The Eleventh Conference on Remediation of Chlorinated and Recalcitrant Compounds

April 8 – 12, 2018, Palm Springs, CA

BATTELLE

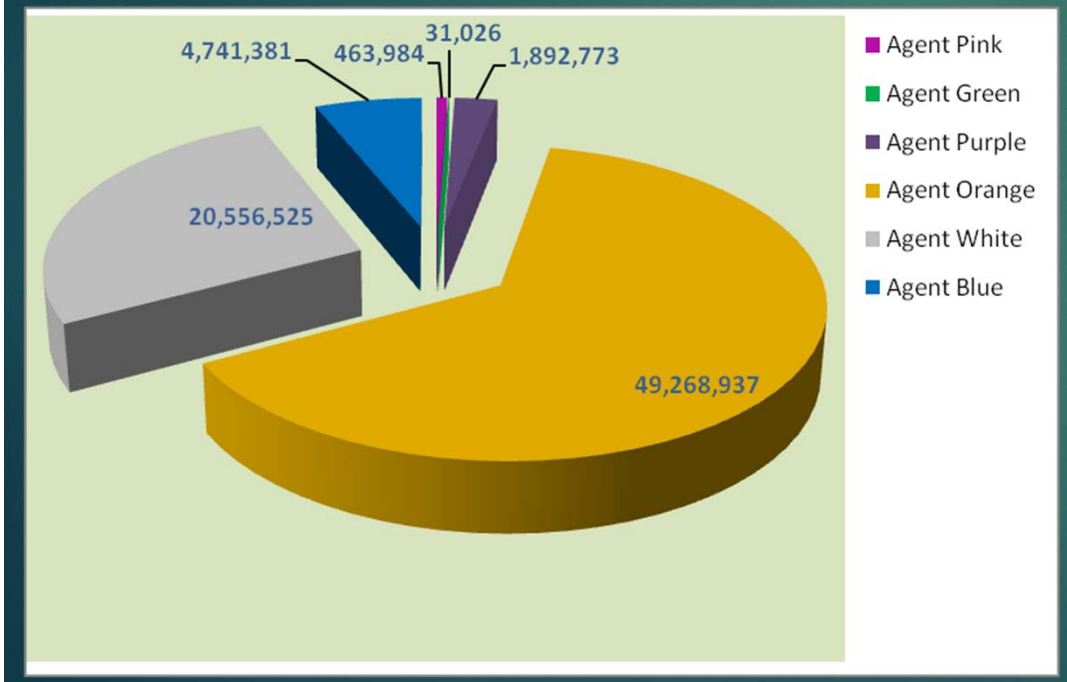
Bioaccumulation of PCDD/Fs in Foodstuffs Near Bien Hoa and Da Nang Airbases: Assessment of Sources, Environmental Distribution and Intake in Humans

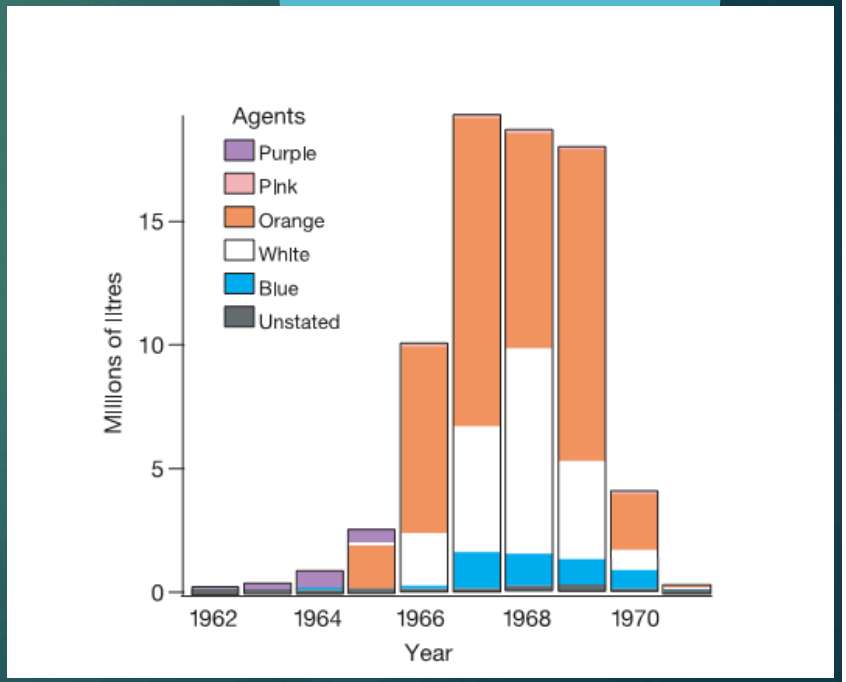
Nguyen Hung Minh, Nguyen Thi M Hue, Nguyen Van Thuong, Tran Manh Tri, Tran Thi T Hanh, Tu Binh Minh

Corresponding address: Lab.dioxin@gmail.com

Historical Usage of Herbicides During the US-Vietnam War

- From 1961 to 1971, the United States used approximately 76 million liters of herbicides as defoliants and for crop destruction in Southern Vietnam
- 64% of the herbicides used In Viet Nam was Agent Orange which contained 2,4-D and 2,4,5-T as the active ingredients. Dioxins (PCDD/Fs) were by-products of the production process. Approximately 600 kg of TCDD was released into the environment.

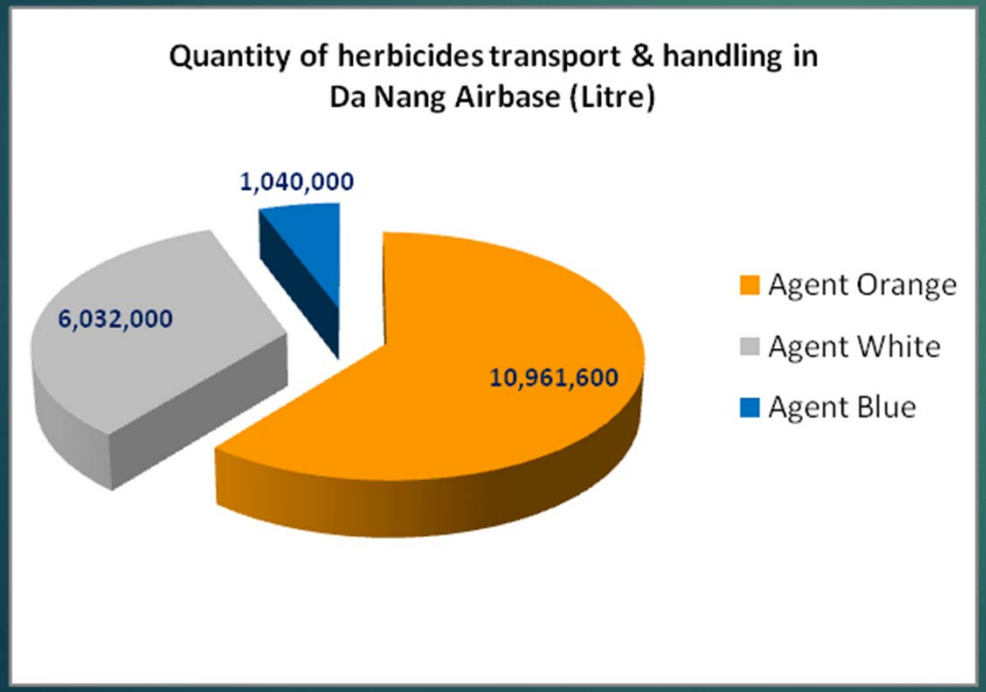




(Stellman et al., 2003; Alvin L. Young., 2009)

Transport and Handling of Herbicides on Da Nang Airbase

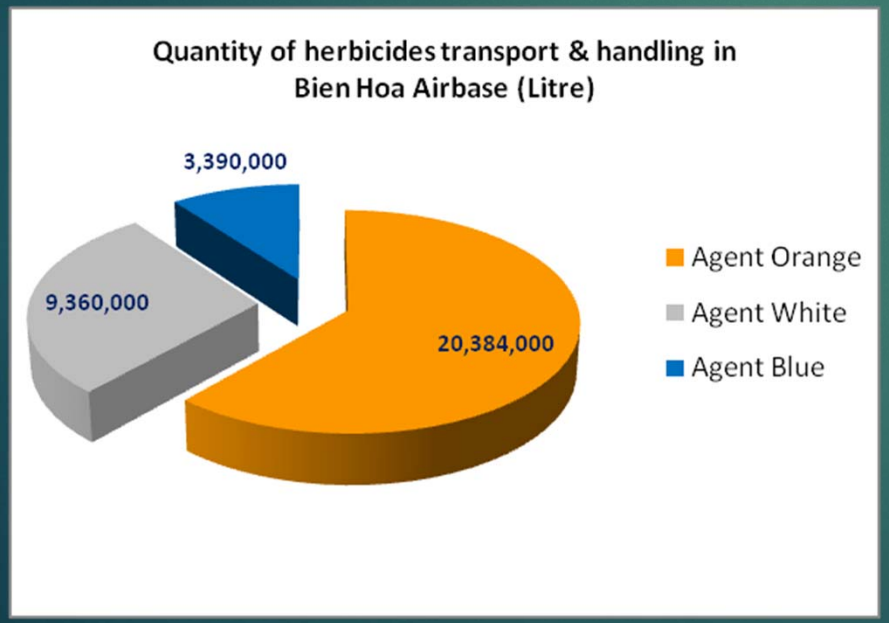
- During Operation Ranch Hand, more than 18 million liters of herbicides were transported and handled on Da Nang Airbase
- As part of the Pacer Ivy Mission (collection and disposal of herbicides to Johnstone Island), about 8200 drums of AO were re-packaged and shipped from Vietnam
- Handling and spillage of herbicides during Operation Ranch Hand and the Pacer Ivy Mission resulted in serious contamination



