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A Survey of Pollutions of the Aras River and the South-West of Caspian Sea Case Study: Radioactivity Pollutions

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Abstract: The environment of the earth is threatened through decreasing resources and increasing pollutions. The pollution is defined as disturbing the environment which decrease or destroy negative feedback mechanisms. The pollutions of Aras River consist of the domestic sewage, agricultural toxics and radioactive pollutions. The pollutions of Caspian Sea consist of oil and radioactive pollutions. In order to investigate the radioactive pollutions of these ecosystems, 240 samples of water, soil and sediment were gathered through four seasons of 2002, from 14 stations across Aras River and south-west of Caspian Sea. We used ^{226}Ra, ^{40}K, ^{232}Th elements to measure the natural radioactivity and ^{137}Cs, ^{134}Cs elements to measure the artificial radioactivity. In water, soil and sediment samples the average concentrations of activity of ^{40}K, ^{226}Ra and ^{137}Cs were 263.75±6.18 Bg.Kg^{-1}, 14.64±0.68 Bg.Kg^{-1}, 4.42±0.46 Bg.Kg^{-1} respectively and in soil and sediment samples the average concentration of activity of ^{232}Th was 20.24±1.18 Bg.Kg^{-1}. Results suggested that in one third samples the activity of ^{40}K is more than allowable limitations and other natural activities are in range of background. The activity of ^{137}Cs, an artificial radioactive element, is clearly identified in all samples, but the activity of ^{134}Cs is Lower Limit of Detection. With respect to ecologic and human importance of Caspian Sea and Aras River ecosystems, we suggest that in order to maintaining the ecologic equilibrium, safety and health an environmental management system (EMS) for Caspian Sea and Aras River be designed and implemented.

Key words: Radioactivity pollutions · Aras river · Caspian Sea · Environmental management · Common resource · Artificial radioactivity

INTRODUCTION

The earth environment is threatened by source decreasement and incensement of all kind of pollutants. Continuation of life in the future world is possible only by supplement of clean energy, enough sources and pushing back the pollutions in a very systematic way [1]. Pollution is defined as a particular disturbance of the environment that vanishes the negative feedback process. The systems that their negative feedback processes are disturbed change drastically so it can be concluded that the pollution disturbs the system in different ways [2].

The Aras River pollution includes the domestic sewage, agricultural poisons and radioactive pollutions. The domestic sewage may be because of home waterbuck, hospitals and domestic services of cities, Iranian villages and other countries and agricultural poisons are due to location of Aras River beside the major centers of agriculture like Moghan and zagand [3].

The Caspian Sea pollutions include radioactive and oil pollutions. The oil caused pollutions are as a result of oil extracting operations and oil structures mass and pouring the oil elements into the sea and natural and artificial breakings and occurrence of transportation accidents in the north surrounding countries. In Iran oil pollutions are due to transportation and washing the oid ships [4].

Radionuclide events happen naturally in the environment, But a large number of radio nuclides have been produced and released into the environment by nuclear activities of humans including nuclear weapons experiments, The operation of nuclear power plants, Research reactors and nuclear fuel reprocessing nuclear accidents such as the Chernobyl accident have also added huge amount of radio nuclides into the environment. Therefore, isotopic determination of natural anthropogenic radio nuclides of Aras River and Caspian Sea are required for environmental monitoring, nuclear safeguards and nuclear forensic studies[5].

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MATERIALS AND METHODS

Study Regions

Aras River: Aras River forms 450 kilometers of official borderline between the Islamic republic of Iran, Turkey, Azerbaijan and Armenia [1]. Aras River origins from the Migole Dagh high lands (with the height of 3100m) near Arzroom city in Turkey and after passing 341 km through the Turkey the river forms the 141 km borderline between Turkey and Armenia and 16 km between the border of Turkey-Azerbaijan. After joining the border river Chareh-sou which includes parts of the border between Iran and Turkey, Aras leaves the Turkey territory at the 3 km north east of Deym Gheshlag and flows 209 km along the Nakhichevan border. The eastward broad of the river from 44 km of Tehran-Armenia border and it again goes back to the border between Iran and Azerbaijan. The Aras River near the Tazehkand village divides the border in two parts and enters the Azerbaijan territory. In the Azerbaijan it joins the Kura River and drains into the Caspian Sea after following 210 km [6].

The Aras River has a maximum temperature of 40 degree in the summer and the minimum temperature of minus 20 degree in the winter. The minimum flow is 339 $m^3 s^{-1}$ surface meters per second and the maximum flow is 2260 $m^3 s^+$ [1].

