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Natural Diminishing Trend of the Tigris and Euphrates Streamflows is Alarming for the Middle East Future

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ABSTRACT

Over the last decade, numerous studies have appeared in books and journals addressing the climate change impacts on water quantity and quality of the Euphrates and Tigris River Basins. When one focused to these studies it can be seen that several studies link the Syrian uprising and subsequent outbreak of civil war to the drought. it also seems that when the current civil war is over, the most important need will be implementation of a basin wide sustainable water management policy. Therefore this requires more cmprehensive studies on current situation and future threats of the basin. Some of the researches have stated in their recently published articles that, “a severe drought occurred by human-induced climate change and a mass migration of drought-affected farmers fled to Syria’s, then the influx of migrants exacerbated unemployment and inequality in the cities, contributing to civic unrest over a nonresponsive government”. Most researchers agree that climate change contributed to the drought in Syria and civil unrest crisis. Recent studies have also noted that there has been an natural declining trend in Tigris and Euphrates Streamflows That means that changes in flow are more closely related to natural diplomacy features than with human interventions in Tigris and Euphrates Basins. All this abovementioned results are alarming invitations to all riparian states in the Middle East to create a new hydro diplomacy.

Keywords: Middle East water; Climate change; drought; water shortage; transboundary rivers; Tigris and Euphrates

1. INTRODUCTION

Experience gained in the past indicated that result oriented transboundary rivers collaboration need more than some tight cooperation activities. In other words ,increasing threats on water including climate change force 21 Century Hydro Diplomacy paradigm different than that of cold war era in the 20 th Century.

Despite the great size of the Middle East, there are only three rivers that can be classified as large by world standards-the Nile, the Euphrates, and the Tigris. The watersheds of both the Euphrates and the Tigris are situated within the Middle East, predominantly in the countries of Turkey, Syria, and Iraq

The Tigris and Euphrates Rivers are the most important surface water resource for Turkey, Syria and Iraq. They are also important essential to life, socioeconomic development, and political stability in the Middle East.

Figure 1. The Tigris and Euphrates Basin

Historically, development was limited to the semi-arid and arid zones of the lower reaches of the Tigris and Euphrates. The valleys of the two rivers encompass the northern portion of the famous "Fertile Crescent", the birthplace of the Mesopotamian civilizations. Owing to salt accumulation, waterlogging, and poor management of the canal system, the irrigated lands were progressively abandoned and the old civilizations declined.

Experience gained in the past indicated that result oriented transboundary river management policies need stronger innovative approach than some tight cooperation activities. In other words, increased threats on water including climate change force 21 Century Hydro Diplomacy paradigm to be different than that of cold war era in the 20 th Century.

2. WATER POTENTIAL OF EUPHRATES-TIGRIS BASIN

The Euphrates-Tigris basin is by far the most important transboundary watercourse in Turkey, because 56 km^3/y originating from Turkey represents about 4/5th of the total domestic transboundary water potential (Bilen 1996).

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The average water potential of Euphrates is around 32 km^3/y, that of Tigris around 24 km^3 /y in Turkey, the upstream country of both rivers, including tributaries flowing directly to downstream countries (Baran et al., 1995). (Fig.1). The total water potential of Euphrates is in the order of 37 km^3 /y, when 4 km^3 /y contributed by Syria and 1 km^3 /y from Iraq is added (there is virtually no contribution from Saudi Arabia); that of Tigris is in the order of 57 km^3 /y, where 10 km^3 /y from Iran and 23 km^3 /y from Iraq are added, neglecting the very small contribution from Syria; excluding Karkeh and Karun in Iran (Öziş, et al., 1997). Thus, for the entire Mesopotamian basin of Euphrates-Tigris, the total water potential is in the order of 94 km^3 /y.

In various publications dealing with the middle-eastern water conflict, the figures for the total water potential of Euphrates varied from 29 to 37 km^3 /y, those of Tigris from 42 to 58 km^3 /y. The differences between 37 and 29 km^3 /y, thus up to 8 km^3 /y for Euphrates on one hand, between 58 and 42 km^3 /y, up to 16 km^3 /y for Tigris on the other hand, were due to classified observations, lack of information, data bias and disinformation. These discrepancies should definitely be clarified and the accurate long-term water potential of the Euphrates-Tigris basin has to be determined, by contribution of all parties involved, before entering the discussions on any water allocation agreement. This corresponds basically to the first stage of the “three-stage plan” proposed by Turkey to her neighbors since 1980’s, related to the development of the Euphrates-Tigris water and land resources.

The flows of the Tigris and Euphrates in Iraq are largely dependent on the discharges in Turkey. Much of the discharge of the Tigris results from the melting snow accumulated during the winter in Turkey. However, winter rains, which are common in late winter and early spring, falling on a ripe snowpack in the highlands, can greatly augment the flow of the main stream and its tributaries, giving rise to the violent floods for which the Tigris is notorious. The period of greatest discharge for the Tigris system as a whole is from March through May and accounts for 53% of the mean annual flow. The highest mean monthly discharge takes place during April. Minimum flow conditions are experienced from August through October and make up 7% of the annual discharge.

The total flow of the Euphrates is not as great as that of the Tigris, although the river regimes are similar. It, too, rises in the highlands of Turkey and is fed by melting snows, to an even greater extent than the Tigris, but it lacks the major tributaries which the Tigris has. In Iraq, the period of maximum flow on the Euphrates is shorter and later than that of the Tigris and is usually confined to the months of April and May. Discharge during the two months accounts for 42% of the annual total. Minimum flows occur from August through October and contribute only 8.5% of the total discharge. The mean annual runoff of the Euphrates is 35.2×10^9 m^3 at its confluence with the Tigris (Shahin 1989; Beaumont et al. 1988).

These mean values, however, conceal the fluctuations in discharge that can occur from year to year, for it must be remembered that both floods and drought are themselves of variable magnitude.

