Mehmet Ogutcu

Remarks at the Istanbul Water Arena

17 June 2009

Introduction:

I am honored to address this forum. I will not stand long between you and your meal, but I do hope to offer some appetizing food for thought by describing to you a revolutionary discovery that will substantially increase the "fresh water available for beneficial us" in the water balance calculations of most countries worldwide. This new perspective on deep groundwater resources, called "Megawatershed" represents a paradigm shift in the field of water resource conceptualization and assessment and which has profound implications on the closely related topics of Water Economics and Geopolitics in the 21st Century.

A discussion of these topics are especially timely given fact that the 5th World Water Forum was held in Istanbul in 2009. At that meeting, WWF Secretary General Dr. Oktay Tabasaran announced the Forum's theme as: "Bridging Divides for Water" and went on to explain that the theme "…is built around an acknowledgement of the fact that *Istanbul is located at the geographical crossroads* between Europe and Asia, the Middle East and Africa, North and South; among various water cultures; between rich and poor, between developed and developing regions of the world."

Dr. Tabasaran also said "Most importantly, this theme also calls upon the international water community to make concrete proposals so that "*better management of the resource_may contribute to achieving the entirety of the Millennium Development Goals."*

There is no doubt that Turkey is not only a bridge for energy and Islam-Christianity, East-West; it is also a bridge in overcommitted surface water and unexplored, underutilized mountain rainfalls and water-bearing deep, regional geological structures. At the last World Water Summit in Mexico City two year ago, governments and water experts agreed that the world water outlook is bleak unless some serious breakthrough can be achieved, and Turkey could well be a vanguard nation in applying a history-making paradigm and technology for boosting water supply worldwide.

It is in the context of these World Water Forum issues and political imperatives that I ask you to consider the implications to Turkey's future of the "Megawatershed", hydrogeological paradigm, which was first documented and formally reported to the USAID by a geological exploration team I led in East Africa's Great Rift in 1987. Megawatersheds have since been confirmed or implicated elsewhere by EarthWater's teams as well as independent investigators in Africa, Asia and the Americas.

The "Megawatershed Paradigm" has evolved over the past 21 years of follow-on research and field applications into a unifying theory of the natural mechanisms of the Water Cycle and the

