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# A Mini-Review on Chemical and Biological Human Health Risk Assessment of Water Pollution Afterward of Earthquake

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## Abstract

Earthquakes are one of the biggest disasters in the world reality. As a result of earthquake many undesired problem come true. Water is vital for human and health. To protect and predict the water quality is essential all the time included disaster terms. Risk assessment tool is very important for management of disaster likewise many other applications of life. Today risk management and assessment still need more attention. Showing importance of human health risk assessment with considering the earthquakes, risk assessment methodologies, approaches, requirements are main purposes of the present study. As result, very big links were showed between water, health earthquakes along with their potential methodologies.

**Key words:** earthquake, human health, risk management, water pollution

## 1. Introduction

The risk assessment is important for clean-up of released pollutants, besides it has a very critical role in assessing the incident's possibly long-term negative health results. Chemicals has existed for a long time and has effects on human health. Although we do have information about most of chemicals, we still have limited knowledge about some chemicals. Therefore, new materials and new information are constantly being developed [1].

To identify true risk, important chemical information on human health is combined with exposure information. Some researchers have calculated for by their intended use a risk assessment of industrial products of many kind chemicals. We focus on lifetime exposures in this study. In the present, even no proper European guidance is applicable for the risk assessment about following chemical incidents or disasters [2].

Human health risk assessment in chemical incidents are different from all exposures up to a lifetime. To foresee to different health situation as take account of potential sensitive populations are important for chemical risk in terms of human health. Therefore the main purpose of this study is adding value of disaster management in terms of risk assessment methods and water quality relations and attract to decision makers about risk management.

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## 2. Risk Assessment Approaches and Methodologies

The risk assessment is utilized in to many different states. The risk assessment about the process security is valid to all processes. That processes are risk analyzed, identity of risks, risk prediction and risk assessment [3]. Process safety will be able to referred as "result evaluation" in the future and the risk assessment can be used in a toxicological sense.

If we think a risk assessment about human health, this is calculated by the level of exposure to polluted environments. The negative effects on human health are examined. In this process, the nature, severity and probability of these effects are determined. Risk assessment steps are shown to be a four-step process in figure [4]

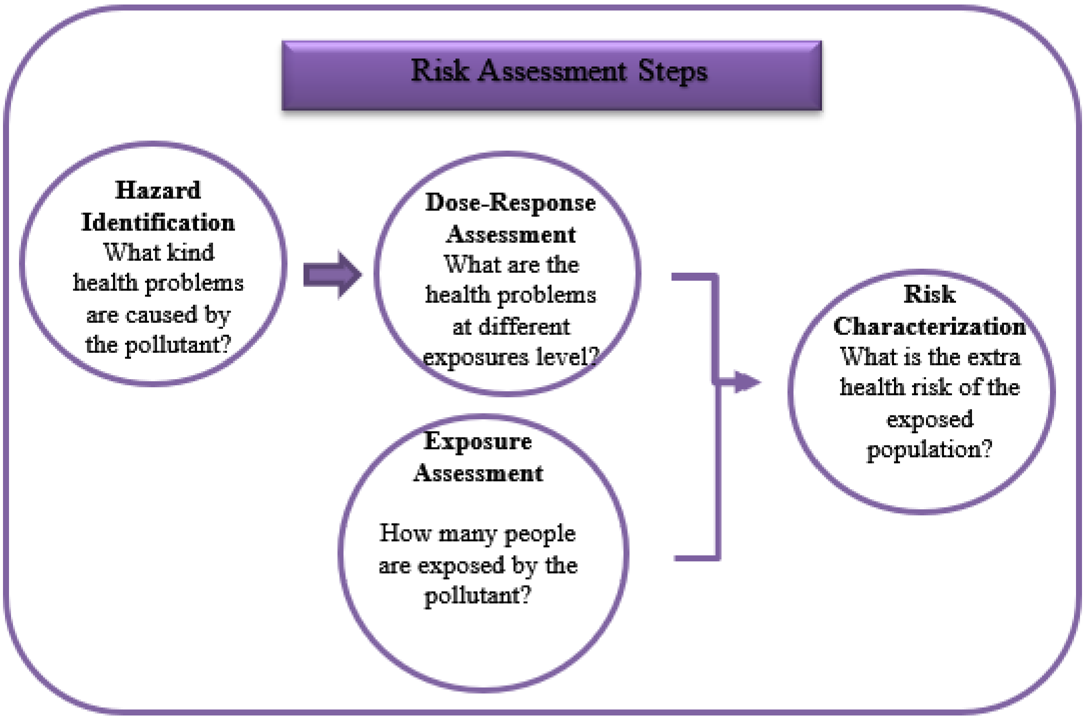


**Figure 1.** Risk assessment model

In the risk assessment on the avoiding stage, risks analysis and risks reduction are an important risk analyze factors. In particular, we should focus on the risks that could have serious consequences. The risk assessment is a scenario analyze factor of emergency response, planning and result assessment. Detection and warning systems are a sustained activity because of engage to collect of the chemical signals, also provide rapid timely alert. If the concentration of the chemical increases, the signal level may also increase. This event depends on risk assessment. Recovery can last for years with activities of to return to the previous state [1].