(Alvin L. Young., 2009)

Transport and Handling of Herbicides on Bien Hoa Airbase

- Dec. 1966 – Feb. 1970: more than 33 million liters of herbicides (mostly Agent Orange) were transported and handled at Bien Hoa Airbase
- Apr. 1970 – Mar. 1972: During the Pacer Ivy mission, approximately 2.3 million liters of herbicides were collected and re-drummed for shipment and disposal.
- As the largest AO storage area in Viet Nam, handling and use of herbicides resulted in extensive dioxin contamination in the environment in and around Bien Hoa Airbase



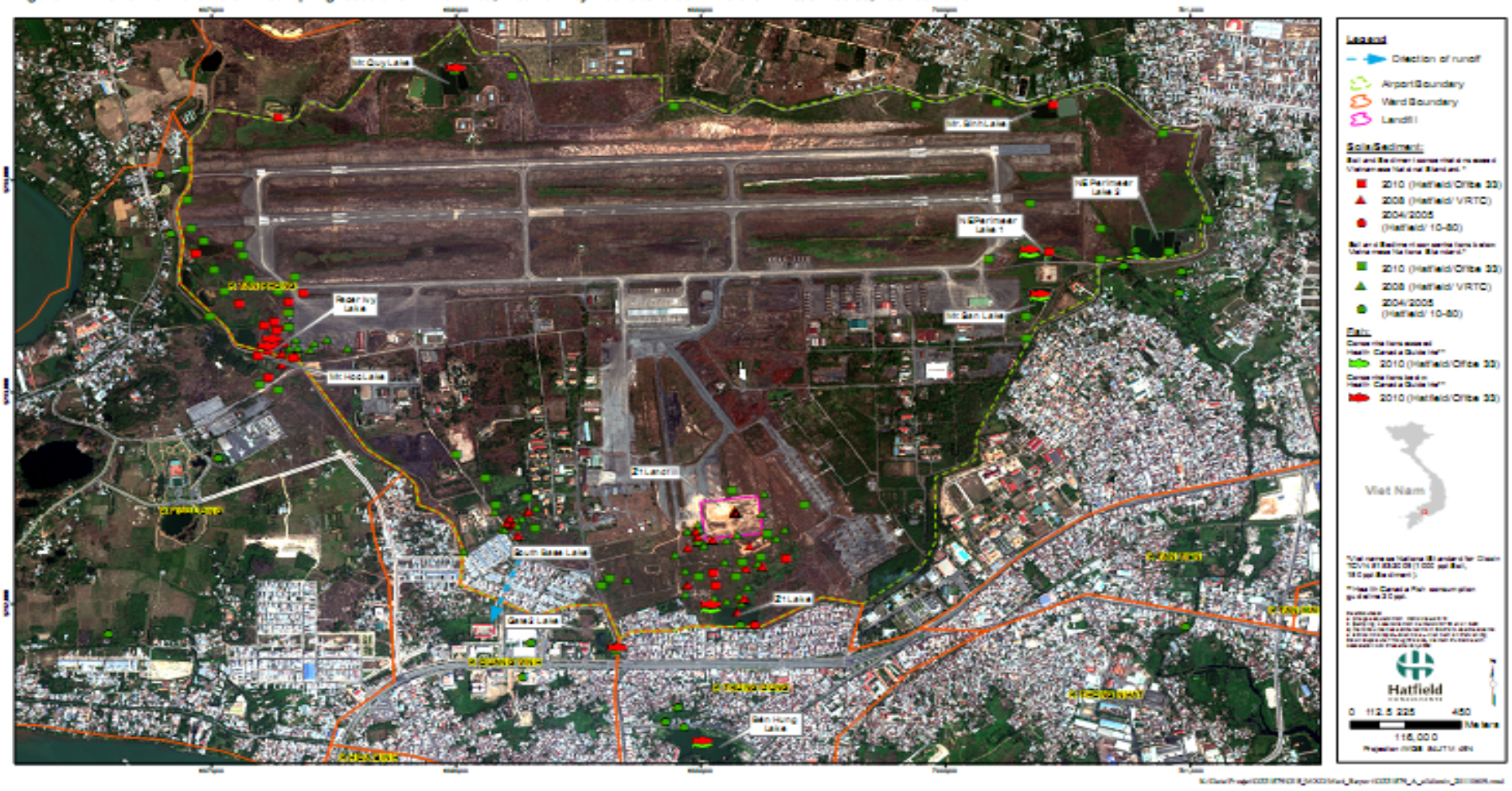
(Alvin L. Young., 2009)

Dioxin Contamination at Da Nang Airbase

(Source: Hatfield Consultants, 2009)

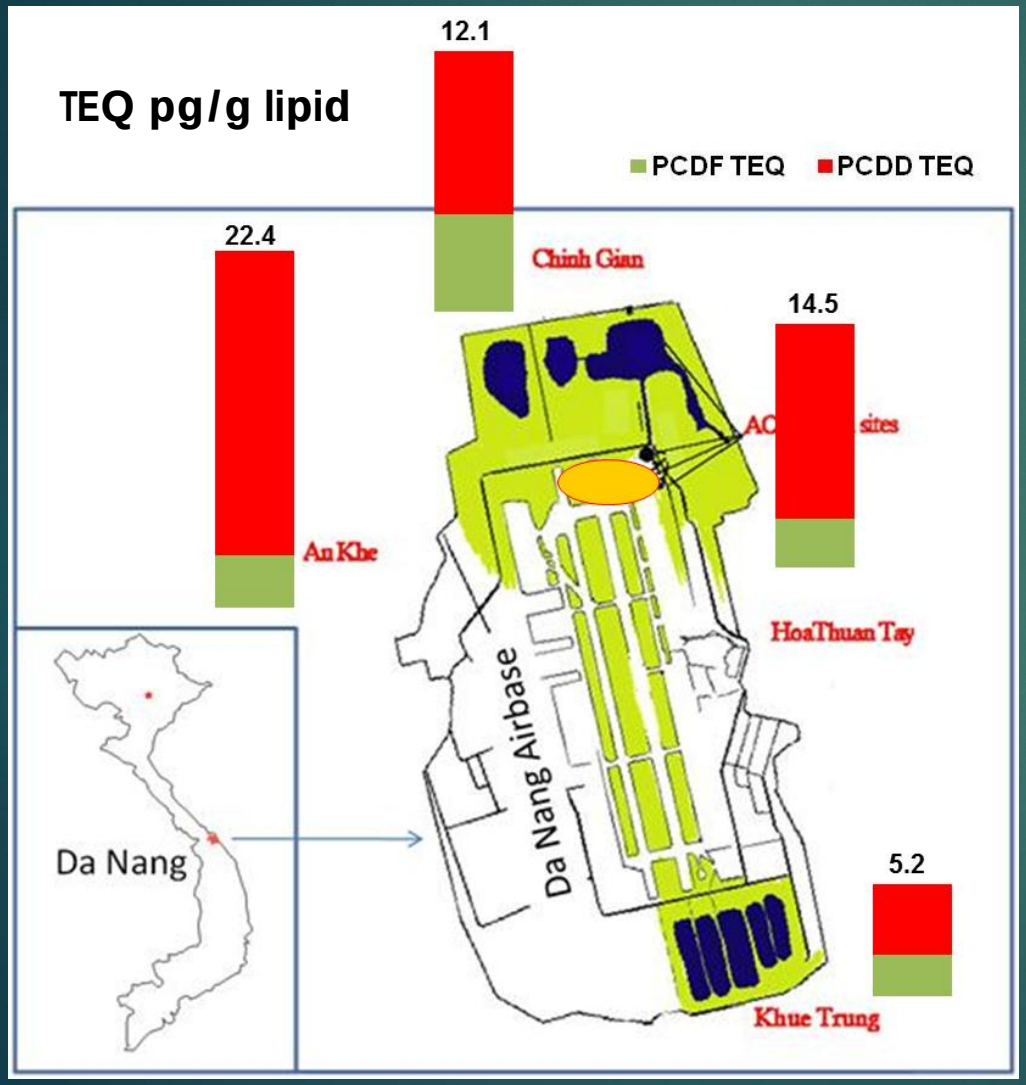
Dioxin Contamination at Bien Hoa Airbase

Figure 1.1 Overview of all dioxin sampling locations in Bien Hoa, Viet Nam by Hatfield/10-60 Division/VRTC/Office 33, 2004 to 2010.