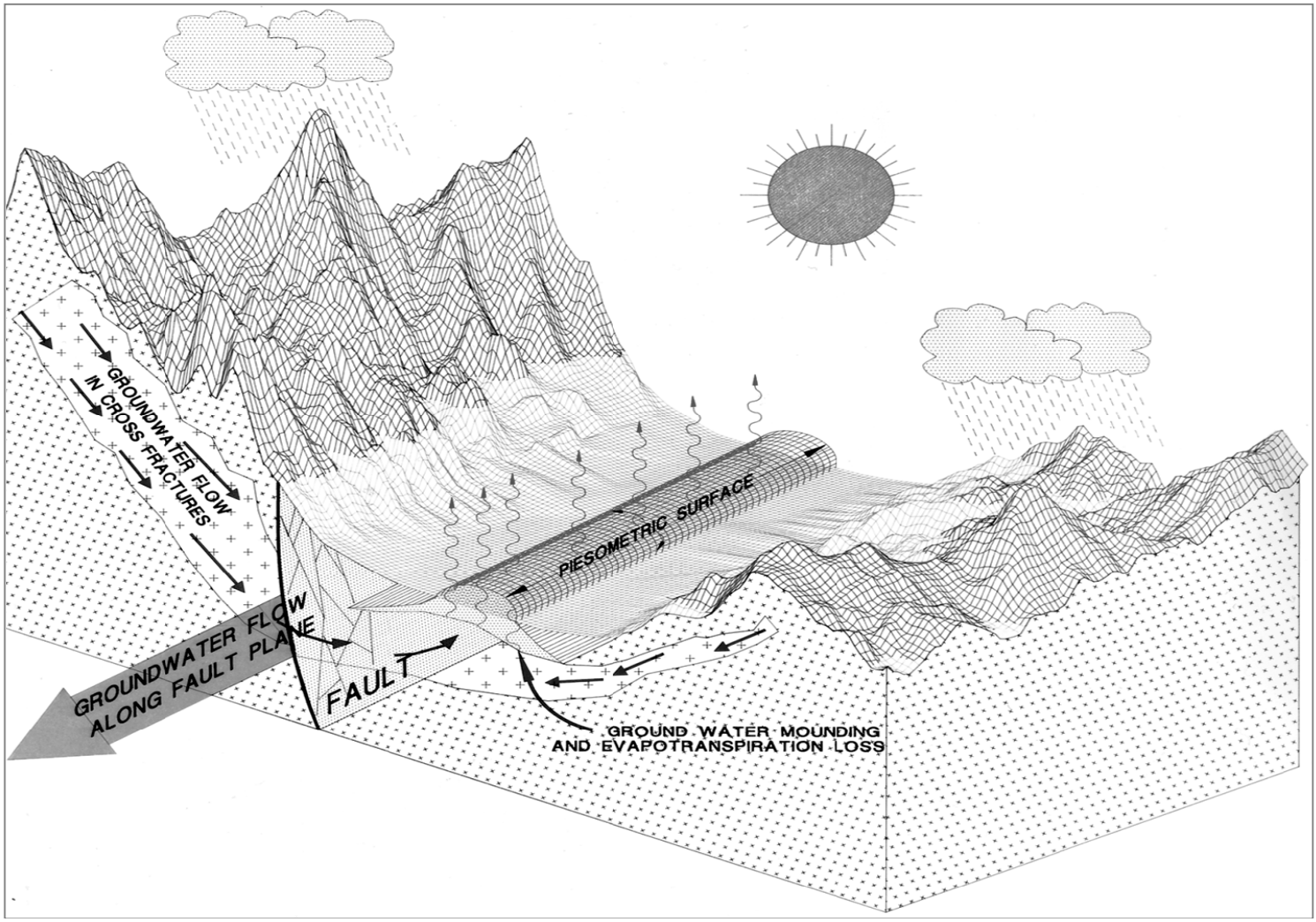
Water Balance that transcends traditional concepts and opens new opportunities for sustainable water development by addressing a means of exploring and exploiting the massive permeability of the Earth's Crust in certain regions that possess three simple attributes:

1. Active tectonics

2. Brittle bedrock (Earth's upper Crust)

3. Mountain Rainfall / Snowpack and/or Glaciers

By applying modern geological exploration methods modified over decades of research and development to quantify these attributes and tap into the "Crustal Permeability" of regions possessing these natural qualities, the traditional model of the Water Cycle and Water Balance gain vast new components of currently overlooked deep groundwater recharge, storage, transmission, plus deep ocean discharge. Megawatersheds exploration and deep groundwater development have profound implications in the practice of Water Economics and Water Geopolitics, especially for the Turkish Republic.

