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United States Secret War in Laos: Long-Term Environmental and Human Health Impacts of the Use of Chemical Weapons

Kenneth R. Olson[1*], David R. Speidel[2#]

[1]College of Agricultural, Consumer, and Environmental Sciences, University of Illinois, Urbana, USA
[2]Natural Resource Conservation Service and Foreign Agricultural Service, Benton, Missouri, USA
Email: krolson@illinois.edu

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Abstract

In 1959, the United States Central Intelligence Agency (CIA) operation, against the Pathet Lao insurgences and Viet Mien military troops and supply route, began. The Hồ Chi Minh Trail was developed after the North Vietnam government and military decided to reunify South and North Vietnam. The People's Army of Vietnam (PAVN) then connected the old trails leading from North Vietnam panhandle southward into eastern Laos, Cambodia and South Vietnam. Starting from Hanoi, the primary trail turned southwest into Laos and eastern Cambodia before branching into South Vietnam. Beginning in 1960s, the volume of traffic on the network of trails expanded significantly, but it still took more than a month's march, by foot and bicycle, to travel from North to South Vietnam. Hồ Chi Minh Trail traffic was impacted by repeatedly by Royal Laotian Air Force (RLAF), which was supported by US Air Force tactical herbicide spraying (Operation Ranch Hand program), and US Air Force bombing runs. By the late 1960s, the trail was improved and could accommodate heavy trucks in some sections and was used to supply the annual needs of over one hundred thousand regular PAVN troops active in South Vietnam. By 1974, the trail was a well-marked series of jungle roads (some of them paved) with underground support facilities such as hospitals, fuel-storage tanks, and supply caches with weapons. The Hồ Chi Minh Trail was the major supply route for PAVN forces that overran Republic of Vietnam (RV) forces in 1975 and unified Vietnam. The primary objective of this paper is to determine the environmental and human health impacts of RLAF and US Air Force secret spraying of tactical herbicides on Hồ Chi Minh Trail in Laos.

*Kenneth R. Olson is U. S. Army Vietnam Era Veteran and Professor Emeritus of Soil Science.
#David R. Speidel is a former USDA Resource Conservationist and Agricultural Consultant with Natural Resource Conservation Service and Foreign Agricultural Service, Benton, Missouri, USA.

Keywords

Hồ Chi Minh Trail, Laos, Cambodia, North Vietnam, South Vietnam, Agent Orange, Agent Blue, Dioxin TCDD, Arsenic, Cloud Seeding, Mud Making

1. Introduction

The Hồ Chi Minh Trail, once called Annamite Range Trail, was a logistical network of roads and trails that ran from North Vietnam to South Vietnam through the kingdoms of Laos and Cambodia (Figure 1). The trail system enabled support, in the form of labor and supplies to the Viet Cong guerrillas and The People's

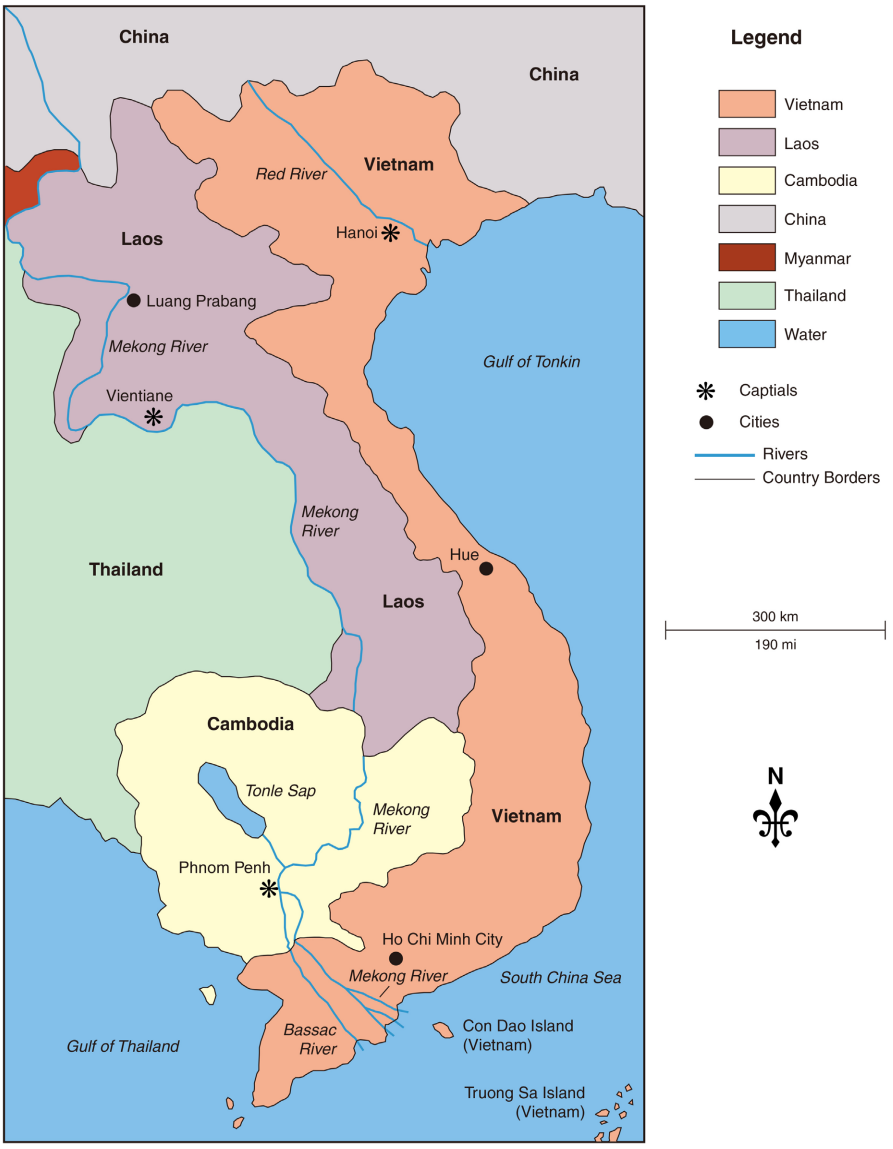

Figure 1. South East Asia countries including Vietnam. The Mekong and Bassac Rivers flow south into the Mekong Delta. Reprinted with the permission of the editor of the Open Journal of Soil Science. Map by Mic Greenberg.

Army of Vietnam (PAVN), during the Second Indochina War. Construction for the network began following the North Vietnamese invasion of Laos in July 1959. The trail was named by the United States after the North Vietnamese President Hồ Chi Minh. The origin of the name is presumed to have come from The First Indochina War. During that war there was a Viet Minh maritime logistics supply line called the "*Route of* Hồ *Chi Minh*" [1]. In the 1960s the present trail was developed. Agency France Presse (AFP) announced that a north-south trail had opened, and they named the corridor *La Piste de Hồ Chí Minh*, the "Hồ Chí Minh Trail" (Figure 2). The trail ran primarily in Laos (Figure 3) and (Figure 4),

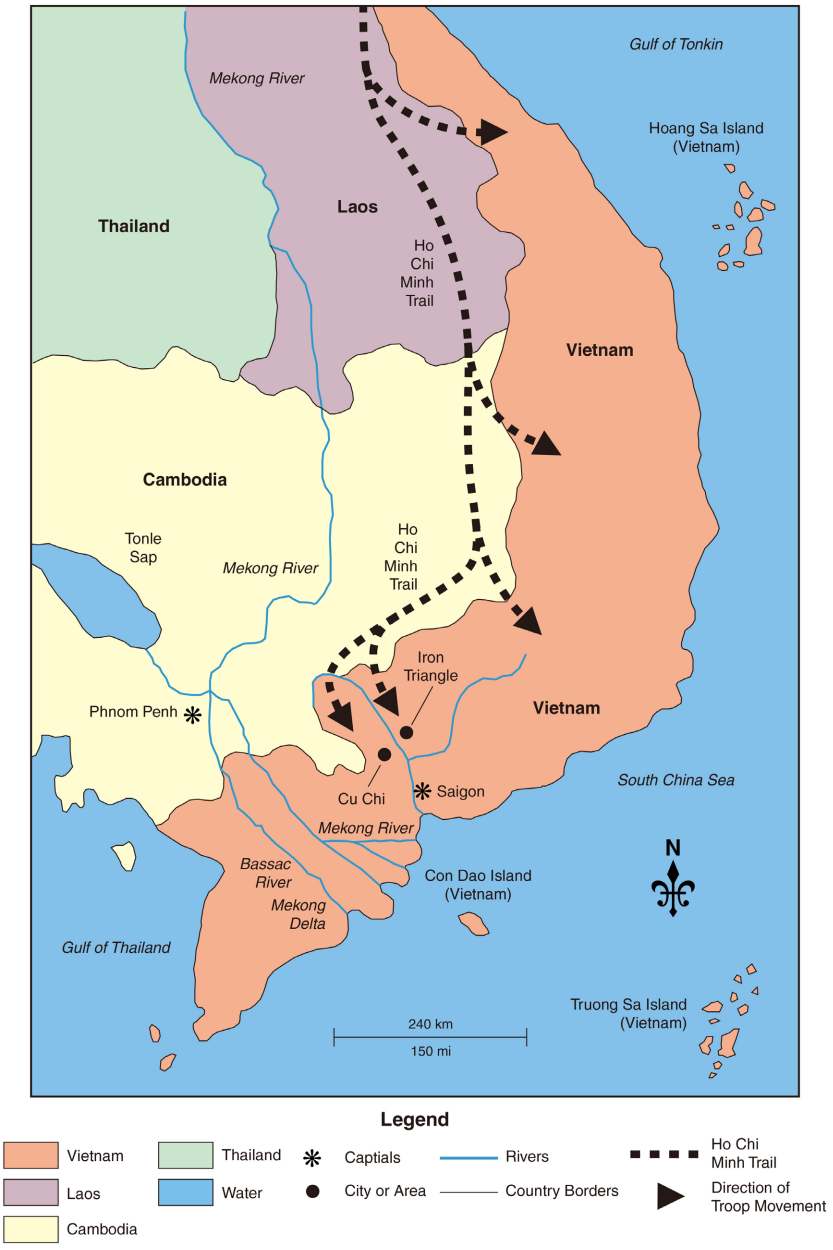

Figure 2. The Hồ Chi Minh Trail from North Vietnam through Laos and Cambodia to South Vietnam. Reprinted with the permission of the editor of the Open Journal of Soil Science. Map by Mic Greenberg.

Figure 3. The Ho Chi Minh Trail through the mountains and jungles of Vietnam, Laos and Cambodia was a system of trails and paths controlled by the Democratic Republic of Vietnam (1959-1975) used for transporting food, military equipment and North Vietnamese Army soldiers into southern Vietnam during the Vietnam War.

Figure 4. Black and white picture of Ho Chi Minh Trail being used by the North Vietnamese Army soldiers.

and was called by the communists, the Truong Son Strategic Supply Route, after the Vietnamese name for the Annamite Range Mountains in central Vietnam [2]. They further identified the trail as either West Trường Sơn (Laos) or East Trường Sơn (Vietnam) [1]. According to the U.S. National Security Agency's official history of the war, the trail system was "*one of the great achievements of military engineering of the* 20*th century*" [3]. The trail was able to effectively supply troops fighting in the south; an unparalleled military achievement given

it was the site of the single most intense air interdiction campaign in history. Parts of what became the trail had existed for centuries as primitive footpaths that enabled trade. The area through which the system meandered was among the most challenging in Southeast Asia: a sparsely populated region of rugged mountains 500 - 2400 m in elevation, triple-canopy jungle of dense tropical rainforests.

PAVN forces, alongside the Pathet Lao, invaded Laos on 28 July 1959, with fighting all along the border with North Vietnam against the Royal Lao Army (RLA). In September 1959, Hanoi established the 599th Transportation Group, headquartered at Na Kai, Houaphan.

Province in northeast Laos is close to the border. The 599th Transportation Group was established, to improve and maintain a transportation system, to supply the PAVN and Viet Cong (VC) guerrilla insurgency against the South Vietnamese government [4]. Initially, the North Vietnamese effort concentrated on infiltration across and immediately below the Vietnamese Demilitarized Zone (DMZ) that separated the two Vietnams [5]. The 559th Group "flipped" its line of communications to the west side of the Trường Sơn Mountains [6].

