The Most Common Factors Effecting Ground Water Quality

Maram ALMuhisen, HüseyinGökçekuş, Dilber Uzun Ozsahin

Abstract: Ever since the existence of living organisms on the planet, water has been a vital element for survival. Not only is it essential for existence, but also for consuming, watering, manufacturing and many other purposes in various fields. Regardless, humans have continuously polluted and allowed the waters to be unacceptable for human consumption by dumping waste into the environment with no care. Furthermore, increasing populations, construction expansions, larger income expenses, both industrial and economical developments have impacted an upsurge in water utilization. Consequently, these aspects have also escalated the pressure placed on the water ecosystem extensively and qualitatively. The water ecosystem also faces a heighten of conceivable risks resulting from dumping household as well as manufacturing waste water into regions adjacent to the water supplies. Evidently, utilization of unsuitable irrigation techniques could escalate earth salinity as well as vaporization percentages. The following research deliberates most of the ground water foundations, water difficulties, as well as the warm and mineral waters which have vitally influenced our wellbeing as a result of its organic and harmful aspects. Furthermore, in this research, the most influential factors affecting the quality of groundwater, will be analysed using the fuzzy method which will focus on the five following factors; coalash, industrial storage tanks, seawater intrusion, Arsenic, agriculture.

Keywords: polluted, ecosystem, wastewater, water supplies, ground water, fuzzy

I. INTRODUCTION

Throughout the world, the issue surrounding the groundwater quality disputes has been increasing being that the pollution of subsurface water has turned into a prevalent issue [1]. Some of the issues on this matter include reports of pollution through coal ash [2], manufacturing storage containers [3], seawater intrusion [4], arsenic [5], as well as cultivation [6].

From outer space the universe can be seen as a blue ball covered in water, with small and large islands scattered everywhere and as a result, the Earth has been referred to as the blue planet. The Earth is covered by a vast amount of water with a water bodysurface of approximately 71% and a volume of almost 1.973 billion cubic meters. Additionally, saline water accounts for approximately 97% of the total water volume found in oceans, seas, lakes, rivers and canals. The remaining 3% represents the freshwater, which is concentrated in some lakes, rivers and ponds. Additionally, the underground waters of the Arctic make up for the largest portion of fresh water that is available for human use, and representing about 1.6% of the total water capacity.

Moreover, this percentage is inconsistent, especially with the inclining salinity ratio in the lakes, as well as the enclosed and semi-closed fresh water bodies, whose waters are linked to the saline sea water unilaterally [7].

Due to the major existence of wide water bodies, there is a broad variety of water sources on Earth's surface, nevertheless, water can be classified according to its natural source as follows:

1. Ocean and sea waters
2. Rain water
3. River waters
4. Lakes/ponds
5. Groundwater
6. Mineral and hot waters

Controversially, scientists have classified the types of water based on its nature and components into two main types, and they are as follows;

1. Purified Water: this type of water is found on the surface of the earth so that it is readily available for use, and in turn it is divided according to its salinity into:
   a. Saline Water; which contains high concentrations of dissolved mineral salts. The sea and ocean are accounted for the main source of salt water.
   b. Fresh Water; which contains low, or in some cases, no dissolved mineral salts concentrations. Rivers, streams, polar ice and rain are considered to be the main source of fresh water.
2. Subsurface Water: which is water that can be found underground, whether in saturated areas (areas that are filled with water) or unsaturated areas (areas that fall directly underneath the earth's surface) and its geological resources contains water and air in the voids between the soil granules. This type of water will be discussed in details later on.

It has been settled by various professionals that research on groundwater control establishments and strategies are required in order to determine the suitable prototypes needed for groundwater governance [8].Currently, intellectual pieces on groundwater control have achieved an increased attentiveness [8]. Some of the prominent endeavors consisting of government representatives, scholars, as well as other proficient consultants entails the "Groundwater Governance: A Global Framework for Action"; which is a sponsored development by the GEF (Global Environment Facility) [9], in addition to the Organization for Economic Cooperation and Developments WGI (Water Governance Initiative),

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Maram ALMuhisen, Faculty of Civil and Environmental Engineering, Near East University TRNC, Mersin 10, Turkey.Maram

Hüseyin Gökçekuş, Faculty of Civil and Environmental Engineering, Near East University TRNC, Mersin 10, Turkey.

