13


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## MERCURY CONTAMINATION ALONG THE ZERKA RIVER/ JORDAN


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## ملخص

جمعت عينات ماء من الآبار والنبعات ومياه نهر الزرقاء وحللت لمعرفة محتواها من الزئبق، وباعتبار الحد الاعلى الذي وضعته منظمة الصحة العالمية لكمية الزئبق المسموح بها في مياه الشرب وهو جزء من البليون يتبين ان كلا المياه السطحية والجوفية في اكثر منطقة صناعية ومأهولة بالسكان في الأردن ملوثة بالزئبق وجزئيا لا تصلح للاستعمال لاغراض الشرب.

## ABSTRACT

Water samples collected from wells and springs along the banks of the Zerka River, and from the Zerka River itself, were analysed for their mercury content. In many samples the Hg- concentration exceeded the WHO maximum permissible concentration (lppb) for drinking water. The Hg may be originating from the industrial wastes which are being discharged into the river system.

## INTRODUCTION

The study area extends along the Zerka River from the city of Amman to the King Talal Dam (Fig. 1). This area was selected for the study because it is the most populated and industrialized area in Jordan.

Two aquifers underlie the area; the upper aquifer consists of a gravel cover overlying chert, chalk and limestone beds (locally designated as B1/2, $A_7$) with a maximum thickness of 70-80 m, and unconfined water conditions; the lower aquifer (locally designated as $A_4$) consists of cavernous, semi-crystalline, dolomitic limestone, 40-50 m in thickness, and confined water conditions. These aquifers are separated by a chalk and chalky limestone unit (locally designated as $B_{5/6}$) which forms an aquiclude. The upper aquifer is hydraulically connected to the Zerka River. The two aquifers are interconnected along fault planes trending in the same direction as the Zerka River course (in the trough of the Amman-Zerka faulted flexure). Therefore, it is expected that pollution of the Zerka River will also affect the interconnected aquifers.

The water abstracted from the two aquifers is used for domestic purposes in the cities of Amman and Zerka, and in the numerous villages in the Zerka River catchment area. Inorganic mercury and its compounds are discharged into the catchment area and, especially along the middle reaches of the Zerka River, by some of the established industries such as phosphate processing and chlorine production plants.

Merucry and, especially, methyl mercury are highly toxic substance which can cause neurological damage, produce chromosomal aberration and result in teratogenic effects.