By 1959, the 559th had 6000 personnel in two regiments alone, the 70th and 71st [2], not including combat troops in security roles or North Vietnamese and Laotian civilian laborers. In the early days of the conflict, the trail was used strictly for the infiltration of labor. At the time, Hanoi could supply its southern allies [7] much more efficiently by sea (**Figure 5**). In 1959, the North Vietnamese created Transportation Group 759, which was equipped with 20 steel-hulled vessels to carry out such infiltration [2].

After the initiation of U.S. naval interdiction efforts in coastal waters, the trail had to do double duty. Materiel sent from the north was stored in caches in the border regions that were soon retitled "Base Areas" (BA), which, in turn, became sanctuaries for VC and PAVN forces seeking respite and resupply after conducting operations in South Vietnam [8].

The system developed into an intricate maze of 5.5-m-wide dirt roads (paved with gravel and corduroyed in some areas), foot and bicycle paths and truck parks (**Figure 6**). There were numerous supply bunkers, storage areas, barracks, hospitals, and command and control facilities, all concealed from aerial observation by an intricate system of natural and man-made camouflage that was constantly improved. By 1973, trucks could drive the entire length of the trail without emerging from the canopy except to ford streams or cross them on crude bridges built beneath the water's surface [5].

The weather in southeastern Laos came to play a large role both in the supply effort and United States and South Vietnamese efforts to interdict it. The southwest monsoon (commonly called the rainy season), brought heavy precipitation (70% of 380 cm per year). The sky was usually overcast with high temperatures. The dry season, from mid-October to mid-March, had lower temperatures. Since the road network in the trail system was generally dirt, the bulk of supply transport, and the military efforts that they supported, were conducted

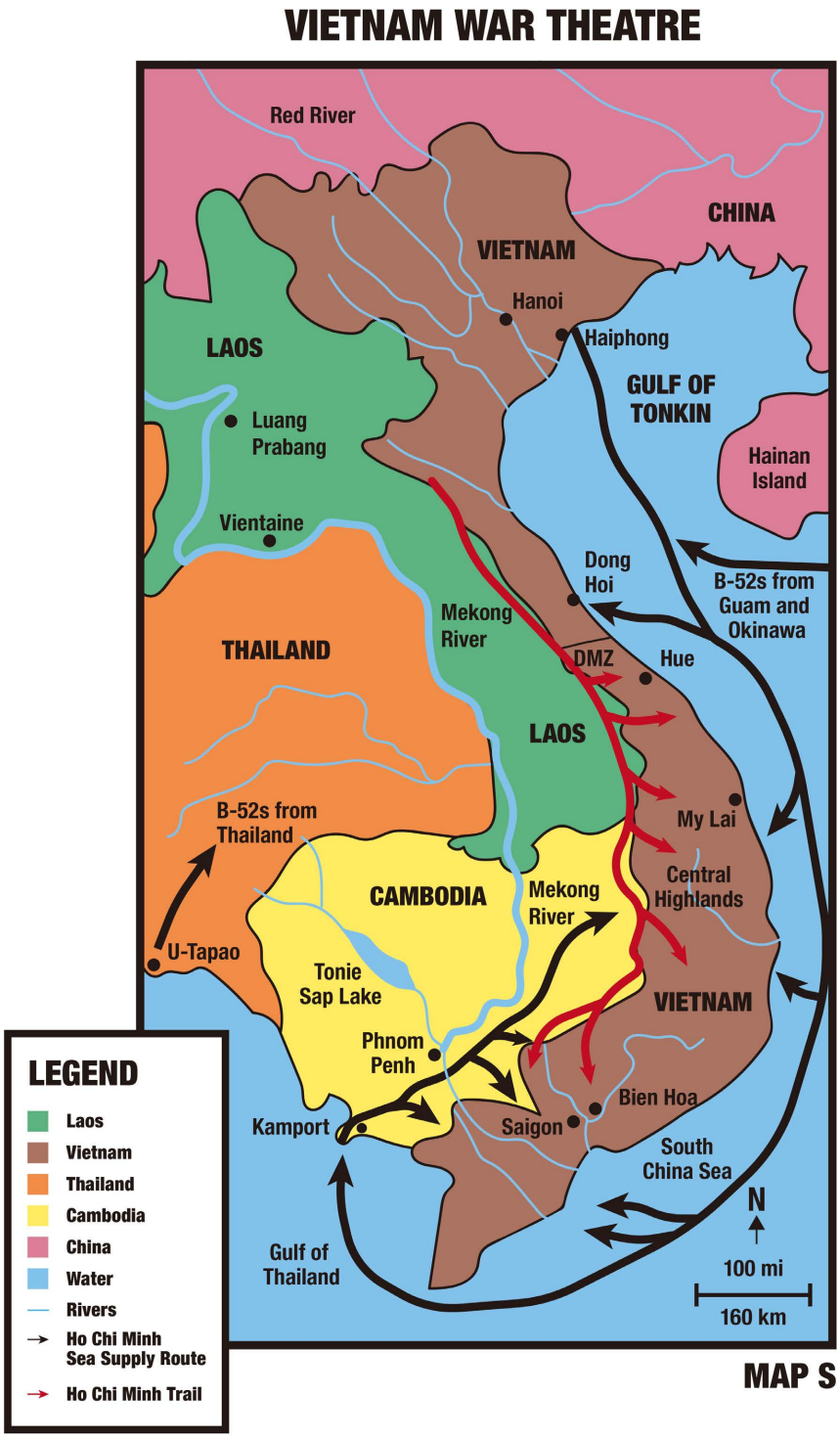

Figure 5. Map of Ho Chi Minh Sea supply route via South China Sea and the Gulf of Thailand and the Ho Chi Minh Trail through North Vietnam to South Vietnam via Laos and Cambodia. Map by Cruz Dragosavac.

during the dry season mid-October to mid-March. Eventually, the bulk of the trail was either asphalted or hard packed, thus allowing large quantities of supplies to be moved even during the rainy season [5].

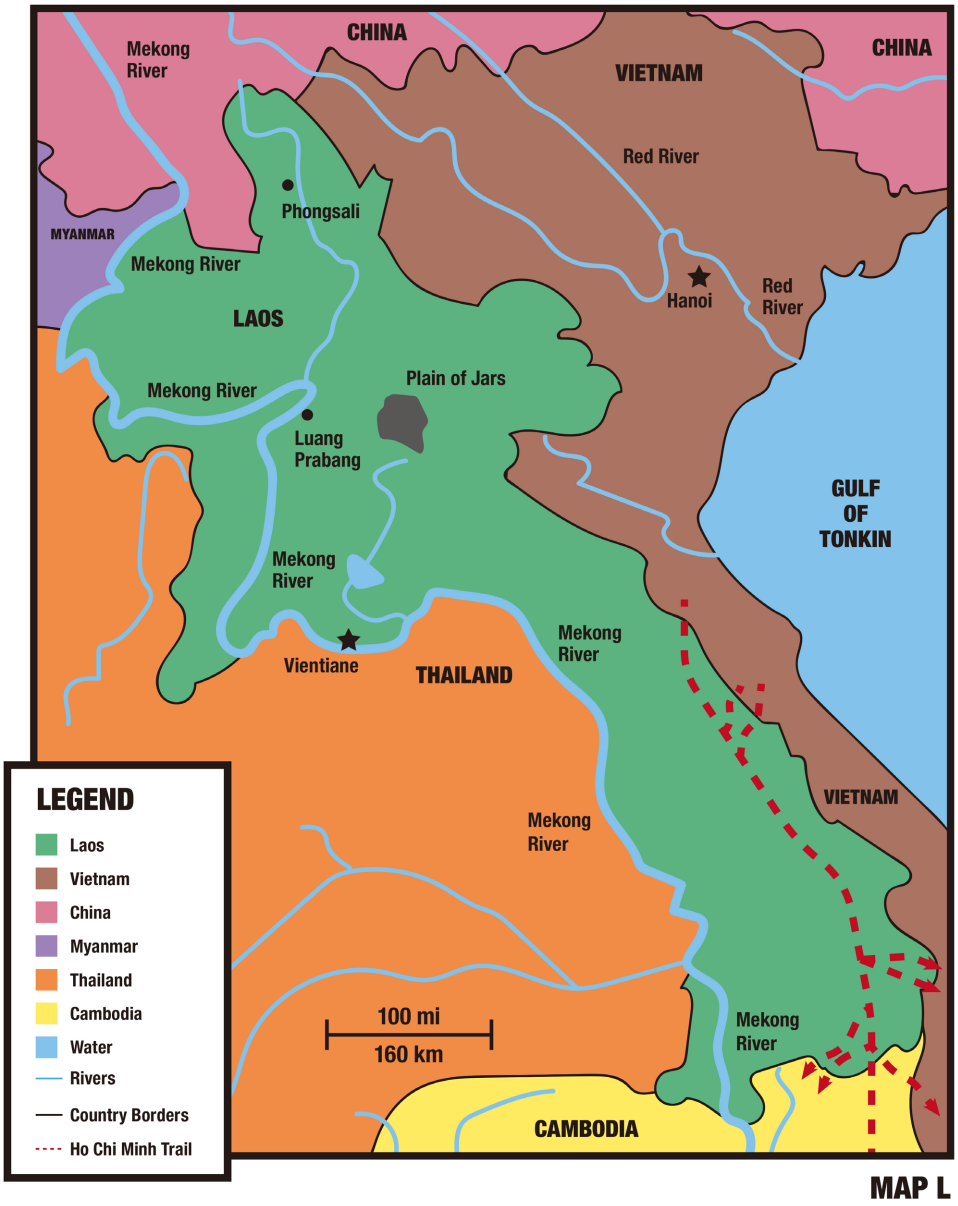

Figure 6. Ho Chi Minh Trail in southern Laos. Map by Cruz Dragosavac.

The primary objective of this study was to: 1) determine locations of potential dioxin TCDD and arsenic hotspots as a result the secret chemical spraying missions on the Hồ Chi Minh Trail in Laos and 2) determine environmental and human health effects from the spraying of tactical herbicides containing dioxin (TCDD) and/or arsenic.

2. Geology and Soils

Early Quaternary and older alluvial deposits reveal the tectonic and sea level adjustments, fold and fault lines, subsidence and uplifts that characterize the evolving Mekong River [9]. About 40 million years ago, its precursor drained into the sea near where the Red River now flows just south of Hanoi, Vietnam. Over

time, earthquakes and volcanic activity of the Himalayas altered the mountain drainage southward via steep gorges that appeared about 13 million years ago and by 8 million years ago formed the present courses of three rivers: the Mekong, Yangtze and Yellow rivers which run in parallel sutures [10] [11].

Below this area was a wide inland sea during the Upper Mesozoic. It is likely that the Mekong River at that time flowed directly south and to the west of the Korat Upland, joining what has become the Chao Phraya River in Thailand [11]. There is evidence that subsidence in the Tonle Sap basin of Cambodia, perhaps during the last 12,000 years, drew the Mekong River eastward and away from its former Chao Phraya connection and the Tonle Sap basin. The modern day river carries a large supply of fluvial transported fine sediments and sands that originated in the Tibetan and Himalayan mountainous region that have been mediated over time by glaciation, precipitation and evapotranspiration [9].

The Mekong River channel has several distinct hydromorphological reaches as it flows south. In some places, the channel is straight; but in other locations, it becomes sinuous with high radius bends as it follows bedrock carved fault lines and tectonic lineaments [9]. As the bedrock walled single channel flows into alluvial lowlands, the channel meanders with low radius bends. When the single alluvial channel at high flows takes a short cut across the neck of a bend, the river becomes braided and divided creating islands and multiple channels with water levels that vary with the season. From Vientiane to the Mun River confluence, natural levees composed of silt and clay about 8 - 10 m high line both riverbanks, evidence of historical overtopping. However topping of these levees is not common today [9]. Many wetlands beyond the levees are artificially drained for rice paddies, corn, vegetables and other crops. Where the riverbanks are not steep, they are cultivated for flood recession agriculture, that is, planted according to the river level as it transitions from wet to dry season. The riverbed in this reach is fine sand with occasional outcrops of fluvial pebble beds with about 30 - 50 cm of organic rich or black inorganic silts [9].