4. DEVELOPMENT OF EUPHRATES-TIGRIS RIVER

The development of the Lower Euphrates in Turkey, within the context of G.A.P., together with Western and Central Tigris, serve as the driving force of the socio-economic development of the region. Hence, Turkey will regulate the flows for flood control, irrigation and/or energy production, as well as certain urban and industrial water supply schemes. About 1.8 million hectares of agricultural land will be irrigated in the context of G.A.P., two-thirds in Lower Euphrates and one third in Western and Central Tigris. 18 hydroelectric power plants with 20 TWh/y in Lower Euphrates, 12 plants with 8 TWh/y in Western and Central Tigris in Turkey are anticipated. Outside the scope of the G.A.P., 22 dams and 30 hydroelectric schemes with 9 TWh/y are planned on Eastern Tigris tributaries in Turkey. Keban -Karakaya - Atatürk - Birecik - Karkamış Dams and power plants form a continuous series of reservoirs on the Euphrates main river, down to the border with Syria. Among the major dams of the Upper Tigris, the Kralkızı, Dicle and Batman Dams are in operation.

5. DEVELOPMENT IN SYRI AND IRAQ

Three dams are located on the mainstream Euphrates in Syria; these are Teshreen with the maximal reservoir level reaching the Turkish border; At-Thawra (Tabqa) as the key dam for irrigation, energy production and urban water supply to Aleppo; Al-Baath to regulate the discharge of the former dam. Turkey’s proposal to set up jointly a high dam (Yusufpaşa) using the head of Teshreen Dam in Syria and Karkamış Dam in Turkey, which will be more beneficial to both countries, has not been received favorably by her downstream neighbour. Three dams for irrigation (Saab, Taaf, Shuhey) are located on Khabur and two tributaries in Syria, originating as Cirçip & Zerkan and Çağçağ tributaries of Euphrates in Turkey (Kolars & Mitchel 1991; Karadamur & Hadid 1992; Bilen 1996).

Syria anticipates to irrigate 800,000 ha of land; however various factors, especially the soil quality appears to limit it to 300,000-400,000 ha. The application of the second stage of the "three-stage-plan" proposed by Turkey would have clarified this critical issue. Turkey's proposal to heighten and shift the location of the Cizre Dam towards the end of the Turkish-Syrian border formed by Tigris, in order to divert part of Tigris waters to supplement Syria's irrigation needs in Khabur region, has also not been received favorably by her neighbor. Hadithia Dam is located upstream of the Hit stream-gaging station on Euphrates in Iraq; followed by Ramadi weir, Habbaniyah off-stream reservoir, Hindiyah and Nassiriyah weirs near Kerbela, all supplying irrigation systems (Hadithi 1978; Bilen 1996; Altınbilek 2004). No significant water scheme is apparently possible nor anticipated on the ephemeral dry creeks at the south-west regions of the Lower Euphrates in Saudi Arabia.

The hydroelectric potential of the upper stretches of certain eastern tributaries of Tigris in Iran could eventually be harnessed by high-head diversion plants, diverted either by weirs or partly regulated by dams. There is no accurate information about such hydroelectric schemes; however, their operation might not cause serious problems, as long as the diverted discharges flow back to the same basin. Mossul (formerly Saddam) Dam, Fattah and Samarra weirs are located on the main River Tigris in Iraq. On eastern tributaries of Tigris in Iraq are located, some equipped with power plants, Bekme Dam on Greater Zap, Dokan and Dibbis Dams on Lesser Zap, Derbendikhan and Hamreen Dams, Adheim and Diyala weirs on Diyala; south of Baghdad on Lower Tigris in Iraq are located Kut, Dibban and Gharraf weirs; all supplying irrigation systems (Yussif 1983; Bilen 1996).

The Thartar closed basin in northwestern Iraq is used to store excess flood waters of Tigris; it is also linked with Euphrates, and might be used among other options, to transfer water from Tigris to Euphrates for irrigation along its banks (Kolars & Michell 1991; Beaumont 1992). The link between the two canals can better be directly established, bypassing the turbid waters of the Thartar Lake and avoiding excessive evaporation losses. Between Euphrates and Tigris in Iraq a long canal, called also the "Third river", was built to provide an efficient collection of the drainage systems. In this context, the marshlands of the Shatt-al-arab's delta have been significantly reduced; thus, environmental concerns of the "environmentalists", that the dams in Turkey cause significant reduction of the Shatt-al-arab marshlands, is substantially lacking evidence.

6. HYDRAULIC CIVILIZATION

The term "hydraulic civilization" has been used to describe societies similar to those in the alluvial lowlands of Iraq, which required large scale management of water supplies by the bureaucracies of central governments for widespread agriculture to be feasible.

Although the agricultural recovery of the Tigris-Euphrates lowlands began during the late nineteenth century, with the rehabilitation of a number of the ancient canals, it was not until the early part of the twentieth century that the first modern river-control work, the Al-Hindiyah barrage (1909-1913) was constructed on the Euphrates. Its original function was to divert water into the Al-Hillah channel, which was running dry, but later, following reconstruction in the 1920s, it was also used to supply other canals. Between the two world wars, considerable attention was given to the Euphrates canal system, and many new channels were constructed and new control works established. Development on the Tigris tended to come later. The building of the Al-Kut barrage began in 1934 but was not completed until 1943, while on the Diyala, a tributary of the Tigris, a weir was constructed in 1927-1928 to replace a temporary earth dam that had to be rebuilt each year following the winter flood. The weir allowed six canals to be supplied with water throughout the year.

Following the Second World War, river-control schemes tended to concentrate on the problems of flood control. Two of the earliest projects, completed in the mid-1950s, were situated towards the upper part of the alluvial valley. The Samarra barrage was constructed on the Tigris River with the objective of diverting flood waters into the Tharthar depression to provide a storage capacity of 30 x 10^9 m³. A similar scheme was also built on the Euphrates, where harthar depression to the Al-Ramadi barrage diverted flood waters into the Habbaniyah reservoir and the Abu Dibis depression. It had been hoped that stored water from these two projects might be used for irrigation during the summer months, but it was discovered that the very large evaporation losses, together with the dissolution of salts from the soils of the depressions, seriously diminished water quality and rendered it unsuitable for irrigation purposes. In conjunction with the barrages on the main streams themselves, two major dams were constructed on tributaries of the Tigris. The Dukan dam, with a reservoir storage capacity of 6.3 x 10^9 m³, was completed on the Lesser Zab River in 1959, while further south, on the Diyala River, the Darbandikhan dam, with 3.25 x 10^9 m³ of storage, was opened in 1961.

Before Turkey began building large dams on the Euphrates, the river's average annual flow at the Turkish-Syrian border was about 30 x 10^9 m³. To this, a further 1.8 x 10^9 m³ is added in Syria from the Khabur River (Beaumont 1988).

