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Short Communication

Dioxin hot spots in Vietnam

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During the Vietnam conflict, US forces sprayed a greater volume of defoliant with higher dioxin content than originally estimated (Stellman et al., 2003). The Vietnamese have been exposed to these levels during spraying, and it is suspected on a regular basis for the past 30 years, primarily through contact with former US military infrastructure. Vietnamese people continue to be exposed to dioxin and its effects today; this is not a historical problem. The revised estimates of defoliant volumes and dioxin content (Stellman et al., 2003), increase the quantity of 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD) released in Vietnam to perhaps over 600 kg, much greater than the ~170 kg quoted since the war (IOM, 2001).

Stellman et al. (2003) raise the profile of the "Hatfield hot spot theory", which was proven through field validation studies in the Aluoi Valley, central Vietnam (Dwernychuk et al., 2002). Hot spots labeled by Hatfield exist today, that is, soils that have very high TCDD levels due to higher levels of TCDD loading during the conflict. A significant point is that Hatfield hot spots are not the expansive forested areas targeted by routine flights of Operation Ranch Hand, the US military code name for the spray program.

In barren regions of the Aluoi Valley, once consisting of triple-canopy jungle and heavily sprayed with Agent Orange by aircraft, soils do not retain high levels of TCDD (Dwernychuk et al., 2002), given years of tropical rains, erosion, and chemical degradation. Forces of nature have reduced TCDD in soils when defoliants were originally dispensed from aircraft during planned spray missions. Hot spots that exist today are soils where Agent Orange was spilled, applied by truck-mounted sprayers, including intensive perimeter spraying of bases, etc., thereby effecting a dioxin loading to soils that was significantly higher than that resulting from aerial spray applications. The highest concentration of TCDD in soils was collected from within the boundaries of a former US Special Forces base in the Aluoi Valley (Dwernychuk et al., 2002); soil samples originated from the former personnel camp. Two other former bases in the valley, operational for a shorter period of time, also had soil TCDD levels that were generally higher than aerially sprayed regions. This strongly suggests that any US soldier assigned to a military installation in southern Vietnam where Agent Orange was used, could have been exposed to dioxin.

Ranch Hand bases at Bien Hoa and Da Nang are examples of major hot spots. A TCDD concentration in soil from Bien Hoa was reported up to 1.2 million parts per trillion (ppt) (Schecter et al., 2001). Anecdotal information from Vietnamese scientists suggests soil dioxin levels from Da Nang are in the several hundred thousand ppt ranges. Typical urban soils in the United States are less than 10 ppt TCDD (Nestrick et al., 1986).

Stellman et al. (2003) outline potential hot spots through graphical representations of defoliant volumes sprayed over Vietnam. These hot spots probably existed at the time of spraying, and relate primarily to exposure of US troops on maneuvers in specific areas during

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Ranch Hand operations. Stellman et al. (2003) configurations of volume are more relevant to historical contaminant levels, than to levels that may exist today.

Important footnotes to Stellman et al. (2003) hot spot configurations are their qualifiers regarding estimates of increased defoliant volumes which do not include herbicides sprayed by the Republic of Vietnam, US Army and US Navy forces, the 400 000 l of Agent Pink that were unaccounted for, and the possibility that 200 spray missions released Agent Pink not Orange. Given that Pink was more contaminated with TCDD than Orange, the true loading of TCDD to the Vietnamese environment could be higher than suspected on the basis of recently uncovered records. To what extent these uncatalogued volumes have compromised the health of US veterans, and continue to compromise the health of the Vietnamese remains unknown.

Hatfield hot spots (i.e., former US military installations) must be the focal point of studies to determine sites for remediation, thereby removing them from the exposure equation for perhaps hundreds of thousands of Vietnamese. This strategy is particularly justified where former US bases have been abandoned and settled by locals to form villages and sites of concentrated human activity. Remediation efforts must also be directed at situations where topographical features near former US bases are such as to direct runoff water to areas presently used for food production by local inhabitants. This scenario relates primarily to circumstances where a former base continues to serve as a public airport or military establishment for the Vietnamese government. These contaminated areas are logical sites for comprehensive epidemiological and human health investigations, including appropriate interventions.

New information on the use of herbicides by the US military during the Vietnam conflict should heighten health concerns for US veterans and the Vietnamese who continue to deal with the consequences of TCDD throughout their daily lives, and potentially for many years into the future.

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