Cretaceous volcanics occurred throughout southern Lao and eruptions of basalts in the Miocene and Quaternary were widespread. The modern day Mekong River near the town of Muang Khong is locally controlled by basalt outcrops and fault patterns that give rise to the spectacular Siphandone (4000 islands) and Khone Falls on the Lao-Cambodia border [9]. The river in this reach has bedrock-anastomosed channels overlain by alluvial deposits. The term anastomosed means the river flows are separated by many large islands about 5 - 10 m above the low water mark that sustain mature vegetation and are fairly stable or may migrate slowly from bank erosion [12].

2.1. The Southeast Asian Monsoon

The Mekong River drains an area of 795,000 km^2 and discharges 457 km^3 of fresh water annually. Discharge volume and flood timing are highly predictable and concentrated in an extremely regular wet season peak [13]. The summer monsoon or wet season begins when warm moist winds from the ocean blow

eastward over Thailand, Cambodia, Vietnam and Lao PDR and bring heavy rainfall. The onset of flood season occurs in the end of June each year and lasts about 130 days. The start and end of the annual flood occurs within a period of two weeks with little variation. The dry season onset begins in late November [9].

The left-bank (eastern) tributaries of the Mekong receive high levels of rainfall from the monsoon as moisture-laden winds encounter the ridges and mountains of Lao. In northern Lao, 14 tributaries drain into the Mekong River including the 447 km long Nam Ou River, the longest Mekong tributary river in Lao. Runoff from Lao tributaries is the source of major wet season flooding and Mekong River discharge [13]. The largest single tributary of the Mekong is the Mun River of northern Thailand at 673 km. However, despite its length, the Mun drains a dry, flat region, and contributes a very small portion of the Mekong's discharge [9].

2.2. Fishing, Forestry and Agricultural Systems of Lao PDR

The people of Lao derive their incomes from fishing, agriculture and forestry (**Figure 7**). The longest river in Southeast Asia and the 7th longest in the world, the Mekong is considered by many to be the world's most productive inland fishery. Its giant fish are well-known including the Mekong catfish (*Pangasianodon gigas*), the giant barb (*Catlocarpio siamensis*), Julien's Golden Carp (*Probarbus jullieni*) and two probarbids (*Probarbus labeamajor* and *Probarbus labeaminior*) [14]. Laotians and Cambodians catch more freshwater fish per capita than any other people worldwide [15]. The more than 500 known species of Mekong River fish have sustained millions of people through droughts, deluges and even the genocidal Cambodian regime of Pol Pot. Fish are grilled, fried, or boiled, wrapped in palm leaves, garnished with ant eggs or simply mixed into a

Figure 7. Planted teak trees for wood working products. In northeastern Laos near the Mekong River.

wooden bowl with rice. The main fishing seasons are March-April and November-December with women catching smaller fish and the men going after the giant fish. Fish production is a central part of river communities' social and economic activities ranging from managing fisheries to fish processing and marketing. In addition to being used fresh, fish are preserved by drying and pickling [12].

Many kinds of crops are grown on the banks of the Mekong River and its tributaries and within narrow floodplains [16]. Flood recession agriculture is practiced extensively to cope with annual wet season flooding and dry season conditions. This type of farming uses the residual soil moisture stored in the soil profile after the rainy season flooding. Sedimentation of fine-grained materials under a seasonal flooding environment develop clayey soils (e.g. vertisols, fluvisols, gleysols and camisols) with high water retention [17] [18] which allows cropping (**Figure 8**) during the dry season as river water levels drop.

Laotian farmers plant vegetables, melons, rice, corn, peanuts and other crops on sloping riverbanks (**Figure 9**) for family use and local markets. The predictability of the wet season flooding and onset of the dry season reduces risks of crop loss and enables farmers to match specific crops and flood tolerant varieties to the river stage and bank location as the flooding recedes. Flood recession farming has been practiced for generations along the Mekong River and the local knowledge on which crops and varieties perform best under specific practices (**Figure 8**) is specific to each village and its location within the reach [12].

Vegetable plots are also found in the valleys of tributaries near small mountain villages and cities such as Luang Prabang, Lao that are tourist destinations. The raised beds are carefully maintained and often employ five or more family members and friends. These plots must be irrigated daily during the dry season to ensure productivity and are watered manually. A number of tributaries have

Figure 8. Raised beds with vegetable crops in a garden. This picture taken March 2016 at the height of the dry-season.

Figure 9. As the wet-season floodwaters recede crops are planted on the riverbanks and benefit from the residual soil moisture during the dry-season. This picture taken March 2016 at the height of the dry-season.

small pocket dams that are used for irrigation, fisheries and hydroelectricity (Figure 10). Vegetable plots including military gardens are grown in the ditches along local highways. Some of the hotels have their own vegetable gardens, ducks and chickens to feed workers and guests. Banana, Dragon fruit, cashew and other tropical fruit and nut trees are used for landscaping and food.

Laotian farmers and fishers supplement their food and incomes by raising cows, pigs, buffalos and small animals such as ducks, geese, and chickens. Wild mushrooms, bamboo, and herbs are also gathered by women and children for family use and village markets. The Mekong River valley in China is famous for rubber tree plantations and the plantations have spread into Lao, Myanmar and Vietnam. The mountain slopes and valleys are often cleared and farmed. The northern Lao highlands with 30% to 60% slopes are planted to pineapples and other tree crops including teak (Figure 7) and rubber trees (Figure 11).

Lao PDR has over 150 ethnic groups including the Khmer, Hmong, Mien, Tai and Rau. The Tai and Hmong peoples came to Lao and Vietnam highlands from China during the 1860s as refugees from Qing armies [19] (Figure 12). One Hmong mountain village about 20 km south of Luang Prabang is adjacent to a rubber tree plantation (Figure 11) and offered a glimpse of life in Lao rural highlands. The village appeared to be home to about 50 families living mostly in thatch huts with a UNICEF water supply source and electricity. While most of the village homes had packed dirt floors, new construction underway involved cement floors and support beams. A communication reception dish was visible outside one of the village buildings; and cell phones were used by a number of young people. Some of the women make small bags, hand woven fabrics and rugs, baskets and other crafts to sell in the Luang Prabang city market.

Figure 10. Hydroelectric power is produced from a small dam on a Mekong River tributary in northern Lao PDR highlands. The reservoir behind the dams is used as a fishery and for irrigation.

Figure 11. Rubber trees grow in a plantation near a Hmong village south of Luang Prabang, Lao PDR.

Figure 12. The Luang Prabang, Lao PDR farmers' markets in the mornings are a regional social center. After 10:00 P.M. the unsold night market goods are bundled up, carried or put on carts or motorcycles and transported to storage areas until the next day's market.

Regional cities have farmers markets where rural highlanders and riverbank villagers bring their products to sell: fruits, vegetables, fish, meats, nuts, wild and farm-grown insects including crickets, hand woven silk and cotton fabrics and rugs. Luang Prabang has a farmers market and a large night market where locals and tourists shop. The main street several blocks long is closed to vehicles around 5:00 P.M. daily. Within an hour, the tents are set up and the goods spread out for viewing and purchase (**Figure 12**).

3. Findings

3.1. Hồ Chi Minh Trail Interdiction and Expansion (1965-1968)

In 1961, U.S. intelligence analysts initially estimated that 5843 enemy infiltrators (*actually* 4000) had moved south on the trail; in 1962, 12,675 (*actually* 5300); in 1963, 7693 (*actually* 4700); and in 1964, 12,424 (*actually* 9000) [20]. The supply capacity of the trail reached 20 to 30 tn per day in 1964 and it was estimated by the U.S. that 9000 PAVN soldiers had reached South Vietnam [2]. By 1965, the U.S. command in Saigon estimated that communist supply requirements for their southern forces amounted to 234 tn of all supplies per day and that 195 tn were moving through Laos [20]. U.S. Defense Intelligence Agency (DIA) analysts concluded that during the 1965 Laotian dry season the enemy was moving 30 trucks per day (90 tn) over the trail, far above the Saigon estimate [20].

U.S. officials had only estimates of its enemy's capabilities; intelligence collection agencies often conflicted with each other. Thanks to improvements to the trail system (including opening new routes that would connect to the Sihanouk Trail in Cambodia); the quantity of supplies transported during 1965 almost equaled the combined total for the previous five years. During the year interdiction of the system had become one of the top American priorities, but operations against it were complicated by the limited forces available at the time and Laos's "neutrality" [21] [22].

The Sihanouk Trail was a logistical supply system in Cambodia used by PAVN and its VC guerillas during the Vietnam War (1960-1975). Between 1966 and 1970, this system operated in the same manner and served the same purposes as the much better-known Hồ Chi Minh trail (the Truong Son Road to the North Vietnam) which ran through the southeastern portion of the Kingdom of Laos. The name is of American derivation, since the North Vietnamese considered the system integral to the supply route mentioned above. U.S. attempts to interdict this system began in 1959.

The intricacies of Laotian affairs, and U.S. and North Vietnamese interference in them, led to a mutual policy of ignoring the other, at least in the public eye. This did not prevent the North Vietnamese from violating Lao neutrality by protecting and expanding their supply conduit with the support of their Pathet Lao allies in their war against the central Lao government. U.S. intervention came in increments in the form of a CIA-backed clandestine army in its fight with the communists and constant spraying of herbicide weapons and bombing

of the trail. The CIA also provided support for the Lao government [22] [23].

On 14 December 1964, the U.S. Air Force's "Operation Barrel Roll" carried out the first systematic bombardment of the Hồ Chí Minh Trail in Laos [20]. By mid-year, the number of sorties being flown had grown from 20 to 1000 per month. In January 1965, the U.S. command in Saigon requested control over bombing operations in the areas of Laos adjacent to South Vietnam's five northernmost provinces, claiming that the area was part of the "extended battlefield" [20]. In addition to the cloud and mud programs promoted by the chemical contractors the desperation to turn off the supplies running down the Trail was also seen in the fence program.

Political considerations complicated aerial operations. Nevertheless, the seasonal monsoons that hindered communist supply operations in Laos also hampered the interdiction effort. These efforts were slowed by morning fog and overcast, and by the smoke and haze produced by the slash-and-burn agriculture practiced by the indigenous population. During 1968, the US Air Force undertook two experimental operations that it hoped would worsen the monsoons. "Project Popeye" was an attempt to indefinitely extend the rainy season over southeastern Laos by cloud seeding [24]. Clouds were seeded by air with silver iodide smoke and then activated by launching a fuse fired from a flare pistol. Fifty-six tests were conducted by October; 85% were judged successful. President Johnson then gave authorization for the program, which lasted until July 1972 [20].

Testing on the second operation, "Project Commando Lava", began on 17 May: scientists from Dow Chemical had created a chemical concoction that, when mixed with rainwater, destabilized the soil creating mud. The program drew support from its military and civilian participants, who claimed that they were there to "make mud, not war." In some areas it worked, depending on the nature and properties of the soil. C-130A aircraft dropped the chemicals, but the overall effect on North Vietnamese interdiction was minimal and the experiment was cancelled [20]. This was a fascinating attempt to use natural elements for tactical advantage, but lacked detailed planning. Where mud was created on the Trail. PAVN and its VC maintenance teams had logs and bamboo matts on standby to bridge the gaps. The best tactical employment was on the Trail where the surface soil was sand. The program failed badly because of limited field and soil knowledge.

The Sihanouk Trail was also a logistical supply system in Cambodia used by the PAVN and its VC guerillas during the Vietnam War (1960-1975). Between 1966 and 1970, this system operated in the same manner and served the same purposes as the much better-known Hồ Chi Minh trail (the Truong Son Road to the North Vietnamese) which ran through the southeastern portion of the Kingdom of Laos. The name is of American derivation, since the North Vietnamese considered the system integral to the supply route mentioned above. U.S. attempts to interdict this system began in 1964. On 14 December 1964, the

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3.2. Management of the Secret War in Laos

Starting in 1959, the United States government conducted the Secret War in Laos. The CIA took the operational lead but its interactions with and connections to other agencies and countries were complicated. The Secret War in Laos involved the CIA operatives, the US State Department via the Laos and South Vietnam Ambassadors, Department of Defense military soldiers, the White House, USDA and the governments of Laos, Thailand and South Vietnam. An additional complication was the frequent changing of Laotian Ambassadors (five times) in addition to a few South Vietnam Ambassador changes. All these Ambassadors, CIA Station Chiefs and various DOD military Generals all wanted to have their voices heard.