(Source: Hatfield Consultants, 2010)

Dioxin Concentrations in Mother's Milk Samples Collected near Da Nang Airbase



TEQ levels ranged from 5.2 – 22.4 TEQ pg/g lipid

Khue Trung < Hoa Thuan Tay < < Chinh Gian < An Khe

TEQ levels in mother's milk were several times higher compared to those recorded in non-exposed areas (Tai et al., 2011)

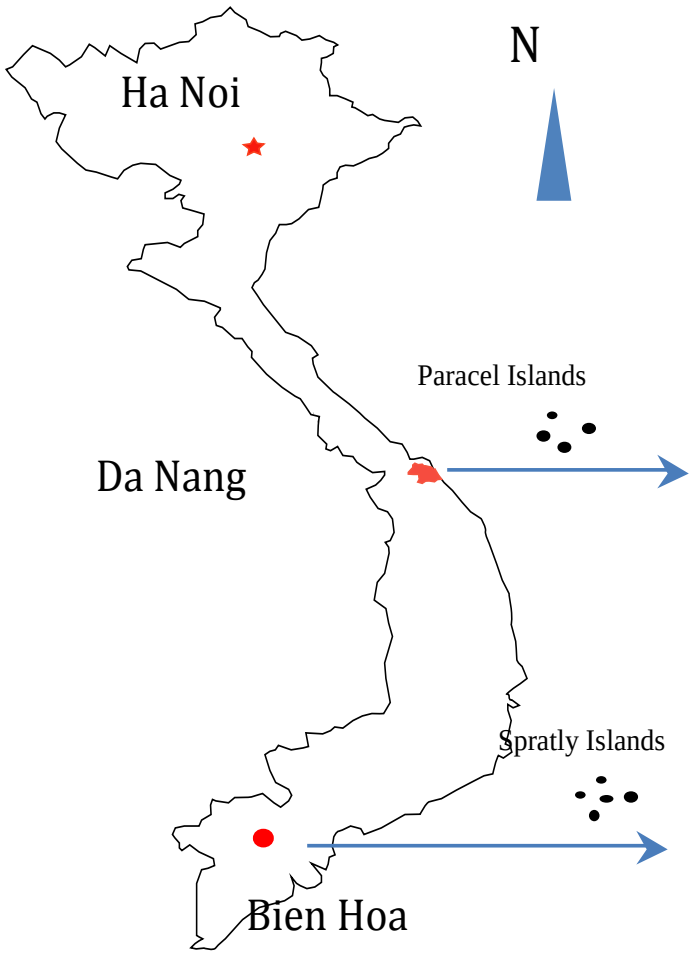
Research Objectives

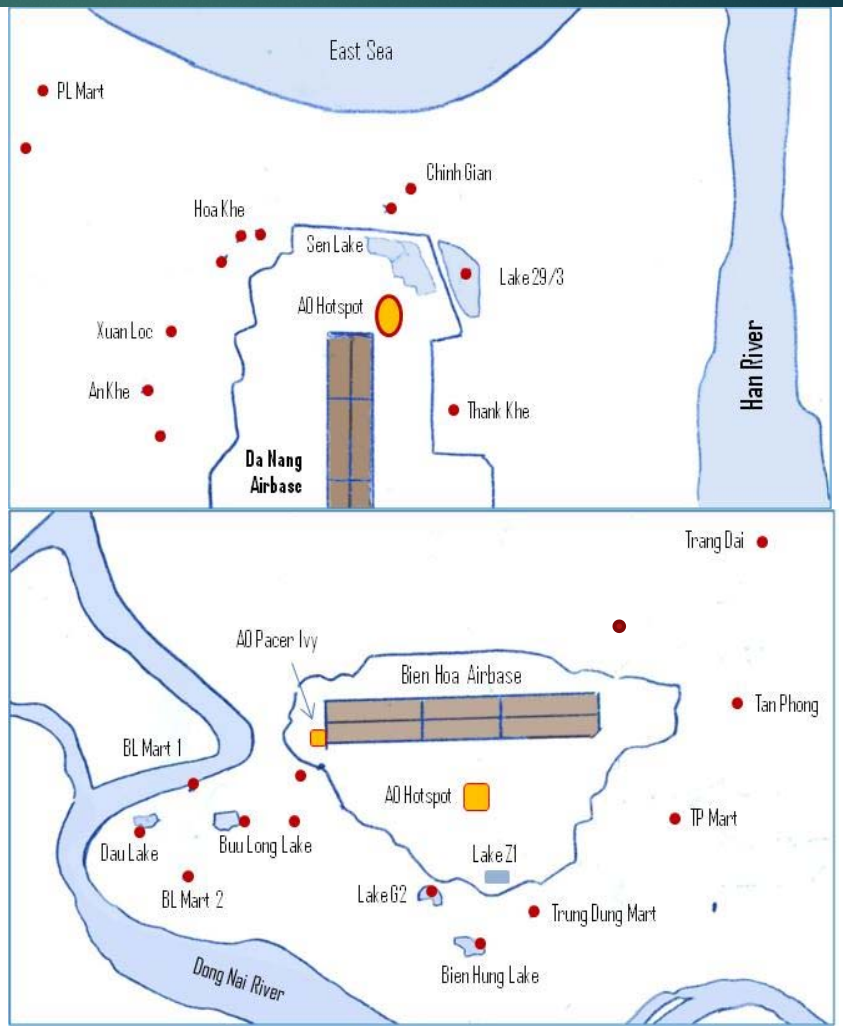
- Although bioaccumulation of dioxin in the local population has been recorded, there is lack of information regarding exposure pathways of dioxin into people.

Objectives:

- Examination of PCDD/F spatial distribution and their specific bioaccumulation.
- Estimate the human exposure doses of PCDD/Fs through consumption of major food items.
- Better understand the fate and transport of these toxic chemicals, and recommend effective interventions for specific areas.

