kazanan su meselelerinin analizi için önemli, kullanışlı ve esnek bir metottur.

Temel olarak bu modeller Walrasgil genel denge analizine dayanırlar. Sistemin formülize edilmesi ise Kenet Arrow ve Gerard Debreu'ya dayanmaktadır. Model, arz kısıtlarını açık olarak gösterir, fiyatları ve miktarları ayrı ayrı tanımlar ve iki kez türevlenebilen üretim fonksiyonları kullanır. Bu sayede, üretim ve tüketimde ikame etkilerini de içerir. Fiyatlar üzerinde faktör ve ürün piyasaları dengeye gelir. Üretim ve tüketim kararlarından elde edilen denge fiyatları sektörlerdeki istihdam ve gelirleri belirler.

Bu çalışmada, Türkiye için 2003 yılı verilerine dayanan bir HGD modeli kurulmuştur. Model, 9 sektörlü ve statik bir modeldir. 9 sektörden 4'ü tarım sektörüdür. Bunlar, tahıl ve diğer bitkisel ürünlerin yetiştirilmesi; sebze, bahçe ve kültür bitkileri ile fidanlık ürünlerinin yetiştirilmesi; meyve, sert kabuklular, içecek ve baharat bitkilerinin yetiştirilmesi ve diğer tarım sektörüdür. Bu sektörlerin ilk üçü 1998 Girdi-Çıktı (I-O) Tablosu ile aynıdır. I-O tablosundaki diğer tarım sektörleri, "diğer tarım sektörü" adı altında toplanmıştır. Tarım dışı kesim 5 sektöre ayrılmıştır. Bunlar, gıda sanayi, dokuma, giyim eşyası ve deri sanayi, kimya, petrol, kömür, kauçuk ve plastik sanayi, metal ana sanayi ve diğer tarım-dışı sektörlerdir. Belirlenen bu tarım dışı sektörler görece daha fazla su kullanan sektörlerdir. Sektörel su kullanımları verisine ancak bu detayda ulaşılabildiğinden, bu ayrımın ötesinde bir detaylandırma mümkün olmamıştır.

Modelde, özel ve kamu olmak üzere iki iktisadi ajan tanımlanmıştır. Üretim faktörleri ise dört tanedir. Bunlar, sermaye, emek, toprak ve su'dur. Toprak, sadece tarım sektörü için girdi olarak kullanılmaktadır. Faktörlerin toplam arzı dışsal olarak verilmiştir ve sabittir. İşgücü, sermaye ve toprak için arzın tamamı kullanılırken su kaynaklarının bir kısmı kullanılmakta, kalanının akışa bırakıldığı varsayılmaktadır.

Türkiye için yapılmış olan diğer HGD modellerinden farklı olarak, üretimde aşamalı bir üretim profili uygulanmıştır. Burada, öncelikle toprak ve su, sabit katsayılarla (Leontief tipi) bir araya getirilmiş, daha sonra bu birleşik faktör sermaye ve emekle Cobb-Douglas (C-D) üretim fonksiyonu ile birleştirilmiştir. Tarım dışı sektörlerde üretim, emek, sermaye ve su girdilerini kullanan bir C-D üretim fonksiyonu ile tanımlanmıştır.

Açık bir ekonomide "küçük ülke" hipotezi geçerli kabul edilmiş, buna göre dünya fiyatları dışsal olarak alınmıştır. Armington varsayımı uygulanmış, bu çerçevede yerli ve ithal mallar arasında aksak ikame olduğu varsayılmıştır. Buna göre, hanehalklarının yerli ve ithal malların bir kombinasyonu olan bir "birleşik mal" tükettikleri varsayılmıştır. Bu sistemde, tüketiciler kendi optimizasyon problemlerini çözerek tüketimlerinin ne kadarını ithal ne kadarını yerli mallarından yapacaklarına karar verirken, üreticiler yine kendi optimizasyon problemlerinin sonucuna göre iç veya dış pazar için üretim yapmak konusunda karar verirler.