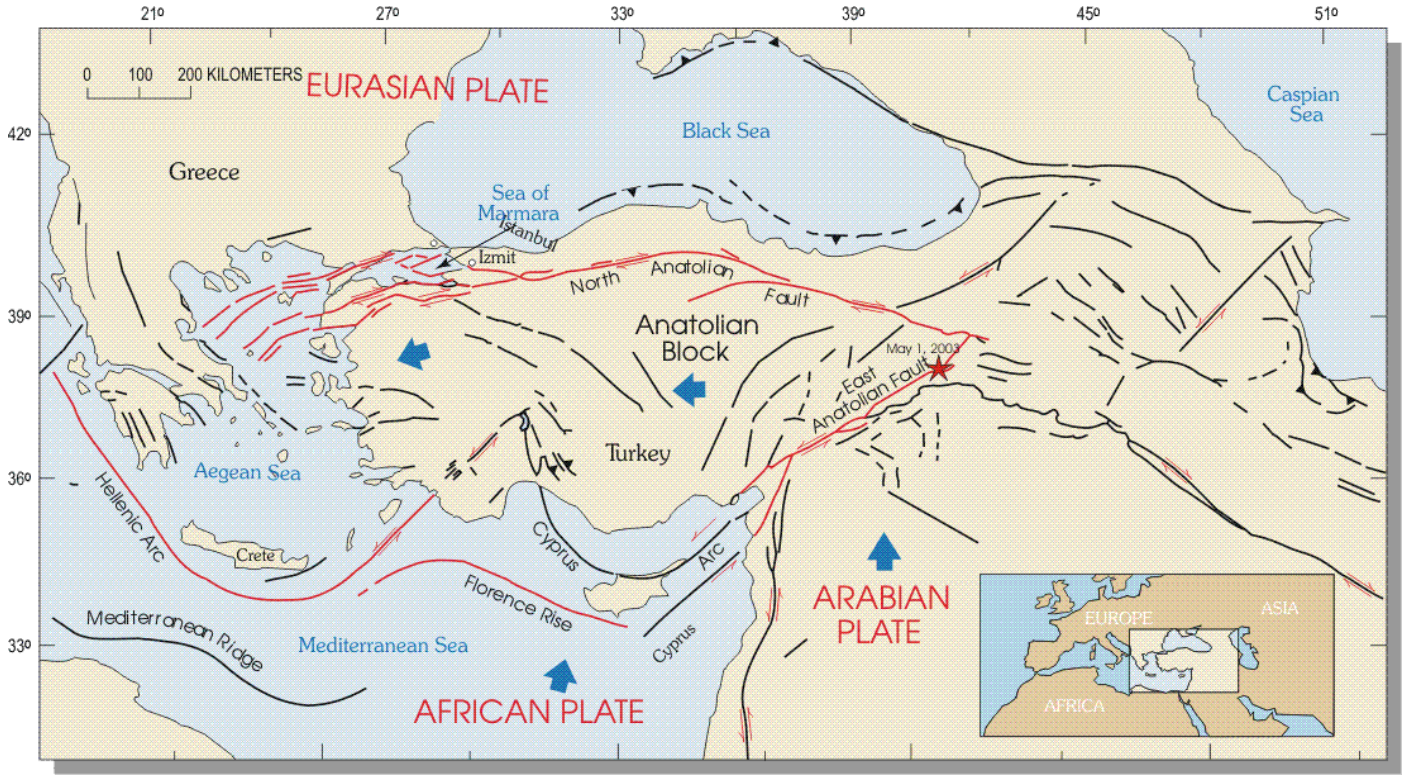


Megawatershed Paradigm: Crustal Permeability Adds new Component to Water Cycle & Balance

Recent experience in the Caribbean indicate that new assessments of water balance incorporating the Megawatershed Paradigm can result in 10X to 100X more fresh water than a traditional water balance and to better water management policies and practices.

The reasons I believe the Megawatershed paradigm is of particular relevance to Turkey and to the participants of this economic forum are because Turkey is not only at the geographical crossroads, but also a geotectonic crossroads, in fact a "Triple Junction" collision point of the Eurasian, Arabian and African tectonic plates, each one representing a large piece of the Earth's Crust.