Dilber Uzun Ozsahin, Department of Biomedical Engineering, Near East University TRNC, Mersin 10, Turkey.

whose concentrations are on controlling all forms of water [10]. One researcher, Varady et al. [11], observed ten research profiles on the groundwater control which exemplifies varied worldwide areas and local circumstances. Nonetheless, there has been a level of global awareness on groundwater approaches which involve various transboundary watersheds. Fundamentally, groundwaters are considered as local reserves for various excavations and management approaches. Studies involving subsurface water control and supervision all over the united states has been restricted. Mainly, studies have been turned towards watershed extent [12], provincial range [13], or transboundary aquifers [14]. However, various state-level subsurface water control and supervision studies have been implemented throughout the United States [15], in which very little researchers have investigated water control and supervision on a state-level, even in the face of the reality that the majority of control mechanisms and supervision activities are concentrated on state-levels. Even so, researches associated to tackling significances and techniques on groundwater quality continue to be constrained[16].

II. SOURCES OF GROUNDWATERS

Groundwater is found in underground reservoirs, which is a rock or sedimentary layer that can hold a quantity of water and is composed of unstructured materials such as sand, pebbles or integrated rocks like sandstone or limestone, or they can be found in voids and cracks between soil granules [17]. There are several sources for groundwaters and they are as follows:

1. Rain water: The main source of groundwater is rain water, where part of this water is gathered along the earth’s surface so that rivers may form, while some of it is filtered through the pores and cracks of the earth and gathered underground into a fixed reservoir form which is then transformed into water basins.
2. Mineral and Sulfur Water: Some lakes or rivers leak nearby, so the water is then gathered into basins underground and remains locked. These basins cannot be accessed or exploited except by drilling wells.
3. Magmatic Water: This type of water ascends the top following the various crystallization phases of the magma.
4. Connate Water: It is the water that accompanies the formation of sediments in the early stages and is trapped between their parts and pores. [7].

Groundwater is found at the top of the earth’s crust, also known as the rocky silt area, and it is divided into two components:

1. Ventilation Range: It includes the upper part of the rocky regions and the majority of the rock voids are filled with air and partially contains some water.
2. Saturation Range: It comes right after the ventilation range, towards the bottom, where the rock pores are filled with water called groundwater. The upper surface of the saturation range is referred to as the (Water Table).

Modern science has been able to identify the amount of fresh groundwater throughout the universe, which is considered to be much larger than that available on the earth’s surface. Groundwater is responsible for an estimated 98% of the world’s total fresh water, with the exception of glaciers. While the fresh waterswhich are represented by fresh rivers and lakes, streams and the atmospheric clouds do not exceed 2%. Additionally, groundwater accounts for almost 0.6% of the total water on the planet, including fresh and saline waters. Notably, the groundwater may be renewable and flowing under the earth’s surface while forming a network of sewers and rivers where the water maintains its levels, despite the constant consumption of the water, which is constantly recharged with rainwater that keeps falling or from the seepage of the rivers and lakes through the soil which accesses the groundwater. Contrarily, the ground water may not be renewable and could gradually decrease as it is consumed, where these waters are often below the surface which have accumulated underground in earlier centuries and rainy eras and lack any connections to renewable water sources. This type of groundwater has distinct characteristics from other forms of groundwater due to its presence in the ground for a long time, and these characteristics include high temperature and increase content of salts as well as dissolved gases,which is called hot mineral water. In some cases, it isn’t necessary to excavate wells so that the groundwater can appear, it may explode in the form of fountains and springs as a result of increased pressure in the ground or crust pressure in the region. Water may flow from the fountain in the form of a waterfall due to the increased pressure applied onto the water or the pressure is reduced and the flowing water seeps onto the earth’s surface and is drained into the watermills that crack and split waters. This water, which may be hot, derives its heat from the high height of the subsoil, or as a result of its proximity to places of volcanic activity, or is cold as a result of its emergence from layers close to the earth’s surface.

III. GROUNDWATER CONTROL AND WATER QUALITY

The following segment will deliberate in what manner the nature of groundwater complicates control and supervision, in addition to the ideologies on efficient groundwater control and supervision. Although various paradigms are obtained from the United States, several annotations acquired in this section have become global.

The Nature of Groundwater and Control Complications

Most of the literary works regarding the matter of natural-pool reserves, advocate that public access may result in excess abuse of the reservesas well as being deprived of efficient establishments. Generally, people are incapable of refraining from utilizing natural pool reserves without the existence of a superficial authoritarian [18]. With the presence of efficient laws and establishments that serve to restrict

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and identify inhabitant privileges, it is possible to prevent misuse as well as various harmful influences [18].

Groundwater may be categorized as a natural-pool reserve as a result of many factors including; it's detracted capability; which means that every consumer is capable of minimizing the well-being of another consumer,in addition to its minimum excludability, which refers to access management [19]. Groundwater can be exceptionally vulnerable to the issues linked to the natural aquifers, since they are comparatively economical and develop consistently at the instant availability of scientific knowledge and power to the probable consumers [20].

