



Commission 6

CONSEQUENCES OF CHEMICAL WARFARE IN VIETNAM

PROF. DR. TRAN XUAN THU
*Vice-President and Secretary General,
The Vietnam Association for Victims of Agent Orangedioxin*



Containers of Agent Orange, Agent White, Agent Blue in the Bien Hoa Air Base, 1971

I. A GENERAL CONSIDERATION OF THE U.S CHEMICAL WARFARE IN VIETNAM

Long, long time ago, poisons were already used by men in wars for military purposes. However, arrows and swords then were mainly dipped in poisons made out of natural sources such as animals or plants. Unfortunately, along with newer progresses of sciences and technologies, men also develop more and more advanced chemical substances and greater mass destruction weapons

In the First World War, Germans on April 22, 1915, used Chlo to suffocate and kill thousands of British and French soldiers, and in the Second World War, Japanese used toxic Yperit in China and Germans - Zyklon B to poison prisoners-of-war in their concentration camps.

However, there has been no chemical wars so far in the history of mankind that can be comparative to the one conducted by the American forces in Vietnam from 1961 to 1971.

Lets review the positions, schemes and aims that the U.S and Saigonese administrations insisted on at the time prior to the implementation of the chemical warfare in Vietnam. The U.S Minister of Defense, Cyrus Vance stated "the national political policies of the U.S does not prohibit the use of toxicants for mass suppression".

The U.S Chemical Warfare Commission even held "that toxic gasses are more humane than other types of weapons." Ngo Dinh Diem, President of the then Saigonese administration in an interview with the Voice of America, March 17, 1963 said "the sprayings of toxic chemicals constitute a very effective means of war that the under-developed countries may experiment on what the communists called the liberation war" . The chemical warfare under the cloak of a defoliation and crop-destruction program was approved by the U.S President J. Kennedy on November 10, 1961.

The war was waged only within a narrow space of about 170.000 square kilometers of South Vietnam. Herein, the U.S forces sprayed more than 111.000 tons of toxic chemicals, along with more than 300.000 tons of burning substances and 14 million tons of ammunition of all types, twice greater than the total tonnage exploded in the Second World War. The toxic chemicals were sprayed directly over 1/4 of the area of South Vietnam. Consequently, 3 million hectares of forests and 112 million cubic meters of timber thereof were destroyed; 4.8 million people were exposed to them and 3 millions become their victims.

The toxic chemicals did not only impact the Vietnam people but also the American soldiers and soldiers of other countries involved in the war. The sprayers were harmed as well.

According to Admiral Elmo R. Zumwalt, the commander-in-chief of all American forces in the South Pacific from 1968 to 1970, and many other scientists, there were at least 2.6 to 4.2 million exposed American participants and according to the President of the Korean Agent Orange Connection Disabled Veterans Association, there were about one hundred thousand Korean victims, of whom about 20.000 have died

1. The toxic chemicals used

During the war in Vietnam, there were about 110.000 tons of toxicants used by the American forces from 1961 to 1971. This is the greatest chemical warfare and the first destruction warfare ever known in the history of mankind

Approximate 70 types of toxicants were resorted in this war [11] [12], in which there are various types prohibited by the international conventions and many national laws such as military poisons, Dioxin, Hexachlorobenzen, Chlordane, Dieldrin, 2,4,5 T, DDT, etc.

According to levels of toxicity, they can be classified into the following groups:

- The ecological toxicants include 65 types. The most noteworthy are Agent Orange, Agent Blue, Agent White, Agent Pink, Agent Purple, Agent Green, Dinoxol, Trinoxol, Malation, DDT, etc.
- The military toxicants include CS (O, chlorobenziliden, nervous BZ toxicant, suffocating CBU bombs.
- The poisoning substances include cyanide and Arsenic

The most substance that humanity has been concerned about however is Agent Orange. Dioxin-laced Agent Orange has been the most harmful poison ever known and ever produced, was used with greatest proportion (54%) of total toxicants sprayed in Vietnam

2. The ecological toxicants used.

There were three principal types of ecological toxicants used in Vietnam in great amounts. They are Agent Orange, Agent Blue and Agent White. Their total amount

reached to more than 92.000 tons. This corresponds to 86% of total weight of toxicants sprayed in Vietnam. These substances were sprayed by different kinds of airplanes such as C-47s and B-57s, but mainly by C-123s.

