THE EXISTENCE AND MOBILITY OF DIOXIN IN SOIL, WEATHERING CRUST AND SEDIMENTS IN THE BU GIA MAP AREA, BINH PHUOC PROVINCE

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Introduction

Binh Phuoc is newly established province has borders with Dac Nong, Lam Dong, Dong Nai and Binh Duong Province where was affected heavily by war.

This study identifies that the highest dioxin concentration concentrates in red-yellowish ferralite basaltic soil (Fu) (in average: 26.5 ppt), especially, in the Bu Gia Map Airport (43.2 to 236.3 ppt). It is higher than permitted limits for agriculture and forestry soil. Moreover, this study also shows that dioxin can move from the Bu Gia Map Airport to surrounding areas, as well as dioxin concentration gradually reduces in depth following the exponential function of $y = 461e^{\frac{x}{-61}} - 24$.

I. Materials and methods

Mud/sediment samples were taken by polluted level from core area (Bu Gia Map airport) to surrounding areas.

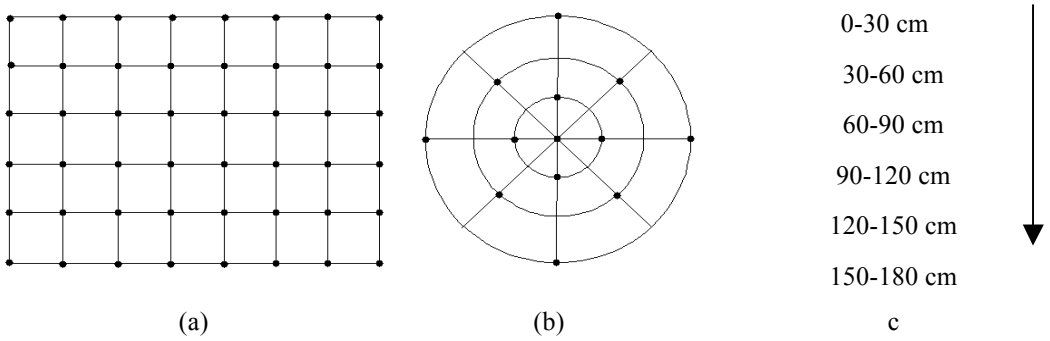

Figure 1. Sketch map showing drilling positions for soil sampling (a, b) and trench samples at soil profiles (c)

Reserve and transport of samples: All samples were stored in brown glass or PE gab, then put into iron box, kept in cool area and transported to the lab. The dioxin concentration in samples was analyzed using the procedures of Vietnam-Russian Tropical Centre [7].

II. Results and discussion

1. Distribution characteristics of dioxin in Bu Gia Map area

In the study area, there are 4 soil types, namely: reddish ferralite basaltic soil (Fk), red-yellowish ferralite basaltic soil (Fu), Jurassic sediment grey soil (Fs) and diluvial soil (Fd). The concentration of dioxins in the area depends on soil types, river-stream networks; plant covers and occurs mainly in the red-yellowish ferralite basaltic soil (Fu).

The analyzed results of 153 soil samples have been showing that dioxin concentration is in range of 1.02-236.34 ppt (Table 1), among which:

- 18.30% of samples with concentration of from 5 to 236.34 ppt.

- 9.8% of samples with concentration of from 10 to 236.34 ppt.

- 5.22% of samples with concentration of from 43.23 to 236.34 ppt.

1.1. Distribution of dioxin in reddish ferralite basaltic soil **(Fk)**: This soil type is abundant, spreading on the whole area and often located at the low altitude. The largest area is distributed in the west and southwest of the Bu Gia Map Airport.

Total samples were 81samples. Their analysis results showed that PCDD varies from 0.9 to 8.6 ppt, in average: 4.1 ppt. PeCDD changes from 0.6 to 33.8 ppt, in average: 1.0 ppt. TEQ has a large range of concentration, from the lowest values of 1.0 to the highest of 236.34 ppt, in average: 15.8 ppt.