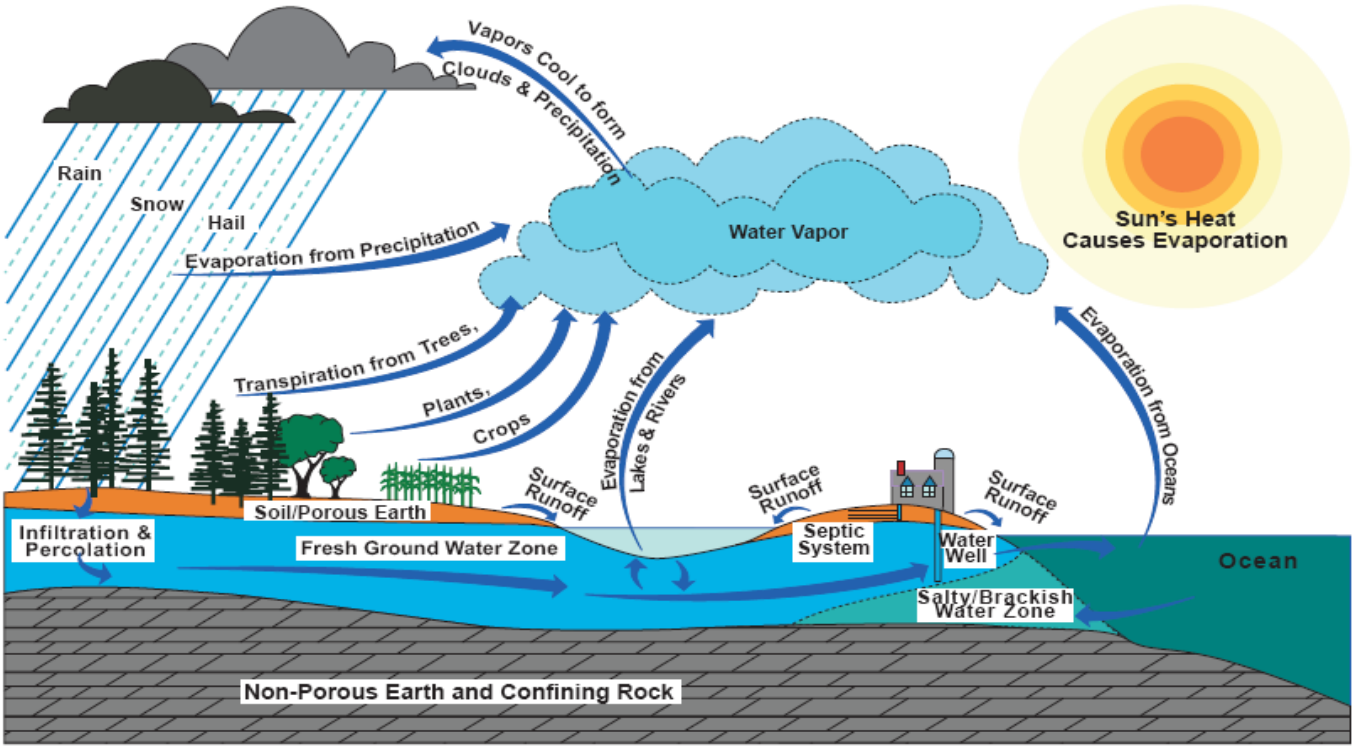
TURKEY IS AT CROSSROADS OF GEOGRAPHY AND GEOTECTONICS



Why is this "Triple Junction" Continental Plate Collision relevant to Turkey?

Because:

1. The collision of these plates places colossal stress on the each plate's crust, which is comprised of hard, brittle bedrock units that respond to the stress by folding and fracturing;
2. The result of the collision in Turkey is the building of great mountain ranges and creation of regionally extensive, highly complex and often hydraulically conductive and continuous fault and fractures systems in the mountain blocks as well as in adjacent kilometers-thick bedrock units underlying alluvial basins.
3. These tectonic forces are both destructive and potentially beneficial. While the adverse impacts of Turkey's strong earthquakes on Turkey's citizens and economy are well documented, there has been no such documentation of the actual percentage of Rain and snow falling in Turkey's mountainous areas that percolate deeply into fracture zones and flow deep under the country's interior and coasts only to discharge, unmeasured and untapped, far out under the seas.



The Traditional Hydrological Cycle Model Assumes Crustal Impermeability and Omits Deep Mountain Block Recharge and Deep Bedrock Groundwater Transmission and Storage
Where has the Megawatershed concept been applied and why now in Turkey?