7. LONG TERM DECLINING TREND IN THE EUPHRATES RIVER

Recent studies key findings on reasons of negative trend in the Euphrates Flow

When we do a comprehensive literature survey on the Euphrates flow's variation flowing to Syria and Iraq by the years, we can see belowementioned key findings in some articles, books and reports;

- "Since Turkish and Syrian dams came into operation in the 1970s, the flow into Iraq has dropped dramatically – from 700 m^3/s to the current level of 260 m^3 /s." This is according to the agreements regulating the flow between Turkey and Syria (1987), and between Syria and Iraq (1990), respectively (Shamout, at all 2015.)
- ***" A comparison of the hydrographs in Figure 9 illustrates the alarming fact that <u>the river has lost 40–45 per cent</u> of its flow since the early 1970s, when most of the major dam infrastructure was established. This drop is a result of the huge storage facilities that have been built along the river***." (Shamout, at all 2015)
- "The natural flow regime of the Euphrates has changed entirely over the last 40 years, mostly due to human interventions, as exemplified by the water development programmes along the upper Euphrates (ESCWA-2013 the Euphrates River Basin Chapter 1 P.58).
- The annual reduction of the flow of the River Euphrates was 0.245 km^3 /year was 0.1335 km^3 /year . The reduction of flow in the Tigris River is less than that of the River Euphrates by 0.1115 km^3 /year. This is due to the fact that there are many dams constructed on the River Euphrates within Syria and Turkey (Al Ansari ,Knutsson 2011,Al Ansari 2013)
- With the construction of many dams in Turkey and Syria, the quantities of water that enter Iraq have decreased, and with the execution of an ambitious water management plan for

Turkey (GAP), the quantities of water will decrease more and more (Al Bomola, Ahmed Hussein. 2012).

8. IS WATER REGULATION NECESSERY IN THE EUPHRATES RIVER?

The flow in the Euphrates River depends on snow-melt in the highlands of Turkey. Thus, the flow is highly seasonal, with high precipitation of snow during the winter resulting in peak flow in the river during the spring.

The availability of water through Euphrates River is not coinciding with irrigation requirements of the river basin in terms quantity and time.The peak river flow occurs in April and May due to the combined action of snow melt and rainfall, while the low season flow occurs during the period from July to December. The lowest flows occur in August and September when water is most needed to irrigate the land for winter crops (Fletcher, 2007).

For this reason, all riparian states have decieded to increase water storage capacities by building new dams, water diversion projects, and reservoirs, which use their storage water for irrigation and electrical power production. Euphrates River has almost a yearly regular regime, characterized by two months of high discharge, which are the months of April and May, with maximum floods occurring between mid-April and early May under the combined effect of melting snow and rains. The river flow during just these two months is approximately 42% of the total annual flow (Kolars, 1994). This period is followed by eight dry months from July to February, and the flow in the river is decreasing after June reaching its minimum values around September to October. It is also worth to note that the annual flow of Euphrates varies considerably from year to year.

Negative trend in the Mean Annual Euphrates Flow (ESCWA-2013)

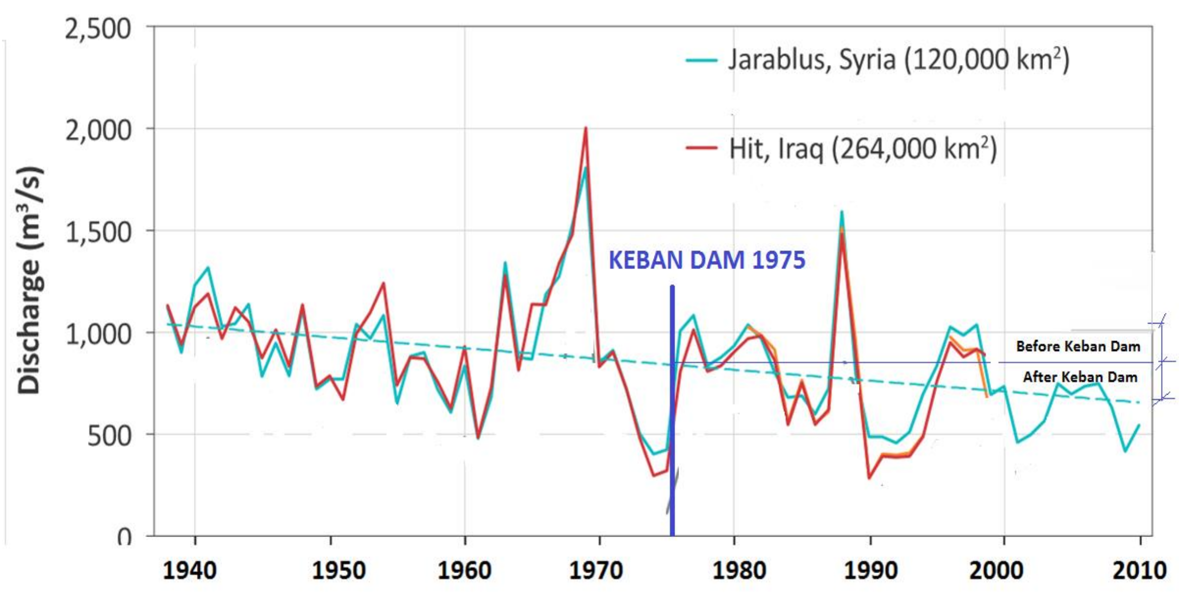

Figure 2. Mean annual discharge anomaly time series of the Euphrates River (1937-2010) (ESCWA 2013)

Iventory of Shared Water Resources in Western Asia is a very comprehensive recent study including a Euphrates River Basin Chapter. In this chapter ,Decrease in mean annual flow of the Euphrates at the Syrian-Turkish border (Jarablus) and Reasons of the negative trend were explained as follows;