These above mentioned substances were used in doses many times higher than the acceptable ones, therefore they became poisons. For example, the level of 2,4 - D in the sprayed Agent Orange and Agent White was 13,61kg/ha and this is 24 times higher than the acceptable one (0.57kg/ha). Note that the LD-50 for white rat is only 375ppm [2] [10].

But the more important matter is that all the above mentioned substances contained high levels of various extremely harmful ingredients.

- Agent Orange contained dioxin, the most harmful ever known.
- Agent Blue contained Arsenic, the poison long known.
- Agent White contained Hexachlorobenzen, another harmful substance.

Dioxin and Hexachlorobenzen were both persistent organic pollutants (POPs), prohibited by Stockholm Convention [13]

TABLE 1.
Principal toxicants used by the American forces in Vietnam.

Toxicant types	Composition	Physical properties	Application	Area sprayed (ha)
Agent Orange; 45,68 mil. liters or 59.000 tons	Two-component mixture in weight proportion (1.124:1) of 2,4,5-T (545.4 kg/m ³) and 2,4-D (485.1 kg/m ³), containing 2,3,7,8-TCDD (3.83 g/m ³)	Liquid soluble in oil but not in water, specific weight 1,285 kg/m ³	28,06 l/ha, of which 15,31 kg/ha 2,4,5-T; 13,61 kg/ha 2,4-D in acid equivalent; 107 mg/ha dioxin	1.6 mil
Agent White; 20 mil. liters or 22,800 tons	Two-component mixture in weight proportion (3.882:1) of tri-isopropanolamine salt of 2,4-D (239.7 kg/m ³) and picloram (64.7 kg/m ³)	Liquid insoluble in oil, specific weight 1.150 kg/m ³	28,06 l/ha; 6.73 kg/ha 2,4-D and 1.82 kg/ha picloram in acid equivalent	0.6 mil
Agent Blue; 8 mil. liters or 10,700 tons	Two-component mixture in Liquid insoluble weight proportion (2.663: 1) in oil, specific of natricacodylate and weight 1310 cacodylic acid (371.46 kg/m ³ kg/m ³) containing arsenic	Liquid insoluble in oil, specific weight 1.310 kg/m ³	28,06 l/ha; 10.42 kg/ha in acid equivalent, containing 5.66 kg/ha arsenic	0.3 mil

Table 1 shows that a huge amount of Agent Orange, 45, 68 million liters or 59,000 tones, was sprayed at a concentration of 28.06 liters or 21 kg per hectare [1] [4].

3. Dioxin

Dioxin is the most toxic substance ever produced by humanity. It is even more harmful than any other military ones, such as Yperit, Tabun or Sarin.

In 1957, actually 4 years prior to the use of these poisons by the Americans in Vietnam, two scientists from Germany and the U.S, W.Sandermann and J. Detrick had already been able to produce this dioxin with full knowledge of its toxicity

LD-50 of dioxin for a monkey is 70 ppb, while LD-50 of Sarin is only 83 and Tabun 208 [14].

TABLE 2
Lethal Dose 50% (LD-50) ($\mu\text{g}/\text{kg}$ – PPb) of certain toxicants
 (Source: L.A.Fedorov – Russia)

Toxicants	Experimental animals	
	Rat	Monkey
2,3,7,8 – TCDD	22 – 45	70
2,3,7,8 – Furan	916	1000
DDT	200.000	
Tabun		208
Sarin	100	83
VX	50	20.1

TABLE 3
Acceptable doses of dioxin
 (Source: Lois Marie Gibbs, Boston, U.S.A)