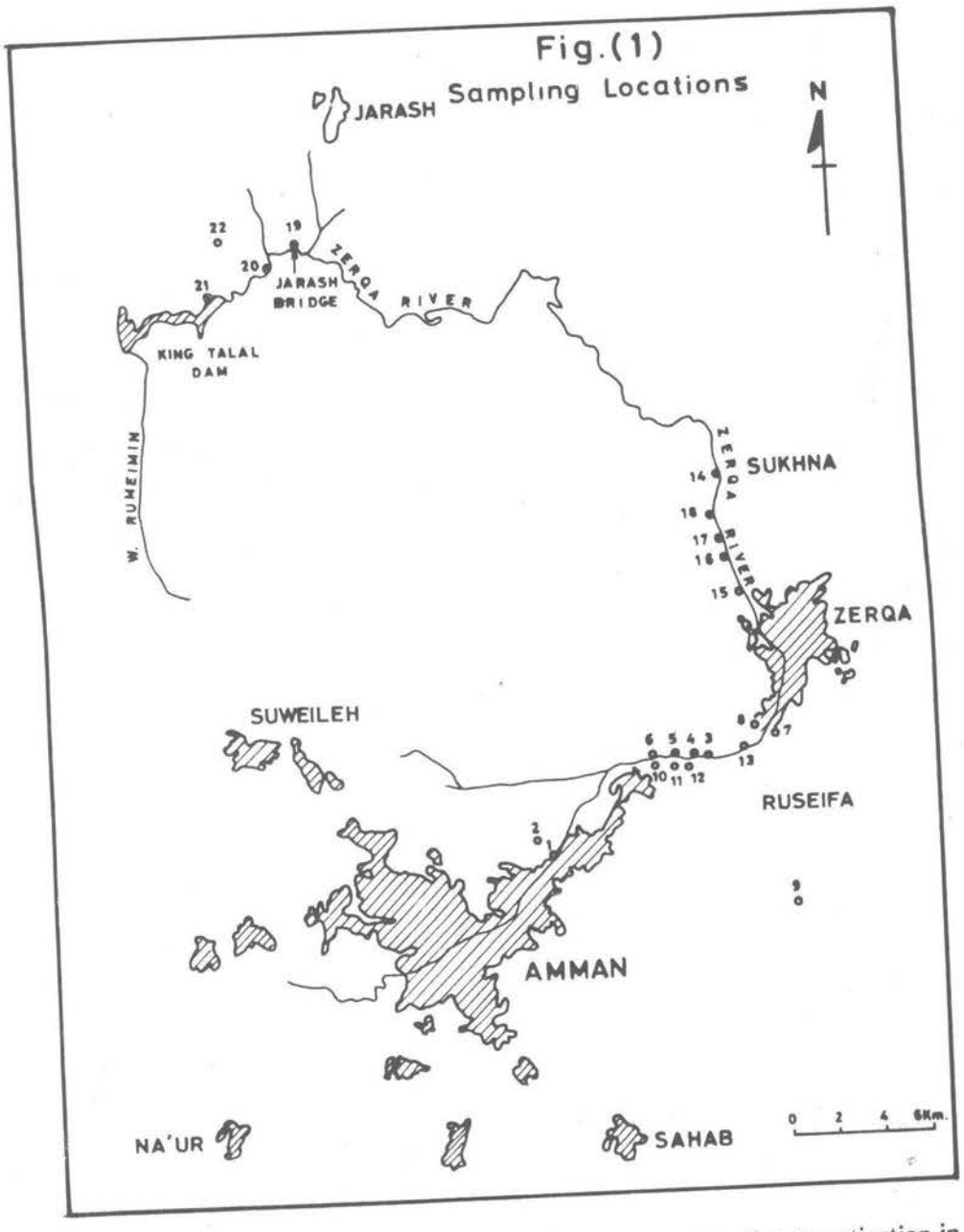
This study was undertaken with the aim of obtaining preliminary information about the level of mercury contamination and its possible sources. It will serve to alert us to the expected hazards if no concrete measures are taken to limit the discharge of mercury wastes in the cathcment area and into the Zerka River itself.

## METHODOLOGY

Water samples were collected in glass bottles from the Zerka River and from wells in both aquifers. Every location of the 22 sampling sites shown in Fig. (1) was sampled twice, one in April and the other in May 1979. the pH and temperature were measured in situ. Upon arrival at the laboratories in about 2 hrs, the samples were filtered through No. 42 filter paper and immediately analysed. In very few cases, however the samples were stored for one or two days below 5°c.

To a 100 ml portion of the water sample 5 drops of 5% $KMNO_4$ solution, 10ml of 5% $HNO_3$, and 10ml of 5% $H_2SO_4$ were added consecutively. The excess permanganate ions were reduced by adding 5 ml of 2.5% hydroxylamine HCl solution. Finally, the Hg- ions were reduced by the addition of 5ml of 10% $SnCl_2$ solution. A standarded curve for varying Hg- concentrations was prepared following the same procedure.

The Hg- content was measured according to the Deutschen Einheitsverfahren (1979) with flameless atomic absorption (Jarell Ash, model 850) using a mercury




analyser system (Perkin Elmer). The relationship of concentration to extinction in the standard solution was linear within the concentration range adopted.

## RESULTS AND DISCUSSION

The results of the analyses are given in Table 1. They show that the surface water downstream of the sewage treatment plant in Amman contains about 3ppb Hg.