- *"Figure 2 shows a statistically significant negative trend for the period of record (1937-2010) on the Euphrates at Jarablus indicating a decrease in mean annual discharge. Before 1973, the mean annual flow of the Euphrates at the Syrian-Turkish border (Jarablus) was around 30 BCM, but this figure dropped to 25.1 BCM after 1974 and fell to 22.8 BCM after 1990 . This is most likely due to climate variability and more frequent drought periods, and the construction of large dams in Turkey as part of the Southeastern Anatolia Project (GAP).*
- *The construction of a series of dams in Syria and downstream Iraq since the 1960s has further impacted flow volumes due to regulation and increased evaporation losses.Even though a significant long-term trend could only be detected at Jarablus, all stations show lower mean annual flow volumes after 1973, most likely due to stream regulation through water abstractions and storage .*
- The Euphrates River Basin Chapter of The INVENTORY UN –ESCWA-2013 says that "The natural flow regime of the Euphrates has changed entirely over the last 40 years, mostly due to human interventions, as exemplified by the water development programmes along the upper Euphrates. **However, not all changes are negative as regulation of the Euphrates can protect downstream countries from destructive floods and droughts, provided that reservoir water is released"**
- Increased regulation of the naturally snow-melt-driven flow regime of the Euphrates resulted in less pronounced seasonal flow variation (1973 to 1998)
- Inventory says "The maximum storage capacity of the major dams and reservoirs (>144 BCM) on the Euphrates exceeds" .But as of 2015 ,Euphrates river has the total dam reservoir capacity in Turkey is 88.24 km^3 and it's only 35,3 km^3 is active storage capacity.
- Inventory says "The natural flow regime of the Euphrates has changed entirely over the last 40 years, mostly due to human interventions" Large Storage Dam Construction has changed the natural flow regime of the Euphrates. But in the same chapter it is accepted that the flow regime must have been changed because of needed Euphrates flow regulation. It is said that" However, not all changes are negative as regulation of the Euphrates can protect downstream countries from destructive water floods and droughts, provided that reservoir water is released"
- As it is indicated in the Inventory, Flow regulation is necessery in the Euphrates River. It is clear that upper part of the euphrates river is the most suitable (climatogically, and topoghraphically) region to be regulated the flow with smaller reservoir surface area and less evaporation as well as high storage capacity.
- The reason of the Regulating Seasonal Variability of the Euphrates River is described as follows in the Inventory; *"The seasonal variability of the Euphrates is not suitable to meet crop needs. Water for winter crops is most needed during the low-flow season in September and October. The flood season with frequent inundations in spring puts the harvest at risk. Engineering works have therefore prioritized Euphrates stream-flow regulation in order to provide irrigation water in the low-flow season."*

- The Euphrates river flow regime before 1973 can be considered near natural as there was limited water regulation in the runoff-generating area in Turkey.

The construction and operation of the Keban Dam in Turkey in 1974 and the Tabqa Dam in Syria in 1975 led to a shift in the Euphrates flow regime. The water discharged during the high- flow period from March to July was mainly stored to fill the reservoirs and released later. Therefore it is beter to say that Euphrates flows is not restricted but regulated for all riparian countries use . By this regulation of the naturally snow-melt-driven flow regime of the Euphrates resulted in more steady regulated flow .

For instance; If we compare with the mean monthly flow regime before and after regulation we can see that releasing mean monthly flow at the Jerablus (Turkey–Syria border) is higher and steady in the period of 1974-1998. In details, the flow measured at the Jerablus in the mounths of June, July, August, September, October, November, December, January February, is higher then the period of unregulated flow between 1938-1973.
In addition that the mean monthly flow measured at the Jerablus shows that flow is only 3 months lower then unregulated period. These months are March, April and May that measured at Jerablus about 1000 m^3/s as mean monthly discharge

9. CHANGES IN THE HYDRO-CLIMATE OF THE TIGRIS AND EUPHRATES BASIN

Some of the publications stated a substantial changes in the hydro-climate of the Tigris and Euphrates Basin. Hydro-climatic effects of future climate change in the Euphrates–Tigris Basin are investigated by Bozkurt and Sen (Bozkurt and Sen 2013). They obtained a broad agreement amongst the simulations in terms of the winter precipitation decrease in the highlands and northern parts and increase in the southern parts of the Tigris and Euphrates Basin. They also found a statistically significant declines (25– Syria Iraq 55%) for the annual surface runoff of the main headwaters area(Bozkurt and Sen 2013).

Bozkurt and Sen concluded that projected annual surface runoff changes in all simulations suggest that the territories of Turkey and Syria within the basin are most vulnerable to climate change as they will experience significant decreases in the annual surface runoff.

It is highly probable that this trend will increase the challenges associated with the management of dam reservoirs and hydropower plants in the Upper Tigris and Euphrates basin.Bozkurt and Sen stated that the territory of Turkey will likely experience more adverse direct effects of the climate change compared to the territories of the other countries in the basin. The annual surface runoff is projected to decrease by 26-57% in the territory of Turkey by the end of the present century. Because much of the headwaters are located in this territory, all other countries in the basin are expected to feel the stress for the diminishing waters during the twenty first century

The most likely adverse impact of the climate change in the Euphrates–Tigris Basin will be the decreased water availability.

10. SYRIAN CIVIL WAR AND WATER AND CLIMATE CHANGE RELATED FACTORS

Gleick, P. H (2014). stated that " The Syrian conflict that began in 2012 has many roots, including long-standing political, religious, and social ideological disputes; economic dislocations from both global and regional factors; and worsening environmental conditions". He argued that key environmental factors include both direct and indirect consequences of water shortages, ineffective watershed management, and the impacts of climate variability and change on regional hydrology.

Gleick also (2014). pointed out that severe multiyear drought contributed to the displacement of large populations from rural to urban centers, increased unemployment—with subsequent effects on political stability.

It seems that drought, water and agricultural management, and climatic conditions are factors in the syrian conflict and all these water-related factors are likely to produce even greater risks of local and regional political instability.In order to reduce water insecurity in the region there is an urgent need to declare a political will for collaboration on transboundary water issues. Even if current limited political relation wont help to improve cooperation on water issues, this can draw attention to the issues and create an awaranes on the political agenda to be ready for emergency.

In the current civil war, some analysts have argued that factors related to drought, including agricultural failure,watershortages,and water mismanagement, have played an important role in contributing to the deterioration of social structures and spurring violence (Femia and Werrell 2013; FAO2012; Mhanna 2013).