Kamu gelirleri ise vergi gelirleri, faktör gelirleri, vergi dışı normal gelirler, sosyal fonlar ve dış transferlerden oluşmaktadır. Vergi gelirleri, üretim faaliyetleri ve ürünler üzerinden alınan vergilerlerden oluşmaktadır. Üretim faaliyetleri üzerinden alınan vergiler toplam üretim değeri üzerinden alınırken, üretim üzerinden alınan vergiler, birleşik mal değerinin bir katsayısı olarak tanımlanmıştır. Faktör gelirleri, emek, sermaye ve su kullanımları üzerinden alınmaktadırlar. Özel kesim gelirleri, faktör gelirleri, kamudan gelen karşılıksız transferler ve dış dünya faktör gelirlerinden oluşmaktadır.

Kamu kesimi, gelirinin belli bir kısmını tüketim harcamalarına ayırır. Tüketimin sektörlere dağılımı dışsal sabit katsayılar yoluyla olmaktadır. Özel kesim ise kullanılabilir gelirinin tasarruf etmediği kısmını tüketim amaçlı kullanmaktadır.

Özel tasarruflar, özel harcanabilir gelirin marjinal tasarruf eğilimi (MPS) ile çarpılması ile elde edilir. Kamu tasarrufları ise kamu gelirleri ile harcamaları arasındaki fark olarak belirlenir. Yatırım miktarı ise yatırım-tasarruf dengesinden hesaplanır.

HGD modelleri için kapsamlı ve dengede bir veri setine ihtiyaç vardır. Bu bağlamda, Sosyal Hesaplar Matrisleri (SHM) gerekli veri setini sağlamaktadır. SHM'ler, muhasebe hesaplarına uygun olarak, her satır toplamının kendisine karşılık gelen sütun toplamına eşit olduğu tablolar şeklinde tasarlanmışlardır. 2003 Türkiye SHM'si temel olarak DPT ve TÜİK'ten alınan verilerle oluşturulmuştur. Sektörel ayrıştırmalar ise 1998 I-O Tablosu'ndan alınan katsayılar yardımıyla yapılmıştır. Devletin vergi gelirleri, SHM'ye yerleştirmek için uygun hale getirilmek üzere ayrıştırılmış ve yeni tanımlar gereği yeniden gruplandırılmıştır.

Benzetim sonuçlarına bakacak olursak, birinci benzetim olan tarife benzetiminin sonuçları GSYİH ile özel ve kamu gelirlerinde bir artışa işaret etmektedir. Tarımda tarife indirimiyle birlikte ithal tarım malların fiyatları düşmüştür. En büyük fiyat düşüşü diğer-tarım sektöründe gözlemlenmiştir. Bu, söz konusu sektör içinde yer alan hayvancılık ürünleri ile ilgili olarak Türkiye'nin konumundan kaynaklanmaktadır. Bu alanda Türkiye, dış ticaretinin yarısını yaptığı AB'nin çok gerisindedir. Kuzey Avrupa ülkelerinde hayvancılık çok gelişmiştir ve verimlilik düzeyi çok yüksektir. Ticaret serbestisi durumunda, Türkiye'nin çok daha düşük fiyatlarla piyasasına girecek bu ürünlerle rekabet etmesi mümkün değildir.

Azalan ithal malları fiyatı ithal tarım ürünlerini daha cazip hale getirmiş, bu nedenle tüketim bu mallara kaymıştır. Tarım ürünleri ithalatı, başta diğer tarım ürünleri sektörü için olmak üzere artış göstermiştir. Tarım ihracatında sadece sebze sektörü için bir artış gözlenmekte, diğer sektörlerde ihracat düşmektedir. Sonuç olarak, toplamda tarım net ihracatında ciddi bir düşüş gözlenmiş, Türkiye tarım ürünleri açısından net ithalatçı konuma gelmiştir.

Sebze üretimi hariç diğer tarım ürünlerinin üretimi düşmüştür. Sebze üretimindeki artış, bu sektördeki ihracat artışı sayesinde sağlanmıştır. Meyve üretimindeki azalış ise düşük seviyede kalmıştır. Bu ise, toplam meyve tüketimi içinde ithal meyve ürünleri tüketiminin yüzdesi artmış olmasına rağmen, yerli malları tüketiminin çok az düşmesinden kaynaklanmaktadır. En fazla üretim düşüşü tahıl ürünleri için gözlenmiştir. Bu sektör, yerel tüketimin en fazla düşüş gösterdiği tarım sektörüdür. Tarım dışı sektörlerde üretim artışı gözlenmiştir. En fazla üretim artışı tekstil sanayide olmuştur. Bu da en fazla ihracat artışının bu sektör için gerçekleşmiş olmasından kaynaklanmıştır.

