# WATER RESEARCH ACTIVITIES IN TURKEY

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**Abstract**

Many strategic options are implemented to converge the research dimension relevant to water science with local, regional actions and water policies which are of multidisciplinary nature allowing decision makers, researchers and water managers to compare different solutions, to assess them and to propose the priorities for the on-ground implementation. Universities, research institutions and decision makers in Turkey are involved with a wide range of water-related research activities which have been significantly increased by EU accessing programme. Water policy and vision of Turkey and water research activities have been reviewed with regard to scientific bases, related projects as well as research facilities of Selcuk University.

## 1. Introduction

Turkey is a mountainous, hilly country and some areas is lowland, surrounded by the seas, Black Sea from the North, Mediterranean Sea from South and Aegean Sea from the west and the average altitude is 1132 m. It is also seems to be a peninsula which has very great differences in terms of climate changes, soil differences and the other ecological properties (Özden D.M., et al. 2008; Hallett S.H**,** et al., 2003; Ilbeyi, A., & Sonmez, B, 1995). Average rainfall is around 600 mm annually, it can be changes for regions and this is considerably decreases by years, particularly the affects of global warming. This causes of the water deficiency that will be real problem in the future.

Renewable freshwater capacity of Turkey is estimated at 234 billion $m^3$. Technically and economically useable amount of this capacity is about 110 billion $m^3$ (Özden D.M., et al. 2008). The current use of freshwater amounts to 32 billion $m^3$, which are about 29 % of the technically and economically useable capacity (Kanber, 2006). For this reason, Turkey has already built dams to regulate and store surface water. Irrigation consumes the largest portion of the water resources, which was about 75%. The national development projects for irrigation are the South East

Anatolian Project (GAP) and Konya Ovum project (KOP). Nowadays, the water saving strategies are formulated by Government, policy and decision makers have been concentrated on the efficient use of water resources and recycling of water at larger scale. The water saving programs are started to implement in many municipalities or city councils as a whole, in order to maximize the benefits of water management development. Water research activities includes on the removal of toxic substances in the academic research scale (Tokmak B., et al. 2004; Çöl, M., and Çöl, C., 2004; Dogdu, M. S.and Bayari C. S, 2005; Altındağ, A. and Yiğit, S., 2005) and also appropriate mechanisms of water management, and the establishment of water resources authorities, or other institutional arrangements (Baytak, D., 2008; Karam, F., et al. 2006).

The efforts have been started by Turkish authorities and researchers to improve the management of water resources, use and recycle, concerns about the enormous growth in the demand of water due to global warming effects. Water resource management should be concerted to promote by the policy makers and they applied to integrate them in a planning process framework. Therefore, commitments are urgently needed to implement coordinated actions that address problems related to water saving in a socio-economic and institutional development context.

Regional programs for improving of institutional capacity to manage water resources were commenced with participation of Turkey to Framework Programme 6 (FP6). However, the approaches and experiences gained by EU countries in these areas still have to be transferred to a larger scale i.e. regional, catchments and trans-boundary basins scale. To these concerns, abundant literature exists but its application still very limited throughout the Turkey. Case-studies conducted in some municipalities need to be disseminated and, for providing a forum for exchange of experience and knowledge transfer. Nevertheless, there is need to understand how these knowledge and inputs can be pulled together with policy makers to enhance integration in new water saving and proper regionalization.

## 2. Water Policy

In Turkey, water policy already developed by considering, the present and future water needs parallel for its growing population and developments at global levels as well as the on-going EU accession process. The priority is given to policies and plans to fully utilize Turkey's water potential and water management in an efficient manner through necessary measures and projects. The strategy has been focused on

securing the quantity and the protection of the quality of water resources. Turkey's water resources policy is based on;

- ✓ Water resources in Turkey is not rich and it is anticipated to be a water-stressed country by 2030.
- ✓ Most part of Turkey, particularly central and southeastern of Anatolia is situated in a semi-arid region. Some of the water resources are not in the right place, thus they cannot be fully utilized.
- ✓ Given its climate, Turkey needs to store water during the brief season of rain and snowfall, in order to use throughout the year. The need for building dams and reservoirs is inevitable. The evaporation is main problem for dams during the hot and long summer p period
- ✓ The builted dams have enabled Turkey to use water resources in an efficient and sustainable manner so far. They contributed significantly to the overall socio-economic development of the country.
- ✓ There is a need to regulate the flow of rivers in order to prevent floods, provide safe drinking water, water for sanitation.
- ✓ Energy consumption is growing parallel with development ratio as about 6% a year. Therefore, it is a need to install new hydropower plants to the extent possible for sustainable development for additional capacity by 2020.