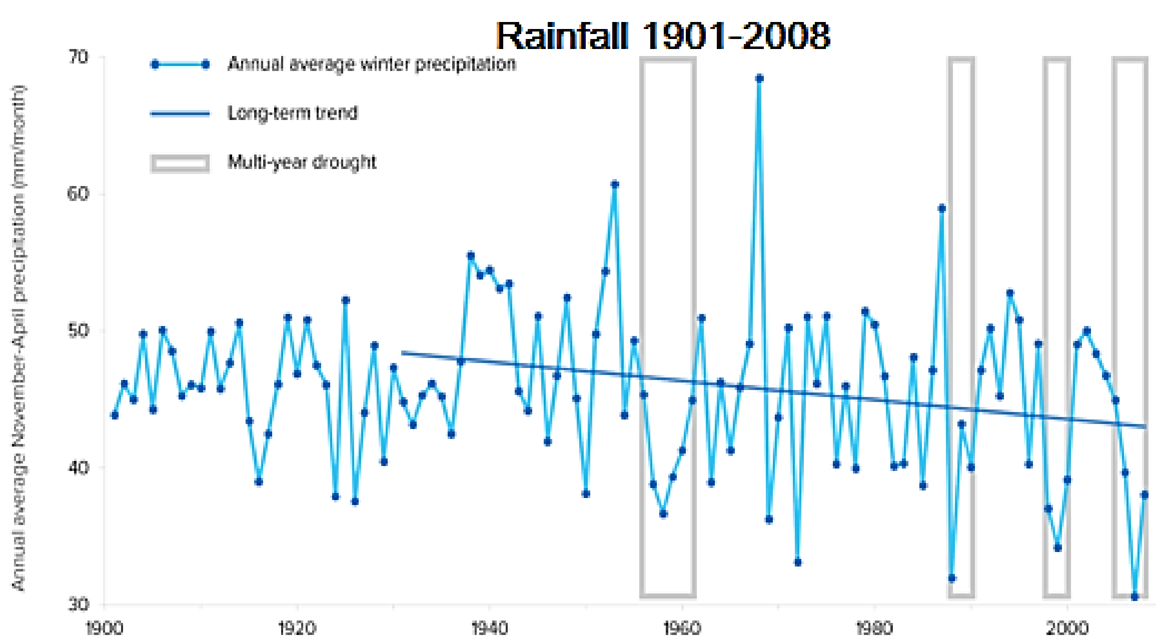

Figure 3. Long term precipitation trend in the Fertile Crescent (Fond 2016).

Some analysts have also argued that water withdrawals upstream by Turkey for its own agricultural production in the southern Anatolia region, and broader changes in regional hydrology have further contributed to a reduction in surface flows inside of Syria. All of these factors added to growing economic and political uncertainty. For instance Martin Hoerling, one of the study authors, stated, ‘‘The magnitude and frequency of the drying that has occurred is too great to be explained by natural variability alone’’ (NOAA 2013).

Fond (2016) from Circle of Blue mentioned about some studies concluded some relations between Syrian uprising that began in 2011 and severe drought. Fond stated that in March 2015, a study published in the *Proceedings of the National Academy of Sciences* laid out an argument for a climate-conflict link in Syria. This study found that precipitation during the winter months, when Syria receives most of its rainfall, was a third less in 2007 than the century-long average. The study also noted that the entire Fertile Crescent region (Traditionally the area between Tigris and Euphrates Rivers has been defined by scienticst as Fertile Crescent) in the eastern Mediterranean has seen a 13 percent reduction in winter rainfall since 1931 as shown in Figure 3 (Fond 2016). The boxes represents multi year droughts, which are defined as three or more consecutive years when precipitation is belowe the century long avarage.

Temperature has shown a long term increasing trend in the Fertile Crescent .Every year from 1994 through 2009 was warmer than the century-long avarage for the region (Figure 4).

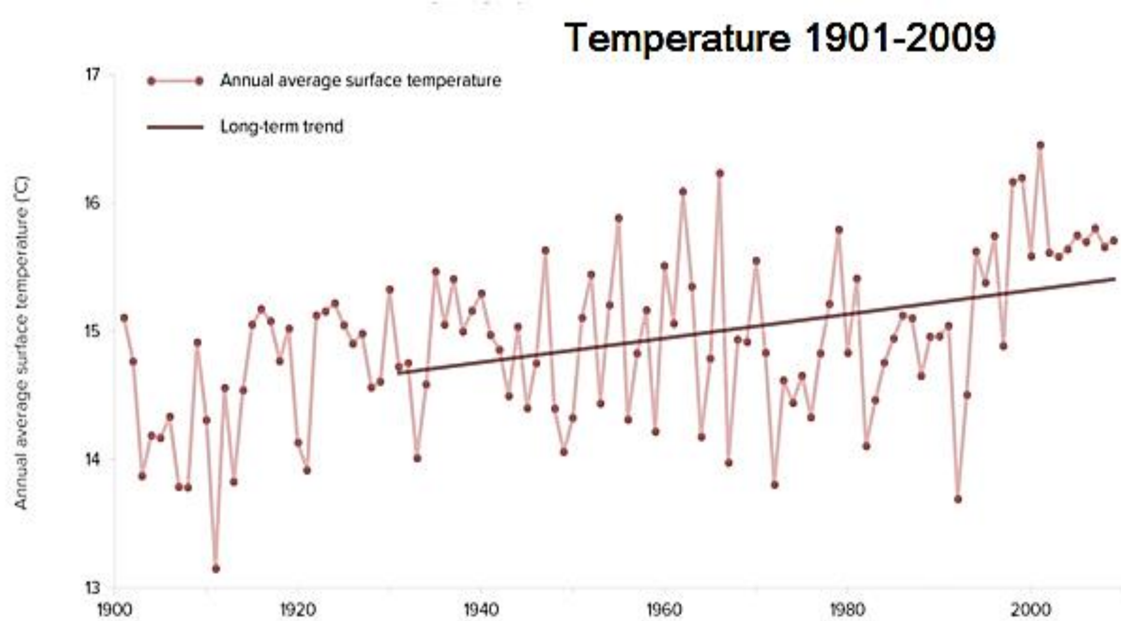

Figure 4. Long term temperature trend in the Fertile Crescent (Fond 2016).

Another study published recently in the *Journal of Geophysical Research: Atmospheres* found that the 15-year period between 1998 and 2012 was likely the driest in the last 900 years in the region of the eastern Mediterranean that encompasses Syria (Fond 2016).

Kelley at all (2015) also stated obviously that "There is evidence that the 2007−2010 drought contributed to the conflict in Syria" He argued the drought had a catalytic effect, contributing to political unrest. Kelley et all (2015) estimates of the number of people internally displaced by the drought are as high as 1.5 million (IRIN 2009, Solh 2010, Massoud 2014). Most migrated to the peripheries of Syria's cities and the influx of an estimated 1.2–1.5 million Iraqi refugees between 2003 and 2007, many of whom arrived toward the tail end of this time frame at the beginning of the drought and remained in Syria (UNHC 2010).