Tüketiciler, fiyatlardaki düşüş ve gelirlerindeki artış ile daha iyi duruma gelmiş görünmektedir. Ne var ki model gelir dağılımının nasıl olduğu hakkında bilgi vermemektedir. Fiyatların ve üretimin düşmesi üreticilerin aleyhine olduğundan onların gelirlerinde bir gerileme olduğu düşünülmekle birlikte nihai etkiler modelde gözlemlenememiştir.

Modelden elde edilen sektörel su kullanımları, beklendiği üzere tarımda su kullanımlarının azaldığına işaret etmektedir. Sermaye de aynı şekilde tarımdan diğer sektörlere kaymıştır. İşgücü durumuna bakıldığında ise üretimi artan sebze sektörü için çalışan sayısının arttığı, meyve üretiminde neredeyse sabit kaldığı ve diğer iki tarım sektöründe ise düştüğü gözlenmiştir.

Bu çalışmada analiz edilen diğer benzetim, tarım dışı su kullanımları üzerinden alınan bir verginin etkilerini incelemektedir. Beklendiği üzere vergi konulmasıyla birlikte özel kesim gelirleri azalırken kamu gelirleri artmaktadır. Su kullanımları, tarım sektörleri dışında gıda sanayi ve tekstilde de düşmektedir. Tekstil endüstrisinin özel gelir değişimlerinden etkilendiği düşünülmektedir. Hanehalkları tüketimlerini bu ürünlerden diğerlerine kaydırabilmektedir.

Suyu yoğun kullanan sanayiler olan, kimya ve metal sanayide su kullanımları artmıştır. Diğer sektörler su kullanımlarındaki değişiklikleri üretimlerine yansıtarak üretimlerini azaltma yoluna giderken kimya ve metal sanayi su maliyetlerindeki artışa cevap vermemekte ve üretimleri düşmemektedir. Bu sektörlerde su, hammadde olarak, tepkimelerde çözücü olarak, soğutma, taşıma veya temizlik gibi birçok aşamada kullanılmaktadır. Bu nedenle, bu sektörlerde su kullanımını azaltmak teknik olarak mümkün olmamaktadır. Büyük yatırımlarla kurulan bu işletmelerde üretim düşürme eğilimi azdır. Bunların yanında, su yoğun kullanılıyor olmasına rağmen, diğer maliyetler içinde su maliyeti görece düşük kalmaktadır. Bu nedenlerle, suya konulan bir vergi bu sektörlerde su kullanımlarını azaltmamaktadır.

Temel olarak hizmetler ve turizm sektörlerini içeren diğer tarım-dışı sektörlerde de su kullanımları düşmemektedir. Sermaye akışı da üretimin azaldığı sektörlerden arttığı sektörlere kaymaktadır.

Dış ticaretimizde, ithalat ve ihracat, tarım ürünleri için gerilerken tarım dışı ürünler için artmıştır; ancak her iki ürün grubu için de net ihracat sabit kalmıştır.

Türkiye'nin uluslararası ticarette rekabet gücünü arttırması için tarımda verimlilik artışına gitmesi önemlidir. Bu, özellikle Türkiye-AB arasındaki ticari ilişkileri inceleyen çalışmalarda gösterilmiştir. Türkiye, toplam ithalat ve ihracatının yarısını yaptığı AB ülkelerinden verimlilik açısından geride bulunmaktadır. Çalışmalar, olası bir üyelik durumu veya Gümrük Birliği'nin (GB) tarım ürünlerini de içerecek şekilde genişletilmesi halinde, Türkiye'nin meyve ve sebze ürünleri açısından sahip olduğu avantajı dahi kullanamayacağına işaret etmektedirler. Çakmak ve Kasnakoğlu (2002), hayvancılıkta küçük bir verimlilik artışının bile olası bir üyeliğin olumsuz etkilerini giderebileceğini göstermişlerdir.

