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Trend Analysis of Cesium-137 Concentrations Observed in Kuwait Before and After Fukushima Nuclear Disaster

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1. INTRODUCTION

The State of Kuwait has a typical dry desert climate which involves deposition and re-suspension of atmospheric particulate matter. The International Data Centre (IDC) of the Comprehensive Nuclear-Test-Ban Treaty Organization (CTBTO), has been processing radionuclides data received from the RN40 station located in the state of Kuwait (Figure 1). The data includes gamma-ray spectrometry, meteorological data, as well as the backward trajectory atmospheric modelling (ATM) results. This poster presents a trend analysis of the measured cesium-137 (¹³⁷Cs) concentrations for the years 2009-2014 collected from RN40, as well as the dust fallout analysis for the years 2009-2011 before and after the Fukushima nuclear disaster in Kuwait. The aim of this work is to evaluate the potential impact of the Fukushima incident on the concentrations of terrestrial deposition of Cs-137 in Kuwait. The activity of this radionuclide was present in the soil and atmosphere due to the past nuclear testing and/or accidental reactor releases into the atmosphere.



FIGURE 1: The building of station RN40 on the premises of KISR.

2. WEATHER CHARACTERISTIC OF KUWAIT

The climate of Kuwait is dry and hot in the summer, and mild to relatively cold in the winter. The Particulate matter less than 10 µm (PM10) during dust storm events can reach as high as 5000 µg/m³. During the operation of the RN40 station, the meteorological parameters (i.e., wind speed, wind direction, temperature, ..etc...) were recorded and obtained to assess the possible source location of the measured concentration of ¹³⁷Cs isotopes (see, Figure 2).

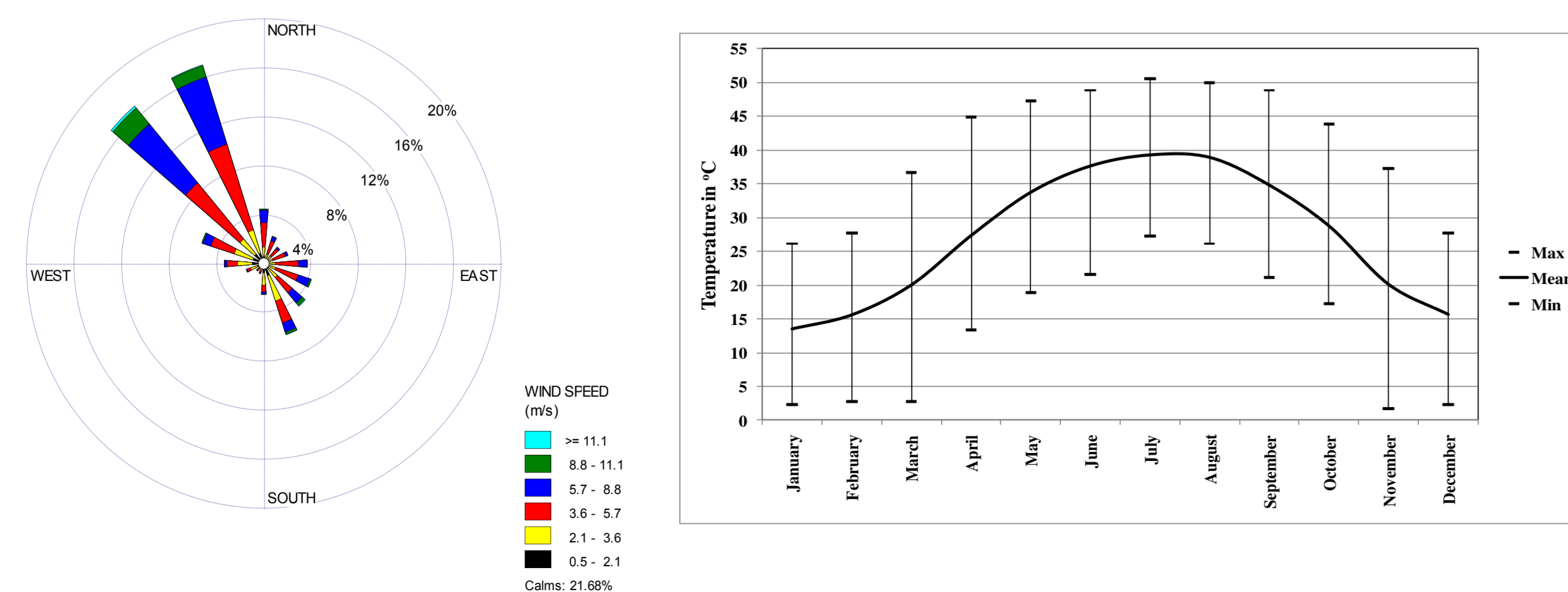


FIGURE 2: Surface meteorological data plot for the frequency distribution for wind and wind temperature.