Kelley et all (2015) stated that "By 2010, internally displaced persons (IDPs) and Iraqi refugees made up roughly 20% of Syria's urban population. The total urban population of Syria in 2002 was 8.9 million but, by the end of 2010, had grown to 13.8 million, a more than 50% increase in only 8 years, a far greater rate than for the Syrian population as a whole (US 2014). The population shock to Syria's urban areas further increased the strain on its resources (Erian 2011).

Most of the researchers agree the drought in Syria and it's contrubution of the displacement of large populations from rural to urban centers.This can take an evidence to asses the role of transboundary water managementin the region.

11. PREDICTION OF FUTURE CLIMATE CHANGE IMPACT ON WATER.

Smiatek et al. analysed the potential effects of climate change on water availability in the region using regional climate models (2013). The analyses focused on differences in annual spring discharge between second half of the 20th Century climate and climate until 2050. The results showed potentially serious reductions in water availability from increased evapotranspiration demand and decreased precipitation (Gleick, 2014).
The relative change in mean discharge for the climate ensemble showed a decrease during the peak flow from March to May of up to 220% in the period 2021–50 and almost 250% in the period 2069–98, compared to the past climatic mean. Decreases of this magnitude would have dramatic effects on local water availability. A broader climate assessment for theTigris–Euphrates River basins evaluated the hydrologic impacts of climate changes (Bozkurt and Lutfi Sen 2013).

All simulations resulted in higher temperatures and variable precipitation changes .In all the simulations, decreases in snowfall due to higher temperatures were noted, consistent with many other studies of the impacts of climate change on mountain hydrology. Statistically significant reductions of 25%–55% in annual surface runoff from the headwaters regions of the Euphrates–Tigris watersheds were seen in all simulations. Bozkurt and Sen noted that these runoff changes ''suggest that the territories of Turkey and Syria within the basin are most vulnerable to climate change as they will experience significant decreases in the annual surface runoff. (Bozkurt and Lutfi Sen 2013, p. 149).

12. HOW TO REDUCE CLIMATE AND WATER-RELATED CONFLICT RISKS

Reducing the risks of water-related conflicts requires reducing the pressures on water resources.Local economies and employment heavily depends on agricultural production.

Climate change and growing demands will make it progressively more difficult to reach agreements over time. As a further complication, few international water agreements include mechanisms for addressing changing social, economic, or climatic conditions.

The region firstly needs social and economical stability which is not likely to be seen in near future.But there should be something during this transition period to stability like creating awareness and if possible establishing some technical joint study committees. A new hydropolitics approach is also needed to improve present situation using gained experinces. Negotiations over the allocation of theTigris and Euphrates Rivers, for example, could include adjustable allocations strategies,response strategies for extreme events such as droughts and floods, amendment and review procedures in the event of disputes, and joint management institutions (Cooley and Gleick 2011). Water in the Middle East is a complex issue that needs much more attention anymote. For instance Jessica (2009) is one of experts pointed out a new orientation in the geopolitical studies of water in the Middle East. Rather than continuing focus on the international dimension of water conflict in the region, which has received extensive attention in the literature, there is a need for more examination of political dynamics surrounding water use within the countries of the region.

13. PAST PRESENT AND FUTURE OF THE MIDDLE EAST TRANSBOUNDARY ISSUES

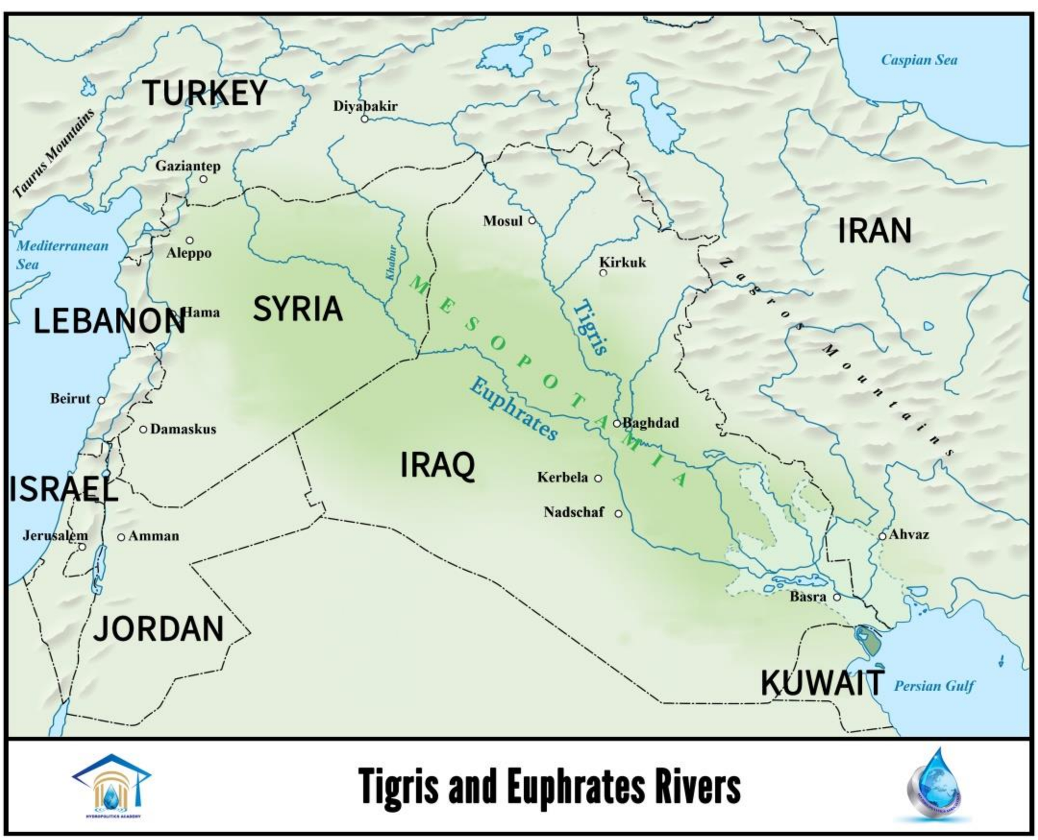

Figure 5. Tigris and Euphrates Rivers Basins

It is unfortunate that there have been no inclusive agreements over exactly how the water is to be managed between riparian state. Previous negotiations haven't led to significant steps forward to define and implement a framework for technical cooperation.