Sampling Locations Near Da Nang and Bien Hoa Airbases

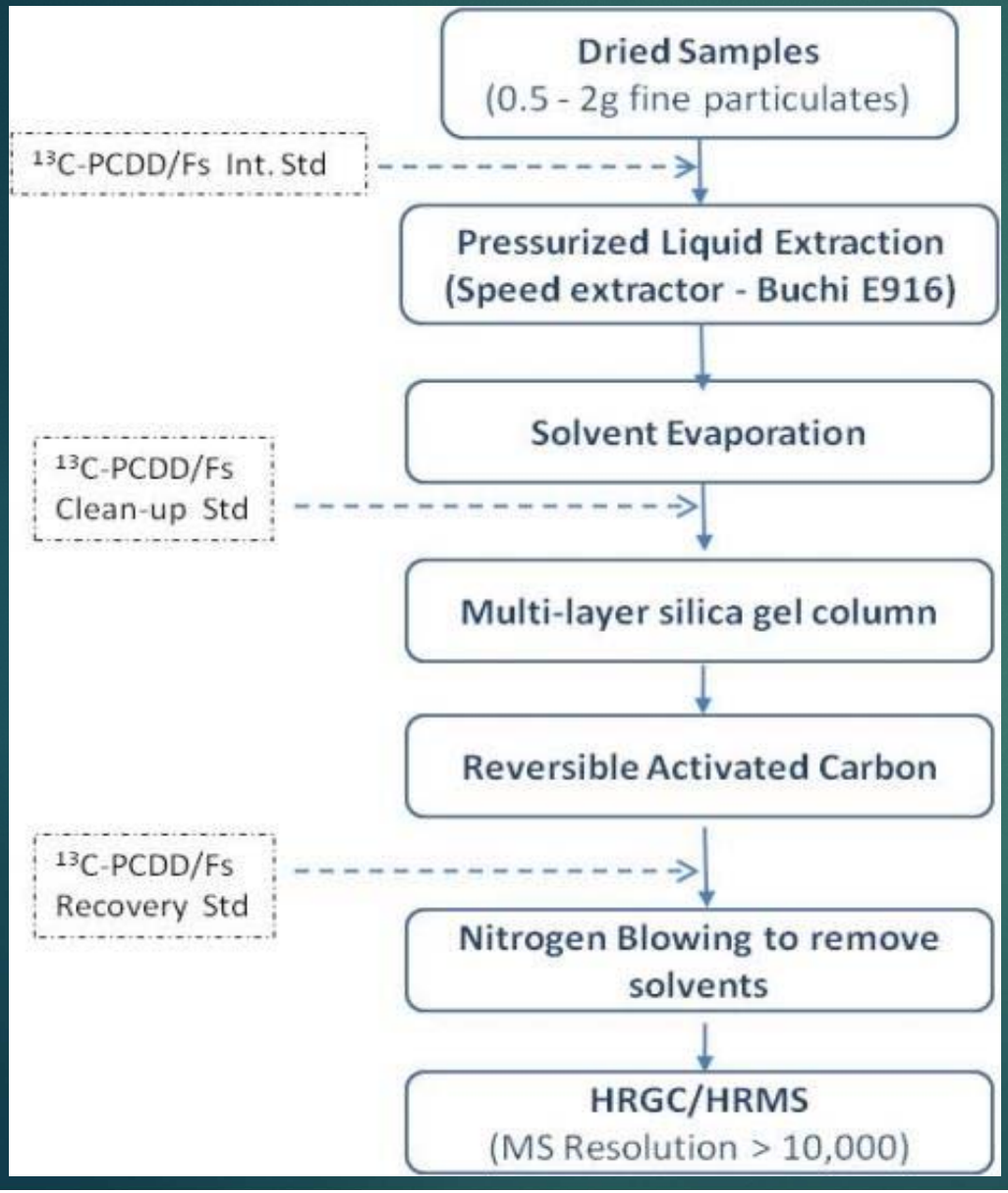




Samples Collected and Analyzed

- 43 samples of various important food items: pork, beef, chicken, chicken egg, fish, rice, vegetables
- Edible portion of samples were selected for analysis.
- For small food items such as leafy vegetables, fish and rice, samples were composited by combining individual samples to obtain least 200 g for analysis.
- Samples were kept on dry ice and transported to the laboratory.
- Samples were processed, freeze-dried and homogenized before analysis.
- PCDD/F concentrations in vegetables and rice are presented on a dry weight basis, and for tissues on a lipid weight basis

Analytical Methods



Quality Control

- Laboratory blank samples, laboratory duplicate samples
- Followed UNEP interlaboratories program
- Cross-checked analysis with Eurofins Laboratories Germany
- Operation in accordance with **ISO 17025** (approved number VILAS 545)
- Other QC Assessments conducted by independent consultants

Member of ILAC/APLAC MRA

CHỨNG CHỈ CÔNG NHẬN

Certificate of Accreditation

Phòng thí nghiệm: BAN QUẢN LÝ DỰ ÁN XÂY DỰNG PHÒNG THÍ NGHIỆM DIOXIN
TỔNG CỤC MÔI TRƯỜNG

Laboratory: PROJECT MANAGEMENT UNIT FOR ESTABLISHMENT OF DIOXIN LABORATORY
VIET NAM ENVIRONMENT ADMINISTRATION

Địa điểm PTN/ Lab location:
Số 556 Nguyễn Văn Cừ, Long Biên, Hà Nội
Số nhà 6, Ngõ 560 Nguyễn Văn Cừ, Long Biên, Hà Nội

đã được đánh giá và phù hợp với các yêu cầu của
has been assessed and found to conform with the requirements of

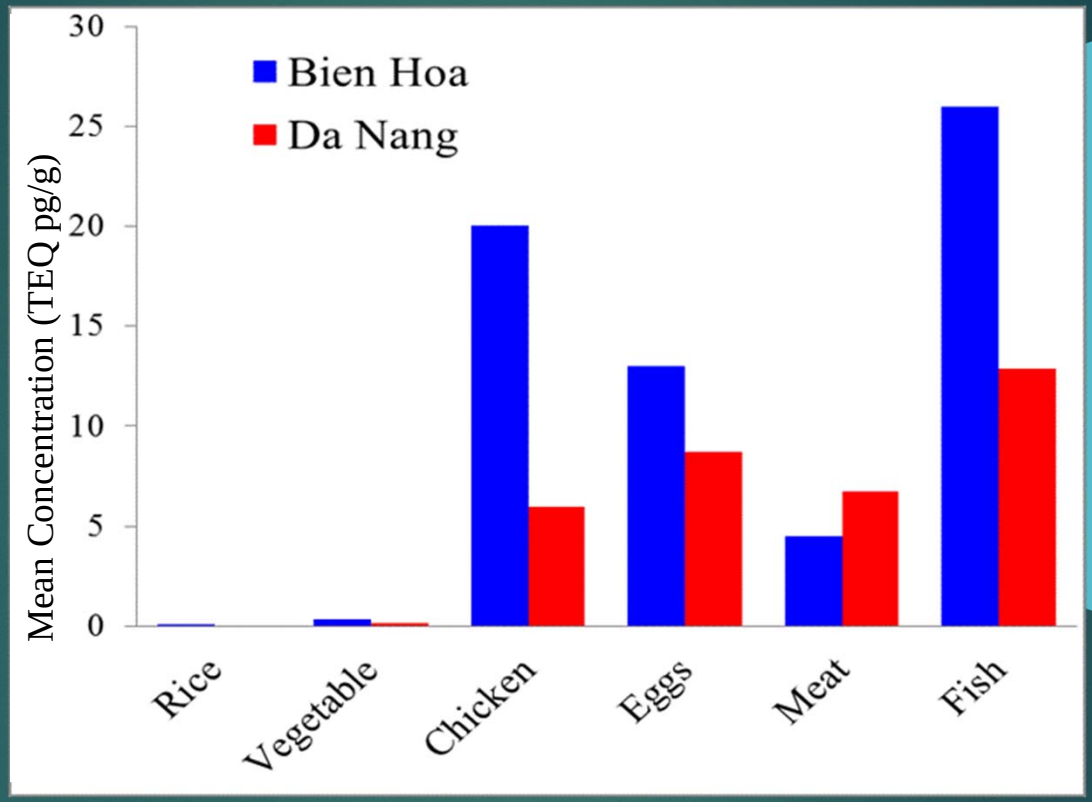
ISO/IEC 17025: 2005

Lĩnh vực công nhận
Field of Accreditation
HÓA
Chemical
Mã số
Accreditation No
VILAS 545

GIÁM ĐỐC
VĂN PHÒNG CÔNG NHẬN CHẤT LƯỢNG
(Director of Bureau of Accreditation)

VŨ XUÂN THỦY

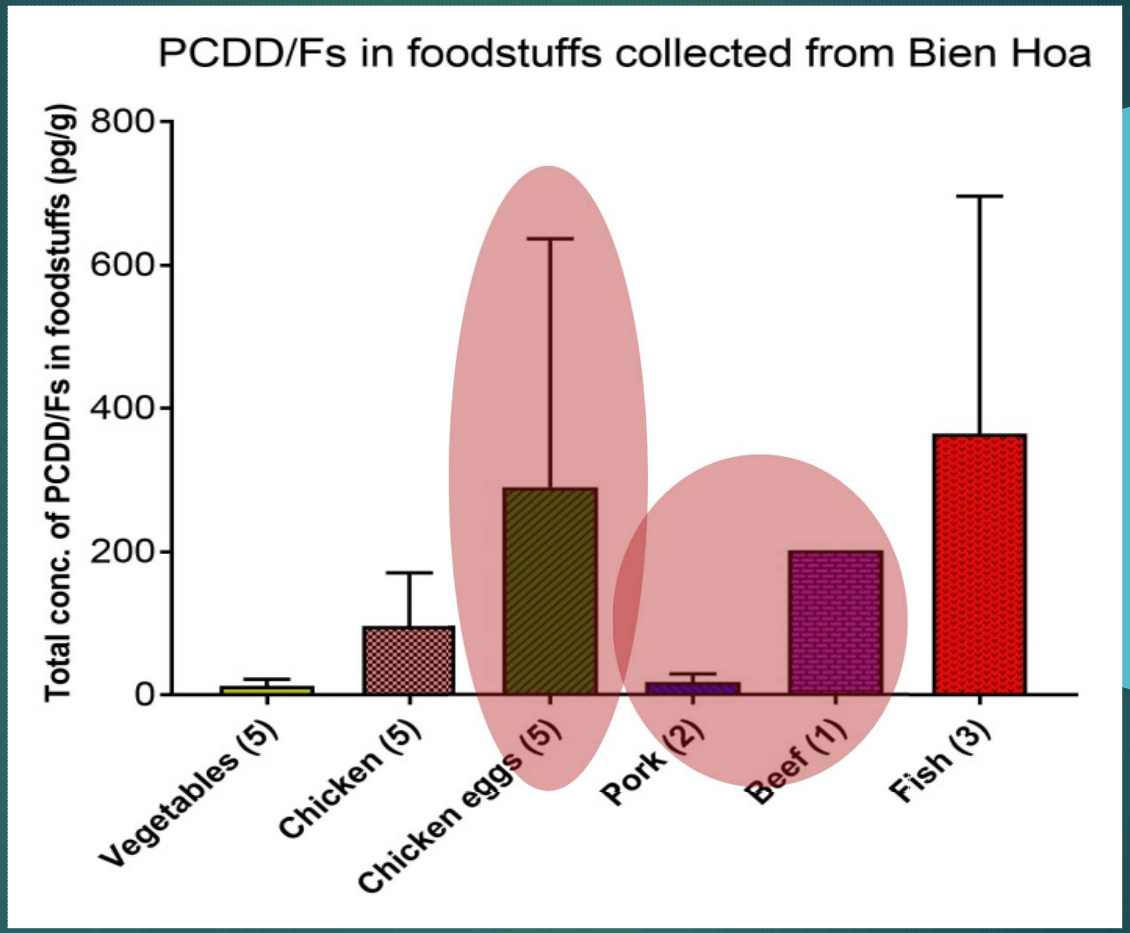
Dioxin (TEQ, pg/g) in Food items from Outside Bien Hoa and Da Nang Airbases