**3. Governmental Institutions for Water Research**

Turkey has established a number of governmental institutions functioning in the field of water research and management. The functioning and their responsibilities related to water issues is given as below:

**The General Directorate of State Hydraulic Works (DSI):** The most established water authority is the (DSI) which is the responsible for water development, management and allocation, needs advanced decision-support tools to be integrated to the decision-making process for basin management (The General Directorate of State Hydraulic Works, 2008). DSI is one of the competent authorities for the implementation of the Water Framework Directive (WFD) in Turkey. The WFD, establishing a framework for community action in the field of water policy, forms the general principles of integrated river basin management. Its main focus is to integrate economical and environmental aspects to secure sustainable management of water resources.

The main objective of DSI is to develop all water and land resources in Turkey. It aims at all the wisest use of the principal natural resources. It is charged with "single and multiple utilization of surface and ground waters and prevention of soil erosion and flood damages". For that reason, DSI is empowered to plan, design, construct and operate dams, hydroelectric power plants, domestic water and irrigation schemes**.**

**The Ministry of Environment and Forestry (MoEF);** MoEF has an overall co-ordinating role for the development and implementation of environmental policies and the competent authority for the implementation of the Urban Wastewater Treatment Directive (UWWTD). For this respect, the MoEF has collaboration links with other ministries, government agencies and stakeholders. Its specific duties for water activities are; i) Pollution prevention of water resources, ii) Water quality management of surface water and the related permitting and inspections, iii) Enforcement of the Regulation on the Control of Water Pollution.

**4. Research Projects Related for Water with EU**

Related water research projects under EU accession programme are described as follows;

*Implementation of the Water Framework Directive in Turkey (MATO1/TR/9/3):* The objective was to support Turkey with the implementation of the WFD. With this respect, legal and administrative analysis was performed for implementation of the WFD required to meet EU legal requirements in the field of water management.

*An Integrated Environmental Approximation Strategy for the Turkish Republic (2002/31739):* The overall purpose of the Integrated Approximation Strategy, which is still under consideration with a view to elaborating various aspects contained, is to help provide a strategic framework through which Turkey may move into full compliance with the EU environmental *acquis* with the full accession of Turkey to the EU.

*Technical Assistance for Environmental Heavy-Cost Investment Planning For Turkey (Tr/0203.03/001):* The aim is to enable the Turkish authorities to meet Turkey's environmental infrastructure requirements for EU accession by identifying and prioritizing water sector and identify the existing financial instruments available for environmental investments and their characteristics.

*Strengthening the capacity of sustainable groundwater management:* The project aims to assist Turkey in the transposition and implementation of Directive 80/68/EEC

(Groundwater Directive) and relevant groundwater legislation under the Directive 2000/60/EC.

*Capacity Building Support To The Water Sector In Turkey (TR 06 IB EN 01):* The aim is to assist Turkey in the water management in line with the EU water legislation, in particular the WFD, 2000/60/EC of 23 October 2000, Urban Wastewater Treatment Directive (UWWTD) 91/271/EEC of 21 May 1991 and Dangerous Substances Directive (DSD) 76/464/EEC of 4 May 1976 and daughter directives in order to enable the full implementation of the EU water acquits by the date of Turkey's accession to the EU (http://www.tubitak.gov.tr/home.do?ot=1&sid=472&pid=468**)**.

**5. Vision of Turkey for Water Research**

Likewise many other developed and developing countries, a national Technology Foresight Program was carried out under the name of Vision 2023 in which the water research activities was already planned (http://www.tubitak.gov.tr/home.do?ot=1&sid=472&pid=468. From the point of priorities of the reports about "Energy and Environmental Technologies Strategy Group", "Energy and Natural Sources Panel" and "Environment and Sustainable Development Panel" formed within the scope of Vision 2023 Technology Project view, the technologies that are strategic in the areas of energy and environment in 20 years period are determined and the competences that should be gained by these technologies. Water Treatment Technologies is determined by Strategy Group and it was accepted to realize a series of actions;

- ✓ Integration of water sources management strategies as well as water/wastewater substructure services
- ✓ Preventing deformation of natural sources and with this aim, activating every kind of financial sources at the national and international level, transfer of technology, supporting the development of capacity for water substructure
- ✓ Development of integrated water sources management and water efficiency plans, evaluation of recycling alternatives by preventing water losses
- ✓ Development of domestic and industrial wastewater treatment technologies for prevention of water pollution and protection of the ecosystem.

The Strategy Group developed route maps by 2023, aimed at providing competent in the areas of "prevention of water sources pollution", "treatment of underground waters" and "wastewater treatment" which were thought to form the base of integrated water sources management technology and to be strategically important in this respect (http://www.tubitak.gov.tr/home.do?ot=1&sid=472&pid=468).

It's suggested to develop permeable reactive barrier technology and electrokinetic methods in at most 10 years period for the treatment of underground water. Development of high-performance membranes and biological and chemical regeneration methods of them is in the foreground for the treatment of wastewater. In addition to this, development of low-pressure nanomembranes is also among these targets.