Turkey being the upper riparian has developed it's water potential in South Eastern Anatolian Project without any meaningful basin shared agreement.

At present, Syria and Iraq are suffering from serious security and social problems. It is also clear that thousands of people and farmers are suffering from water shortage problems and threat is increasing. Half of the Syria populationa has already immigrated.

> *"Climate change forced water-related factors are likely to produce even greater risks of local and regional political instability especially if the region has limited political cooperation on water issues(Figure 5). This case has been mentioned in some of the most recent publication. For instance one of them (Kelley at all. 2015) indicate that "There is evidence that the 2007−2010 drought contributed to the conflict in Syria. It was the worst drought in the instrumental record, causing widespread crop failure and a mass migration of farming families to urban centers. Century-long observed trends in precipitation, temperature, and sea-level pressure, supported by climate model results, strongly suggest that anthropogenic forcing has increased the probability of severe and persistent droughts in this region, and made the occurrence of a 3-year drought as severe as that of 2007−2010 2 to 3 times more likely than by natural variability alone. We conclude that human influences on the climate system are implicated in the current Syrian conflict".*

Gleick stated in his article (Glieck 2014) that "In the current civil war, some analysts have argued that factors related to drought, including agricultural failure, watershortages and water mismanagement have played an important role in contributing to the deterioration of social structures and spurring violence (Femia and Werrell 2013; FAO2012; Mhanna 2013).

In the article (Glieck 2014 a) Gleick also stated that *"Water withdrawals upstream by Turkey for its own agricultural production in thesouthern Anatolia region, and broader changes in regional hydrology have further contributed to a reduction in surface flows inside of Syria. All of these factors added to growing economic and political uncertainty. The early warnings were prescient: some ofthe earliest political unrest began around the town of Dara'a, which saw a particularly large influx of farmers and young unemployed men displaced off their lands by crop failures."*

Gleick (2014 b) stated that Water use and the construction of large water infrastructure upstream by Turkey have also decreased surface water supplies flowing into Syria (see Figure 6). He also stated that "there is evidence that climate changes are already beginning to influence droughts in the area by reducing winter rainfall and increasing evapotranspiration" (*Gleick 2014 b)*

Saleeby (2012), argued that ''*the regime's failure to put in place economic measures to alleviate the effects of drought was a critical driver in propelling such massive mobilizations of dissent.*''

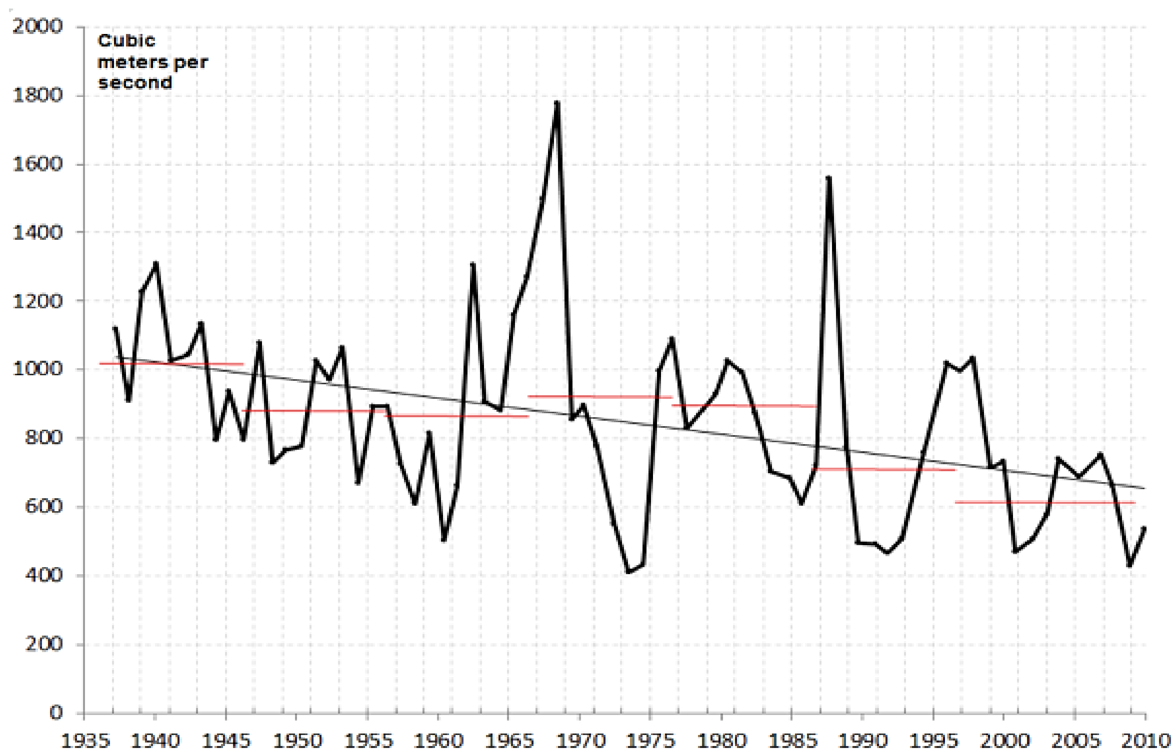

Figure 6. Discharge of the Euphrates River measured at Jarablus, Syria from the mid-1930s to around 2010. Red lines show the decadal averages. The long-term linear trend is also shown. Data from the United Nations Economic and Social Commission for Western Asia, 2013. (*Gleick 2014 b)*

Gleick (Glieck 2014) concluded that *"Severe multiyear drought beginning in the mid-2000s, combined with inefficient and often unmodernized irrigation systems and water abstractions by other parties in the eastern Mediterranean, including especially Syria, contributed to the displacement of large populations from rural to urban centers, food insecurity for more than a million people, and increased unemployment—with subsequent effects on political stability"*

Because of Syria and Iraq are too much involved in civil war, water shortage problems, lack of water management since last 5 years growing climate change threats are not of prime importance now.

But it is obvious that sooner or later, both countries will try to get their water requirements. Turkey is not seriously concerned to negotiate with Syria and Iraq and it might continue to negotiate to avoid any negative criticism from international community and it will lose nothing by agreeing to meet. Turkey will take the advantage of the present weak status of Syria and Iraq and continue to control the water of the Euphrates and Tigris Rivers according to its plans. All predictions models suggest that future water resources of the area are gloomier.