3. DATA MONITORING AND ANALYSIS

To understand the ¹³⁷Cs trends before and after the Fukushima nuclear disaster event occurred on 11 March 2011 at the concentrations of terrestrial deposition of ¹³⁷Cs in Kuwait. Two main sources of data were used, these are; the RN40 Station (type RASA system) daily sampling and analysis results for the period 2009-2014 and the dust fallout sampling and analysis study carried out between 2009-2011 by KISR in Kuwait.

RN40 Data Monitoring: The radionuclides in atmospheric samples as a particulate matter measured in the RN40 and report the results to the IDC of CTBTO. The RASA system equipment contains a gamma radiation detection system used to monitor the atmosphere for evidence of radionuclide activities. The particles are collected on filter media for 24 hours, decayed for 24 hours, and measured for another 24 hours. The sampling rates are around 600m³/hr. Figure 3 shows the OpenSpectra GUI software used for data analysis of the ¹³⁷Cs concentration in Kuwait the results reported in µBq/m³.

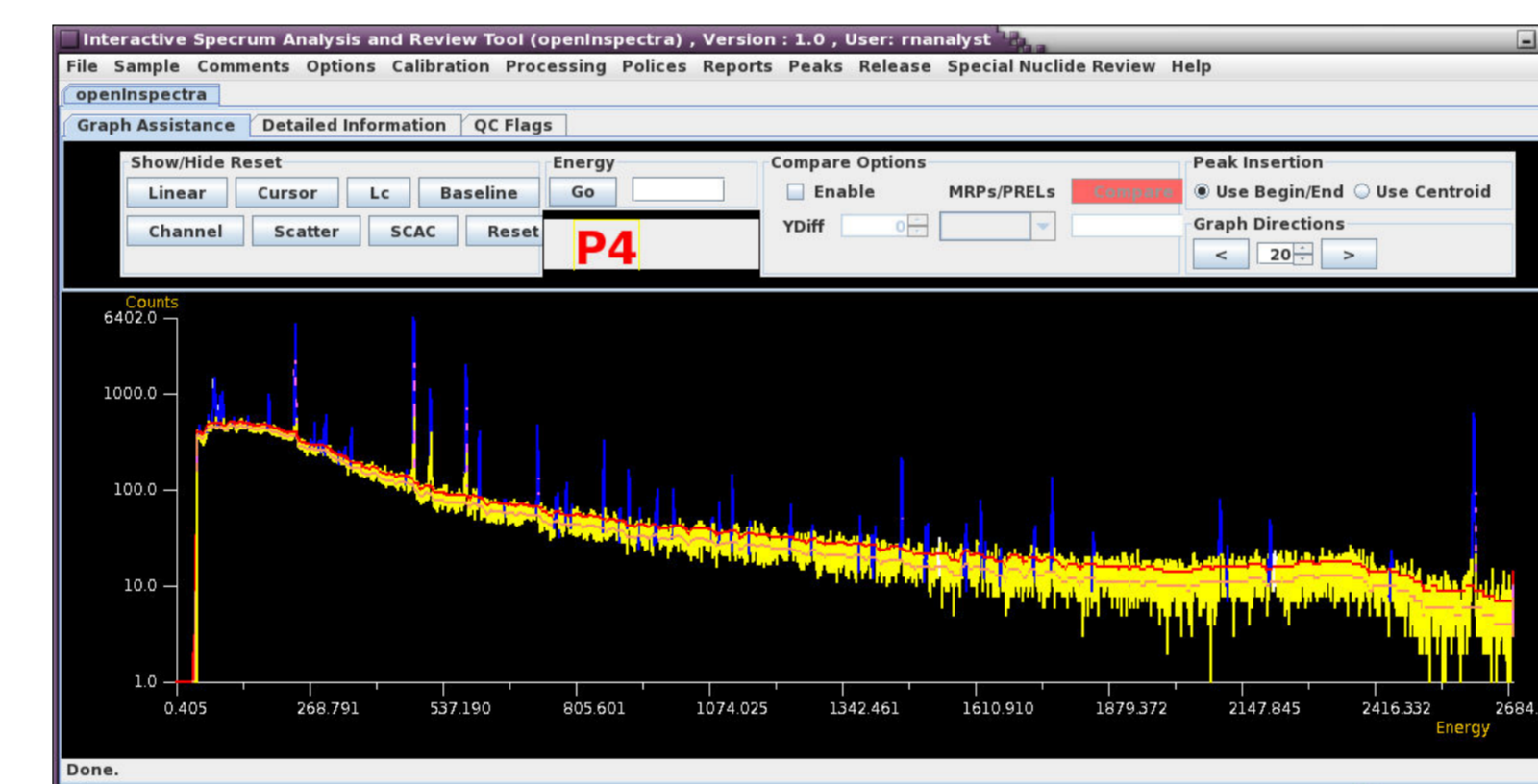


FIGURE 3: NDC-in-BOX OpenSpectra GUI software used for data analysis.

Dust Fallout KISR Monitoring Study: In this study, the monthly depositional fluxes of the man-made radionuclide (¹³⁷Cs) were measured in nine sampling locations covering Kuwait between 2009-2011 (seen in Figure 4). And all analysis was carried out at KISR Environmental Radiological Laboratory showing in Figure 5 below.