The CIA, because of official neutrality of Laos, did have a strong influence on Laos Secret War operations. However, the Laotian Ambassador often directed the CIA missions. The first two Ambassadors to Laos strongly upheld the Laos neutrality rule by restricting official missions. In the early years, this was influential since less than 10 CIA operatives in country [25]. CIA clandestine missions first were limited to guerrilla forays supporting the Royal Laos Army. Ambassador Sullivan, the fourth Ambassador, was the most hawkish and requested the defoliation and food denial program, being used in South Vietnam, for Laos in July of 1965.

Since the US Air Force spray mission (Operation Ranch Hand) were head quartered in South Vietnam, their Ambassador had influence as well. Most of the tactical herbicides sprayed in Laos were air lifted to Udorn Air Force Base in Thailand for use on the Ho Chi Minh Trail. These tactical herbicides were temporarily stored in warehouses on Udorn Air Force bases and could not be used in Thailand. The tactical herbicides stored at Udorn Air Force base were then either flown to remote Laos airstrips for spraying or were sprayed directly on the Ho Chi Minh Trail in Laos and Cambodia by aircraft originating from Udorn Air Force base. The jungle along the Ho Chi Minh Trail was defoliated (Operation Ranch Hand) using Agent Orange or Agent Purple to expose the enemy and the Trail. The adjacent food crops areas in Laos and Cambodia were sprayed with Agent Blue as part of an enemy food denial program. Unfortunately, only the Laotian and Cambodian civilians along the Ho Chi Minh Trail were deprived of food. The PAVN and VC soldiers transported their own food supplies.

3.3. Air Operations in Laos

Udorn Royal Thailand Air Force (RTAF) base was established in the 1950s. The civil war in Laos and fears of it spreading into Thailand led the Thai government to allow the United States to use covertly six Thai bases beginning in 1961 for the air defense of Thailand and to fly reconnaissance flights over Laos. Udorn

Air Force base [23] [26] was one of those six bases. Under Thailand's "gentleman's agreement" with the US, RTAF bases used by the US Air Force (USAF) were considered RTAF bases and were commanded by Thai officers. Thai air police controlled access to the bases, along with USAF Security Police, who assisted them in base defense using sentry dogs, observation towers, and machine gun emplacements. The USAF forces at Udorn were under the command of the United States Pacific Air Forces (PACAF) Thirteenth Air Force.

Udorn RTAFB was the Asian headquarters for Air America (17.3863˚N 102.788˚E), a US passenger and cargo airline covertly owned and operated by the CIA which provided essential resources for the war in Laos and elsewhere [23]. Its predecessor, Civil Air Transport (CAT), started operations from Udorn on 11 September 1955 with the arrival of three C-46s delivering food and emergency aid into Indochina. By the end of September, CAT had flown more than 200 missions to 25 reception areas, delivering 1000 tons of emergency food. Conducted smoothly and efficiently, this airdrop relief operation marked the beginning of CAT's and, later, Air America's support of US assistance programs in Laos [23].

Air America's roles supportive of covert and overt situations related to hostilities in Southeast Asia and elsewhere worldwide provided buffers and solutions to problems the United States faced in various locations. Operations were focused in Laos as part of the "secret war" the United States carried out against the Pathel Lao forces operating in the country. Udorn RTAFB also served as the site of "Headquarters 333", the Thai organization in charge of their forces in Laos. Air America continued operations from Udorn Air Force base into Laos until 3 June 1974 [23].

3.4. US Marine Corps Use During the Laotian Crisis

In 1961, the 300-man Marine Air Base Squadron Sixteen was deployed to Udorn to maintain helicopters supporting Royal Lao Army forces in Laos [27]. Following the defeat of Royal Lao Army in The Battle of Luang Namtha in early May 1962 by PAVN and Pathet Lao forces, it appeared that a communist invasion of northern Thailand was imminent and on 15 May, the Kennedy Administration ordered US combat forces into Thailand to deter any attack. On 29 June 1962 with the situation in Laos's stabilizing and international negotiations underway, the Kennedy Administration ordered all US combat forces to begin withdrawing from Thailand. The International Agreement on the Neutrality of Laos was signed on 23 July 1962 and the remaining Marines began to withdraw with all combat units withdrawn from Udorn by 31 July [27].

By 1967 or earlier, USAF weather modification flights were originating from a special operations group at Udorn. No more than four C-130s, and usually only two, were assigned to the restricted section of the base. Their mission, Operation Popeye (1967-1972) was to create rainfall over North Vietnam, Laos, and South Vietnam to hamper enemy logistics and tactical initiative [24]. Beginning in late 1970, Udorn was drawn down as part of the overall US withdrawal from the

Vietnam War.

3.5. Tactical Herbicides Transported to Laos from Udorn Air Force Base in Thailand

From December 1965, Agent Orange, Agent White, Agent Blue spraying operations were begun in Laos to counter the use of the Hồ Chi Minh trail by the PAVN and VC. The spraying operations ended in September 1969. Personnel from the US Army Biological Center stationed at Fort Detrick were involved in training of Thailand Udorn Royal Thai Air Force. Operation Ranch Hand aircraft and Thailand Udorn Royal Thai Air Force aircraft were used. The tactical herbicides were stored temporarily at Udorn (Thailand) to refill planes for missions in northern Laos. Aircraft at Udorn Air Force base were used for spray missions in northern Laos and adjacent areas in South Vietnam (**Figure 13**) (**Figure 14**). Support personnel were flown into Udorn Air from Phu Cat Air Base (Vietnam) for missions flown in northern Laos. Sorties were flown from Tan Son Nhut and Da Nang.

3.6. Sapper Attacks

On 26 July 1968: A team of 25 or more personnel equipped with automatic weapons attacked Udorn RTAF base, causing severe damage to a USAF C-141 Starlifter and a F-4D Phanton 1, and killing one Thai security guard and the C-141 crew chief were killed [28] [29]. On 3 October 1972, a group of seven guerillas attempted an attack, with three attackers killed and one-captured [30].

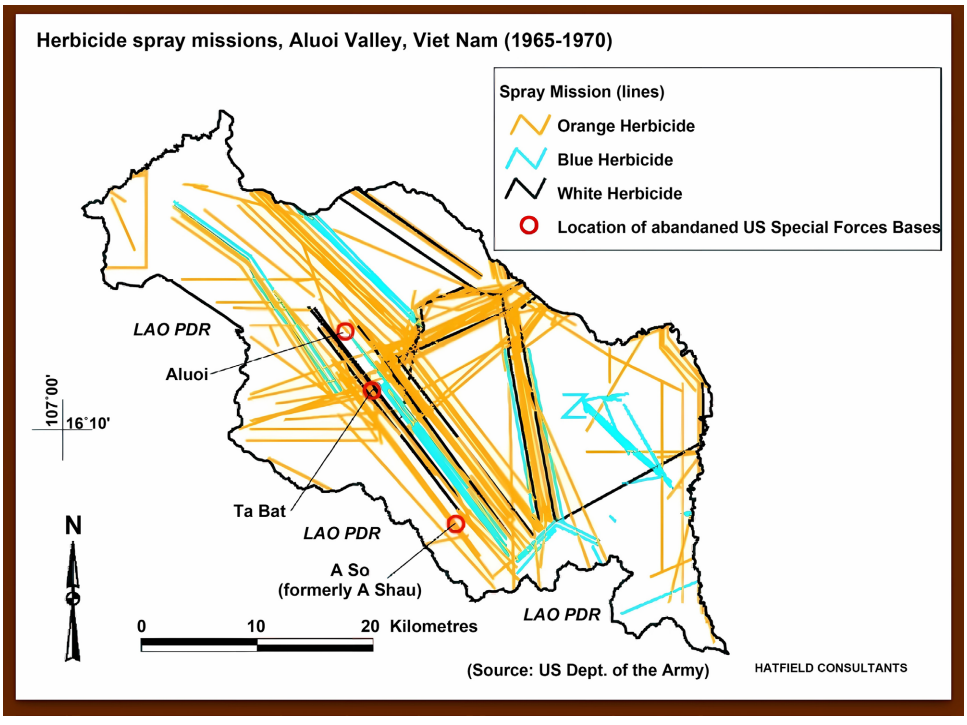

Figure 13. A Luoi Valley area with three temporary US Air Force bases. Depicts each tactical herbicide mission including Agent Orange, Agent Blue and Agent White spray missions.

Figure 14. C-123s spraying tactical herbicides in formation over southern Vietnam in the 1960s. Credit line: Photograph courtesy of National Museum of Air Force and Chronical on-line.

3.7. Ground Operations in Laos

On the ground, the CIA and the RLA had initially been given the responsibility of stopping, slowing, or, at the very least, observing the enemy's infiltration effort. Control of military operation in Laos was complex. The CIA actions were not completely autonomous since the CIA Station Heads reported and had concurrence from Washington daily. The RLA Generals were responsible to the Laos King; however, needed support of US forces required the Ambassador's approval based in Vientiane whom represented the US President. Public scrutiny by reporters was kept to a minimum with Embassy/CIA PAO press briefing from Udorn or Vientiane. In Laos, the agency began Operation Pincushion in 1962 to accomplish that goal [23]. The operation evolved into Operation Hardnose, in which CIA-backed Laotian irregular reconnaissance team operations took place [23].

A common historical perspective supports the efficacy of the campaigns (despite their failure to halt or slow infiltration), as they did restrict enemy materiel and labor in Laos and Cambodia. This viewpoint pervaded some official U.S. government histories of the conflict. John Schlight said of the PAVN's logistical apparatus, "This sustained effort, requiring the full-time activities of tens of thousands of soldiers, who might otherwise have been fighting in South Vietnam, seems proof positive that the bombing of the Hồ Chi Minh Trail had disrupted the communication efforts of the North Vietnamese" [31]. This interdiction of logistics; however, proved inadequate.

Despite U.S. anti-infiltration efforts, the estimated number of PAVN infiltrators during 1966 was between 58,000 and 90,000 troops, including five full enemy regiments [6]. A June 1966 DIA estimate credited the North Vietnamese with 1000 km of passable roads within the corridor, at least 300 km of which were good enough for year-round use [32].

3.8. Defoliation

In December 1965, the USAF began its first Operation Ranch Hand defoliation missions against the trail in Laos using both Agent Blue and Agent Orange defoliants. More than 210 missions took place (Figure 15), spraying approximately 1.7 million liters of defoliants. Unlike Laos, the trail in Cambodia was not systematically targeted for defoliation, although more than ten missions were mounted against the Parrot's Beak area, spraying approximately 155,000 liters of Agent Orange [33] [34].