Bien Hoa airbase: Fish > Chicken > Egg > Pork/Beef > Veget > Rice

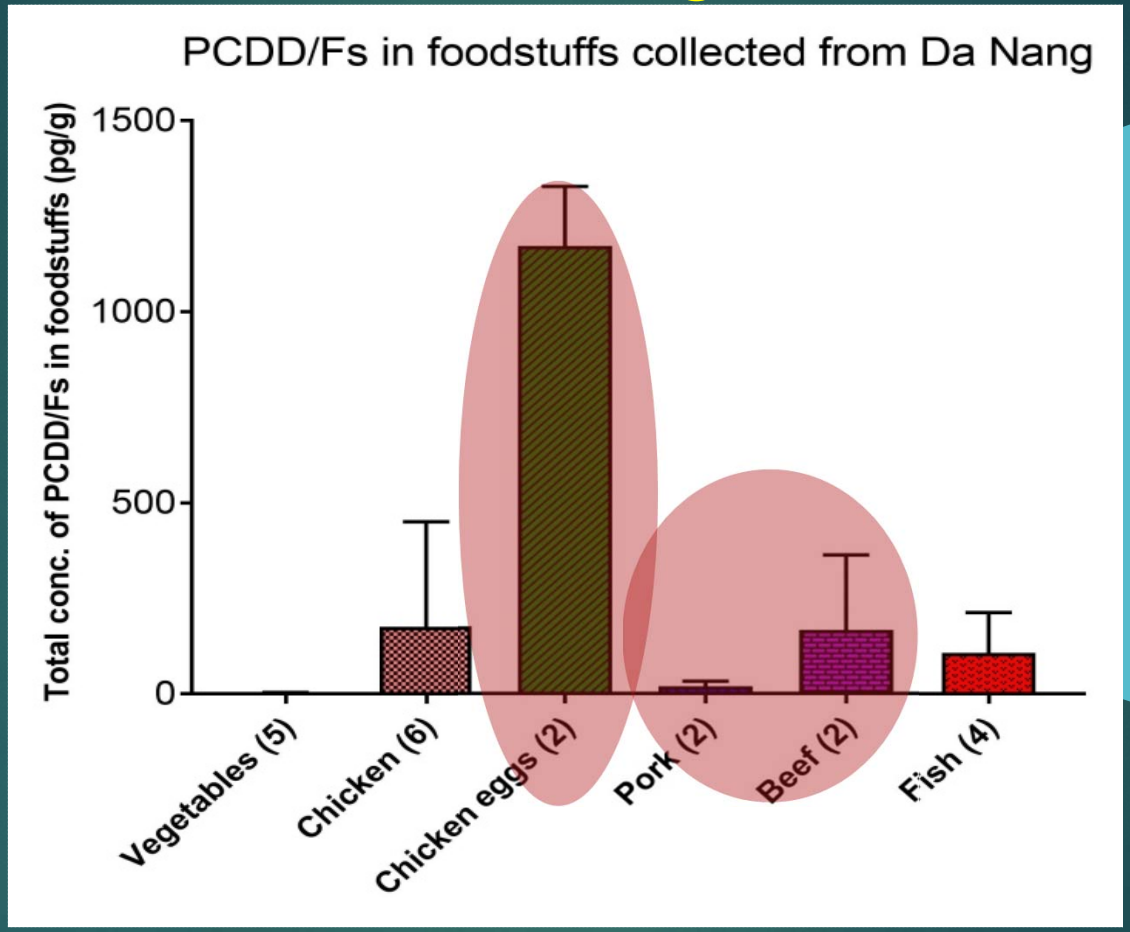
Da Nang airbase: Fish > Egg > Chicken > Pork/Beef > Veget > Rice

Mass Concentration of PCDD/Fs in Food Items Bien Hoa



In terms of mass concentration, PCDD/Fs in Bien Hoa dominated by OCDD
PCDD/Fs in beef are higher than in pork
PCDD/Fs in chicken egg are higher than in chicken

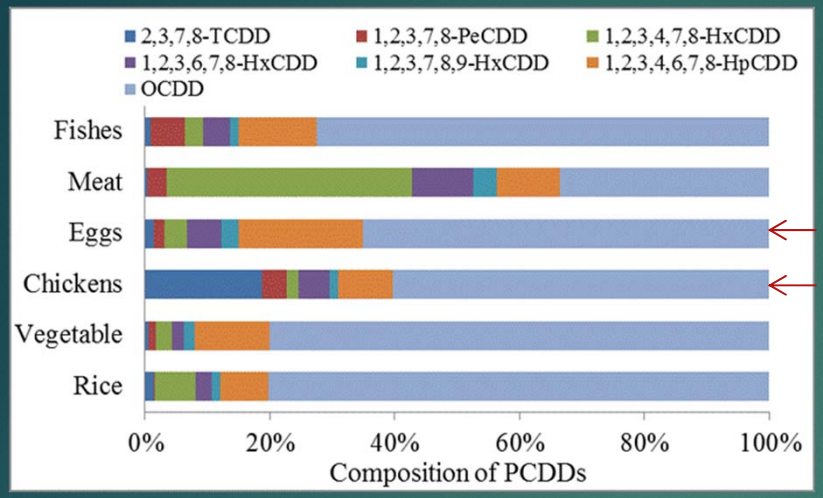
Mass Concentration of PCDD/Fs in Food Items Da Nang

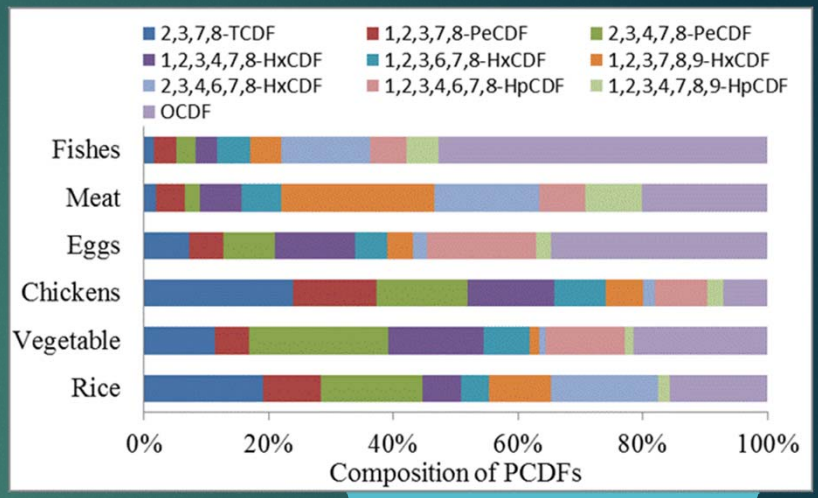


On mass concentration: PCDD/Fs in Da Nang dominated by OCDD
PCDD/Fs in beef is higher than in pork
PCDD/Fs in chicken egg is higher than in chicken