Country (institution)	Dose (Pg/Kg/ day)
USEPA	0.006
California	0.007
Health Service Agency, Washington. U.S.A	20 – 80
Canada	0.07 – 10
Federation of Germany	1 – 10
Holland	4
World Health Organization (WHO)	10

Due to its high level of toxicity, the permissible maximum dose for exposed persons is very small. The World Health Organization (WHO) provides that the permissible dose of dioxin is 1 – 4 pg/per one kg of body weight in one full day time. Therefore, the permissible dose for a person of 50 kg of body weight may be at maximum 50 – 200 pg/in one day. The U.S estimation of dioxin toxicity is even higher, hence its Environment Protection Agency (EPA) determines the permissible dose is 0.006 pg, 160 times less than that is stated by WHO.

Dioxin's persistency in our environments normally may last in many years. Several studies have been conducted by various world scientists on the sustainability of dioxin. Its sustainability is determined in accordance to its half-life (time for dioxin to disintegrate half of its amount). Dioxin's haft-life in the soil may persist extremely long. According to D.J Paustenbach (1992) and R.K Puri (1989, 1990), on the surface layer, it's half life fluctuates between 9 – 25 years, for other deeper layers – from 25 – 100 years, respectively.

Dioxin's half-life in human body is about 7 – 10 years. Prof. Schecter (U.S), once stated that a person may be found with dioxin in his/her blood after 35 years of getting contaminated.

Dioxin persistency in environments and in humans may last long. In combination with its capability of resonant harms, dioxin, at any level, may still cause harms. At 1 ppt, pregnancy may be effected, at 5 ppt cancer may be generated and at 50 -70 ppb man may be killed.

As required by the U.S Government to have more Agent Orange for war efforts plus with a desire for maximum corporate profits, the temperature applied to produce this agent in 1960s was pushed up very high and hence generating high levels of dioxin. It's average level was 13 ppm. Occasionally, this might reach 140 to 2,000 ppm.

Consequently, Agent Orange/dioxin is considered as a war poison. It is impossible to talk about Agent Orange without mentioning 2,4,5-T and dioxin in it. Because Agent Orange was a mixture of various definite substances, and quite different from other substances used in agriculture with respect to dose, proportion, composition of ingredients and level of dioxin. Therefore, Agent Orange should be considered as an extremely harmful substance.

4. CS (CS1 – CS2)

CS (O.Chlorobenziliden malononitril) successfully developed by two chemists, Corson and Stoughton, in 1928 is considered as a strongly stimulating toxicant. CS was widely used in the Vietnam Theatre with an amount of about 9,000 tons and up to now certain barrels of this substance were still scattered around in the forests of Vietnam's High Plateau region. There were approximate 20 types of weapons/equipments that contained CS such as:

- CS barrels with fuses such as E158 – R2 and XM – 15...
- CS canteens
- CS grenades
- CS 105mm canon shells, CS cluster bomb units
- CS bombs that could be dropped from such air planes as B-47s, B-57s, F-84s and F-100s, and helicopters
- CS projectors attached to airplanes, such as XM-28s to UH1; CBUs to jet and fixed - wing air planes, etc.
- Ground projectors E-8.
- Mity – Mite M106 spraying equipments may dispense toxicants into tunnels, or create smoke screen over open spaces.

CS is a dangerous toxicant. Threshold of stimulating level for men is $0.5\text{mg}/\text{m}^3$ (according to Schumascher – 1970). Unbearable level is $10\text{mg}/\text{m}^3$. Lethal dose is 25mg minutes/liter. When breathing CS-contaminated air, eyes and respiratory tracts will be strongly affected and show such symptoms as chest tightness, running tear, continuously strong coughing and difficult breathing. CS may kill people because it inhibits the action of certain enzymes, and generates Cyanide that instantly affects entire human body due to CS hydrolysis.