**6. Water research Activities at Department of Chemistry, Selcuk University**

The water research activities have been studied by Membrane Research Group (MRG) which is an acknowledged scientific group with a high research potential with a fundamental research-education in the field of membrane research over 10 years (Ersoz M., 2007; Alpoguz, H. K., et al. 2005; Durmaz, F., et al., 2005; Alpaydin, S., et al., 2004; Tor, A., et al., 2004; Cengeloglu, Y., et al. 2003; Alpoguz, H.K., 2002). Ongoing activities include the application of membrane technology for water treatment, metal and contaminated substances removal from aqueous solutions (Ünlü, N. and Ersoz M., 2007; 2006; Tor, A., et al. 2006; 2003; Cengeloglu, Y., et al. 2002) the studies on ion exchange membranes, hybrid processes (membrane filtration with adsorption processes), liquid membrane applications in cooperation with international partners. Recently, group focused to removal of boron and arsenic from drinking water by using of hybrid processes. In addition, group involved the following activities related with water research;

- ✓ The implementation of EU environmental directives in the water sector.
- ✓ Drinking water safety planning in line with WHO recommendations.
- ✓ The strategic, operational and technological control of drinking water contaminants.

**Ongoing projects**

EU-COST 637: *Metals and Related Substances in Drinking Water (2006-2010)*;

The main objective is to stimulate better control of metals and related substances in drinking water and to minimize environmental impacts (http://www.cost.esf.org /index.php?id=205&action_number=637) Supporting activities are;

- ✓ To provide an on-going forum for knowledge exchange in connection with metals and related substances in drinking water.
- ✓ To promote good practice in the control of metals and related substances in drinking water.

- ✓ To more critically determine the environmental and socio-economic impacts of control measures through the sharing of practitioner experience.
- ✓ To stimulate relevant collaborative research and demonstration studies at the European scale
- ✓ To perform of mapping of European tap survey for metals and related substances in drinking water
- ✓ To promote greater public health protection across Europe for a significant increase in compliance with the standards for metals and related substances that are set by the EU Directive (98/83/EC).
- ✓ To gather information of potential relevance to the impending implementation of the European Acceptance Scheme for construction products in contact with drinking water.

*Removal of Arsenic from drinking water by using of membrane processes TUBITAK-106Y299.* In this project, the removal of arsenic from drinking water (high ratios of arsenic) has been investigated by using pressure-driven membrane processes. i) pressure-driven processes, i.e RO and NF, ii) Charged NF process, iii) The new design hybrid system will be identified according to results obtained for i and ii stages. The considered hybrid system; pre-treatment on adsorption (active carbon and activated red mud) processes will be tested with RO and NF. For the removal of arsenic from drinking water and groundwater, optimization of the most effective process will be carried out by testing all of these processes and their optimum parameters due to seasonal changes.

*The investigation of ion transport features of activated composite membranes (TUBITAK-CAYDAG).* The aim of this project is to prepare activated composite membranes having different carriers for removal of Cr(III) and Cr(VI) from water.

*Boron removal from water by reverse osmosis (TUBITAK-MAG).* In this study, removal of boron from water by using of RO was investigated in terms of effect of pressure, pH, feed concentration and membrane type. Experimental results indicated that boron removal increased by increasing pressure and pH, boron concentration in feed phase had no effect on removal of boron and polyamide membranes provided more boron removal than other membranes used.

*The development of sustainable techniques and optimization tools for achieving safer drinking water (FP7-PEOPLE-ITN-2008) Initial Training Networks (ITN).* The multi-disciplinary Joint Centers for Water & Environmental Management Research at Swansea (UK) and Selcuk (TR) Universities is roposed to undertake a major

programme of research over four years, focusing on safe drinking water. Ten joint PhD studentships are intended to fund, each researcher attending both universities (50/50 split). The integrated research programme covers a range of topics, each contributing to the development of techniques, technologies or models that will improve the safety of drinking water, particularly for small supplies.

The research programme is timely and relevant to the implementation of the Protocol on Water and Health and to achieving the World Health Organization's recommendations on drinking water safety planning and guidelines for drinking water quality. The range of climates experienced by the two countries will facilitate research into climate change impacts, of particular relevance to water stress and its alleviation, and the maintenance of water supply infra-structure. It will also assist Turkey's accession preparations for future compliance with the European Union's drinking water directive.

## 7. Recommendations

The long-term sustainable management of water resources is based on reaching a balance between the social, environmental and economic uses with the principles of Integrated Water Resources Management (IWRM). This balance can only be achieved when a wide range of inputs from government, the public and the private sectors. The implementation of water saving strategies and integrated water management policies is not yet fully been progressed in Turkey, so European WFD have to be implemented. Giving the reason that the effective water saving policies in the framework of an integrated water management approach need an institutional change in the sense of an opening of participation processes to all relevant stakeholders.

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