Complications linked to the quality of groundwater are remarkably demanding to alleviate as a result of the groundwater's natural-pool environment. As soon as pollution in groundwater takes place, it becomes very complicated to classify [13] and treat [11]. One researcher, Theesfeld, distinguish a group of attributes that cause complications in groundwater control. A variety of these attributes will be briefly discussed below.

- Irreversibility; It should be known that consumption of groundwater can result in permanent physical destruction towards the aquifer or the terrain directly above from developments like ground collapse . Furthermore, the harm resulting from pollution can be costly, complex, or yet unfeasible for treatment, not even any mechanism can deliver a result like thrust and remediate or surfactant- enriched aquifer treatment [21].
- Time lag; Consequences following extraction or pollution require time to become evident. Therefore, time lags among extraction and succeeding effects provide water control with some challenges [22]. The procedure for movement and transportation of groundwater take time. Following the activation of the sources, or in some cases once the source does not subsist, pollution can evidently be distinguished [23].
- Indivisibility; It is not possible to confine or even physically shelter aquifers. However, the susceptibility of an aquifer relies on the form of pollution, extent of contamination, in addition to its hydrogeology [24].
- Hydrogeological vagueness; Due to the vast disparity in hydrogeology, in addition to the varieties of groundwater consumption, management and control becomes very complex. Such conditions can be witnessed in regions, like California, in which the ambiguities of aquifer peripheries and overlays in the GSA (Groundwater Sustainability Agency) limits multiple problems in groundwater control [25]. Surface-groundwater collaborations present difficulties for water control as a result of insufficient management between state organizations. Hydrogeology vagueness generates difficulties in obtaining the amount of water is contained by the transboundary aquifers in each region. Information is needed. Similarly, surface water material and groundwater material are generally of ambiguous trait. Generally, groundwater information is not as accessible as surface water information. It was advocated by Sugg et al. [26] that for efficiency, groundwater requires more information material and technical assistances to serve the groundwater maintenance districts.
- Construction of abstraction; There is insufficient monitoring not only on the quantity of wells that are extracted from groundwaters, but also on the amount of groundwater which wells abstract. For instance, Arizona was required to monitor the groundwater diminution so that the Central Arizona Project could be built [26].
- Material asymmetry; Typically, data on groundwater is restricted and distortedly alleged, resulting in complications for control. This happens in situations where water consumers hold better data on their historic water consumption techniques than the governing administrators [27].

Moreover, size also causes complexities for control and supervision of groundwater. Specific aquifers, like the Ogallala Aquifer located in central United States, may lie behind thousands of square kilometers. Nevertheless, supervision and effects of groundwater consumption are explicit to their environment and in some cases location, given the disparity in geology and water consumingfeatures in various sections of the aquifer [28].

IV. METHODOLOGY

A. Fuzzy Promethee (F- Promethee)

Brans et al, established the PROMETHEE method for innumerable substitutes to be implemented in the decision-making system. It is founded on the comparison of pair alternatives regarding the chosen criterion. It has been considered as one of the few complex decision-making mechanisms when it comes to utilization and comprehension.

The fuzzy PROMETHEE combines both fuzzy logic as well as the PROMETHEE logic which permits the utilization od such a technique feasible in various decision-making schemes. Moreover, Wang,et al [22], attempted to develop a non-numeric alternative comparisons of this methodology. Genuinely, acquiring appropriate information material to evaluate conditions and deliver suitable outcomes has become more and more difficult. Accordingly, fuzzy sets are able to help the consumer to assess the mechanism in a pragmatic fuzzy state. Furthermore, a thorough seminar on the F-PROMETHEE technique was given by the researcher Ozsahin, et al. [23,24,25]. This symposium has assisted in utilizing this methodology within this research.

The following table, Table 1, shows the fuzzy scale that was applied and efficiently implemented to evaluate the identified criterions of the most common factors impacting groundwater, in addition to attaining the weight of each criterion.In order for the triangular fuzzy values to be de-fuzzified, the Yager scale was utilized to anticipate the significance of every criterion.

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Table 1: Linguistic Fuzzy Scale

Linguistic Scale for Evaluation	Triangular Fuzzy Scale	Priority Ratings of Criteria
Very high (VH)	0. 195, 1,	Irreversibility Hydrogeological uncertainty Information asymmetry
Important (H)	0.5, 0.75, 1	Time lag Structure of abstraction
Medium (M)	0.25, 0.50, 0.75	Indivisibility
Low (L)	0, 0.25, 0.5	
Very low (VL)	0, 0, 0.25	

Following the accumulation of the constraints regarding the assessment of the typical factors which impact groundwater, Gaussian preference function was implemented for each criterion and is evident in the following table, Table 1. Thenceforth, the visual PROMETHEE decision lab database was employed.

