THE NATIONAL KEY SCIENCE AND TECHOLOGY REARCH PROGRAM ON AGENT ORANGE/DIOXIN IN VIETNAM AND ITS PROSPECTIVE COOPERATION

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Introduction

Throughout history, during the war Vietnam was subjected to the widespread spraying of the chemical defoliants Agent Orange, containing the most toxic dioxin congener 2,3,7,8 TCDD[1]. Due to the high adsorptive property and persistency, dioxins are accumulated and remain in environment for a long time. More than 40 years after the war, yet its devastating effects still remain to this day. The poisonous chemical used by the US military at that time left serious and long-term effects on the entire country, its people, nature and environment.

When the war ended in 1975, despite limited socio-economic development conditions, Vietnamese government allotted a big portion of the national budget to study for overcoming and remedy this dreadful problem of the war. Scientific studies and researches were conducted aimed at evaluating the effects of Agent Orange/ dioxin on the environment and the people of Vietnam and provided scientific and practical bases for the government policies in support of the victims of Agent Orange, as well as solutions to proactively prevent and reduce the harmful effects of dioxin on the coming generations. Many projects, programs and studies have been developed by Vietnamese and other international scientists.

This paper overviews the national priority research program on Agent Orange/dioxin for overcoming the war consequences which have been done in recent 5 years in Vietnam. It describes the framework, key objectives, research contents, and achieved results of elements projects of the program. More pointedly, the paper recommend what should be done and opportunities of research cooperation to resolute the dioxin and dioxin - like issues in the coming years.

Materials and Method

Entering the every five year period of National plan on July 25th 2011, the Vietnam government has signed the Decision No 1244/QD-TTg, approving the direction, objectives and tasks of major national science and technology of the period 2011-2015, including the program:"Research to overcome prolonged consequences of Agent Orange/dioxin used by the US military in the war on the environment and the people's health in Vietnam"

Office of National Steering Committee 33 designated by the National Steering Committee 33, the Ministry of Science and Technology, has cooperated with relevant ministries, divisions and sectors to develop the framework of scientific research program, list of the research topics under the program to be implemented during the period of 2011 - 2015, established panels to select organizations and individuals to lead such researches, appraised the cost proposals and submitted to the Government of Vietnam for approval. The framework of the program contains the following key points:

1. The main objectives of the program:

1.1. To assess long term consequences of Agent Orange/dioxin on the environment and the ecosystem; propose solutions to prevent contamination spreading and to remediate the contaminants;

1.2. To assess long term consequences of Agent Orange/dioxin on human health; propose solutions for treatment;

1.3. To study and propose solutions to complete the policy on overcoming the consequences of Agent Orange/dioxin;

2. The key research contents of the program**:**

2.1 The environment field includes the following items:

- To study the residue and spreading possibility of dioxin; propose the solutions to overcome;
- To study the changes of the eco-environment due to Agent Orange/dioxin;
- To study the typical differences between dioxin originated from the war and dioxin originated from other sources;
- To select remediation technologies suitable to the conditions of Vietnam; and

- To study and propose the dioxin and dioxin-like substances contamination management models.

2.2 In terms of healthcare, the following items are focused on:

- The variations of health, diseases and dioxin concentration;
- The study for adoption of prenatal diagnosis, consultancy for reproduction and birth defect in Agent orange/dioxin heavily contaminated areas;
- Psychological support and rehabilitation for victims of Agent Orange /dioxin;
- Genetic, chromosome, hormone and immunity modification of those who have high dioxin concentration in their bodies;
- Studies for adoption of nonspecific detoxification for those who exposed to Agent Orange/dioxin;
- Disease mechanism of Agent Orange/dioxin victims and provide a basis for the identification of victims of Agent Orange/dioxin.

2.3 In terms of policies - society:

- Additional study to complete policies for victims of Agent Orange/ dioxin;
- The study on legal basis and the ways to request the US Government and its chemical companies to be responsible for the consequences of Agent Orange/dioxin in Vietnam.
- The study and proposal solutions for people living in heavily contaminated areas;

Results and discussion

Between 1961 and 1972, during Operation Ranch Hand in the Vietnam War, the U.S. Military had sprayed about 77 million liters of herbicides in order to deny their military enemy[1]. It has been estimated that sprayed areas over 2.63 million hectares of South Vietnam (Fig 1), of which 51.6 million liters of substances contained dioxin (67%) with 366 kg of dioxin over 1.68 million hectares. Consequently, more than two million hectares of forests were devastated by the effects of the herbicides used at high concentrations[2]; the healths of millions of people were severely affected under long impact of dioxin.

The research places were selected dioxin contaminated areas in the southern part of Vietnam, especially in three dioxin hotspots where the U.S. Military used as serve for Operation Ranch Hand such as the airbases: Bien Hoa, Da Nang, Phu Cat (Fig 1).