By location of 39.3 percent of Aras River Basin (approximately 38000 surface meters) in Iran, Iran holds the highest share of this River Basin [6].

The Aras River in Iran passes the east Azerbaijan province, west Azerbaijan province, Ardabil and afford the water needs of cities and villages, fishing industries, agriculture and industries and playes an important role in regional development [1].

The Caspian Sea: The Caspian Sea is between Azerbaijan, Russia, Islamic Republic of Iran, Kazakhstan and Turkmenistan with surface area of 390,000 km^2. The Caspian Sea is the largest sea in the world [7]. The sea is 28 meters below the water surfaces of the world [8] and differs between 204 and 566 km width, with an average width of 330 km and 200km long. about 130 rivers, differing in size drain into the Caspian Sea, which is about 300 km^3 input per year [7]. Major river inputs include the Volga, Ural and Terek, with an annual flow of 88% of the total flow (approximately 370 km^3 per year). The Sulak, Samur, Kora and a number of smaller rivers flow 7% of total flow and what remains comes from the rivers coming from Iranian shore. The dynamics of water circulation within the Caspian Sea were not previously known, but combined oceanographic and isotopic investigations carried out within the framework of the IAEA supported projects have brought new insights into these processes [9].

The nature and circulation of water in the Caspian Sea is presented in Figure 1, with two types of cyclonic currents in the central region and southeastern regions and south with average speed of 20-40 cm s^{-1} and maximum speed of 50-80 cm s^{-1}. Therefore, this water flow takes pollutants from the central and northern coasts to the south coast [10].

The temperature of Caspian Sea air changes very drastically and the difference between average temperature among northern parts and southern parts reach to approximately 15 to 17 degrees. The south Caspian merely freezes and freezing can be traced more in northern parts. The Caspian Sea has 910 mm annual vaporization and 180 mm annual raining [11].

The geographical situation, width and plant living sources and animal one, oil supplies and salt and also birds flying situation, water supplement of wetland, good transits, fish industries and protein supplements and Caviar purifying have made the Caspian Sea one of the most unique seas in the world [3].

Sampling and Measuring: Sampling and measuring methods according to the international standard was tested [12-14]. Natural circulation of water mass in the Caspian Sea and position of sampling station is showed in Figure 1.

240 water, soil and sediment samples during the four seasons of year (2002) from 14 station along the Aras River and southwest of Caspian Sea from 37-05-39 N 26-24-45 to 24-26-38 N 56-52-38 has been collected. Caspian Sea sampling stations were chosen in the shortest topography centers of southern coast of Caspian Sea and in regard to water circulation pattern in the Caspian Sea the existence of radio active artificial products in more probable and Secondly Aras River ultimately drains into Ghazal Aghaj gulf of Caspian Sea and reaches the Astara city coast by the water currents.

The sampling place is far from phosphate place (because of the amount of Uranium) and tall buildings or trees or every obstacle which looks like shadows and covers it.In order to measure the natural radio action of ^{226}Ra, ^{40}K, ^{232}Th forms and for measuring the artificial radio action, of ^{137}Cs, ^{134}Cs were used. Artificial radionuclide were measured using Gamma-ray spectrometry employing a High Parity Germanium(HPG) detector with 40% of output.