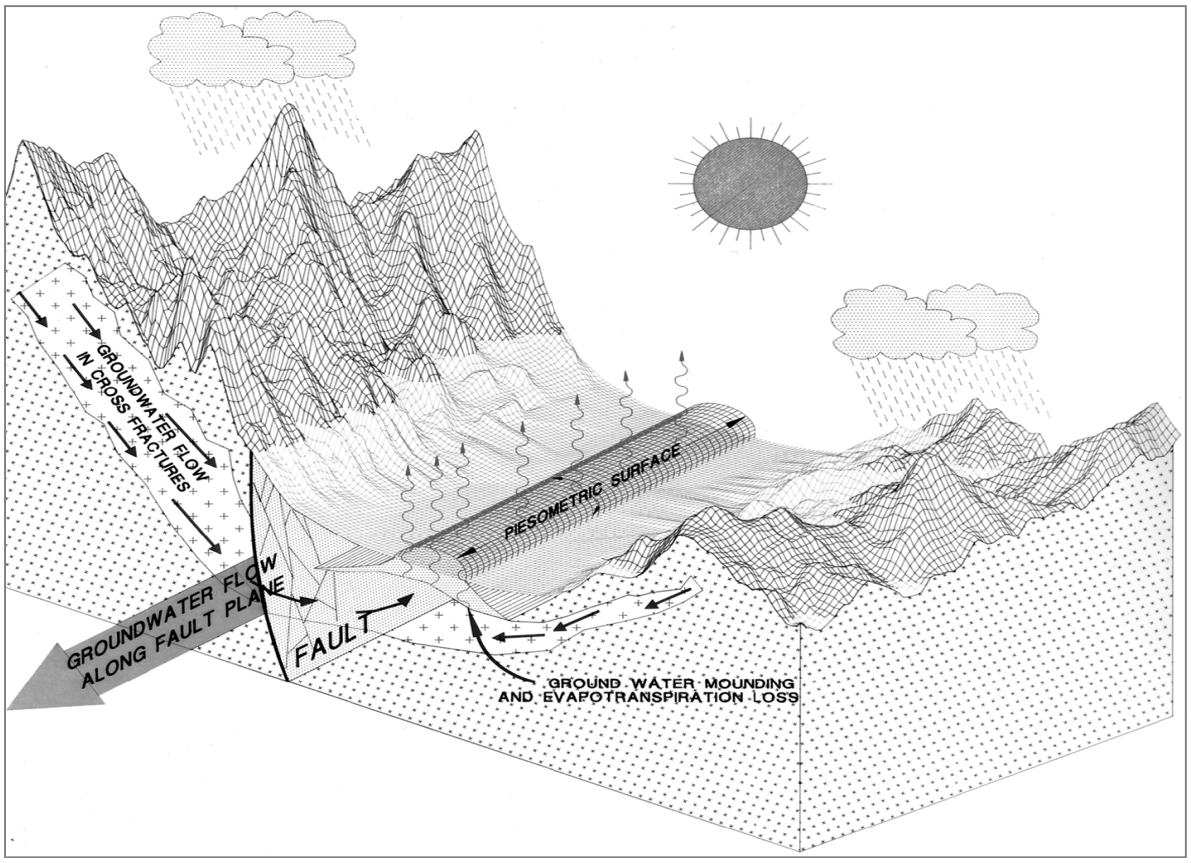
We have applied this concept in may regions with consistent technical success, but limited large-scale development because applying the concept and technology requires both political will and substantial capital, some of it private "at risk" capital for exploration and testing and some capital purely for infrastructure. Also, fresh water is only now being formally valuated in accord with "supply and demand" rules, so private capital has focused solely on R&D related to "hard" technologies, such as desalination & water treatment, as opposed to basic hydrology.

In addition, governments are hesitant to commit to such ventures because major government and institutional investments have NOT been made in basic hydrogeological field research regarding the hydrology and hydraulics of regional fractured bedrock systems and longstanding traditional hydrological concepts/models have not changed appreciably since Henry Darcy's mid-19th Century laboratory experiments in unconsolidated sediments.

Fresh Water is just now achieving a level of recognition as an economic resource with objective, consistent valuation worldwide. As a result, the amount of financial and political capital committed to original research of the Water Cycle and Water Balance has lagged other commodities by at least a century. This oversight must be rectified to provide governmental and institutional analysts who are advising political leaders with the facts about known fresh water sources and recommending timely, appropriate action in order to avoid future economic and political destabilization in the face of global warming

I pose this question: Has any country performed a comprehensive and auditable inventory of fresh water anywhere on this planet?

We have completed many evaluations of potential Megawatershed water development in regions ranging from Afghanistan (42×10^9 m^3 per year) to Nevada's carbonate basin (15×10^9 m^3 per year) I am aware of only one example - the small island developing state of Trinidad and Tobago in the Caribbean, where we have been able to follow through with model calibration and actual new sustainable water development from previously undetected Megawatersheds . The reason for lack of follow through on most of the projects was political, because the projects were solely public ventures. The Caribbean success was a novel public private partnership PPP that solved a 40-year chronic (and fast becoming acute) water shortage within 3 years at no risk to the government.



Megawatershed Model

Megawatersheds are recharged from Permeable Mountain Blocks and Other Sources

Importance of Water in Global / Turkish Economy and Geopolitics

One of the world's great religions, Islam, contributed the seminal statement about the importance of fresh water both locally and globally.