Table 1. **Existence of dioxins in soil at Bu Gia Map area**

Soil types	TCDD (ppt)			PeCDD (ppt)			TEQ (ppt)		
	Min	Max	TB	Min	Max	TB	Min	Max	TB
(Fk)	1.1	5.8	2.3	0.4	1.0	0.5	1.2	8.3	3.0
(Fu)	0.9	8.6	4.1	0.6	33.8	1.0	1.0	236.3	15.8
(Fs)	1.1	2.2	1.9	0.4	1.2	0.7	1.0	4.8	2.7
(Fd)	0.4	2.7	1.8	0.5	1	0.7	1.9	4.8	3.1
Suggested level for agricultural soil by: US (27 ppt), Germany (<5), Italy (10), Holland (10), Russia (0.26).									

The soil samples containing high value of dioxin are mainly distributed around the Bu Gia Map Airport, while mud or sediment samples with high concentration of dioxin are mainly located in about 500 m of the lower course of the Bu Gia Map Airport. In this area, the TEQ in mud/sediment samples is in the range of 4.16-5.95 ppt.

1.2. Distribution of dioxin in Jurassic sediment grey soil **(Fs)**: This soil type covers a small area in the northwest of the studied area. This area is located in the Bu Gia Map National Reserve area. The concentration of dioxin congener in this soil type is as follows: TCDD from 1.1 to 2.2 ppt, in average: 1.9 ppt; PeCDD less than 1 ppt; TEQ from 1.0 to 4.8 ppt, in average: 2.7 ppt.

1.3. Distribution of dioxin in diluvial soil **(Fd)**: The diluvial soil forms a narrow band along stream networks in the studied area. This soil type covers small part and is distributed mainly in the southwest of the studied area. This soil type is unstable, and is often affected by stream flow, runoff flow and human activities. The concentration of PCDD in this soil type varies from 0.4 to 2.7 ppt; in average: <0.38 ppt. The PeCDD congener has low concentration, mainly less than 2 ppt. TEQ changes from 0.001 to 2.7 ppt, in average: 1.1 ppt. The results have been showing that the concentration of dioxin in this soil type is low.

2. Correlation between dioxin concentration and soil features in Bu Gia Map

The results have been showing that there may be a link between dioxin concentration and soil features, such as: soil texture, organic matter content, available phosphate (P_2O_5), available potassium (K_2O) (Fig. 2). The Fig. 2 (A, B, C and D) revealed the good correlation between them. Unfortunately, the analyzed results of other soil types did not allow us to interpret in the same

way. There is not any correlation between TEQ and soil features for other soil types in the study area (Fig. 3A, B, C and D).

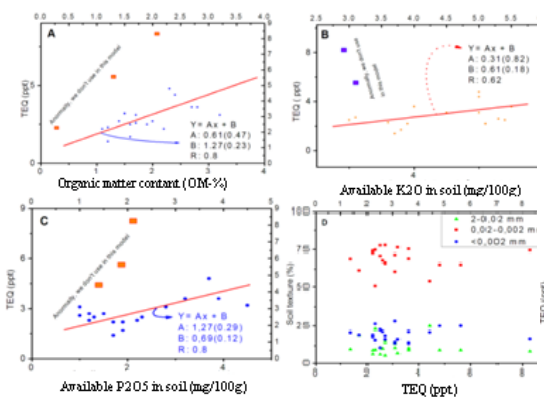

Figure 2. *Correlation between TEQ and: A) organic matters; B) available potassium (K_2O); C) available phosphate (P_2O_5) and D) soil texture in reddish ferralite basaltic soil (Fk)*