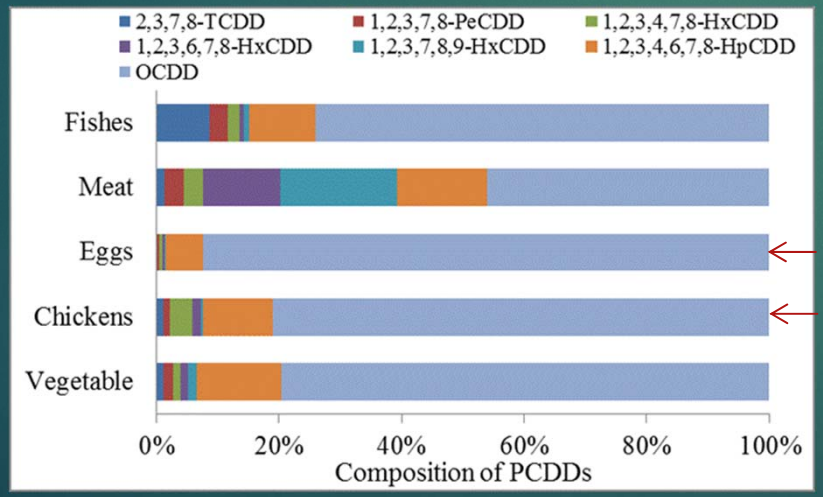
Composition of PCDD/Fs in Food Items

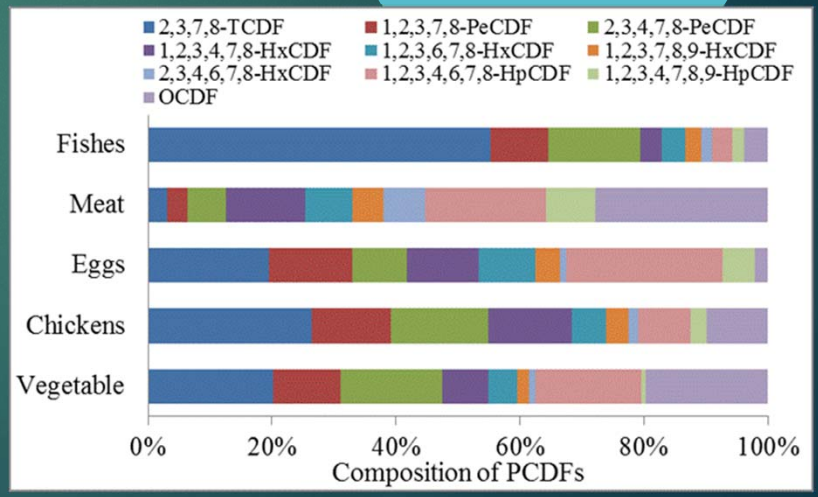
BHA





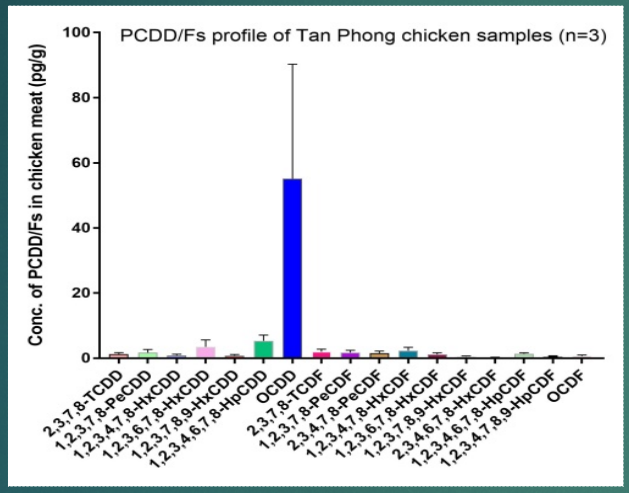
DNA

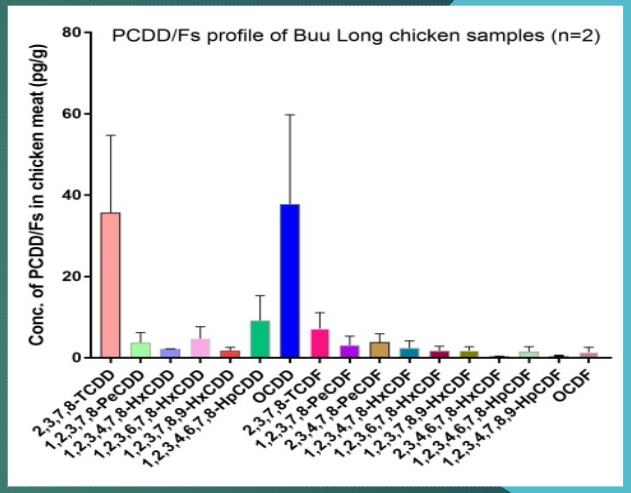


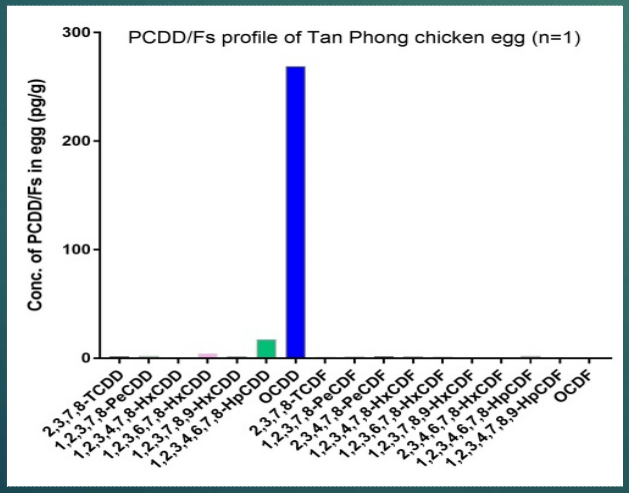


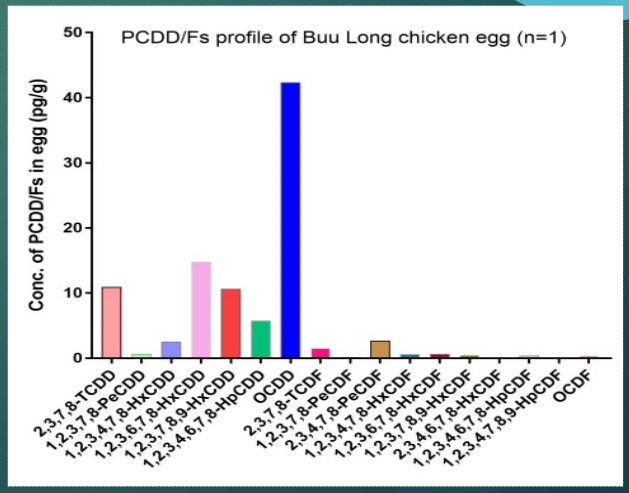
Accumulation Pattern of PCDD/Fs in Food Items

Congener profiles for PCDD/Fs in food items vary in some areas, especially for chicken and chicken eggs in Tan Phong and Buu Long

