

ASSESSMENT THE EFFECTS OF AGENT ORANGE/DIOXIN CONTAMINATION AFTER VIETNAM WAR IN HOT SPOTS AND SOLUTIONS TO REDUCE NEGATIVE IMPACTS IN SURROUNDING AREAS

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Introduction

In April 1975, after the war, Vietnam suffered from the consequences of environmental contamination by chemical agents. Approximately 80 million liters of herbicides containing dioxin which was used by the US Army from 1961 to 1972 caused an environmental catastrophe for a long time. Based on the cause and time of exposure, the victim can be divided into two groups:

Group 1: People were directly contacted during spraying who lived in the spraying and contaminated areas. According to Stellman J.M. et al., (2003), at least 2.1 millions but perhaps as many as 4.8 million people would have been present during the spraying. It was estimated about 3 million people who had high risk of dioxin exposure¹.

Group 2: People living in contaminated areas by agent orange/dioxin such as former US military bases were able to affect. Storing, gathering and preparing herbicides places during the war were called "hot spots". By the end of the 1990s, the 10-80 Committee and the Ministry of Defense of Vietnam published the first studies about dioxin in hot spots²⁻⁵. The studies confirmed that the effects of Agent Orange / dioxin after the war in hot spots were extremely serious for the environment, ecology and people⁶. After the war, people have been exposed dioxin through the food chain in environment. Human exposure of dioxin through dermal and digestive pathways has accounted for 10% and 90%, respectively⁷. Research has demonstrated that concentration of dioxin in blood, fat and breast milk in contaminated areas has higher than the areas which are not contaminated⁸⁻¹¹.

After the 2000s, agent orange/dioxin effects and human exposure in the hot spots have been reduced by remediation technologies and solutions of public health.

Materials and methods

Environmental impact assessment studied the current environmental situation at three dioxin hotspots in Vietnam that are Da Nang, Bien Hoa and Phu Cat airbases.

Environmental health impact assessment was conducted in the affected areas surrounding these mentioned hotspots and other selected areas.

Methods for environmental studies:

- Survey and sampling by Multi-increment sampling method
- Determination of 17 dioxin/furan compounds using GC/MS and HRGC/HRMS based on US EPA-8280b and US EPA-1613B regulations
- Comparison between TCVN 8183: 2009 and QCVN 45: 2012/BTNMT regulations about permitted limit of concentration of dioxin in remediated soil and sediment

Methods for assessment of environmental health risks:

- Interview and statistical survey according to questionnaires
- Evaluation, comparison
- Assessment of environmental health risks according to P/CCRARM 1997 and NRC 1983

Results and discussion

3.1. Results of environmental status at Da Nang, Bien Hoa (Dong Nai) and Phu Cat airbases (Binh Dinh)

Table 1 shows about results of agent orange/dioxin contamination status at Da Nang Airbase, Bien Hoa Airbase (Dong Nai province) and Phu Cat Airbase (Binh Dinh province)

Table 1. Results of agent orange/dioxin contamination status at three hot spots

Hot spot Time	Bien Hoa Airbase	Da Nang Airbase	Phu Cat Airbase
During the War 1961-1975 (Ranch Hand operation)	98,000 barrels of Agent Orange 45,000 barrels of Agent White 16,000 barrels of Agent Blue (540g dioxin)	52,700 barrels of Agent Orange 29,000 barrels of Agent White 5,000 barrels of Agent Blue (550g dioxin)	17,000 barrels of Agent Orange 9,000 barrels of Agent White 2,900 barrels of Agent Blue (60g dioxin)
After the War 1975-2018 (Investigation, assessment and environmental remediation)	Average level: 150,000-200,000 ppt High level of contamination: 800,000-900,000 ppt Amount of soil and sediments need to be remediated: 500,000m ³ Z1 area: burial of 97,000m ³ Z2 area: burial of 50,000m ³	Average level: 60,000-100,000 ppt High level of contamination: 160,000-260,000 ppt Total of remediated soil and sediment: 200,000m ³ (2012-2017) Untreatment about 60,000 ton soil and beton materials.	Average level: 5,000-12,000 ppt High concentration: 20.000-30.000 ppt Total of remediated soil and sediment: 7,500 m ³ (2012) Burial sites in the plan need to treat
Solution 2019-2025 (De-contamination, Minimizing impact)	- Environmental assessment, Chosing treatment technologies; - Monitoring; - Studying on decreasing exposure - Support affected communities.	- Monitoring, post-processing environmental assessment. - Survey and assessment of medicine around hot spot - Increasing of supported medicine	- Monitoring, Environmental Impact assessment. - Using treatment technologies to obtain clean environment in order to develop economy