**Table 1**
**Hg Concentration, Temperature, pH and Source of Samples**

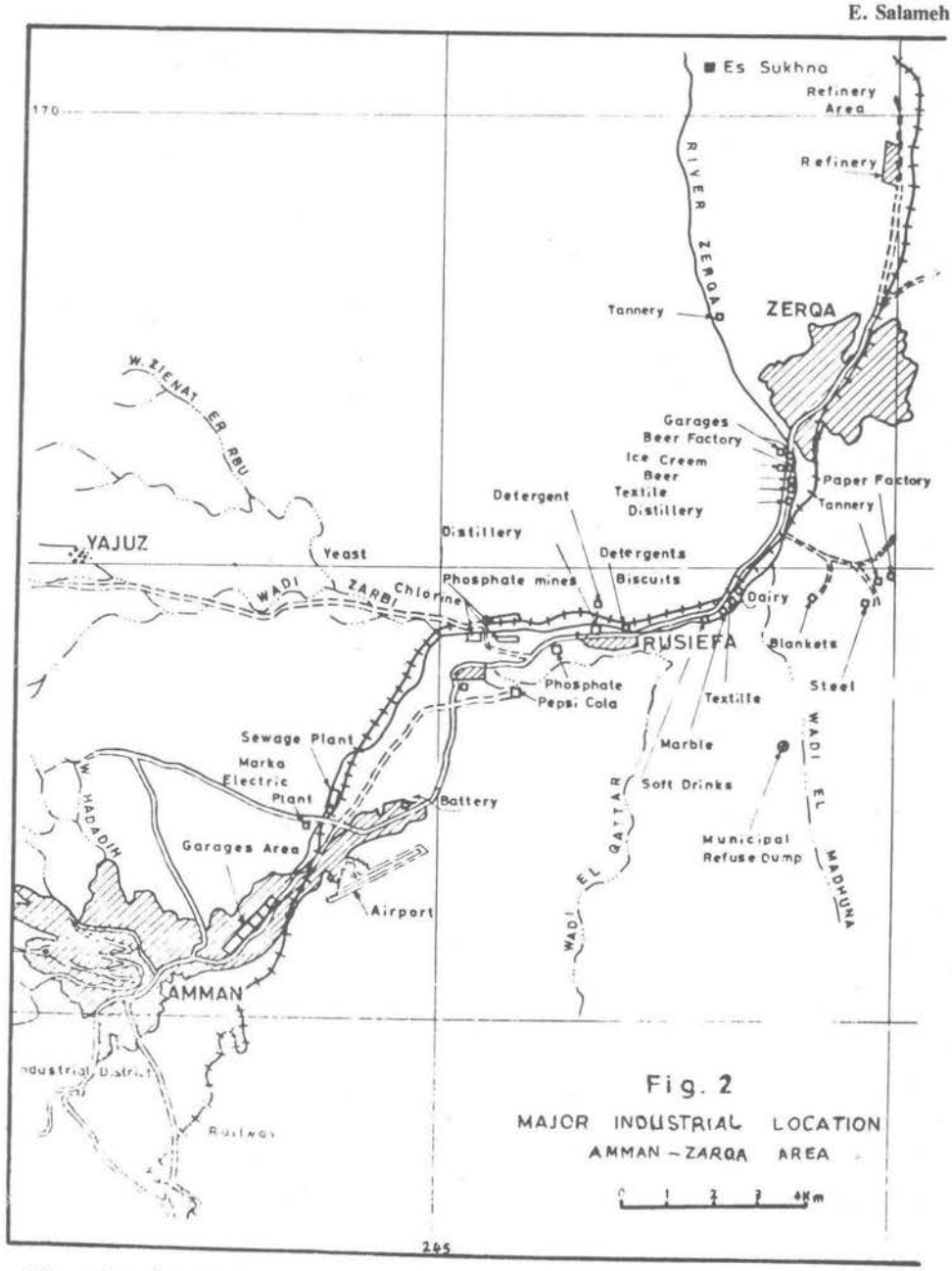
| Source | Hg concentration (ppb) | Temperature ($c^0$) | pH | Aquifer |
|---|---|---|---|---|
| Ain Gazal well | 2.0 | 20.5 | 7.2 | upper |
| Tabarbour well | 1.8 | 25 | 7.4 | lower |
| Ruseifa well I | 0.7 | 19 | 7.1 | upper |
| Ruseifa Well II | 0.6 | 20 | 7.1 | upper |
| Phosphate well | 1.1 | 20 | 7.1 | upper |
| Ruseifa spring | 1.8 | 20 | 7.1 | upper |
| Bolad well | 0.9 | 19.5 | 7.1 | upper |
| Nour Ed Deen well | 0.4 | 19.5 | 7.15 | upper |
| Rothemeh well | 0.5 | 23 | 7.4 | lower |
| Zerka River | 3.1 | 21.5 | 7.5 | surface water |
| Zerka River (phosphate factory) | 1.5 | 23.5 | 8.2 | surface water |
| Zerka River (Yeast factory) | 1.5 | 22 | 7.8 | surface water |
| Zerka River (Jordan worsted) | 5.6 | 24 | 7.8 | surface water |
| Sukhna well | 0.4 | 19 | 7.2 | lower |
| Zerka River (Sukhna) | 2.1 | 27 | 9 | surface water |
| Zerka River (Sukhna) | 0.4 | 25 | 8.7 | surface water |
| Sukhna Well I | 1.6 | 24 | 7.2 | mixed water |
| Sukhna well II | 2.2 | 24 | 7.2 | mixed water |
| Zerka River (Jarash Bridge) | 1.9 | 24.5 | 8.7 | surface water |
| King Talal Reservoir (Old Jarash Bridge) | 1.3 | 23 | 7.8 | surface water |
| King Talal Reservoir | 1.4 | 22 | 8 | surface water |
| Ain El-Rubbar | 2.1 | 20 | 7.3 | lower |