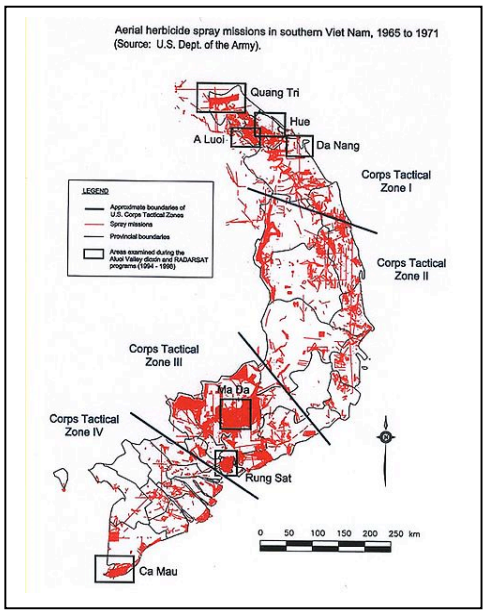

Fig.1. Herbicides sprayed areas at the Southern Vietnam during Ranch Hand Operation

There were 13 research projects which focused on different field, such as environment, medical and human health and social policies. The results of program were showed through these projects as following as:

The field of Environment

- The result determinate dioxin residues levels in soils, sediments and water reservoir of different areas where were sprayed and stored herbicides during the war. Dioxin residues have decreased over time; however, 40 years after the war, high concentrations of dioxin still remain in South Vietnam soils. Moreover, it was found a quite different pattern of dioxin congener profile in samples from herbicides/Agent Orange contaminated areas and from industrial zones. It suggested that the characteristics between dioxin from the war and those from other man-made sources can be the different pattern of congener profile. Moreover, the high contribution of 2,3,7,8 TCDD to total TEQ was found in most samples collected in dioxin hotspots (up to 90%). While, contribution of 2,3,7,8 TCDD to total TEQ was less than 10% in samples collected in industrial zone (Fig.2).

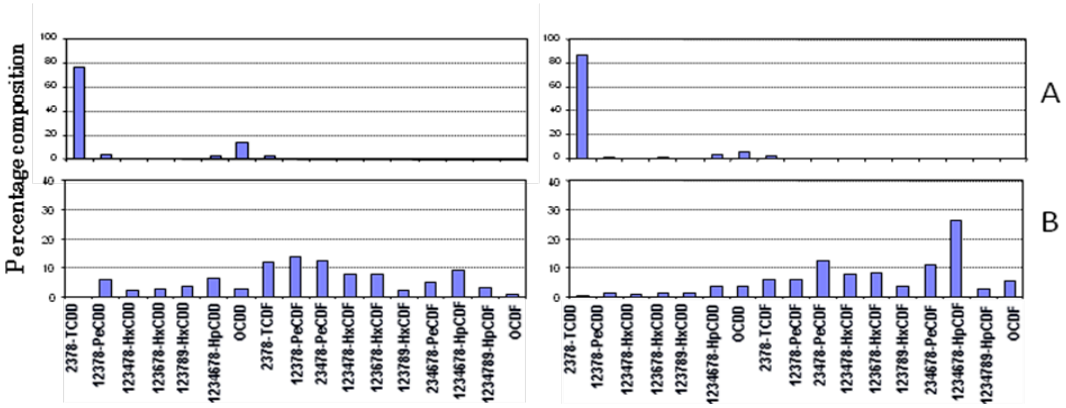

Fig.2: Homolog profile PCDD/Fs in different samples from Agent Orange/Dioxin contaminated hotspots and industrial sources in Vietnam. Vertical bars represent the percentage of each homolog to total PCDD/Fs concentrations.(A: sample location at Bien Hoa airbase and B: sample location in Bien Hoa industrial zone)

• The project research on technology to remediate dioxin in contaminated soils has implemented by the Institute of Military Chemistry and Environment (Ministry of Defense). The result found the integrated technology, which is the combination of soil washing by the surfactant solution and chemical-physiochemical treatment and oxidation at low temperature with the presence of catalysts, could reduce considerably the volume of contaminated soils, requiring the treatment. With the smaller volume, the treatment is easier, more effective and cost-reduced. The complete treatment of Orange/Dioxin is highly effective and meets all requirements of the contaminated sites because of the selection of suitable surfactants, combined with using nano Fe^0 as a chemical agent, activated carbon AC_4 as an adsorbent for the pollutants in the solution and nano CaO/Fe_3O_4 and Fe_3O_4 as catalysts for thermal treatment.

Medical and human health

• Using methodology of Fractionating total DNA and analyzing genome order of new Sanger generation on the automatic ABI PRISM 3730XL, a genetic research project analyzed of the genome of three individual under one family with the characteristics as follows: the father was an veteran in Quang Tri from 1968 to 1974, has high concentration of dioxin in his blood; the mother gave birth six times; 3 children suffered from liver diseases and died at the ages of 2-4; other child died because of liver disease at the age of 15; one other child with mental problem. It was found total of polymorphic points/single mutation between the father and the child are 347,357 points (in which there are 217,233 points announced by other researches to DBSNP bank with 30,123 points have not been announced by any authors before; 124,381/347,357 mutations are located in the functional area; the remaining are located in the area where functions are unknown). Total of polymorphic points/single mutation between the mother and the child are 558,255. In which, there are 57,487 points which have never announced before. 88 single nucleotide polymorphisms (SNP) have been identified of germ cell in the child.