In the Da Nang airbase, contamination of agent orange/dioxin in soil and sediment have been already remediated. This has led to return about 32.4 ha clean-up soil and remove approximately 200,000m³ of contaminated soil and mud¹². Dioxin contamination in the Bien Hoa airbase is very complicated. The majority of surface water from contaminated areas flows into Dong Nai river and accumulates in lakes and ponds in around areas. From 2010, studies and surveys have been conducted and achieved positive results such as limiting the risks and preventing temporary spread of contaminated areas. In the present, there are two isolated burial sites in the area where collected about 150,000m³ of contaminated soil. Besides, only 10,000m² area including contaminated soil has been isolated by fence. The others have just been warned but not removed yet. Comparising the experimental results with threshold of preliminary treatment has shown that of 500,000m³ contaminated soil and sediment has not treated^{12,13}.

The level of pollution in Phu Cat airbase is lower than Da Nang and Bien Hoa airbase. In 2012, 7,500m³ isolated landfill areas consisting of contaminated soil and sediment were conducted by GEF/UNDP. In spite of not treating thoroughly, the contamination has been limited.

In conclusion, dioxin contamination has caused some challenges for each hot spot, such as:

- In the Da Nang airbase, there have been some negative environmental impacts. Concentration of dioxin in burial sites was higher many times than permitted limit, the monitoring sites and frequencies have not been too many, the environmental impacts have not been evaluated completely. It has payed attention to develop technologies of thermal absorption. Besides, food consumption around polluted areas has risk of dioxin exposure based on WHO⁹. It is necessary to carry out monitoring and warning about dioxin and relevant with them.

- In the Bien Hoa airbase, there have been many negative environmental impacts so the studies about environmental health have to be performed more and more.

- In the Phu Cat airbase, the treatment of temporary burial sites is necessary when to construct airport in this area. The spread of contaminated areas should be minimized as possible as. Medical support programs have to be investigated to reduce exposure of dioxin on human.

3.2. Assessment of environmental health risk and solutions to reduce the harmful effects of Agent Orange / dioxin after the war in hot spots

The results of research on food consumption which are infected dioxin around Bien Hoa airbase have been shown in Table 2:

Table 2: The daily food consumption infected dioxin around Bien Hoa airbase

Types of food	Consumed level (A)*	Dioxin concentration in food (pg/g) (B)**	Consumed level of food (pg/day) (C=AxB)	Daily human exposure of dioxin (C/50kg) (pg/kg/day)
Fish	19	9.5 - 66	180.5 - 1254	3.6 - 25.1
Chicken	14	12 - 490	168 - 6860	3.4 - 137.2
Beef	7	8.2 - 8.5	57.4 - 595	1.1 - 11.9
Pork	51	2.7-15	137.7 - 765	28.5 - 15.3
Total			545 - 9202	10.9 - 189.5

It can be seen from both table 1 and table 2 that around both Bien Hoa and Da Nang airports. the total daily human exposure of dioxin are 60.4-102.8 pg TEQ/kg body/day and 27-148 pg TEQ/kg body/day, respectively. This figures are higher as many times than the permitted limit from WHO (1-4 pg/kg body/day)⁹. However, if people don't consume food such as fish, chicken, beef and pork, the risks of effect by dioxin compounds will fall down as possible as permitted limit^{9,14}.

According to studies about quantification of dioxin in environment and food, people living around dioxin areas have the risk of these compounds exposure everyday. The public health association has conducted the Public Health Program with 3 components: (1) training to improve knowledge and quality in decreasing dioxin exposure in food; (2) Improvement of education and training about dioxin effects for people (especially housewife) who living around Bien Hoa and Da Nang airports; (3) study solution for decreasing dioxin exposure from food¹⁵⁻¹⁷.

Besides, several recent studies have shown that the infant have risk of dioxin effects from their mother who living in dioxin contaminated area for a long time¹¹.

This study plays an important role in evaluation of dioxin effect on environment and human. Moreover, it's necessary to determine the number of people who have the risk of dioxin contaminated in these areas in order to alarm the other people.

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Due to consequence of the war, Vietnam have some dioxin contaminated fields which are many different ways for scientific research and technological testing. Among them, people are an important object in the chain of impacts of dioxin contamination. The successful researches and solutions help overcome the harmful effects of dioxin contamination in Vietnam. This study was supported by the 701 Steering Committee, research units, military units, airport management, functional and professional agencies in Da Nang, Dong Nai and Binh Dinh provinces.

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