5. Suffocating CBU

The U.S forces used also in Vietnam a new type of weapons, that was CBU – 55B. This weapon inherently can cause incendiary and exploding effect, suffocating effect and at the same time may generate shock-waves as strong as those sent out by mini-atomic bombs. This type of bombs can be dropped by OV-10s, A-37s or helicopters. A mother-bomb contains three bomb units, each of which is filled with Ethylenoxyt fuel liquid and weight up to 45kg. When the bomb is 10m away from the target it would spray its fuel and create a misty screen to cover the entire target and then be induced to explode by a fuse. Explosion waves can destroy almost anything within a diameter of some

hundred meters or an area of about 5 hectares. Human beings and animals would cease to survive for lack of breathing air. This type of bomb was used in Xuan Loc (Dong Nai) and Can Tho, South Vietnam.

6. Malation.

Malation is an organic synthesis of phosphor (Organophosphate). In commerce, malation mainly is a powerful pesticide, but can strongly impact at the same time on the nerve systems of animals and human beings as well as may cause contamination at different levels, including lethal one. In fact as many as 3,000 tons of this toxicant were used in Vietnam. According to several scientists including Dr. Wayne Sinclair, a specialist in asthma, allergy and immunology, Vero Beach, Florida, U.S.A, Malathion may cause birth disorders, bad generic effect on several generations and immune system in human beings. Like other organic phosphor such as Sarin, Malation may strongly affect on central nerve system that leads to reeling head ache, convulsion, paralysis and death because it inhibits the activation of Cholinesteraza enzyme.

7. Burning substances napalm and white phosphorous bombs

In the course of the war in Vietnam, the U.S forces used over 300.000 tons of incendiary substances such as napalm and white phosphor to burn down villages, natural forests, large rubber plantations, rice fields and vegetation after these targets were sprayed with toxic chemicals. As a result, many favorable living conditions of the population, especially the mountainous people were deprived of. The white phosphor might not only burn skin but also severely poison human bodies. The incendiary substances could even generate secondary dioxin when sprayed forests were burnt down.

The burning of the Boi Loi jungle on Jan. 18, 1965 was an outstanding example of this effect. Herein, the U.S forces had conducted 101 runs of sprayings and poured down a volume equivalent to 83,000 gallons of herbicides plus with 760 tons of bombs, 85,000 bands of 20mm ammunition, in combination with thousands of gallons of diesel, napalm and white phosphor. The entire target was turned into a sea of fire, burning down the whole vegetation thereof, killing about 800 people and forcing about 2,000 farmers to run away from their home shelters. Until the beginning years of the 21st Century, many parts of this area are still exhausted and covered with "American weeds", and dioxin are still found in their soil.

II. Present status of Dioxin in Natural Environments of Vietnam

Agent Orange used by the U.S in the Vietnam War that was manufactured in the 1960s usually contained high dioxin contaminant (2,3,7,8 - TCDD) with fluctuating concentrations ranging from ppb levels - to ppm ones. According to data reported by Westing [4] and other scientists participating in the 1983 International Conference held in Ho Chi Minh City [5], an estimated amount of 170 kg of dioxin was sprayed in South Vietnam resulting in an average concentration of 25 pg per gram of soil. According to Stellman, et.al., [1] the average concentration of TCDD in Agent Orange was 13 ppm, The total amount of dioxin reaches 336 kg. Based on Stellman's report, Dwernychuk calculated the total amount of dioxin sprayed in South Vietnam was 600 kg [6].

Various prestigious scientists and laboratories in the world, including those in Germany, France, Japan, Netherlands, Canada and Russia have more or less participated in analyzing dioxin samples taken from different sprayed areas of South Vietnam. In Vietnam, there have been also laboratories that in cooperation with their foreign counterparts successfully analyzed dioxin in those samples too, such as those of the

Vietnam-Russia Tropical Research Centre, the VHI laboratory at Hanoi National University, the Physico-chemical Analytical Centre in HCM City and the analytical laboratory under Committee 10-80.