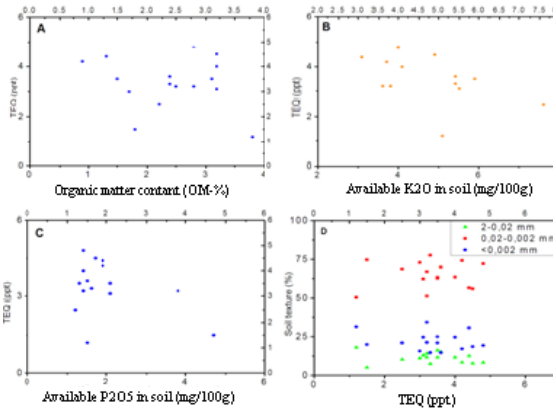

Figure 3. *Correlation between TEQ and: A) organic matters; B) available potassium (K_2O); C) available phosphate (P_2O_5), and D) soil texture in red-yellowish ferralite basaltic soil (Fu).*

3. Mobility of dioxin in soil in the Bu Gia Map area

3.1. Spatial movement of dioxin: In the Bu Gia Map area, there are 4 soil types, distributed at different elevations. Perhaps, terrain features contribute in the accumulation and conservation of dioxin over time and space:

- *Dioxin in Fk soil*: TEQ changes from 1.2 to 8.3 ppt, in average: 3.0 ppt.

- *Dioxin in Fu soil*: TEQ changes widely from 1.0 to 236.3 ppt, in average: 15.8 ppt.

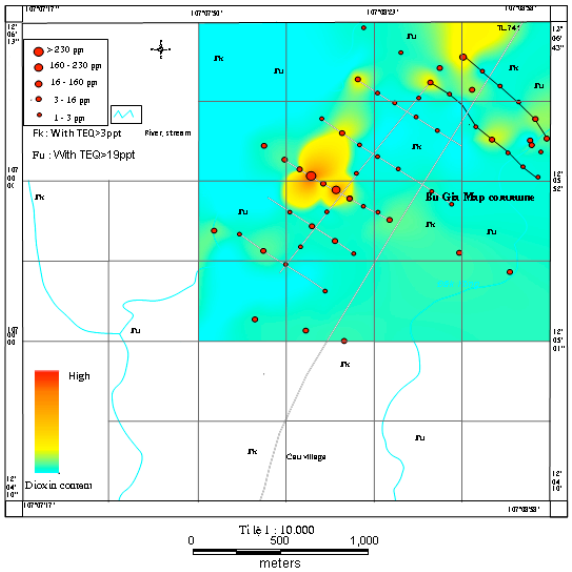

Figure 4: Diagram of dioxin existence in soil at Bu Gia Map Airport area.

- *Dioxin in Jdl soil*: TEQ changes from 1.0 to 4.8 ppt, in average: 2.7 ppt.

`- *Dioxin in Fd diluvial soil*: TEQ changes from 2.0 to 4.8 ppt, in average: 3.1 ppt.

The Fs soil type is distributed mainly in the high terrain, deeply separated in the northwest of the study area and has the lowest dioxin concentration in soil (2.7 ppt). The Fk soil type is distributed in the lower part, with the TEQ of dioxin of 3.0 ppt, while the soil usually located at the lower terrain Fu has the highest accumulation of dioxin, of 15.8 ppt. The Fd diluvia

soil distributed along the river and stream valley has complex origins and multiple compositions and has dioxin concentration of 3.1 ppt.

The results on spatial variation of dioxin in natural environment reveal that topographical features contribute an important role on the control and decision of the spreading direction of dioxin in the nature.

3.2. Movement of dioxin in depth:

Basing on exponential function:

$$y = 46 1e^{\frac{x}{-61}} - 24 \qquad (1)$$

of which: y - depth (cm) and x - dioxin concentration (ppt) in subsoil.

By running the model in the Bu Gia Map area that results also showing that dioxin concentration decreased with the depth. Organic matters and soil texture are factors affecting the capacity of dioxin penetrating in depth. In the Bu Gia Map Airport area, the dioxin concentration may reach 80 ppt at the depth of about 140cm, while at the depth of 160 cm, it remains almost negligible or equal to the baseline of the whole country.

Thus, by using this model, it is possible to predict the mobility trends of dioxin in the soil for other areas when we don't have conditions to study in details with assurance that all conditions of geological, hydrogeological, soil, etc. characteristics are identical with the Bu Gia Map area.

Acknowledgments

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