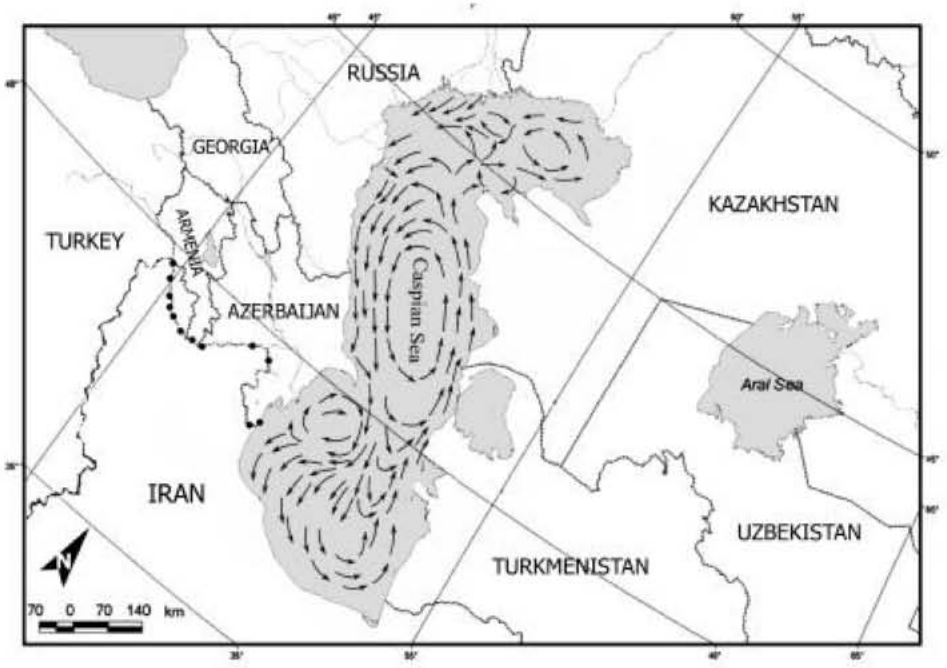

Fig. 1: Map of Studying regions indicating the location of sites mentioned in the text

Table 1: The mean activity concentration of ^{226}Ra, ^{40}K, ^{232}Th, ^{137}Cs and ^{134}Cs

Ser.	Code*	N(Deg,Min,S)	E(Deg,Min,S)	^{137}Cs (Bq kg^{-1})	^{134}Cs (Bq kg^{-1})	^{232}Th (Bq kg^{-1})	^{226}Ra (Bq kg^{-1})	^{40}K (Bq kg^{-1})
1	T-1	44,47,42	39,36,32	7.6±0.78	< LLD	16.23±1	15.2±0.78	270±7.1
2	W-1	44,47,43	39,37,37	2.8±0.25	< LLD	-	4.4±0.28	1.85±0.18
3	S-1	44,47,43	39,37,44	5.8±0.53	< LLD	11.65±0.80	12.85±0.80	230±7.60
4	T-2	45,02,33	39,22,44	6±0.68	< LLD	15.12±0.75	13.6±0.54	272±5.12
5	W-2	45,02,33	39,22,58	2.45±0.24	< LLD	-	5.3±0.30	1.84±0.18
6	S-2	45,02,33	39,22,65	5.18±0.55	< LLD	19.65±1	18.23±0.74	315.75±5.57
7	T-3	45,06,40	39,17,40	5.6±0.68	< LLD	26.18±2.15	< LLD	510.75±14.3
8	W-3	45,06,42	39,18,48	2.28±0.30	< LLD	-	3.04±0.30	1.86±0.21
9	S-3	45,06,42	39,18,48	4.42±0.59	< LLD	22.50±1.33	19.85±1.33	421.25±11.13
10	T-4	45,16,38	39,10,16	5.86±0.61	< LLD	23.9±1.15	31.48±1.25	389.75±12.13
11	W-4	45,16,40	39,10,19	2.3±0.25	< LLD	-	3.04±0.30	1.84±0.19
12	S-4	45,16,40	39,11,12	4.4±0.50	< LLD	23±1.25	30.20±0.95	391.25±11.13
13	T-5	45,25,27	39,04,35	5.55±0.62	< LLD	22.82±0.68	24.06±0.60	348.75±6.6
14	W-5	45,25,30	39,05,30	2.25±0.26	< LLD	-	3.4±0.30	1.85±0.19
15	S-5	45,25,30	39,05,36	4.5±0.45	< LLD	16.42±0.90	18.30±0.61	419.50±7.5
16	T-6	45,39,30	38,55,48	5.12±0.61	< LLD	18.30±0.91	17.91±0.62	344.5±5.9
17	W-6	45,39,33	38,56,29	2.15±0.26	< LLD	-	3.3±0.30	3.12±0.33
18	S-6	45,39,33	38,57,33	4.22±0.50	< LLD	17.30±1.4	19.2±1.7	365±12.8
19	T-7	46,13,30	38,52,15	4.3±0. 5	< LLD	19.27±0.72	21.12±0.52	389.25±7.75
20	W-7	46,13,35	38,52,15	2.15±0.26	< LLD	-	3.3±0.30	3.12±0.33
21	S-7	46,13,35	38,51,05	3.10±0.35	< LLD	21.3±1.2	19.4±1.13	400.75±10.5
22	T-8	46,22,52	38,54,38	4.26±0.47	< LLD	17±1.12	18.75±0.72	349.75±10.24
23	W-8	46,23,58	38,54,38	2.15±0.26	< LLD	-	3.3±0.30	3.12±0.33
24	S-8	46,23,58	38,54,44	3.25±0.50	< LLD	18.1±1.7	18.07±1.3	383.75±12
25	T-9	47,39,19	39,34,30	7.21±0.72	< LLD	23.72±2	23.06±1.3	363.75±9.06
26	W-9	47,40,26	39,34,30	1.85±0.28	< LLD	-	3.4±0.30	3.12±0.33
27	S-9	47,40,27	39,33,37	7.2±0.7	< LLD	25.8±2.1	21.8±0.62	500.75±16.4
28	T-10	47,56,34	39,41,25	8.12±0.67	< LLD	23.1±1.37	21.08±1.04	366±7.77
29	W-10	47,57,40	39,41,45	1.85±0.23	< LLD	-	3.4±0.30	3.12±0.33
30	S-10	47,57,43	39,41,19	7.22±0.53	< LLD	25.45±0.9	23.38±0.65	508±10.25
31	T-11	48,50,56	38,27,44	-	< LLD	-	-	-
32	W-11	48,50,58	38,27,38	4.95±0.54	< LLD	-	< LLD	3.35±0.32
33	S-11	48,50,60	38,27,44	4.45±0.32	< LLD	24.2±0.85	18.4±0.6	805.45±9
34	T-12	48,52,62	38,26,37	-	< LLD	-	-	-
35	W-12	48,52,65	38,27,38	5.2±0.51	< LLD	-	< LLD	3.35±0.32
36	S-12	48,52,65	38,26,37	4.53±0.27	< LLD	14.45±0.85	12.25±0.57	589.5±7