V. RESULT AND DISCUSSION

The following table (Table2) and figure (Figure 1) provide the rankings of the factors that impact groundwater. From the table we can conclude that the most common factor affecting ground water is seawater intrusion, and is followed by coal-ash. The remaining factors following respectively are industrial storage tanks, arsenic and agriculture.

Table 2: Complete Ranking of Factors Effecting Groundwater

Rank	Factor	Phi	Phi+	Phi-
1	seawater intrusion	0,1041	0,1355	0,0314
2	coal ash	0,0844	0,1287	0,0443
3	industrial storage tanks	-0,0609	0,0532	0,1141
4	arsenic	-0,0619	0,0459	0,1078
5	agriculture	-0,0657	0,0323	0,0980

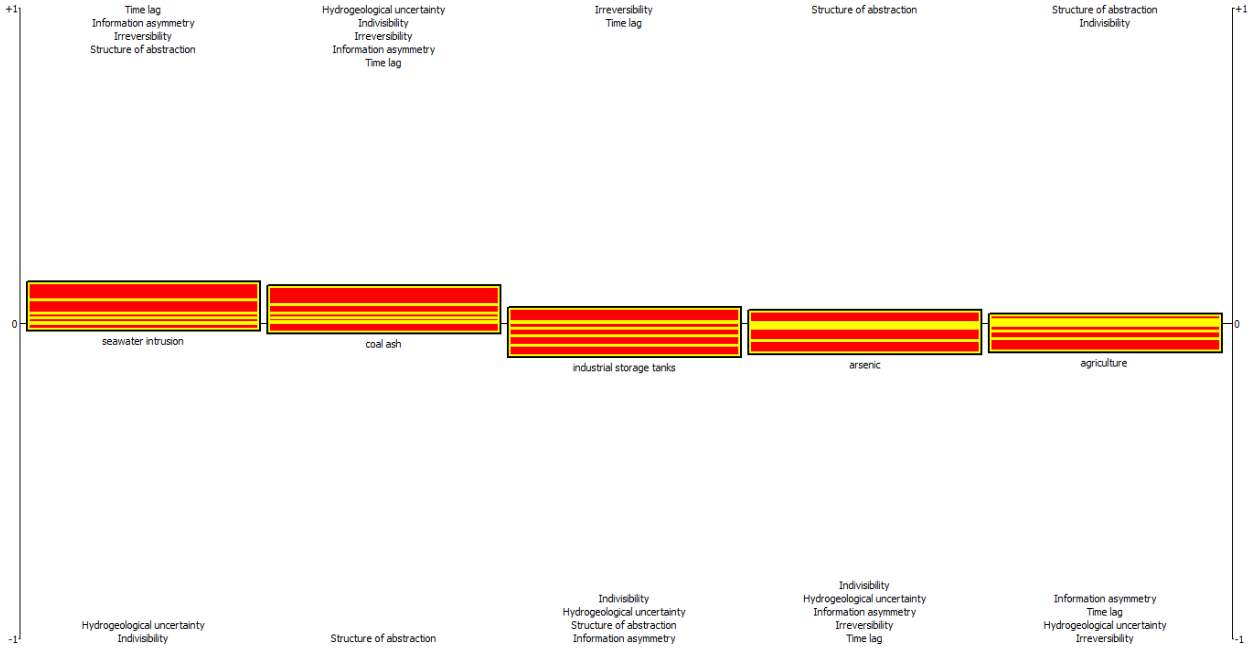

Figure 1: Evaluation of Common Factor Effecting Ground Water Quality

VI. CONCLUSION

Formerly, project implementation mechanisms worldwide have been observing vital modifications as a result of various researches advocating that selecting the proficient implementing technique is able to reduce the projects time and cost quantities by a third pro rata. It has been proven that the fuzzy PROMETHEE methodology in decision making is very efficient and is capable of choosing the most desired common factor which impacts groundwater. The results gathered from this study advocate that the most typical factor effecting groundwater is seawater intrusion and the respectively succeeding factor is coal ash.

Factors that have been affecting the quality of groundwater has become an increasing widespread subject, due to the essential need of groundwater for our well-being. Moreover, defining the factors that impact groundwater quality is considered to be a vital necessity, since it assists in easing the complications faced in the management of groundwater. Hence, the following study is capable of providing an insight on the methodology that can be utilized to help in understanding and defining the factors that impact the groundwater qualities.

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