(Mixed means that both aquifers contribute to the source).

Further downstream, the Hg- content decreases rapidly to 1.5 ppb due to the inflow of less polluted spring water, although part of these inflows are discharged from phosphatic rocks. About 6km further downstream the concentration rapidly increases to 5.6ppb-Hg. Downstream from the Zerka bridge, it again decreases to 2.14 ppb Hg near Sukhna and to 1.86 ppb at the Jarash bridge. This decrease may be attributed to the inflow of uncontaminated spring waters, as well as to reduced industrialization in that area.

The inflow into the King Talal Reservoir showed a mean mercury level of 1.3 ppb, whereas the main body of water showed a level of 1.4 ppb. This difference could be the result of concentration by evaporation from the lake surface.

The upper aquifer represented by samples No. 1 and 3 to 8 showed mercury levels exceeding the WHO - upper limit for drinking water. This indicates that the industrial activity along the Zerka River has already began to pollute the upper aquifer with mercury.




The values for mercury content of the waters of the lower aquifer (samples No. 2 and 22) show that it has already been affected by mercury pollution and, therefore, it can be inferred that in this area both aquifers are connected.

Examination of water samples from the lower aquifer of the upper reaches of the Zerka River (sample No-9) indicates that the Hg content is as low as 0.5 ppb. It, however, increases in Tabarbor well (sample No. 2) which is in the direction of

groundwater flow, to 1.8ppb. At Sukhna spring it again decreases to 0.4 ppb as a result of the inflow of unpolluted groundwater originating from an area in the east and joining the Amman Zerka groundwater system.

The potential contribution from the phosphate deposits to Hg content in ground water and from the leaching of the aquifers into the ground and surface waters seems to be very small. This could be illustrated in samples Nos. 8 and 9 obtained from the upper and lower aquifers in the phosphate deposit area, but further to the north and south of the industrial belt and only contain 0.36 and 0.6ppb Hg, respectively. Sampling location No. 9 lies upstream of the groundwater flow, which means that the recycled industrial water (infiltrated industrial waste waters) does not affect it.

The above discussion shows that the source of contamination lies within the industrialized area, and that the leaching of aquifers and deposits contaminates the water with Hg, yielding values which are still lower than the WHO recommended upper limit, whereas the recycled industrial waters contain levels exeeding this limit.

Because of the great importance to the majority of the population in Jordan of both the upper and lower aquifers as the prime source of domestic water supply, it is feared that these waters will be rendered unsuitable for drinking purposes if the sources of mercury contamination are not immediately dealt with. Prohibiting industries to discharge their wastes untreated into the Zerka River basin would be an essential step.

## CONCLUSIONS

1. The mercury content of the surface water along the Zerka River course exceeds the WHO recommended standards for drinking water.
2. Contamination by mercury has already affected not only the surface waters, but also the groundwater in the upper and lower aquifers. Both aquifers downstream of the industrialized area show higher Hg concentrations than those recommended by WHO for drinking purposes.
3. Mercury pollution in the study area seems to results from industrial activity.
4. If no immediate measures are implemented to limit the discharge of mercury - polluted water into the Zerka River basin, then large sectors of the population in Jordan may soon suffer from the hazards of this toxic element.

## ACKNOWLEDGEMENT

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