3.9. Use of Tactical Herbicides on the Hồ Chi Minh Trail in Laos

The old Hồ Chi Minh Trail is an intricate web of truck roads and secret paths

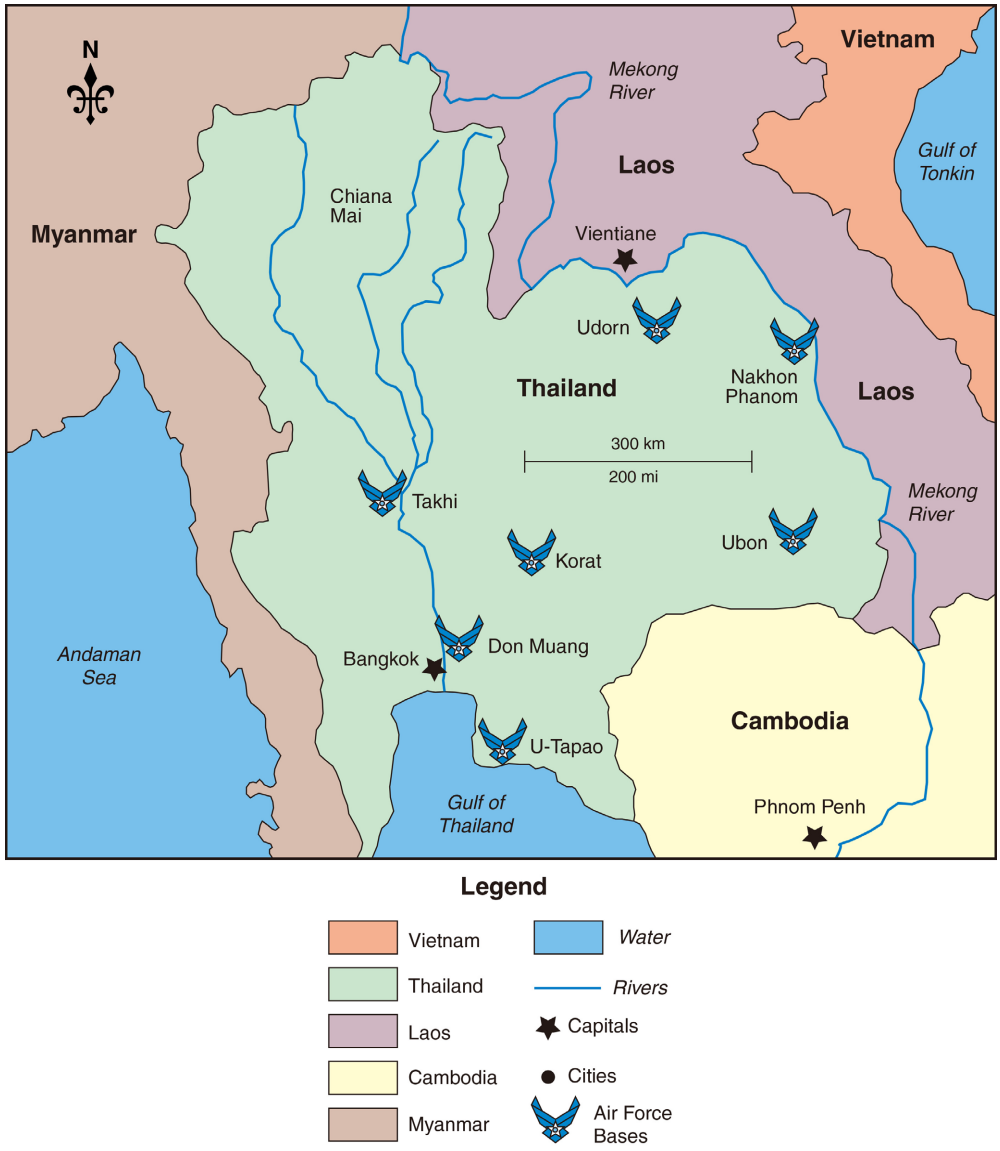

Figure 15. There are seven Thai Royal Air Force bases that were used by the US Air Force during the Secret War in Laos. Map by Mic Greenberg. Reprinted with permission from Editor of Open Journal of Soil Science.

that wove its way across the densely forested and mountainous border between Vietnam and Laos. Once used by the PAVN soldiers to infiltrate South Vietnam [35].

The use of the herbicide in the neutral nation of Laos by the United States-illegally, secretly, and in large amounts—remains one of the last untold stories of the Vietnam War in Southeast Asia. The United States has never taken responsibility for spraying herbicide as a chemical weapon over a broad area of Laos during the Vietnam War.

The focus of the NGO War Legacies Project (**Figure 16**) is to document the long-term effects of the defoliant known as Agent Orange and provide humanitarian aid to its victims [25]. Named for the colored stripe painted on its barrels, Agent Orange—best known for its widespread use by the U.S. military to clear vegetation during the Vietnam War—is notorious for being laced with a chemical contaminant called 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin, or TCDD, regarded as one of the most toxic substances ever created.

Decades later, even in official military records, the tactical herbicide (chemical) spraying of Laos is mentioned only in passing. In 1982, the US Air Force finally released its partially redacted official history of the defoliation campaign, Operation Ranch Hand (**Figure 17**). The three pages on Laos attracted little attention, other than a statement from General William Westmoreland, the former commander of U.S. forces in Vietnam, that he knew nothing about the use of tactical herbicides on the Hồ Chi Minh trail in Laos even though he had ordered their use. Laos remained a forgotten footnote to a lost war [35]. Only in the last two decades has the United States government and military finally acknowledged and taken responsibility for the legacy of Agent Orange in Vietnam, committing hundreds of millions of dollars to aiding the victims (**Figure 18**) and cleaning up the most contaminated hotspots. However, Laos and Cambodia were not included (**Figure 1**).

Figure 16. A Hmong village south of Luang Prabang. The water was provided from a small reservoir at the base of the mountain.

Figure 17. Picture of active Bien Hoa Air Force Base taken in the 1960s during the Vietnam War. Credit line: Photograph courtesy of Vietnam War Commemoration. https://vietnam50th.com

Figure 18. Four children or grandchildren of parents who were exposed to dioxin TCDD or arsenic during the Vietnam War. Photo credit: Picture taken by Ash Annand, Newsmado. Courtesy of the Courier Mail, Brisbane, Australia.

While records of spraying operations inside Laos exist, the extent to which the U.S. military broke international agreements has never been fully documented, until recently [35]. An in-depth, months long review of old Air Force records by staff at the War Legacies Project, including details of hundreds of spraying flights as well as interviews with many residents of villages (**Figure 13**) along the Hồ Chi Minh Trail, revealed that at least 2,271,000 liters of tactical herbicides rained down on the "neutral" nation during the war.

For years, the War Legacies Project was aware of the spraying in Laos, but the remote areas affected were almost inaccessible. Finally, in 2017, with new paved roads connecting the main towns, and many smaller villages accessible in the dry season by rough tracks, staff were able to embark on systematic visits to the villages of the Bru, the Ta Oey, the Pa Co and the Co Tu, four of the ethnic minorities whose homes straddle the Laos-Vietnam border. It was the first time anyone had tried to assess the present-day impact of the defoliant on these groups [36].

Of the 517 cases of disabilities and birth defects so far documented by the War Legacies Project in Laos, about three-fourths, can be clearly linked to defoliants. It is clear, even to a nonprofessional that malformed limbs are identifiable because of exposure to Agent Orange.

War Legacy staff requests for both the United States and Laos to acknowledge the long-term effects of the chemical spraying on the environment and human health have so far been met with bureaucratic rationalizations for inaction. Congress can do nothing without a clear signal from the Lao government. The Lao government has been hesitant to act without hard data. Officials of the United States Agency for International Development in Vientiane have been sympathetic, but other senior embassy officials have waved away the problem.

The War Legacies findings will be submitted to both governments, documenting the extent of the spraying recorded in the Air Force records and the number of disabilities the War Legacies Project has found [36]. Once this documentation is complete governments of the United States and Laos will no longer have any reason to avoid taking action. This is long overdue.

War Legacies staff lived in Vientiane. From there they traveled to remote areas where few outsiders ever ventured. They had heard strange and unsettling stories in Xepon, a small town near the Vietnamese border. Doctors reported a rash of mysterious birth defects. A veterinarian told of farm animals born with extra limbs. There were anecdotal accounts of airplanes trailing a fine white spray. Nevertheless, it was impossible to find out more. "*In those days there were no roads into the mountains. One had to walk*, *sometimes for days to get there*" [36].

After protracted negotiations with Lao authorities, the War Legacies Project signed a three-year memorandum of understanding, promising a full report by March 2021 [36]. More than half the cases identified by the War Legacies Project are children age 16 and under (**Figures 18-20**). They are the grandchildren of those who were exposed during the war, and possibly even the great-grandchildren,

Figure 19. Boy with no hands and deformed feet. Photo Credit: Warfare Legacies.

Figure 20. Girl with no arms who can write with her feet. Photo Credit: Warfare Legacies.

since the people in these villages have traditionally married in their teens. Club-feet are commonplace (**Figure 19**). So are cleft lips, sometimes accompanied by cleft palate. There are disturbing clusters: five babies born with missing eyes in Nong District; a family with five deaf-mute siblings; an inordinate number of short legs (**Figure 19**), malformed legs and hip dysplasia in Samuoi District—the latter a condition that is easily treatable in infancy, but if neglected will lead to severe pain, a waddling gait and more serious deformity. The rudimentary health care system in rural Laos means that few if any infants even get a diagnosis (**Figure 18**).

In each village where the War Legacies Project staff [36] visited, groups of elders assembled to share their stories, many in their 70s yet still with sharp memories. At first, they recounted, they had no idea who was spraying and bombing their villages, or why. However, in time they learned the names of the airplanes: T-28, C-123 (**Figure 21**), and B-52. In most villages, dozens were killed by the bombings or died of starvation. The survivors lived for years in the forests or in caves. They dug earthen shelters, big enough to hide a whole family, and covered them with branches. A village elder said, "We had no rice for nine years (*the rice crop was usually destroyed by Agent Blue spraying*). Sugar cane and lemongrass survived the spraying". So did cassava, though it swelled to an outlandish size it became inedible. The 2,4-D in Agent Orange accelerated the growth of plant tissue, killing most foliage [36]. "*During the war*, *village people went back and forth between Laos and Vietnam*, *the elder said*, "*depending on which side was being bombed and sprayed at the time*". Vietnamese people affected by the chemical spraying get compensation," the elder complained. "*In Laos*, *we need support from America*, *like they receive in Vietnam*."

The 2,271,000 liters of herbicides dropped in Laos is a fraction of the roughly 68 million liters that were sprayed on Vietnam. However, the comparison is misleading [34] [35]. Between 1961 and 1971, some 18 percent of South Vietnam's land area was targeted for spraying campaign. About 31,000 km^2 of Laos was targeted and this was equivalent to 18 percent of South Vietnam's land area. The Laos spraying campaign began on the Hồ Chi Minh Trail between Labeng-Khok and the Vietnamese border was compressed in time and space. It was

Figure 21. C-123 Fairchild Provider aircraft that was used during the Vietnam War to spray tactical herbicides. Photo credit: Picture courtesy of Jim Lang.

focused on narrow, defined strips of the trail, 500 m wide, and on nearby crop fields and the heaviest spraying was concentrated in a four-month period early in the war (These strips could be dioxin TCDD and arsenic hotspots). It was as intense a ramping-up of the defoliation campaign as recorded in any other target area in Vietnam War zone.

To make matters worse, the newly examined Air Force records [35] show that Agent Purple and not Agent Orange was used during the first intensive period (1962 to 1965) of spraying in Laos. The much more toxic Agent Purple the use was discontinued in Vietnam almost a year earlier. Any tactical herbicide defoliation spraying in Laos before 1965, by private consultants and Air America, would have had to use Agent Purple. Tests showed that the average concentration of TCDD in Agent Purple, a different chemical formulation than Agent Orange, was as much as three times higher than in the original formulation of Agent Orange (*later Agent Orange was produced at higher temperatures had much greater amounts of dioxin*).

The four years before the first Marines came ashore in South Vietnam in 1965; infiltrators from the North were trickling into South Vietnam (**Figure 22**) from the still-rudimentary Hồ Chi Minh Trail. During this time, loyalties of the tribal groups along the border were dubious. In response to the growing insurgency with the goal of shifting the loyalties to South Vietnam. US Special Forces set up small camps near the border with Laos. Notably at Khe Sanh, which later became a gigantic Marine combat base, and in the A Shau Valley (**Figure 23**), later infamous for the battle of Hamburger Hill (**Figure 24**) and seen by U.S. strategists as the most important war zone in South Vietnam [36].

Operation Ranch Hand was in its infancy. By July 1962, only a handful of missions had been flown, defoliating the perimeters of highways, power lines,

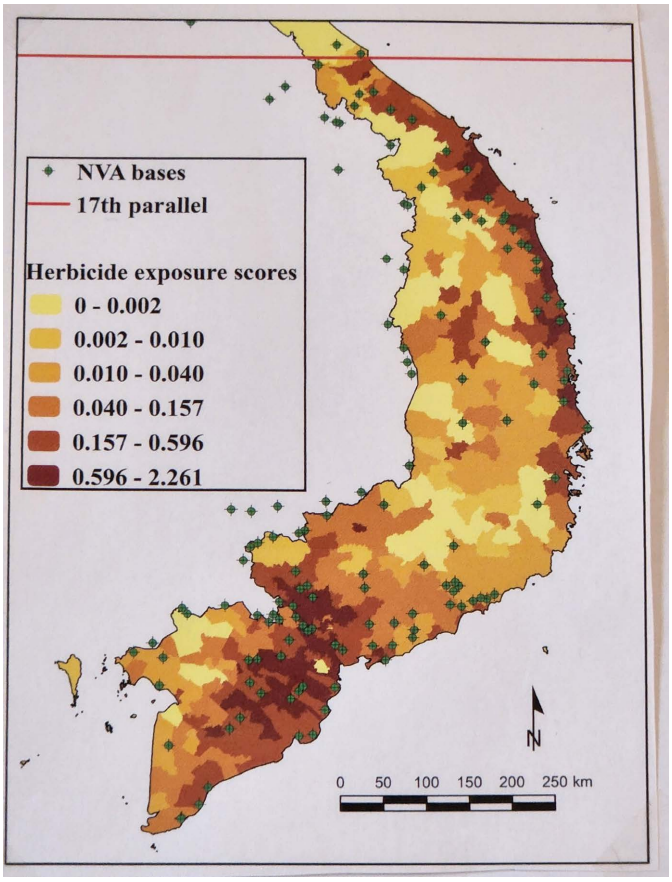

Figure 22. Distribution of herbicide exposure scores and location of North Vietnamese Army bases. The modified figure shows the distribution of herbicide exposure scores and locations of NVA bases. Reprinted with permission from Editor of Open Journal of Soil Science.