This implies that the conflict between the riparian countries must be solved as soon as possible and replaced by cooperation to overcome the problem. This can be achieved by a strong and influential mediator that can bring all the parties to the negotiation table. In the negotiations other maters can be discussed like the possibility of Syria and Iraq supplying Turkey with gas and oil in reduced prices. This can be an incentive for Turkey to cooperate. In addition, all countries (Turkey, Syria and Iraq) should set a long term strategic plan for the management of their water resources. This plan may be based on the ***"Natural Resources Interdependency Approach"*** that is based on unity of effort to regional development and interdependency on water, food energy security.

All simulations resulted in higher temperatures and evaporative demand in the basins, with the greatest increases in the highland areas, where precipitation is greatest. Precipitation changes were variable, with decreases inthe northern portions of the watersheds and increases in the southern portions. In all the simulations, decreases in snowfall due to higher temperatures were noted, consistent with many other studies of the impacts of climate change on mountain hydrology. Statistically significant reductions of 25-55% in annual surface runoff from the headwaters regions of the Euphrates Tigris watersheds were seen in all simulations, along with a shift in the timing of runoff.

The authors noted that these runoff changes ''suggest that the territories of Turkey and Syria within the basin are most vulnerable to climate change as they will experience significant decreases in the annual surface runoff. Eventually, however, the downstream countries, especially Iraq, may suffer more as they rely primarily on the water released by the upstream countries'' (Bozkurt and Lutfi Sen 2013, p. 149).

14. CONCLUSIONS

The Tigris and Euphrates Rivers are the most important surface water resource for Turkey, Syria and Iraq. They are also important essential to life, socioeconomic development, and political stability in the Middle East.Even the rivers are so much important, these states haven't reached yet a multileteral agreement to these transboundary rivers management. Tigris and Euphrates rivers are the 31% total water potential of Turkey and also vitally important for Syria and Iraq .

Therefore Turkey and Syria began to develope Euphrates in the mid's of 1970's. Turkey began to develope Tigris River late 199's. These development projects are not only important for Turkey but also necesserry to Syria and Iraq's water regulation need for agricultural production.

Because of riparian states hadn't reached to an agreement before construction of the projects these projects created high tension and conflicts between riparian states.

After modern exploitation projects the river's flow system has changed from a snow-melt system to a regulated-flow system. But in some articles, it is stated that *"the alarming fact that the river has lost 40–45 per cent of its flow since the early 1970s, when most of the major dam infrastructure was established. This drop is a result of the huge storage facilities that have been built along the river*."

In fact the alarming fact in the region is not regulating the flow (not losting 45 % of the flow). but climate change effects on water resources and droughts that has influenced the civil unrest in Syria. It is estimated that by 2016, millions of Syrians had lost their livelihoods, with hundreds of thousands migrating to cities and other countries.

Several studies link the Syrian uprising and subsequent outbreak of civil war to this drought and how poorly it was managed. And weather extremes add to the challenges. In

2012 Baghdad suffered its worstrecorded foods in 30 years, and Damascus was paralysed by snowstorms in December 2013. The winter of 2014/15 has brought torrential rain and fooding to both Turkey and Syria.

Regional studies conducted by the Turkish Water Foundation suggests that by 2020 the river flow in Turkey will have dropped by 15–20 per cent compared with ‘normal levels’ established in the second half of the 20th century. A fall in precipitation has already been recorded at weather stations across the Euphrates basin. One result is that the Euphrates tributaries inTurkey and Syria now contribute much less to the main river flow than in the past, with their total contribution having gradually dropped since 1930’s.

Experience gained in the past indicated that we are in need of a new innovative Hydropolitics approach. Increased different and stronger threats on transboundary water resources including climate change force a new Hydro Diplomacy paradigm.

For instance; previous negotiations couldn’t reach any satisfactory basin management agreement.At present Syria and Iraq are involved civil unrest crisis and water shortages is not of prime importance now till they reach the stability. But in the long run they will meet their water problems. Turkey should be seriously concerned to this situation and never think to be taken the advantage of the present weak status of Syria and Iraq. Opposite to this approach Turkey should make some preperation to emergency management plan of the Euphrates and Tigris Rivers. Turkey has implemented a training study for engineers and technicians from Iraq for efficient irrigation water management last year.

Turkey should have known that if a water related conflict occurs in the region this certainelly will create instability and Turkey will seriously be influenced from this unstable situation. Turkey gained bed enough experience about the border security and regional instability till now.Therefore each riparian state has no luxary to create water management conflict under the effect of climate change and svereal threats increasing.Opposite to this they should have more responsibility to open the closed doors to improve cooperation.

New hydropolitical and commercial matters can be discussed like the possibility of Syria and Iraq supplying Turkey with gas and oil in reduced prices. This can be an incentive for Turkey to cooperate in joint water project.Energy security and Food Security of the States can be taken into account with an innovative approach. For instance all new or old riparian states should be ready to set a new water management strategic plan based on the “Resources Dependence Theory”.

Because the recent studies showed that changes in flow are more closely related to natural features than with human interventions in Tigris and Euphrates basins.This is an clear warning and alert invitation to all riparian states to set up an innovative hydro diplomacy in soon.

This alarming fact was argued and confirmed in the recently published articles including the ESCWA Inventory that had already showed diminishing in flow in the ‘natural period’ before dam constructions.Some other studies including made by Hydropolitics Academy showed that the diminishing trend has been continued till now and likely to be the same trend in future.

We as the Hydropolitics Academy aim to study to improve understanding of the real situation on water related issues in the Middle East for regional peace and stability.This article is a part of the study and also offers some independent support for recent studies concluding that climate change has had a significant influence on the present situation in the Region and will influence the future of the region.

Biography

Dursun Yıldız is a hydropolitics expert and Director of the Hydropolitics Academy Association located in Ankara-Turkey. He is a civil engineer and used to be Deputy Director at State Hydraulic Works in Turkey; completed hydroinformatics post graduate course at the IHE in Delft,Technical training programme in USBR-USA and a master degree in Hydropolitics at the Hacettepe University-Turkey. He has over 5 years of teaching experiences in some Turkish Üniversities and now works as head of his own Hydro Energy & Strategy consulting company located in Ankara. He has published severel inernational articles and 13 Books. He recieved Most Succesful Reseracher Award on International Water Issues from Turkish Agricultural Association in 2008. He is also President of Hydropolitics Association in Turkey.

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