• Some studies have determined exposure levels to Agent Orange and TCDD by analyzing human tissue samples, usually blood, breast milk, fat tissues from people who may have been exposed and compare the presence of TEQ levels to a control group who presumably were not exposed. A recent survey found evidence of elevated 2,3,7,8 TCDD levels in blood of children who have birth defect and living in vicinities of Da Nang and Bien Hoa airbases. Among these blood sample, the highest concentration of TCDD in vicinity of Da Nang was found to be 365, 99 pg/g lipid12 which more than 100 times globally acceptable levels. Other study showed levels of PCDDs/Fs in the breast milk of mothers residing near Da Nang airbase were threefold to fourfold higher than those in the breast milk of mothers living in unsprayed areas, and that infant daily dioxin intake of Vietnamese infants in hot spots were estimated to be twofold to threefold higher than the recently documented values in US and Japanese infants. Moreover, its clarify the effects of dioxin exposure on thyroid function of general population who living near Da Nang and Bien hoa airbases.

• A study focused on the disease pattern, birth defect and pregnant failure of local habitants of living near hotspots. The result showed that the pattern of abnormal diseases is most frequent of nervous system (Peripheral neuropathy), birth defect, digestive system, respiration cancer, and skin cancer. The studies demonstrate that there are 13 item of birth defect which appears frequently in children living at vicinities of Bien Hoa, Da Nang and Phu Cat airbases. High rate of birth defect found in nervous system, cerebral, the next is hare lipped and then embryotocia, stillbirth congenital heart, paraplegia.

• The study with using questionnaire for mental and psychological tests (test to assess attention capability, test to assess short term memory, test to assess emotional tension, intelligence test, test to assess level and capability of communications, dignity test and test to assess capability of logical thinking) was conducted for 500 people exposed to dioxins in Bien Hoa (with the group lived in the war of 412 person and other ordinary people of 88 person). The result found the problem of cognitive impairment (14.8 % of heavily impairment, 29.2% average impairment and 56% slight impairment; over 50% of those do not meet the normal limit in all tests; with intelligence and emotion tests having the highest percentage (over 80%); Most of the victims having at least one symptom in terms of behavior, mentality; 46.6% having trouble with emotional disorder; 86.4% having symptoms of nerve; 24.0% depression; 23.6% hallucination; 26.8% having trouble with behavior disorder at night.

• The study on hormone modification was randomly selected 200 people in the ages from 20-50 who currently living around Da Nang and Bien Hoa Airbase. Blood was collected from those people to analyze dioxins and hormone content of four main glandules sine duct in their bodies: thyroid gland, suprarenal gland, gonad and pancreas. The initial results show that dioxin contents in those people are at high level, especially TCDD congeners. Of 51 analyzed samples using GCMS method, the highest TCDD content is 641 pg/g lipid. It was found the relationship between dioxin content in blood with a number of hormones. This shows that dioxins can change some normal activities of glandule sine ductibus leading to abnormality in synthesis and transformation of hormones, thus entailing health risks and disease conditions of those who are exposed to dioxins.

• The study on nonspecific detoxication was subject: 34 people (24 male and 11 female) near Da Nang Airport; having been identified as exposed to dioxins. Treatment method: Nutrition, multivitamin, mineral, olive oil; sauna; exercises; with the duration of 03 weeks. Indicators observed before and after treatment: clinical, preclinical, dioxin analysis in blood. Clinical and paraclinical indicators have been remarkably improved.

Conclusion

After 4 years (2011-2015), this program have been gaining many achieved results and contribute to estimate hazardous impacts of dioxin on environment and human health as well as provides a scientific basic for policy making process in order to overcome the consequences of the war.

The scientific and technological products of the program are follows:

- Reports on assessment of dioxin residue and spreading (in soil, sediment, pond and lake); the changes in ecological conditions in hotspots; Changes in terms of diseases, health, and the connections with dioxin exposure; negative impacts of genetic, chromosome, hormone and immunity modification; evaluation of policies for victims of Agent Orange.
- Solution for overcoming such as remediation and detoxification of dioxin in soil, preventing dioxin spreading, monitoring and supervising dioxin; recovering of environment, providing mitigation measures and developing sustainable development models at hotspots; selection of suitable technologies and transference of dioxin and POP remediation technologies in Vietnam.
- Nonspecific detoxification methods for those who exposed to Agent Orange/dioxin; Organizing identification, consultancy and early interference to reduce birth defect in hotspot areas;
- Adjusting and supplementing policies for victims of Agent Orange; providing database for overcoming.

On the basic of results of research program, we believed that it need to be implemented further studies on the environmental health, which can be insight the links between effect of dioxin to environment and from environment to human health. Moreover, it should be expand and focus more deeply in hormone study and put it under the context of neurologic and mental disorder, immunity, reproductive failure, birth defect, cancer and the dioxin content development in body; Continue studying genome modification caused by dioxins. Longitudinal observe those who are exposed to dioxins.; find out the suitable technology to rehabilitation for Rural Areas in Vietnam Affected by Dioxins; Monitor and assess environmental health related to dioxin./.

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