Figure 23. A Shau valley in South Vietnam in 1969. The valley is adjacent to the Laos. Locals moved back and forth across the border to avoid being sprayed and bombed. The brownish red areas were sprayed with Agent Orange and Agent Blue in an attempt to defoliate the jungle. Photo Credit: United States Army.

Figure 24. Hamburger Hill was defoliated by fire and herbicides. The PAVN crossed the Laos border to attack the hill. Photo Credit: United States Army.

railroads and the waterways of the Mekong Delta. The commander of U.S. forces in Vietnam requested authority to hit six new targets. One of them was the A Shau Valley (**Figure 23**), and it would be the first mission aimed at destroying crops that might feed the enemy. (*Agent Blue the arsenic based herbicide was often the herbicide of choice when destroying food crops including rice.*) The Joint Chiefs of Staff refused. The location was too sensitive; the valley was right on the border, and the neutrality of Laos was just days from being guaranteed under an international agreement [29]. The Commander of Vietnam Forces pushed back, arguing that the proximity of the unsecured border was precisely the point. Despite President John F. Kennedy's strong reservations about crop destruction, the food denial mission went ahead with the approval of the Commander of the Vietnam Forces [37] [38] [39].

In January of 1963, an Army captain arrived at the A Shau Special Forces Base. In February, "*We burned down the thatched huts, starting the blaze with Ronson and Zippo cigarette lighters*," he wrote later. "*The destruction became more sophisticated. Helicopters delivered 208-liter drums of a chemical herbicide to us, a forerunner of Agent Orange… Within minutes after we sprayed, the plants began to turn brown and wither.*" The young officer was Colin Powell (**Figure 25**), future Chairman of the Joint Chiefs of Staff and Secretary of State [35]. The chemical was Agent Purple. By the end of the defoliation campaign, at least 1.7 million liters of herbicides would be used in the A Shau Valley (**Figure 13**), making it one of the most heavily sprayed regions in Vietnam; thousands of Vietnamese eventually became sick or died [36] [37] [38]

The flow of North Vietnamese troops down the trail only increased, and by late 1965, the CIA was reporting that hundreds of kilometers of new roads had been built or upgraded to carry trucks. The Air Force was already bombing North Vietnam, so the obvious answer was to escalate the herbicide spraying and bombing on the Ho Chi Minh Trail in Laos.

Figure 25. Official U.S. government picture of former US Army Captain and US Secretary of State, Colin Powell picture.

In addition to Laos's "neutrality", there was a second problem: Where exactly was the trail? It ran through some of the most remote and inhospitable terrain on earth, concealed by dense rainforest, largely invisible to U-2 spy planes, low-flying helicopters, and even infrared sensors on other aircraft. The solution was to strip away the forest cover, using chemical (herbicide) weapons such as Agent Purple or Agent Orange, to expose the bombing targets including truck convoys and logistical centers like Labeng-Khok.

In essence, the initial tactical herbicide spraying of Laos (Agent Purple, Agent Blue and Agent Orange) was a mapping exercise, formally integrated into a massive bombing campaign called Tiger Hound. In early December 1965, the ungainly C-123 aircraft (Figure 21), the workhorses of the herbicide campaign which now included Agent Orange [40], crossed the Lao border for the first time. Within a week, the first wave of B-52s (Figure 26) hit the Hồ Chi Minh Trail (Figure 2).

4. Results

4.1. Attempt to Get CIA and US Air Force's Laos Tactical Herbicide Flight Spray Records

The details of these air operations in Laos remained largely unknown until 1997. When War Legacies Project staff were at a function at the U.S. Embassy residences in Vientiane, they met with Ambassador Wendy Chamberlin, who was on her way to Washington. The War Legacies Project staff were asked by the Ambassador, "*Was there anything they needed*? The staff said "*Yes*" [35]. "*Can you get the Air Force bombing records for Laos? While you're at it, how about the records on Agent Orange*?"

By then, War Legacy staff had gotten to know Thomas Boivin, a scientist with a Canadian company called Hatfield Consultants that was completing a landmark study of Agent Orange on the Vietnam side of the border (Figure 23), in

Figure 26. B-52s bomber dropping bombs. Photo Credit: United States Air Force.

the heavily sprayed A Shau Valley (today known as the A Luoi Valley, named after its main town). The records were in the form of computer punch cards and needed to be painstakingly converted into a database that showed every recorded flight, with its date and the geographical coordinates of where each spray run began and ended [36]. Boivin later calculated that more than 1.7 million liters of chemicals had been sprayed on Laos, but other declassified Air Force documents show additional amounts not found in those initial records, and several village elders gave persuasive accounts of flights that did not seem to conform to the official data.

"*I'm sure the records are incomplete*," says Jeanne M. Stellman, an emeritus professor of health policy and management at the Mailman School of Public Health at Columbia University, who played a pivotal role in documenting the spraying in Vietnam and calculating the risks of dioxin exposure for American veterans [36]. "*And my understanding is that the guys who were assigned to missions in Laos were sworn to secrecy*." Boivin adds, "*The CIA also undoubtedly used herbicides in Laos, but their records have never been declassified*." (*After* 55 *years, perhaps the CIA herbicide spray records should be declassified*).

In War Legacies Program pushed to have the U.S. government take responsibility for its actions in Laos, Susan Hammond, the executive director of the War Legacies Program [36], had been well aware that it took many years for the plight of America's own veterans and their offspring to be acknowledged. However, it took much longer for the same compassion to be extended to the Vietnamese victims of dioxin. The Agent Orange Act of 1991 was passed after 14-years of campaigning and lobbying by American veterans. The bill provided recognition that the chronic illnesses, that tens of thousands of them were developing/suffering, might be directly connected to dioxin exposure. Once the legislation passed, it was determined that if a soldier had set foot (*boots on the*

ground) in Vietnam between 1962 and 1975 and suffered from one of the medical conditions on the growing VA list, you were eligible for compensation. This resolution was a matter of political pragmatism rather than hard science [36]. Although there was growing evidence of the toxicity of the herbicides, studies of their health impacts were inconclusive and fiercely contested by the Department of Defense (DOD) and the CIA. However, the veterans formed an angry and influential constituency, and politicians had to assuage a good measure of guilt, both their own and that of the public, over the trauma of those who had fought in a lost war that most Americans preferred to forget.

Accepting responsibility for the horrors visited on Vietnam [41] and Lao peoples took much longer. Even after diplomatic relations were restored in 1995, Agent Orange was a political third rail. Vietnamese complaints about the effects of the herbicides on human health—raising issues of reparations, corporate liability and possible war crimes—were dismissed as propaganda [36]. American diplomats were forbidden even to utter the words. It was not until around 2000 that the United States was finally forced to acknowledge its obligations, after Hatfield Consultants (Canada) completed its studies of the impact of dioxin and showed U.S. officials incontrovertible evidence of how TCDD moved up the food chain, entered the human body and was transmitted to infants through breast milk [42].

Reconciliation between the United States and Laos was an intricate dance that depended on reciprocal steps to untangle the three most contentious legacies of the war. Once Washington had secured full cooperation in accounting for Americans missing in action, it began to aid Laos' efforts to remove the vast amount of unexploded ordnance that littered its fields and forests, killing and maiming tens of thousands. These steps, plus Hatfield's breakthrough A Shau Valley study [43], set the stage finally for the two countries to deal with Agent Orange, Agent Blue and Agent Purple, the most intractable problem of all.

Since the late 1980s, joint American-Lao teams have conducted hundreds of missions searching for the remains of aircrew who went missing on bombing missions (**Figure 26**), and over the last quarter-century, Washington has committed more than $230 million to ordnance removal (**Figure 27**) and related programs. The missing step has been Agent Orange, Agent Blue and Agent Purple, but lacking any data on its human impact, the Lao government has had little incentive to raise such a historically fraught issue [35]. Few US soldiers fought in the sprayed areas, which were controlled by the North Vietnamese, so there were no US veterans clamoring for recognition of their postwar sufferings. "*In Vietnam, the magnitude of the problem made it impossible to ignore*," Hammond said. "*But in Laos it was on a smaller scale, and in remote places outside of the political mainstream.*"

Forty-eight years later, the mountainous border strip in the southern Lao panhandle remains a landscape defined by war and disease. Unexploded bombs are everywhere (**Figure 27**). The road that follows the Hồ Chi Minh Trail south

Figure 27. Ordnance removal by the United States in Laos. Photo Credit: United States Army.

is a kind of living archive of the conflict, in which its remnants and relics have been absorbed into the fabric of everyday life. Men fish in boats made from the jettisoned fuel tanks of American fighter-bombers. Bomb craters from B-52 strikes (Figure 26) are everywhere. Some are now fishponds in the middle of the rice paddies.

"Cluster-bomb casings have morphed into vegetable planters or substitute for wooden stilts to support the thatched huts that store rice, frustrating the claws of hungry rats" [36]. Everywhere the village soundtrack is the dull clang of cowbells made from sawed-off projectiles. "*These were gifts to the villagers from America*," one elder told the War Legacies Program staffers.

Once or twice, the War Legacies team had to turn back, defeated by roads that were impassable after recent monsoon floods. Halfway to the village of Lapid, the four-wheel-drive vehicle slowly stopped in the mud. War Legacies team staff climbed out and paced up and down the steep slope, inspecting ruts that were deep enough to swallow a person whole [36]. There was no way through. It was frustrating, given Lapid had been hit hard by tactical herbicides. An Operation Ranch Hand plane with its full load of chemicals had been shot down in the nearby hills, and after the war, villagers called the area the "Leper Forest" for the high incidence of cancers and birth defects. On an earlier visit to Lapid, the War Legacies Project found a paralyzed baby, a 4-year-old with a clubfoot (Figure 19), a teenager born without eyes.

The War Legacies project survey was a slow and laborious process. Since 2017, the staff visited scores of villages in heavily sprayed districts in two of the four border provinces that were targeted: Savannakhet and Salavan. In each village, they noted the age and gender of each person affected (Figure 28), a description of their condition—with a firm diagnosis where possible—and a comment on any who might benefit from referral to a hospital in the provincial capital or in

Figure 28. War Legacies project. A grandson of grandparents affected by dioxin TCDD and/or arsenic. A boy with no hands or feet is trying to ride a skateboard. Photo Credit: Warfare Legacies.

Vientiane [36]. They excluded disabilities that are clearly unrelated to dioxin exposure, like the large number of limbs lost to cluster-munition bomblets. Their October 2019 trip was designed mainly to check up on cases they had already recorded, but they also found several new ones, like the boy in La-beng-Khok.

Hammond recognized the limitations of War Legacies staff work. Some of their findings need to be verified by medical experts. "The War Legacies Program staff we're not doctors or geneticists," she says. Yet War Legacies Program staff were the first to try to investigate TCDD impacts in Laos what has long been routine in Vietnam, where dioxin-related disabilities are logged systematically through commune-level surveys and household questionnaires and where victims receive small government stipends, and in some cases humanitarian aid from the United States.