Bu çalışmada incelenen her iki benzetim, tarımda bir toplam verimlilik artışı olması durumu için yeniden analiz edilmiştir. Tarife indirimi senaryosunda gözlemlenen dış ticaretteki bozulma, tarımda verimlilik artışı ile giderilmektedir. Sektörel bazda bakıldığında, tahıl ürünleri ve diğer-tarım sektörü için Türkiye hala net ithalatçı konumda bulunmasına karşın meyve ve sebze ihracatında sağlanan ciddi gelişme ile birlikte, toplamda Türkiye tarım ürünleri açısından net ihracatçı konumuna gelmektedir. GSYİH ile özel ve kamu gelirlerindeki artış daha fazla olmaktadır.

Su benzetiminde ise özel gelirlerde gözlenen düşüşün tarımda verimlilik artışı ile giderildiği görülmektedir. Verimlilik artışı ile tarımda üretim ve ihracat artmakta, bu sayede gelir düzeyi ve tüketim de artmaktadır. Tahıl ve meyve üretiminde su kullanımları artarken sebze ve diğer tarım ürünleri üretiminde su kullanımları düşmektedir. Su benzetiminde net ihracat değişmezken verimlilik artışı senaryosunda tarımda net ihracat neredeyse dört katına çıkmaktadır.

Kayıt altına alınmayan su kullanımları, bilinçsiz kuyu suyu kullanımları ve şehirlerdeki kaçaklar gibi sorunlar, gerçek su kullanım miktarlarının belirlenmesine engel olmaktadır. Suyun maliyetinin altında satılması su israfını getirmekte, tarımda suyun fazla kullanılması, gereksiz yere fazla su kullanılmasına neden olmanın ötesinde toprak kayıplarına da neden olmaktadır. Yalnızca Türkiye için değil tüm dünya için hayati önemi olan bu konuda bilinçli adımlar atılması için gerçekçi modellemelerin yapılması çok önemlidir. Konunun önemi ile ilgili olarak model yapıcılar bilinçlenmiştir. Pek çok ülke için modelleme çalışmaları yapılmaktadır. Türkiye için de somut politika önerileri sunabilecek modellerin oluşturulması önemlidir. Bunun için, suyun toplanması ve dağıtılması, su kullanım miktarları gibi su verilerinin sağlıklı bir şekilde oluşturulması gerekmektedir. Suyu doğru kullanma bilincinin topluma, özellikle de çiftçilerimize yayılması çok önemlidir. Bu gereklilik sadece şehirlerde sularımız kesildiğinde değil her zaman düşünülmelidir. Bunun için su kullanım hakları konusuna önem verilmeli ve modellere dahil edilmelidir. Suyun üretimi açık olarak modellere eklenmeli, su piyasası oluşturmanın etkileri incelenmelidir.

Olası su kıtlığı senaryoları yanında iklim değişikliklerinin etkilerinin de analiz edilmesi önemli hale gelmiştir. Aynı zamanda bu iki durumun farklılıklarının da bilincinde olmak önemlidir. İklim değişikliği durumunda yeterince sulama yapılması halinde bile topraktan istenen verim elde edilemeyebilir. Bu durumu incelemek üzere modellere yağış değişkeni eklemek mümkündür.

Bunun yanı sıra, dış ticarette, görece fazla su kullanımı gerektiren ürünlerin yurt içinde üretilmesi yerine yurt dışından satın alınması ile sağlanan su tasarrufu da önem kazanmaya başlamıştır. Özellikle Orta Doğu ülkelerinde göz önünde bulundurulan bu alternatifin etkilerinin incelenmesi de ileriye dönük politikaların belirlenmesi açısından önemli olacaktır.

Bundan sonraki çalışmalarda, yukarda belirtilen şekillerde, su içeren HGD modelleri genişletilebilecektir. Bu şekilde oluşturulacak modellerden elde edilecek bulgular ışığında bilinçli su politikalarının oluşturulabileceğinin mümkün olacağına inanmaktayız.