"By means of water, we give life to everything." Koran, 21:30

In fact the availability of fresh water gives life not only to biological organisms but also to local, regional and global economies throughout history. From a geopolitical perspective, efficient large-scale high quality water delivery to a regime's constituents empowers governments. Conversely, regimes that cannot provide for this basic human need fail to prosper and are inherently unstable. Thus, when surface and groundwater water sources are shared, national and regional water resource management and geopolitical interests are inextricably interrelated. The stakes are especially high for political leaders who must devise fair and responsible long term stewardship of fresh water supplies for all current and future stakeholders. Since fresh water is not only a catalyst for economic strength, but also necessary for the very survival of every living organism within the geographic bounds of each sovereign state, country leaders must insist on a

comprehensive, accurate accounting of available, renewable and sustainable fresh water resources within their domains.

The Republic of Turkey currently has at least four multilateral transboundary water agreements with neighboring states and is considering options to mitigate perceived inequities and resolve regional water deficit related issues and the potential for international adverse impacts of internal Turkish water projects, such as the GAP project. The 2003 Transboundary Water Policy Initiative for Overcoming Intersectoral Water Competition and the visionary "Peace Pipeline" are examples.

Is Something Missing in the Hydrological Balance?? - Auditing the Balance Sheet

While big-city and regional water supply engineering practices have evolved over several millennia to a very advanced state-of-the-art, the basic hydrological concepts and baseline data upon which modern water engineers depend have not kept pace, and the hydrological accounting system commonly used to calculate the water balance is a study in flawed data and circular reasoning that would not stand up to a 10 minute review by a professional accountant.

The concept of a water balance is based on the water cycle, in which water evaporates from the Earth's surface and then falls back to the surface as precipitation. The practice of calculating water balance has more variables and is supposed to provide an accounting of all water inflow to, water outflow from, and changes in water storage within a geographic area over a specified period, generally one year. However, the execution of this exercise is not standardized and depends largely on an investigator's training and experience, which also vary widely. Unlike in the practice of modern Engineering Sciences, in the discipline of hydrology the transition from academic theoretician to reliable practitioner has not yet evolved to meet the urgent needs of society.

The current knowledge-base of groundwater hydrology is severely biased by anachronistic assumptions used to calculate water balance that grossly oversimplify the attributes of groundwater environments, ignoring the paradigm shifts in geological theory that led to explosive growth in the oil, gas and minerals industries over the past four decades.

For example, traditional hydrogeological theory assumes that most of the world's mountains are "solid" and impervious to water infiltration or active recharge from rainwater and snowmelt. Yet there is substantial evidence from independent studies that most mountains possess fracture permeability and that 30% to 90% of rainfall and 40% to 90% of snow pack can percolate deep into and through the mountain, flowing through fracture systems in the Earth's crust under alluvial basins and ultimately into the sea or desert evaporation.

The traditional model <u>assumes:</u>

- the only indigenous annually renewable water comes from rainfall within Turkey's borders
- annual rainfall data is of sufficient coverage to accurately represent total rainfall over the country
- most bedrock units comprising mountains are impermeable

- most bedrock underlying basins fill materials is impermeable
- all groundwater is accounted for by existing data from logged and tested water wells
- Calculating "back into" ET by subtract the sum of measured (river gauge) overland water runoff amounts plus all documented groundwater withdrawals from the total measured rainfall quantity. The quantity of water remaining is assumed to be ET.

According to a 2001 report by the Republic of Turkey Data Collection and Analysis Department of Soil & Water Resources National Information Centre, General Directorate of Rural Services, Turkey's annual rainfall averages about 500 billion m^3, of which 186 billion m^3 (37%) runs off into seas or lakes and 41 billion m^3 (8%) is attributed to groundwater recharge. The remaining 274 billion m^3 (55%) is actually not accounted for, but since evaporation and plant transpiration (together called E-T) cannot be directly measured, then the missing 55% of rainfall is categorized as E-T. Thus, the books appear to be balanced.