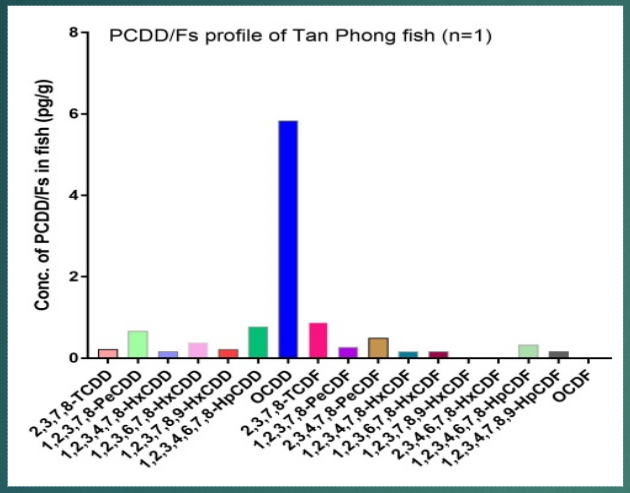


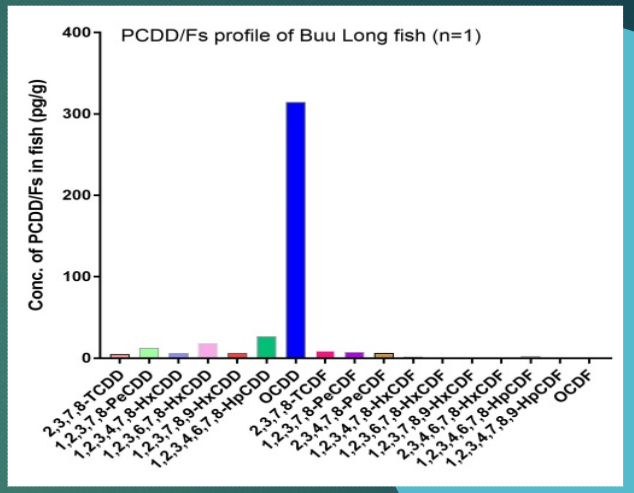


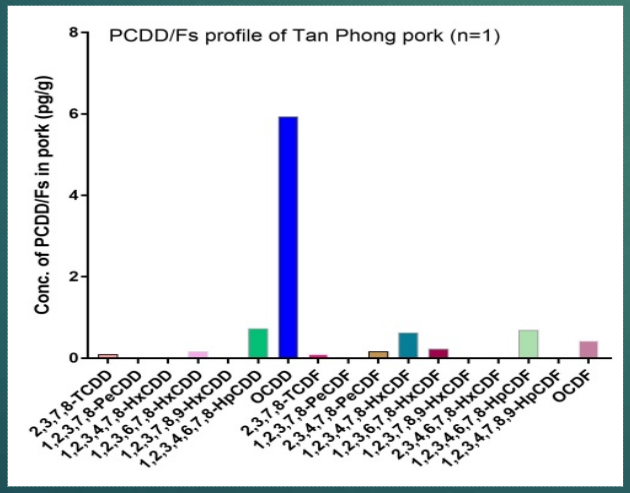


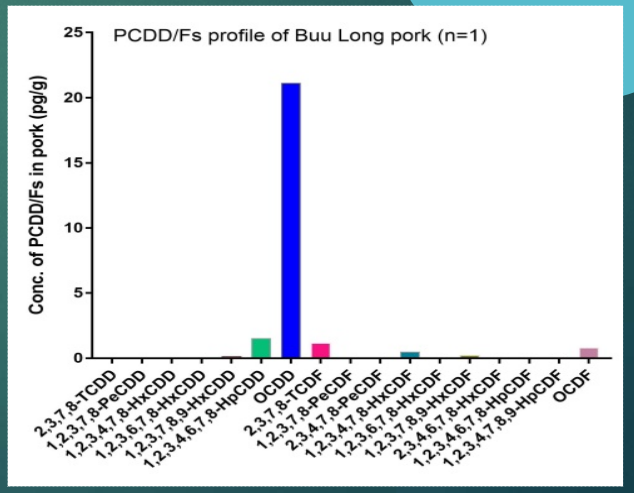


Accumulation Pattern of PCDD/Fs in Food Items

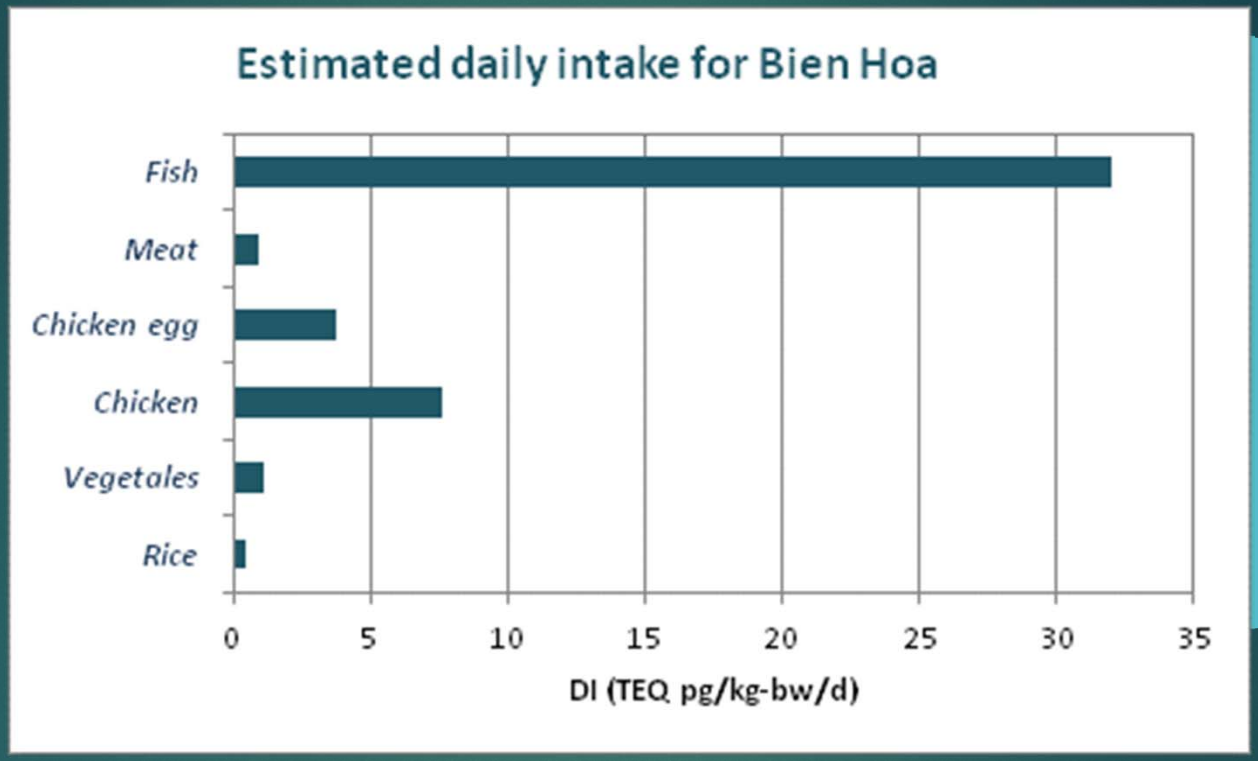






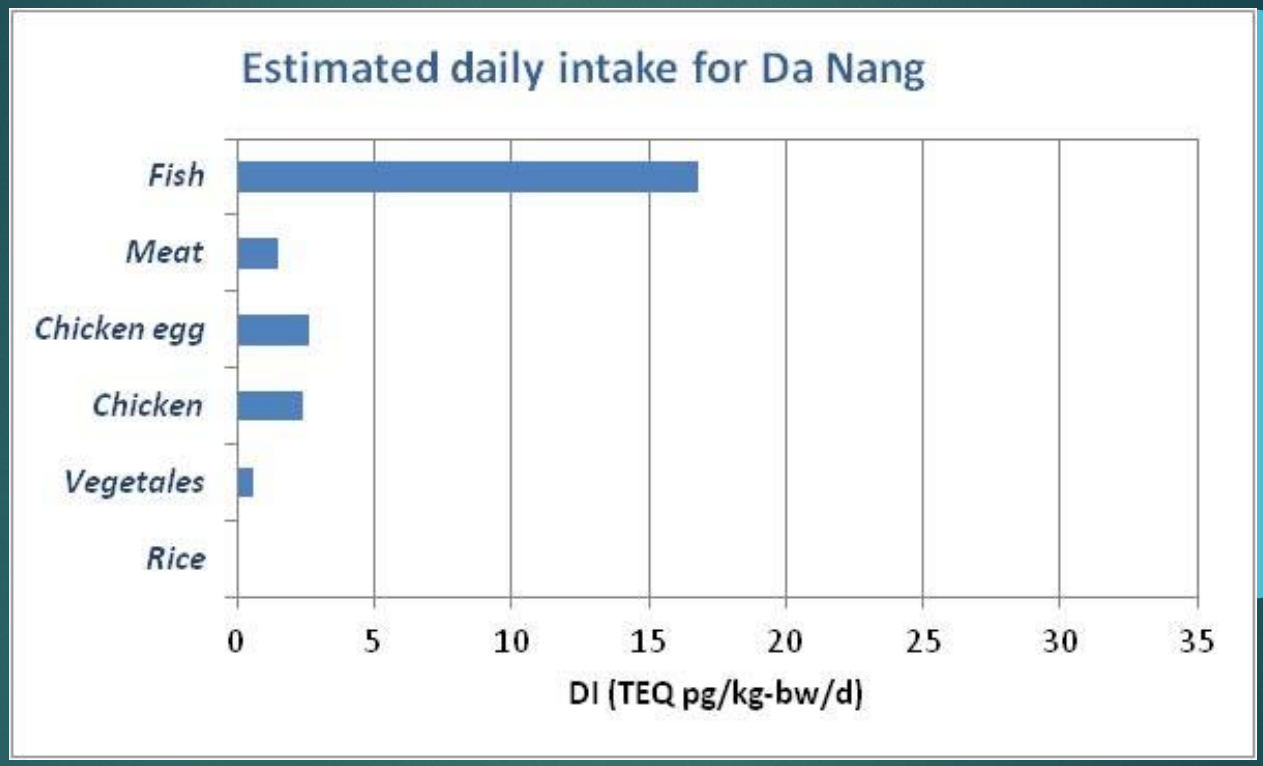


Estimated Daily Intake of Dioxin TEQ (pg/g) for Bien Hoa Airbase



Estimated daily intake of dioxin in BHA (TEQ pg/kg-bw/d): Fish(32) > Chicken(7.6) > Egg(3.7) > Vegetable(1.08) > Meat(0.95) > Rice(0.42)

Estimated Daily Intake of Dioxin TEQ (pg/g) for Da Nang Airbase



Estimated daily intake of dioxin in BHA (TEQ pg/kg-bw/d): Fish(16.8) > Egg(2.66) > Chicken(2.4) > Meat(1.5) > Vegetable(0.57)

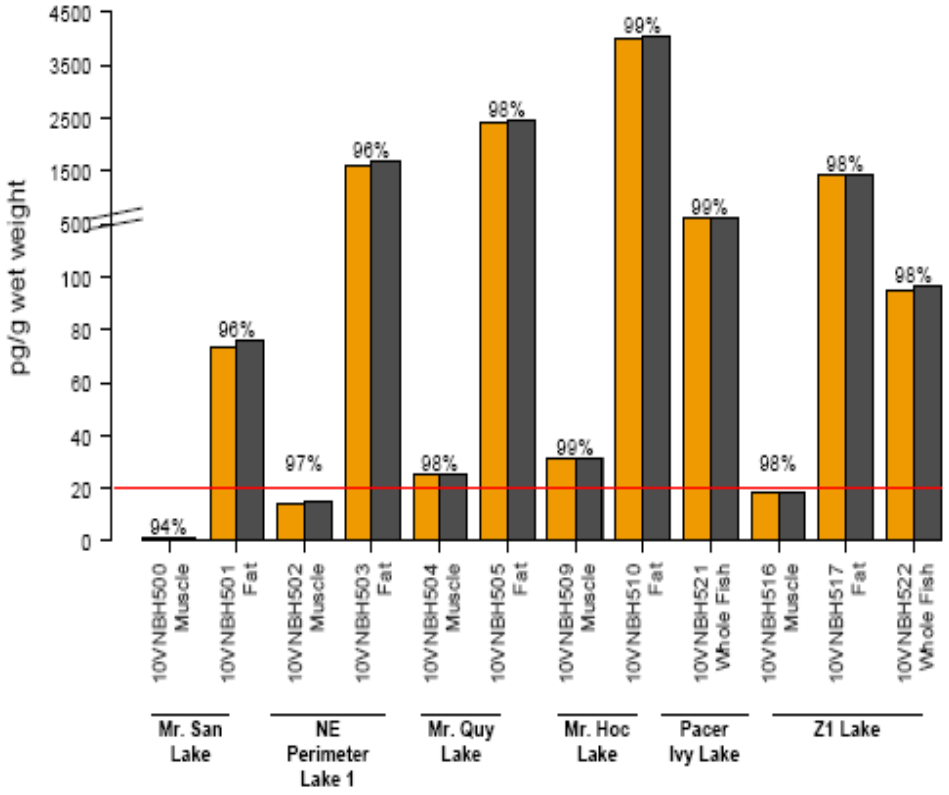
Conclusions and Recommendations

- Local fish, chicken and chicken egg are important potential sources of dioxin exposure for those people who regularly consume locally-raised food items
- Bioaccumulation of dioxin in free-range chicken and chicken egg suggest their potential use as bio-indicator for monitoring local pollution sources of Dioxin and other POPs.
- 2,3,7,8-TCDD concentrations in free-range chicken in Buu Long suggest recent exposure to dioxin, probably via soil consumption by chickens.
- Community awareness raising program have been carried out to help people in such areas reduce potential exposure to dioxin