Up to now, Vietnamese scientific institutions have analyzed more than 2000 samples of soil and sediment, and surveyed nearly all sprayed provinces in South of Vietnam and certain number of unsprayed areas in Vietnam for comparison [7]. The results of this effort may enable us to draw out certain preliminary conclusion on the persistency of dioxin in general and in certain areas as follows:

The level of dioxin contamination caused by the U.S military's use of Agent Orange during the war was the highest one in the world; with time and Vietnam's conditions of high tropical humidity, this level has been substantially decreased. However, in areas where former U.S military storages were located, this level is still very high:

- a. In Mekong Delta, the greatest rice producing and exporting center of Vietnam, the samples analyzed did not show any traces of dioxin.
- b. In former U.S military bases where storages were situated and Agent Orange was fed into aircrafts, such as Bien Hoa, Danang and Phu Cat air bases, the persistency of this poison is now still substantially high, possibly high up to dozens or hundred thousand ppt. One sample in Bien Hoa Airbase was found up to 1 million ppt, 1,000 times greater than the permissible level stipulated by the U.S.

From these "hot spots", one may find high level persistency of dioxin in areas around or nearby them that need great concern.

Having analyzed data collected from hot spots, scientists working for the Vietnam-Russia Tropical Center, Prof. Olaf Paepke (FDR) and T. Boivin (Canada) and others determined that isomer 2,3,7,8-TCDD occupied 90% - 99% of total level of 17 toxic isomers of PCDD and PCDF. This confirms that dioxin existing in these areas has derived from war Agent Orange.

III. CHEMICAL WARFARE'S AFTER-EFFECTS ON ECO-ENVIRONMENTS.

The U.S undertook first war of ecological annihilation in the history of mankind in Vietnam. One fourth of natural area of South Vietnam was sprayed with toxicants . The combination between eco-toxicants and napalm bombs led to the destruction of nearly 3 million hectares of natural inland forests, and 160,000 hectares of mangroves; and the disappearance of nearby 112 million cubic meters of timber and the destruction of substantial tropical jungles, land forests and mangroves very rich in biological plurality, including botanical species, animal species and fertile soil. Various international scientists have noted that only after decades, even hundred of years, their recovery may be seen.

The destruction of eco-environments has impacted directly on the sources of subsistence needed by the Vietnamese people and badly effected human health of millions of persons. It may be well said that Agent Orange/dioxin have twice badly harmed our people's health. (Prof. Furukawa Hisao, Japan)

IV/ ECO-TOXICANTS' AFTER-EFFECTS ON HUMAN HEALTH.

Vietnam has nevertheless became a real colossal laboratory with millions of people exposed to toxicants used by Americans. As said by J. M. Stellman, there were

about 4.8 million exposed persons and according to preliminary account, possibly about 3 millions of whom have become victims. According to initial data collected in certain provinces, among victims, more than half were civilians (Kontum, Quang Nam, Quang Ngai, the ratios between civilians and total victims were 70,7%, 75,4%, 67,9% respectively) and 85% of households had two and more victimized members, 3% - five ones.

In this war, the U.S unquestionably intended to attack civilians. It used 4.7 million liters for destroying 33.339 hectares of crops and directly spraying on 3.138 hamlets/villages while overwhelmingly effecting 20.585 ones [1]. To poison civilians and destroy crops needed by population became one special characteristic of this U.S chemical warfare in Vietnam (during the First World War, there were 1.3 million victims of chemical poisoning, 91,000 deaths but most of whom were combatants.

Dioxin in human bodies of victims.

In parallel with the construction of domestic laboratories, Vietnam has cooperated with various international laboratories, such as Axys of Canada; Ergo (Eurofin) of FDR, Academy of Sciences of Russia, in analyzing bio – samples. We would like to present herein analytical data of blood and fat-tissue samples taken from 50 persons (1999 – 2001) by A. Schecter (U.S) and Olaf Paepke (FDR).

Most of these persons were and are living now in hot spots. Dioxin levels in their fat and blood were found at 1.9 ppt to 413 ppt, the average figure was 76.68 ppt while in pooled blood samples collected in Hanoi were shown 2 ppt average. According to two French scientists, P. Vermeulin and F. Gendreau [9], if in blood dioxin level was 4 ppt, even 1 ppt, this should be considered as unusual and risky for human health and thus the above-mentioned victims should also need urgent and considerate health care.