It was Hatfield Consultants [43], who unlocked the door to that aid, first through its four-year investigation of the A Luoi Valley (**Figure 29**), then through subsequent studies of the former Dan Nang and Bien Hoa air bases. There had never been any secret about the huge volume of defoliants used in Vietnam, and the evidence of congenital disabilities in the sprayed areas was inescapable. Hatfield Consultants joined up the dots, showing how the two were connected and how dioxin could be transmitted from one generation to the next [44]. Nevertheless, that was not Hatfield's only insight. According to what it called the "hotspot" theory, the ongoing risk of present-day exposure was greatest around former military installations like the Special Forces base at A Shau, where the chemicals had been stored, spilled and sprayed on the perimeter fences or adjacent areas. Boivin wondered whether there might be similar dioxin hot spots on the Lao side of the border.

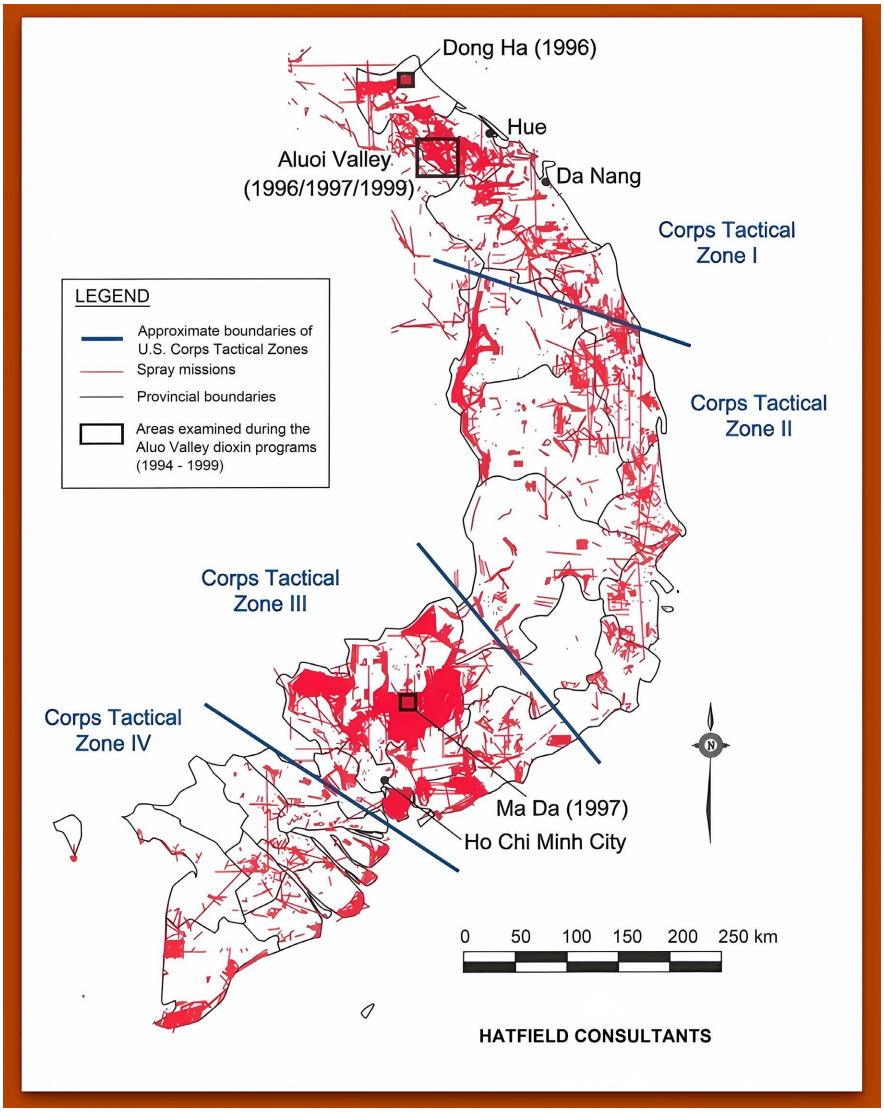

Figure 29. Tactical herbicides spraying mission zones in South Vietnam by the US Air Force Operation Ranch Hand. Overlay of 1994-1999 dioxin examination areas.

In 2002, Laos signed the Stockholm Convention on Persistent Organic Pollutants, a class of 12 "forever chemicals" including the dioxin family. All signatories were obligated to report on the extent of contamination in their countries. Boivin got a small grant from a U.N. agency to investigate dioxin in Laos, as the nation had little scientific expertise of its own. He found very little. However, pursuing his hunch about Agent Purple, Agent Blue, Agent Orange use, he made an arduous trip into the remote border areas. It was suspected that the CIA had built secret airstrips, the kind of facilities that might have been used by herbicide planes and that would have been routinely sprayed to keep down vegetation, as they were used in Vietnam [39] and [41].

Near a village called Dak Triem, he noticed a strikingly flat piece of land. Yes, the village elders said, it had once been an airstrip. Scavenging for scrap metal after the war, they found some barrels painted with orange stripes. Boivin had

time to do no more than some perfunctory sampling, but he found elevated concentrations of TCDD, enough to classify the site as a possible hotspot and recommend further investigation. Boivin (Hatfield Consultants) and Hammond (War Legacies) had known each other for years. In 2014, with funding from Green Cross Switzerland and the European Space Agency, they collaborated on a more detailed report, which included a chronological table of all the known herbicide flights in Laos and a list of hundreds of clandestine CIA facilities that might pose an ongoing health risk. Today the location of the Helo Pads in the battlefields has been made open due to the historian interest in the battle. Storage areas and any refitting pads outside of Udorn may be less open to the public. This is where Agents Orange, Purple and Blue spills, if these exist, would be found.

Boivin submitted his reports to the Lao government, but the documents gained little traction. This lack of Laos's government interest might seem surprising. A retired foreign-service officer, who served as deputy chief of mission in Vientiane, said "*Things move slowly and cautiously there* [43]. *For an overworked midlevel official, there is no real incentive to act on something like this. Only people at the very highest level can consider or speak about controversial issues*."

Nevertheless, there was a deeper reason for the lack of action on Boivin's findings. He had made a preliminary estimate of the volume of defoliants used in Laos and found one contaminated air base. However, he had never set out to collect data on the human health impact. That was the missing piece of the puzzle that had been assembled in Vietnam. The War Legacies Project, using further Green Cross funding, set out to find this missing piece of data. For years, the remote areas affected in Laos were almost inaccessible [36]. Finally, in 2017, the War Legacies Project was able to embark on systematic visits to the villages that straddle the border.

When the United States finally agreed to clean up the Da Nang and Bien Hoa air bases in Vietnam, the two main hubs of Operation Ranch Hand, and aid the victims of Agent Orange in that country, it was an integral part of building trust between former enemies who increasingly see themselves as strategic allies and military partners. (*Today*, *Bien Hoa is an important Vietnamese Air Force base and access by foreigners is restricted*). In one of the larger oddities of history, the most painful legacy of the war has become a cornerstone of reconciliation.

In 2019, USAID made a new five-year commitment to provide another $65 million in humanitarian aid to Vietnamese people with disabilities in areas sprayed with Agent Orange and otherwise contaminated by dioxin. The funds were passed through the Leahy War Victims Fund, named for its creator, Senator Patrick Leahy, a Democrat from Hammond's home state, Vermont [36]. The Senator, for years, has led the effort to help victims of Agent Orange in Vietnam. So why would the same logic not apply in Laos? "*We weren't aware of significant spraying in Laos*," Leahy said by email, "*Nor of people with disabilities in those areas*

that are consistent with exposure to dioxin. But if that is what the data shows, then we need to look at it and discuss with the government of Laos what could be done to help those families." Nan, 30, was the victim of a cluster-bomblet explosion, one of thousands in Laos killed or injured by unexploded ordnance leftover from the war. She was never able to receive proper medical care for her injury.

Hammond has met several times with Leahy's longtime aide Tim Rieser, who seems eager to see what the War Legacies Project has found when it presents its report to his boss. "*We have our work cut out for us in Vietnam*," he says, "*but we'd also want to know what was done in Laos, since clearly those who were involved*" (*meaning wartime political and military leaders*) "*have not made a point of making it widely known* [36]. *I've always approached this as doing what is necessary to solve the problem, and if there's more to the problem than we knew, then we need to deal with it.*"

Hammond is painfully aware that bureaucratic wheels turn slowly; that Leahy, after 46 years in the Senate, retired January 3 2023; and that Vietnam will always be the front-burner issue. In principle, the smaller scale of what is needed should make it easier to address. "*Even* $3 *million, which is what the U.S. started off with in Vietnam, would go a long way in Laos*," Hammond says. Meanwhile, the affected people are running out of time. Nine children under the age of nine on the War Legacies Project list have already died [36].

USAID already has an active disabilities program in Laos, which includes help for people injured by unexploded bombs. "*All we need to do*," Hammond says, "*is add the language we use now for Vietnam, earmark some money for 'areas sprayed by Agent Orange and otherwise contaminated by dioxin.' That one little sentence. That's all it takes.*"

Laos Spray Missions Flight records taken from the database show that spray missions flown on 209 dates, between 1965 and 1970, sprayed a total of at least 2,034,600 liters of tactical herbicides (**Figure 30**). The heaviest spraying began in early 1966 and continued at a steady rate until February 1967, after which the rate of spraying became intermittent until October 1970. For over five years, these spray runs were coordinated out of Bien Hoa Air Force base, with some earlier run out of Tan Son Nhut Air Force base and Da Nang Air Force base, in Vietnam [36].

Candidates for future TTDS investigations are Savannakhet, Salavan, Sekong and Attapeu provinces, all abutting Vietnam's western border. These providences encompass an area in Laos's territory where the Hồ Chi Minh Trail had extended into and from Vietnam. Two other southeastern provinces in Laos were the most heavily sprayed include Khammouane province a choke point located at the Northern section of the Trail, lays to the north of Savannakhet, and Champasak province (**Figure 30**) straddles the Trail's link to Cambodia (**Figure 24**).

The communication routes into in Cambodia were also sprayed; however, with significantly less tactical herbicides than in Laos and Vietnam. In Cambodia

Figure 30. The named and located Laos providences.

as in Vietnam, the herbicides were used not only to defoliate forests, but also to destroy crops (Agent Blue the arsenic based herbicide was often the herbicide of choice). Records from Military Assistance Command Vietnam (MACV) show that 64 crop destruction missions (an area a total of 82 km^2 along the Hồ Chi Minh Trail) took place between September 1966 and September 1969. The spraying and heavy bombing (**Figure 31**) forced villagers to flee to the hills for up to ten years. The food supply chain was inevitably upended as a result, triggering an immense loss of crops and livestock that was followed by malnutrition lasting decades, even after the war.

According to William Buckingham's history of Operation Ranch Hand [43], the U.S. Air Force sprayed 1,589,850 liters—of which, 75 percent were Agent Orange, 15 percent Agent Blue (the arsenic based herbicide used to destroy the rice crops), and 10 percent Agent White—over 582 km^2 of Laos, up until September 1969. Like the bombing of Laos during the war, the use of herbicides in

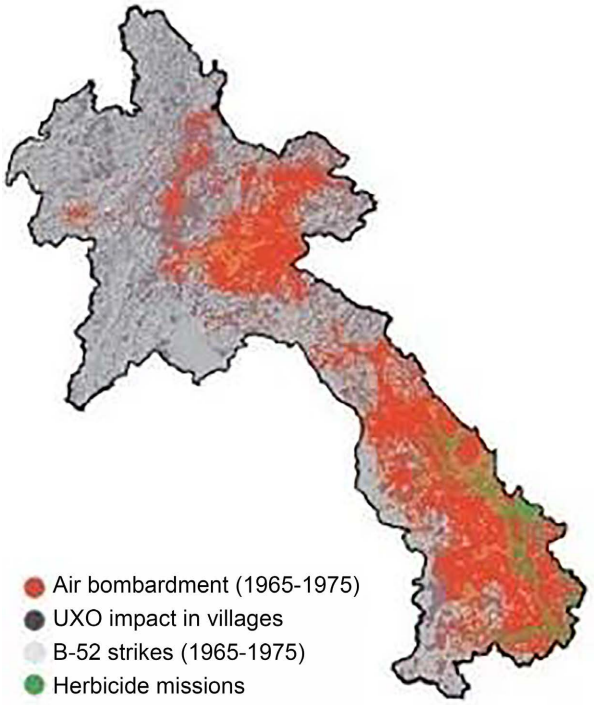

Figure 31. Laos's bombardment and tactical herbicide missions in Laos. Photo Credit: Hatfield Consulting.