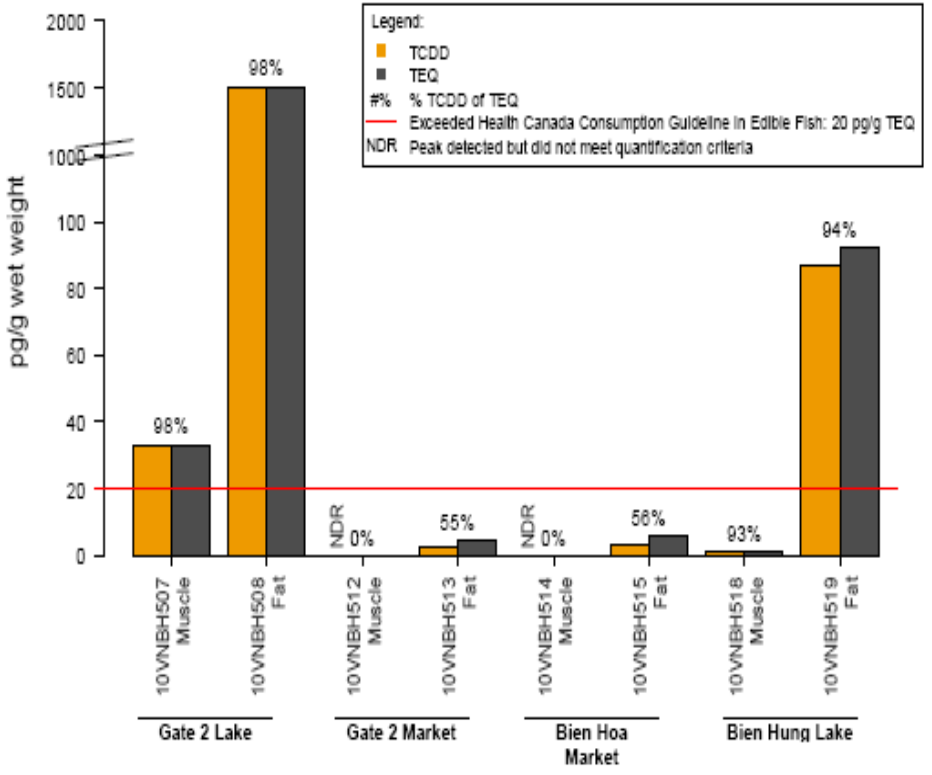
Historical Fish Data from Bien Hoa

Tilapia sampled from all lakes and ponds inside and outside the Airbase exhibited very high dioxin concentrations in fish fat and muscle tissue, as well as in whole fish sampled.

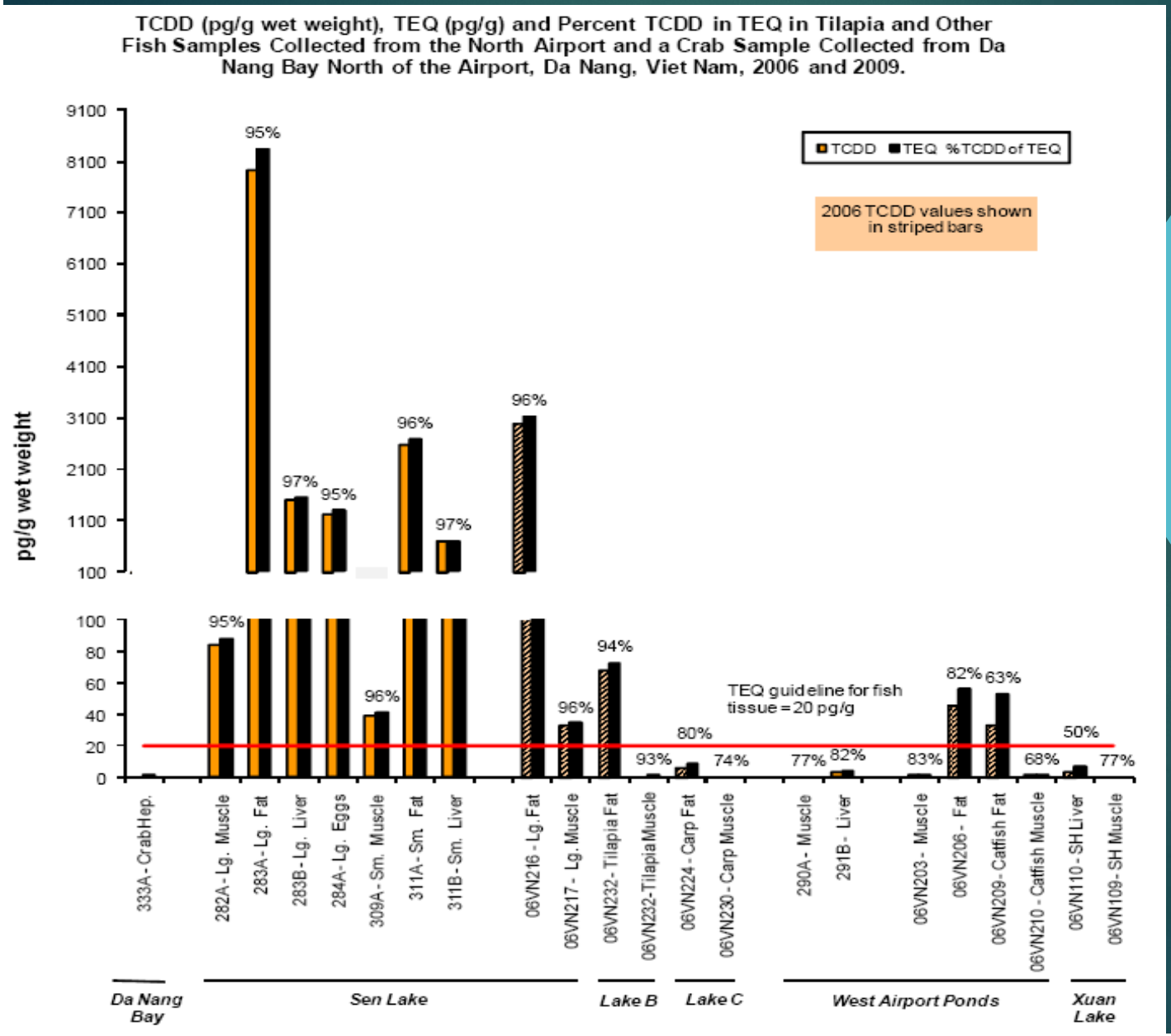
Dioxin concentrations (TCDD and TEQ; pg/g) in fish sampled inside the Bien Hoa Airbase, 2010.



Dioxin concentrations (TCDD and TEQ; pg/g) in fish sampled from Bien Hoa City, 2010.



Historical Fish Data from Da Nang Airport



Tilapia sampled from Sen Lake A, located downstream of main hotspot areas, exhibited the highest recorded TEQ in fish tissue to date in Viet Nam (TEQ = 8,350 ppt).

TCDD is > 95% of the TEQ

Bien Hoa Airbase – Risk from Fish Consumption

- For on-base tilapia, muscle concentrations of 2,3,7,8-TCDD ranged from 1.4 to 32.7 pg/g. Fat concentrations ranged from 73.3 to 3,990 pg/g.
- People who eat fish and other aquatic organisms from the Airbase have higher risk of elevated dioxin levels in their bodies.
- Estimated human exposure doses exceed international guidelines and exceed 2,3,7,8-TCDD's lowest adverse effect level criteria.
- The Bien Hoa fishponds are a completed human pathway for TCDD exposure.

Acknowledgements

- This study was funded by the Vietnam National Science and Technology Research Program (NAFOSTED) (Grant number 104.04-2014.40)
- Supplementary data from studies conducted with funding from Ford Foundation.
- The authors would like to express their sincere thanks to USAID's Scientific Writing Training Program under the Environmental Remediation at Da Nang Airport Project for support on technical writing issues.