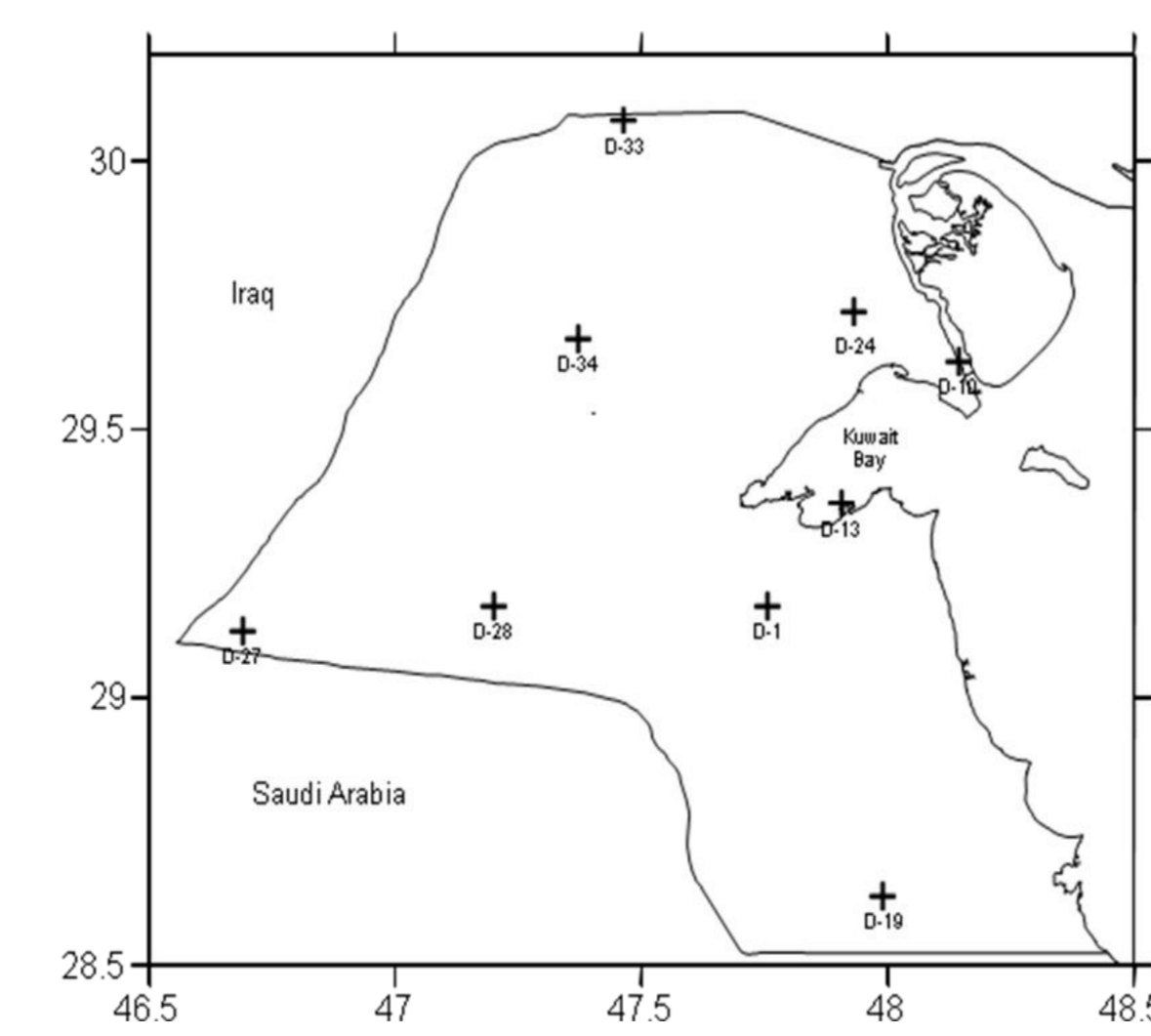


FIGURE 4: Dust Fallout Sampling sites in Kuwait.



Gamma spectrometry systems at KISR:

- 1) Ortec n-type; 50% eff_{rel}
- 2) Ortec p-type; 45% eff_{rel}
- 3) Canberra well type; well volume cm³
- 4) Canberra bege type; surface area 5000 mm²
- 5) Canberra n-type; 100% eff_{rel}

FIGURE 5: KISR Environmental Radiological Laboratory Equipment.

4. TREND ANALYSIS RESULTS

Cesium-137 Trend analysis at RN40 Station: ¹³⁷Cs is a man-made radionuclide produced through nuclear fission. It has very high fission yield, and has a 30.1 years half-life. The results of Fukushima nuclear disaster releases occurred on 11 March 2011 were registered at CTBTO RN40 station in Kuwait after 15 days on 26 March 2011 (seen in Figure 6; Cs-137, I-131 and Cs-134). It can be noted that the ¹³⁷Cs as well as other isotopes i.e., Cs-134 and I-131 gives a good indication to monitor and confirm the event releases from Fukushima Daiichi nuclear disaster. Figure 7, shows the overall trends of the ¹³⁷Cs before (i.e., from 2009 till 10 March 2011) and after (i.e., from 11 March 2011 till 2014) the nuclear disaster. The average ¹³⁷Cs concentrations before the event was 9.05 µBq/m³, whereas, after the Fukushima crisis was 16.23 µBq/m³.