* T= Sediment, S= Soil, W= Water

RESULTS AND DISCUSSION

Radio activation average in various annual seasons for the isotopes of ^{226}Ra, ^{40}K, ^{232}Th, ^{137}Cs, ^{134}Cs, in the sampling station is showed in Table 1. In water, soil and sediment samples the average concentrations of activity of ^{40}K, ^{226}Ra and ^{137}Cs were 263.75±6.18 $Bg.Kg^{-1}$, 14.64±0.68 $Bg.Kg^{-1}$, 4.42±0.46 $Bg.Kg^{-1}$ respectively and in soil and sediment samples the average concentration of activity of ^{232}Th was 20.24±1.18 $Bg.Kg^{-1}$.

The comparison between average amount of radio action in different seasons of the year with the International recommended limits [15] shows that in one-third of the samples the radio action of ^{40}K is more that its accepted (370 $Bg.Kg^{-1}$) and other natural radio action were in the level of background of detection systems. The most radio action level of ^{40}K are found in soil samples and the least radio action of ^{40}K in water samples and they are according to the background level. The amount of radio action of ^{40}K along the Aras River enhances from the Iran, Turkey and Azerbaijan zone to Pars Abad. The maximum amount of ^{40}K radio action 805.45±9 $Bg.Kg^{-1}$ are located in the soil sample in the zero point of Astara in southwest of Caspian Sea.

The radio action of ^{137}Cs which is an artificial radio active element, are clearly detected in all samples but radio action of ^{134}Cs in all samples are lower that limits of detection.

The maximum amount of ^{137}Cs radio action, is 8.12±0.67 $Bg.Kg^{-1}$ in the soil sample in Tazehkand in Pars Abad. The average radio action of ^{137}Cs in south west station of Caspian Sea is more that the average radio action of stations located along the Aras River.

CONCLUSIONS

Radioactivity more that international limits for ^{40}K [16] and radioactivity of artificial radio nucleotide of ^{137}Cs is reported by other experts [16, 17, 18].

Radio isotopes of ^{134}Cs and ^{137}Cs are both among artificial radio active elements that their probable sources might be nuclear weapons, bomb experiments, nuclear plant outputs and accidents, but as the sake of the short half–life of ^{134}Cs (752days), it couldn't be measured, But radio isotopes of ^{137}Cs are observed in all samples.

Although technology solved most of the problems, it results in new problems which more complicated expertise and more expensive technologies are needed in order to solve them. As a result, the biggest part of our money, sources and energy and activity is spent for solving the problems rather than revealing the humanity soul that is our most valuable source, but existence of crisis, however, is an opportunity for change is thinking and action models [19].

Aras River Basin and Caspian Sea are the common water districts and regarding that the sustainable development is due to interaction between regional and international [20], It should be taken into consideration that according to Game Theory [21], the best strategy for Common-Property Resource [22], that means corporation between the surrounding various countries should be adapted, So that these common sources never face the tragedy of commons [23].

Finally regarding ecological and humanitarian importance of water ecosystems of the Caspian Sea and the Aras River, It is recommended that by formation of common commissions between the neighborhood countries of these ecosystems, The environmental management system(EMS) for Caspian Sea and Aras River should be edited and operated and the environmental situation of them should be always monitored.

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