Laos was secretive until 1982, when a draft of Buckingham's study of Operation Ranch Hand was made public. Much about the U.S. war effort in Laos is still classified. Records were redacted before being released. (*This needs to be changed*). Very little is known about spraying that may have been done under the auspices of the US CIA; nor is it known if there was any hand or helicopter spraying done on bases controlled by the U.S. or allied forces. (*After* 50 *years, the CIA spray mission records including airstrip locations in Laos should be totally declassified and made publicly available. A more complete data set would help researchers document the human health impacts of dioxin TCDD and arsenic*).

In 2019, the U.S. Department of Defense released a list of where herbicides were used outside of Vietnam. It states that Agent Orange was stored and loaded onto planes at Udorn Air base in Thailand. Between October 1968 and September 1969, the base was used for "missions flown in northern Laos." Only three spraying missions, which were conducted over an area only 96 kilometers of Vientiane, the capitol city of Laos, in September 1969, show up on the HERBS database [39]. For a very short time in 1968, Air America used one of its Porter PC-6aircraft to spray Agent Orange in central Laos. Technical issues with the spray nozzles made this impractical, however. Both the RLAF with its pilots and tactical aircraft and Air America with 300 pilots and supporting air and ground crew for at its height in Laos 24 transports, 24 SLOT planes and 30 helicopters had the means for herbicide spray missions. However, their primary mission was the defend of the Patho Lo and PAVN invasion. That priority, the technical is-

sues of equipping plans for spray missions and the autonomous organization the three entries, the Laos's government, CIA and Air America records may have not survived the 1975 regime change after the final peace conference. The complete account of the use of herbicides in Laos has yet to surface. However, a survey conducted to determine the impact of aerial spraying of herbicides in Laos is underway.

4.2. Laos Facts

For ten years (1964-1973), the CIA, with the assistance of the US Air Force, conducted intensive daily aerial bombing campaigns over northern and southern Laos using automated air war techniques (**Figure 29**). Local mercenary armies and U.S. military units were sworn to secrecy. Two-thirds of Laos was subjected to 580,344 bombing missions (**Figure 31**) and a total of more than two million tons of aerial-dropped explosive ordinance. The bombing equates to one B-52 plane load of bombs being dropped every eight minutes for nine years—about two tons of bombs per person. Laos holds the per capita record as the most heavily bombed country in world history [43].

Most Americans, indeed most of the world, have never heard about the CIA's Secret Air War in Laos. The CIA and its covert military units conducted this autonomous air war beyond the watchful eyes or interest of the world's media. The war was never publicly sanctioned or approved by the U.S. Congress. Historian Geoffrey Gunn claims that the "*U.S.-Laos theatre of the sixties and early seventies remains one of the least studied areas in western scholarship on Indochina*."

The poorest and most undeveloped ethnic groups of Laos have been most affected by the post-war legacies—unexploded ordinance, environmental and human effects of Agent Orange defoliation (**Figure 27**), and enormous social and economic disruption. Today, poverty mapping shows a strong correlation with the areas subjected to the intense and long air war. Yet no systematic recording of the post-war legacies has been done [30] [44] [45].

The U.S. accounts of the bombing and defoliation of Hồ Chi Minh Trail fail to mention that the area is home to small indigenous ethnic groups of the southern Annamite Mountains. They are the Makhong, Taliang, Ta-oy, Oy, Alak, Bru, and Tri, to name a few. During the warfare, these ethnic groups suffered silently. They lost their homes, fields and forests; they were subjected to toxic herbicide spraying (Agents Orange, Blue and White) for at least five years [44] [45]. They remain the least educated, the most disease-ridden, and the poorest peoples in Laos. They are highly vulnerable and fragile societies and the least able to cope with external complications.

4.3. Agent Orange Legacy in Laos

Along the southern mountainous spine between Laos and Vietnam ran the Vietnamese military transport route, known as the Hồ Chi Minh Trail. Like in Vietnam, the area was extensively and sprayed regularly with herbicides from

1962 to 1971. Unlike with Vietnam, few outsiders know about it.

The 1962 Geneva Accords proclaimed Laos a neutral country and forbade outside military involvement there. The agreement by 14 countries placed an important role in how the US approached the challenge from PAVN. As the U.S. war in Vietnam escalated, however, neither the U.S. nor North Vietnam were able to resist intervening. As local Laotian revolutionaries and their Vietnamese allies built a network of paths along the border, later termed the "Hồ Chi Minh Trail," covert U.S. operations used every means available to try to stop them. Among these methods was defoliation by herbicides, especially Agent Orange [45].

Herbicides had a military purpose of clearing land around roads and trails so that enemy movements could be detected and stopped. The environmental and human consequences never entered the calculation. By far the greater concern was preservation of secrecy.

The use of herbicides was reported on during the conflict but officially denied until 1982 when the National Veterans Task Force on Agent Orange made Air Force historian William Buckingham's draft of the Operation Ranch Hand study public under a Freedom of Information Act request. According to Buckingham, the U.S. Air Force conducted herbicide operations in Laos from December 1965 to September 1969.

In 1999, the U.S. Government released the first set of undisclosed Operation Ranch Hand herbicide spray records to the Lao government. According to these U.S. Defense Department records, millions of liters of Agent Orange and other tactical herbicides were sprayed over Laos (**Figure 30**) during the war from 1965 and 1971 (*CIA spray records and documents were redacted and released and other records, such as airstrip locations in Laos are still classified and were not included in these totals*). This disclosure, though incomplete, represents the only official account of the secret herbicide spraying activities in Laos (**Figure 31**). In 2005, the Lao Government began to test a few sites as part of the Persistent Organic Pollutants Treaty [40].

How extensive was the spraying? Are health consequences from Agents Orange, Blue, White and Purple spraying showing up in Laos? Are deformities, reproductive problems and cancers on the increase in sprayed areas? Do ecological consequences persist? Currently, data are incomplete. Furthermore, the hidden health and environmental dangers of Agents Orange, White, Blue and Purple may be compounding livelihood problems for some of the poorest people. The sprayed zones are home to small, remote aboriginal groups, facing the serious risks of extinction. A full accounting and disclosure are long overdue.

4.4. Unexploded Ordnance (UXO) Remnants of War Legacy

Vast amounts of unexploded ordnance (UXO) (**Figure 27**) continue to litter almost two-thirds of the Lao countryside [43]. Since 1975, live ordnance has killed about 12,000 people and crippled, blinded and dismembered tens of thousands

of Lao farmers, according to the United Nations Development Program and the Lao Unexploded Ordnance Program (UXO-Lao). Over the next century, the financial estimates by the UNDP for clearing UXO go into the billions of dollars. Currently, after then-President Obama's visit to Laos in 2016, the U.S. Government is committing to a pledge of $40 million for FY2021.

The most prevalent and dangerous of explosives are the anti-personnel bomblets or anti-civilian "bombies." These tennis ball-size bomblets are scattered through airdrops of a large "mother bomb" which opens and spews out in mid-air the bombies which then act as landmines. Today, many live bombies remain hidden below the soil's surface. Victims include children playing with them like a toy (*some of these bombies were painted orange to resemble oranges or other fruit*); people collecting scrap metal to sell for cash to feed their families and even people cooking over a hidden bombie. Now the story is gaining some attention thanks to an uptick in international press coverage [44].

Here it is interesting to note that for twenty years after the end of the war (1976-1995), there was no official UXO removal program. UXO-Lao only began in 1996, after a special UN Trust Fund was created. Why did it take so long and so many lives to address this stark problem? This was due to the secrecy of the War; its history and long-term effects were not embedded into public consciousness during those two decades. The Lao-educated citizenry was not aware and speaking about these legacies. Even international assistance staff did not know the history of the war that well either. In addition, few journalists came to visit this isolated country (**Figure 29**), while attention in the region was focused on Vietnam and Cambodia.

4.5. Proposed Future Use of the Ho Chi Minh Trail: A Road or Highway

Hồ Chi Minh Road or Hồ Chi Minh Highway (Vietnamese: Đường Hồ Chí Minh) is a highway in Vietnam. It runs from the north to the south in Vietnam, west of National Route 1 (**Figure 5**). The highway was named after Hồ Chí Minh [6]. The route roughly coincides with the Trail during the Vietnam War. It is a two-lane highway (**Figure 32**) and is planned to become an 8-lane highway and it will connect Cao Bằng Province by the Sino-Vietnamese border to Cà Mau Province with the total length of 3167 km. As of 2007, this road runs from Hoa Lac in Hanoi to Ngoc Hoi in Kon Tum Province with a total length of 1234 km.

In Village number 5, Xuân Trạch commune, Bố Trạch district, Quảng Bình province, the road divides (QL15-QL16 intersection) into two separate roads: Đường Hồ Chí Minh Đông (Ho Chi Minh Highway East) and Đường Hồ Chí Minh Tây (Ho Chi Minh Highway West). Đường Hồ Chí Minh Đông is a well-traveled road with many trucks, towns and restaurants along it [22]. There are few steep hills on the Đường Hồ Chí Minh Đông, with the exception of the portion of the highway in Quảng Nam just before it merges with Đường Hồ Chí Minh Tây. Conversely, Đường Hồ Chí Minh Tây cuts through extremely mountainous areas with steep hills and few gas stations. Consequently, all heavy traffic

Figure 32. Ho Chi Minh two-lane road is being paved to become an eight-lane Ho Chi Minh highway.

avoids these portions of Đường Hồ Chí Minh Tây. At times, heavy rain-washes out small segments of the Đường Hồ Chí Minh Tây highway, making it impassable to trucks and cars. Motorists must be alert to domestic goats, cows and water buffalo grazing along the roadside [34]. The roads reconnect at the intersection with National road and Asian highway QL9/AH16 and QL14 in Đa Krông district, province. When the highway was first built, a small portion of the Đường Hồ Chí Minh Tây within Thừa Thiên-Huế and Quảng Nam passed through Laos, but the highway now stays completely within Vietnam's borders. A new expressway (CT.02) is planned on roughly the same route as the Ho Chi Minh Highway, connecting Hanoi and Ho Chi Minh City along the west of Vietnam.

5. Summary

One of the last untold stories of the Second Indochina War in Southeast Asia was the United States secret use of the tactical herbicides, rather than ground troops, in the neutral nation of Laos. The United States has never taken full responsibility for spraying the tactical herbicides used on Ho Chi Minh Trail in Laos during the Second Indochina War. In 2002, Laos signed the Stockholm Convention on Persistent Organic Pollutants, a class of 12 "forever chemicals" including the dioxin family. All signatories were obligated to report on the extent of contamination in their countries.

According to William Buckingham's history of Operation Ranch Hand [44], the U.S. Air Force sprayed 1,589,850 liters—of which, 75 percent were Agent Orange, 15 percent Agent Blue, and 10 percent Agent White—over 582 km^2 of Laos, up until September 1969. Like the bombing of Laos during the war, the use of herbicides in Laos was secretive until 1982, when a draft of Buckingham's study of Operation Ranch Hand was made public. Much about the U.S. war effort in Laos is still classified. Very little is known about spraying that may have been done under the auspices of the United States CIA. After 50 years, the CIA mission spray records should be declassified and made available. A more complete data set would help researchers document the human health impacts of

dioxin TCDD and arsenic.

Recommendation

After 50 years, it is time for the CIA to provide all tactical herbicide records of their secret Air America and the RLAF spray missions in Laos and Cambodia and the purchases and/or donation of defoliant and food destruction materials, and any spray equipment. That would allow the identification of potential dioxin TCDD and arsenic hotspots. Once the locations are determined, it would permit the Hatfield Consultants to assess environmental impacts. War Legacies Program [44] [45] and others could then survey the impact on the human heath on the Laotians. The focus of the War Legacies Project is to document the long-term effects human health effects of the defoliants, known as Agents White, Blue, Orange and Purple, and provide humanitarian aid to its victims. Named for the colored stripe painted on its barrels, and used by the U.S. military to destroy the enemies' food supply and to clear vegetation during the Vietnam War. Agent Blue is known as the arsenic based herbicide used to destroy the rice crop and other food crops. Agent Purple and Agent Orange are notorious for being laced with a chemical contaminant called 2,3,7,8-Tetrachlorodibenzo-*p*-dioxin, or TCDD, regarded as one of the most toxic substances ever created.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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