Now I pose some hypothetical questions:

- What if the indeterminate "ET" in Turkey is actually only 25% or less, while 30% or more of total rainfall (which would be >150 billion m^3 per year) is actually flowing into and through the country's kilometers-thick, highly fractured, and thereby permeable, bedrock units, to ultimately discharge deep under the surrounding seas?
- What if total precipitation (rain, and especially snow & ice) is significantly understated (the WMO found that mountain recharge even in the USA is up to 40% underestimated; snow are very difficult to measure and also assumed to run off as spring melt) and might actually amount to 700 billion m^3 per year?
- What if Turkey actually possesses 300^+ billion $m^{3\ of}$ additional water in its annual water balance that is being cast into the ocean depths via natural, undetected, unexplored and untapped pathways?
- In other words, What if Turkey's basement Leaks!!?

While we have yet not performed an exploration program in Turkey, our preliminary evaluation, which we do before approaching any government, reveals extraordinary potential in Turkey.

We performed a similar analysis in the late 1990s in Trinidad & Tobago and subsequently initiated a PPP with the government. In that twin-island state, rainfall and all surface runoff are demonstrably confined to the islands themselves, and Trinidad, as an oil-rich country had amassed a formidable database from as many meteorological stations as Turkey, thousands of oil, gas and water wells and a 1999 report on future water supply sources prepared by eminent scientists from a consulting consortium including Delft Hydraulics. The report, which employed a traditional hydrogeological model, concluded that most of the groundwater resources were developed with only a few million cubic meters per year remaining available for development. Within two years of that report, the "Megawatershed" Paradigm had been applied using private capital and identified over 400 million m^3 per year of previously undetected, renewable, sustainable fresh water in that small island states, more than 10 times the amount calculated

using the conventional model. At the same time, over 35 million m^3 per year of new deep well production was put into service, supplying much-needed drinking water and calibrating the Trinidad & Tobago Megawatershed model.

Even more than Trinidad and Tobago, the extremely complex hydrogeology of Turkey cannot be adequately described and the water balance cannot be assessed using traditional models based on a largely "flat Earth", 2-D assumptions.
Let us compare just a few of the many variables that create Megawatershed environments in the Trinidad and Turkey and envision the implications of a Trinidad's success to Turkey's unrecognized water development potential:

- Turkey's land surface area (rainfall catchment) is 128 times greater than Trinidad;
- the mountains of Turkey are thousands of meters higher
- Turkey's "basement" complex (the Earth's crust) above sea level is thicker;
- the bedrock of Turkey is generally more brittle than Trinidad's
- the tectonic forces that fracture brittle bedrock are more active than Trinidad

Messages to Turkey's government and business leaders on water policy and investments.

In closing, my three messages to Government and business leaders are:

1. In the face of climate change, water is the most critical of all strategic resources. New knowledge of the actual bounds of your ground water resources will give you the power to manage them. The Megawatershed Paradigm represents to all stakeholders both a template for exploration and a framework for conceptualization of the natural complex systems comprising the earth-bound components of the water cycle.

2. It has taken more than 20 years to demonstrate the existence of a natural resource that has always been hiding in plain sight, because no one connected the dots. No matter the amount of proof to the contrary, modifying long-standing scientific theory still requires decades of independent verification and most often a new generation of scientists. [Anecdote: When we began our research in Jamaica several years ago, we were reviewing the government-published "Hydrogeological map and supporting documentation of Jamaica 1990" and found clear evidence of this common human foible. The map identified all of the crystalline rocks of the islands, including the massive, 2,000 m high "Blue Mountains" as "Aquicludes", while the supporting documents carefully accounted for the natural spring discharge from Mountain's bedrock fractures, totaling 385 million m3 per year – from a non-water-bearing "solid" rock!

Once the Megawatershed paradigm is put into practice by private sector and government stakeholders in water-constrained economies, the potential for economic ruin and geopolitical water conflict will subside as the proof of substantially increasing safe withdrawal from indigenous fresh water sources is acquired. Such proof will be evident within two years of initiating such ventures.

3. Turkey is in a unique hydrogeological and geopolitical position to benefit by exploring this new hydrological frontier and already demonstrate leadership at the World Water Forum in 2009 by introducing fact-based water management policies based on a balanced water budget.

Thank you for your patience and I look forward to questions and further discussions later in the Forum.