The harmful effects of pollutants depend on many factors. These are factors such as the transformation of molecular forms and valences. Chemical pollutants can be toxic at “physiological dose” may be stimulatory in very minute doses, depending upon age, sex, species differences, stress, relationships between chemical pollutants in biological systems [5]. Some chemicals are necessary and useful at low levels. Higher levels are toxic and some have no function. The likelihood of cancer over the course of exposure to potential carcinogens is expressed by the risk estimate for carcinogens. As quantitative level, USEPA has identified a risk level range of one in a million to one in a hundred thousand as an appropriate risk management goal for the general population, as long as the most sensitive population is protected at 1 in 10,000 [6]. The occurrence of carcinogenic effects in the contaminated regions may not be clearly shown because it requires decades of sustained exposure to develop cancer [7, 8].

The Hazard Quotient (HQ) and Hazard Index (HI) of chemicals are easily can be calculated for both children and adults in terms of dermal, inhale and ingestion factors in the source of water. As formulas;

$$HQ_{ingest} = ADD / Rf_{Dose}\ (RfD) \quad (1)$$

$$ADD = C_w \,.\, IR \,.\, EF \,.\, ED / BW.\, AT \quad (2)$$

where units ADD (Average daily dose) is mg/kg-day

Cw(Chemical concentration in water) (mg/L)

IR(Ingestion rate) (L/day)

EF(Exposure frequency) (days/year)

ED(Exposure duration) (years)

BW(Body weight) (kg)

AT(Averaging time) (years)

Ingestion rate can be assumed to be 2 L/day for adults and 0.64 L/day for children; Exposure Frequency can be assumed to be 350 days/year and Exposure Duration 30 years for adults and 6 years for children. The mean Body Weight of adults and children living in the area can be used. Averaging Time is assumed to be equal to Exposure Duration.

For dermal quantitative risk assessment:

$$HQ_{dermal} = DAD/RfD_{dermal} \quad (3)$$

$$RfD_{dermal} = RfD \times GAF \text{ [8]} \quad (4)$$

where GAF = gastrointestinal absorption factor, a risk-based concentration

$$DAD = \text{Dermal absorbed dose (mg/kg-day)} = K_p \,.\, Cw \,.\, ET \,.\, EF \,.\, ED \,.\, SA / BW \,.\, AT \quad (5)$$

In addition; Kp(Dermal permeability coefficient) (cm/h), SA(Skin surface area) ($cm^2$)

Carcinogenic risk is main problem and risk factor which can be determined by two factors. These are reference dose (RfD) and cancer slope factor (CSF). Most factors that cause cancer do not have these values yet. CSF is a measure of chemical potency and specific to each pollutants differently. A dose-response parameter, called CSF, is used for chemicals exhibiting toxic behavior. As rule, carcinogenic risk increases along with carcinogen pollutants. CSF reflects the health effects of certain levels of carcinogenic pollutants. RfD is the daily exposure level without significant health risks. RfD is usually derived from an experimental "no observed adverse effect level" (NOAEL) [5]. Carcinogenic risk can be calculated in all kind water, using the formula;

$$CR = ADD.(CSF) \tag{6}$$

Disaster and especially earthquake can contribute huge amount of chemicals to the water sources. Many chemical has higher level of carcinogen and these Cw value can be very high in the following of earthquake.

## 3. Links between Earthquakes and Water Quality Systems

The environment and drinking water is polluted with various chemicals from the factories. For instance when the wastes of demolition having 12.5 pH value or more, it is a threat to water life completely. Before and after the earthquake, some measures must be taken to prevent all adverse effects. These can be divided into as two "Preparation Activities before the Earthquake" and "Activities to be done after the Earthquake" [2, 9]. Earthquake locations with their depth and strengths are shown in the figure below.