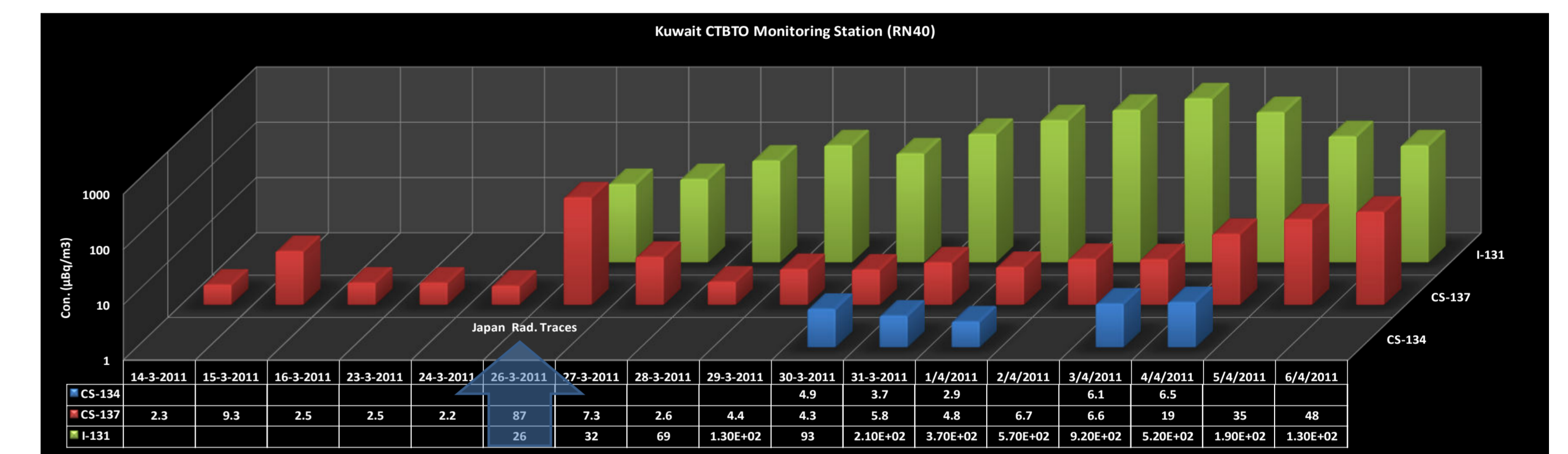


FIGURE 6: Fukushima nuclear disaster releases occurred on 11 March 2011 were registered at CTBTO RN40 station in Kuwait.

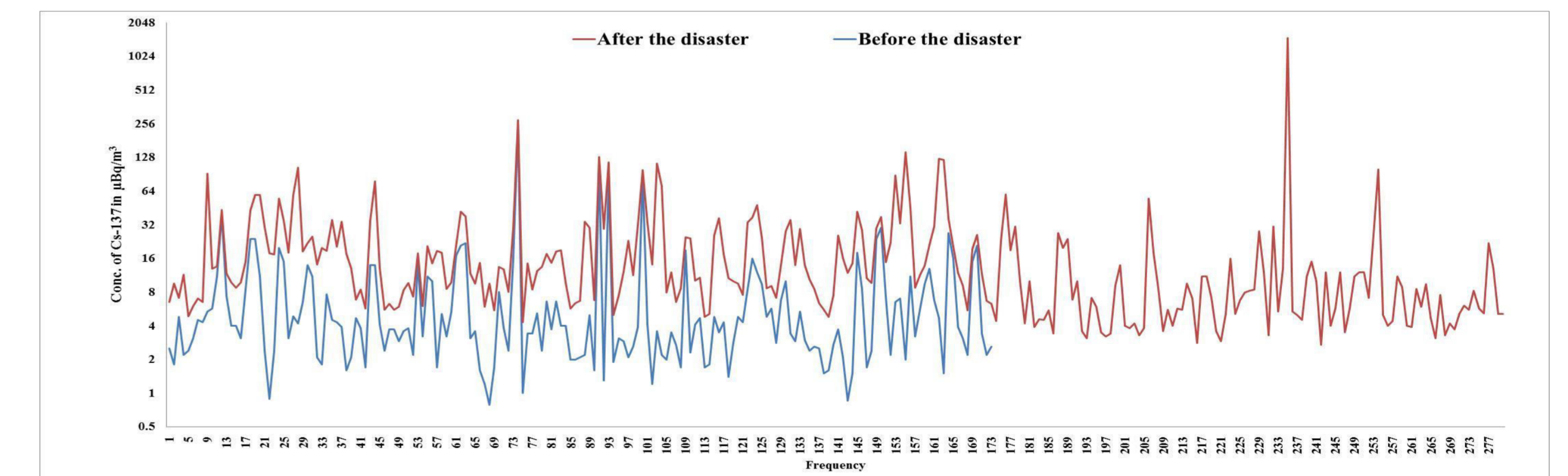


FIGURE 7: Cs-137 Trend before and after Fukushima nuclear disaster reported in Kuwait.

Cesium-137 deposition fluxes before and after the event

Figure 8, shows the overall monthly ¹³⁷Cs deposition fluxes in mBq/m². The average monthly ¹³⁷Cs deposition were 3.65 mBq/m² before the event, and 7.9 mBq/m² after the event. This is clearly indicated that the mean ¹³⁷Cs concentration trends has been changed after the Fukushima Daiichi nuclear disaster and increases the background at Kuwait RN40 site.



FIGURE 8: Monthly Cs-137 deposition fluxes before and after Fukushima event monitored in Kuwait.