The Government of Vietnam has conducted surveys and collected initial data on the health status of million of victims as a basic for setting forth policies and schemes guiding the provision of aids to them in their daily life. Several Vietnamese scientists have been involved in conducting epidemiological studies on thousands of victims (at least 50,000), certain number of them were selected for clinical examinations and medically follow-up records.

Based on the results of surveys conducted by Vietnamese in close collaboration with international scientists of Russia, Canada, the U.S or Japan, etc., coupled with those have been recorded by international researchers, especially by those scientists from the United States and the Federation of Russia, we may reach a conclusion that Agent Orange/ dioxin is possible to force anyone to suffer a decrease in immunity, disorders in endocrine system, loss of adaptability and cancers. Many people even go further to say that dioxin may impact genes. Consequently, from these said grounds, we are entitled to determine that the frequency of unusual diseases and percentage of deformed descendants among the Agent Orange-exposed persons reaches higher than that of those who resided in the unexposed areas. This also enables us to further confirm the list of dioxin-related diseases acknowledged by the IOM of the U.S Academy of Sciences.

General Discussion

1) The chemicals used by the U.S in Vietnam, such Agent Orange/dioxin, CS, BZ as mentioned above were in fact mass destruction weapons, not only against the opposing forces but also ignorant civilians (in Vietnam, over 50% of contaminated people were civilians). These toxicants could not only kill people of a generation but also of many next generations (in Viet Nam and in the U.S, many grand-children have been bornas

victims). They could not only kill people, wild animals, poultry but also damage our living surroundings. Toxicants combined with burning substances and B-52s' carpet bombings made up the first "war of ecological annihilation" in the history of mankind, the consequences of which may last as long as 100 years on our environment, and it is still unknown when this will cease to impact on our people.

2) Despite various accidents and events happening in the U.S and the world, and in reality the U.S chemical companies and Government could foresee well the harms of these chemicals, they continued to use them in Vietnam, causing horrible humanitarian tragedies on the Vietnamese people.

3) The United States violated the Customary International Law, Hague Convention of 1907 and Geneva Convention 1925. For this reason, the U.S have to responsibilities and participate in remediating the consequences and paying compensation for the damages towards the Vietnamese people caused by the chemical warfare

References:

1. Stellman JM, Stellman SD, et "The Extent and Patterns of Usage of Agent Orange and Other Herbicides in Vietnam" *Nature* 422: 681 – 687.
2. Myer Chessin University of Montana Military Biology and Biological Agents (pp310).
3. Eitzer B.D, Hites R.A.// *Intern. J. Environ. Anal. Chem.*1986. Vol. 27, N3. P 215 – 230.
4. Westing A H "Herbicides in War: the Long-Term Ecological and Human Consequences", Sipri, 1984.
5. Tran Xuân Thu *et al.*, "Dioxin Chemistry", *Symposium Summary Herbicides in War*, 1984., Stockholm International Peace Research Institute.
6. Vayne Dwernychuck, complete volumes, Committee 10 – 80.
7. Tran Xuan Thu, "Dioxin Contamination in Vietnam's Environments, Vietnam - US Scientific Conference on Human Health and Environmental Effects of Agent Orangedioxin. 2-6/3/2002.
8. Research Documents. Committee 10-80 and Hatfield Consultant Ltd. Canada.
9. L'agent Orange au Vietnam : Crime d'hier, Tragédie d'aujourd'hui (Association d'amitié Franco – Vietnamienne
10. V.A Drill and Hirastzka, *Arch Industr Hyg* . 1953, 7, 61.
11. Paul, L. Sutton, The History of Agent Orange Use in Viet Nam US-Vietnam Scientific Conference on Human Health and Environmental Effects of OA/dioxin 2-6/3/2002.
12. Le Cao Dai , *The Agent Orange in the Vietnam War* , Ha Noi, 1999.
13. Stockholm Covention on POPs, UNEP
14. L.A Fedorov (M.Nauka, 1993), Dioxin as a Ecological Danger Retrospective and Perspective.