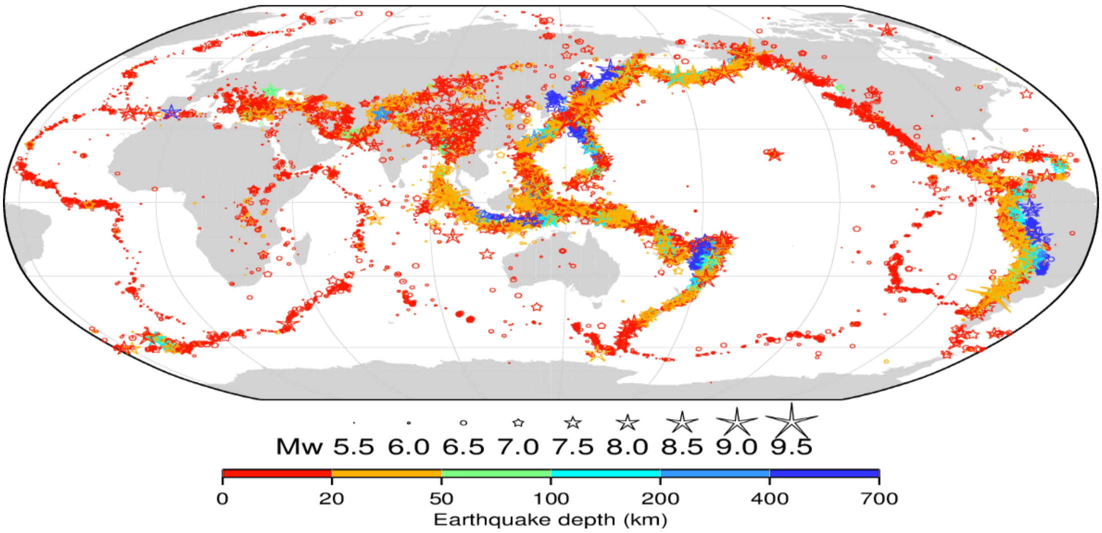


**Figure 2.** World earthquake locations with symbols (ISC)

Earthquake risk may be analyzed in two main ways; deterministic and probabilistic. In deterministic, usually most adverse earthquake scenario be taken into account. In probabilistic, the all potential earthquake scenario be taken into account with their probability of occurrence. Deterministic approaches are simple may be comprehended as conceptual. There are two main approaches to probabilistic earthquake risk analysis (time-dependent and independent). Periodic tendency of earthquake is calculated in the time-dependent approach. The probability of an earthquake is estimated, depending on the previous event and time. Instrumental and historical earthquake catalogs are combined with geological and geodetic evidence and a seismogenic model covering earthquakes have been produced for thousands of years [10].

Earthquakes are mainly affect to ground and groundwater structure. In a study which conducted the area where 2009 earthquake happened are illustrated in figure. In the same study water quality changes were observed significantly different and earthquake almost affected all physical, chemical and biologic parameters in groundwater. pH decreases after seismic water because of as the $CO_2$ in the main faults increases. At the same time, there was a significant increase in $Ca^{2+}$ (Fig. 4).

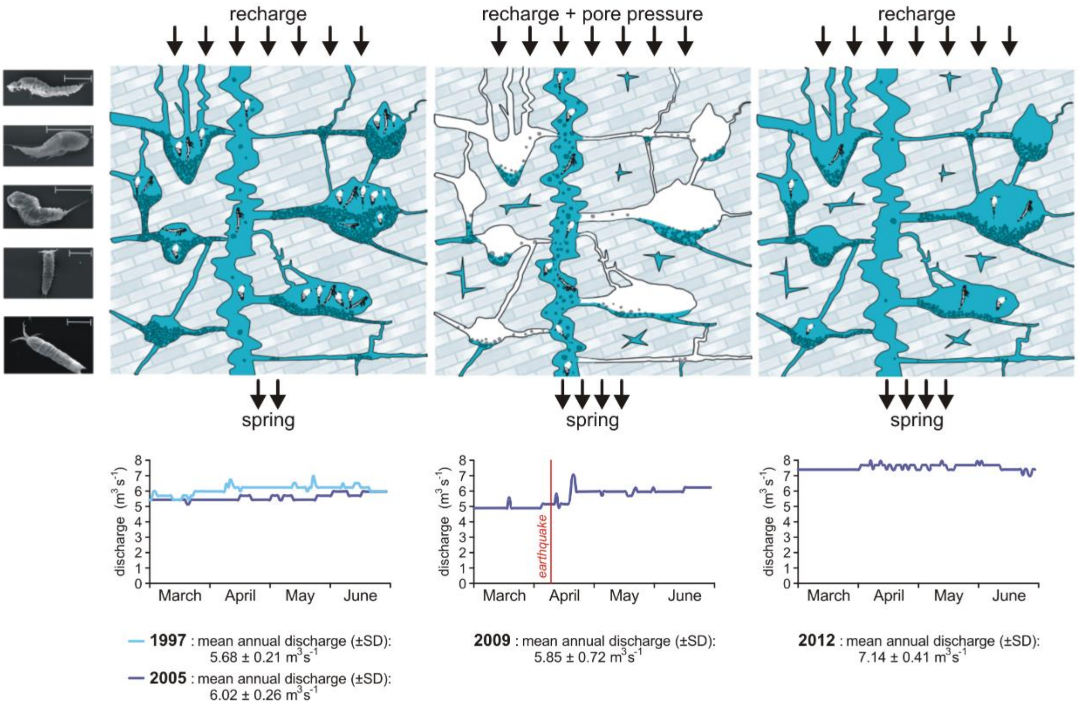


**Figure 3.** Reaction of groundwater diagram before and after the earthquake biodiversity with changes of aquifer hydrodynamics [11]

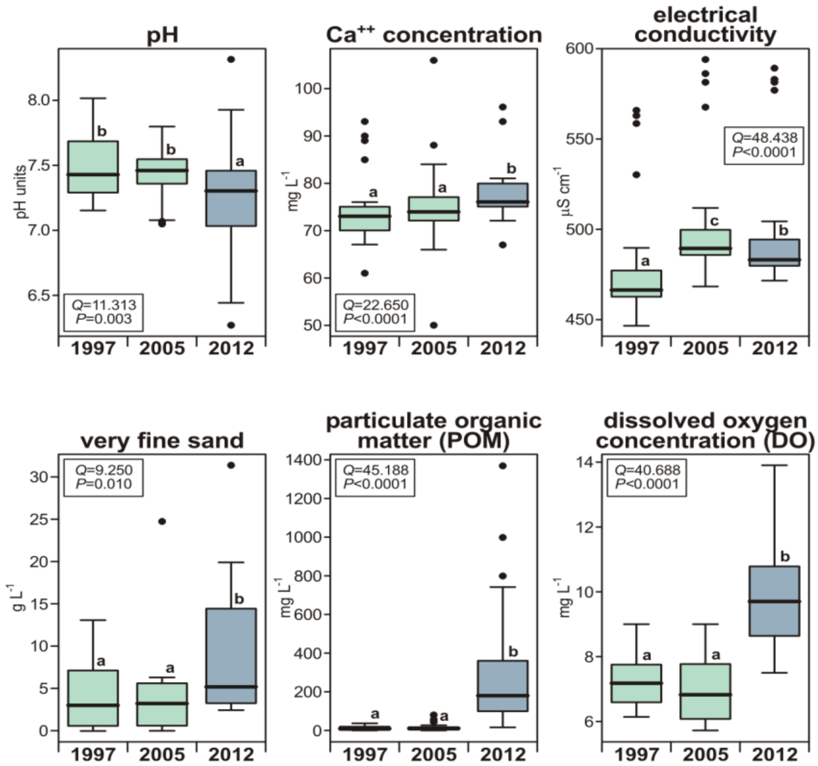


**Figure 4.** Water quality and sand variables recorded at the Springs before (1997, 2005) and after the 2009 earthquake (2012) [11]

In September 2009, previously clogged fractures were cleared after ionic enriched water crustal stress and ground shaking. So that electrical conductivity increased. Concentrations of very fine sand and Particulate Organic Matter increased at the main TS outlets due to the massive dehydrating of the conductive systems. Dissolved oxygen (DO) concentration increased significantly after the earthquake, because of groundwater flow paths in the aquifer due to a post-seismic higher hydraulic conductivity.

Several industrial facilities for instance oil refineries are in flames after the disaster. Oil and pesticide factories, iron, steel works and automotive, electronics, food processing, paper, plastics and pharmaceutical facilities are also factors. When cleaning work was done in the disaster area, next step problem is what to do with the chemical pollutants that were exposed by these damaged industrial facilities and other sources. These industrial main chemicals are listed in the international standards as carcinogen chemicals. Most are respiratory hazards, neurotoxic and / or carcinogenic chemicals. Many of them can be acutely toxic. Some of them are environmentally continuous effects. This can lead to constant pollution, especially in local soil and water. Chemical health risks that may arise from disasters are linked to environmental and local pollution levels. Risk assessment are very important in this stage to determine quantitively “normal” or “safe” for residents and workers in the affected area [12].

## Conclusions

It is simple true that majority of land in the world has earthquake problem. Earthquakes effect ground and all surface water structure. Water quality should be protected for human health. Decision makers should use risk assessment tools in terms of water contamination for the disaster areas. Many risk assessment approaches were developed and ready to apply for disaster managers. Especially chemical pollutants can be toxic and carcinogen afterward of the earthquake. Industrial lands are needed more attention in this management process. Water is source of life and should not neglect in disasters.

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