

TIME-LINE OBSERVATION OF ENVIRONMENTAL IMPACTS SCRATCHED BY HERBICIDE SPLAY DURING VIETNAM WAR

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Abstract

Introduction: Every value of coordinate, date, type of agent and sprayed quantity of whole spraying mission were recorded in HERBS Tape (HBT). HBT was leased by the web site of The National Agricultural Library in Beltsville, Maryland in 2003 as one of the collections of "Alvin L. Young Collection on Agent Orange". *Materials and Methods:* Values and alphabet abbreviations of 5,350 times of missions were punched manually in geographic information system (GIS), then total volume of sprayed herbicide is calculated 58,180 kilo liters. Universal Transverse Mercator coordinates for each spraying mission in HBT was converted into World Geodetic 84 (WGS84) to overlay satellite images and Global Positioning System (GPS) data. Reliability of HBT was examined by GPS and hearing investigations of two veterans of Vietnam War in July 2007. Path of the spraying mission was overlaid with satellite images that have been taken from 1972. *Results and Discussion:* It reveals that heavily and frequently sprayed area lost surface vegetation and subsequent topsoil erosion occurred in mountainous and Cambodian and Laos's border areas. These areas have been exposing rocks and bear soils until today.

Introduction

It is a well known fact that the United State Military Forces sprayed herbicide as one of the weapons to destroy forests and crop fields in South Vietnam. Operation "Ranch Hand" was a code name of this mission aimed to deprive vegetation cover and foods of their opposition enemy. Two thirds of total volume of sprayed herbicide was consisted of so-called "Agent Orange", a half and half mixture of 2, 4, 5-trichlorophenoxyacetic acid (2, 4, 5-T) and 2, 4-dichlorophenoxyacetic acid (2, 4-D) herbicides¹. 2, 4, 5-T contained extremely toxic substance of 2, 3, 7, 8-tetrachlorodibenzo-p-dioxin (TCDD). Half-life of TCDD in soil and sediment is estimated from 50 to 100 years^{2,3}. Herbicide missions were frequently operated mainly in southern part of Vietnam including not only Mekong Delta area but also mountainous areas as well as Cambodian and Laos border. Dense forests in these areas were sure to be severely damaged by the herbicide and bombing fire.

Materials and Methods

1. HERBS Tape (HBT)

"Map book" published by 10-80 Committee in 1999 was used to determine the position and location of herbicide sprayed area in our prior study⁴. This map is paper-based, not electric and each line of spraying mission was traced manually then significant differences occurred inevitably. However, in September 2006, US National Agricultural Library opened a website named "The Alvin L. Young Collection on Agent Orange"⁵. Young has collected literatures relating to herbicide spraying during Vietnam War and "HERBS Tape"⁶ is one of his collections which can be downloaded from this website. Original data printed in HBT is the data punched in general-purpose computer. What we can download today is paper-based data that were optically scanned to remake electric format. In actual HBT, data of every mission is recorded like following;

DATE	AGN	GALS	TYPE	LEG	UTM
650819	O	1200	C	1A	YD222193
650819	O	0	C	1B	YD140240
650819		0		2A	YD161229
650819		0		2B	YD150250

Column DATE means year, month and day with two digits respectively. Sometimes it appears CTZ in second column. It stands for “Combat Tactical Zone” meaning military region. AGN means “Agent” then O is used for “Agent Orange”, B for Blue and W for White. TYPE is representing main purpose of the mission: C is for Crop mission with fixed wing and helicopter, D is for defoliation with fixed wing only. GALS means quantity of sprayed herbicide.

In HBT, columns LEG and UTM are keys to determine to the positions of herbicide spray. 1A means the starting point of the first spraying mission in a day. Some flights had two or more times of drops in one flight mission on the same day, begging point of the second drop was designated 2A. 1B represents the ending point of one spray mission. Some missions have C or D and so on. In these cases, B, C, D... means the tuning points of the missions and the last alphabet means the ending point (See figure 2.).

In the column of UTM, the first two alphabet combinations such as YD or XD represent the “grid identifier” for maps based on the projection of Universal Transverse Mercator covering south east Asian region. Side length of each grid is 100,000 and 100,000 meters. Six digit figure next to two alphabets such as 222193 stand for the geographic coordinate in one UTM grid of the spraying mission. In six figures, the first three digits mark the distance along the horizontal axis (easting) and the subsequent 3 digits mark

vertical axis (northing). Thus we can know the resolution of this record is 100 meters (in YD222193, 222 means 22,200 meters east and 19,300 meters north from the origin of coordinate in grid YD).

2. Map

Whole figures and alphabets except column GALS is zero were punched manually in GIS. Figure 1 shows every path of sprayed missions generated from HBT. Total 5,350 times of record were punched and total volume of sprayed herbicide was calculated 58,180 kilo liters. According to the literature of Stellman, total numbers of mission is 9,141 and volume of herbicide is 73,772 kilo liters⁷. Their data source contains not only Air Forces’ but

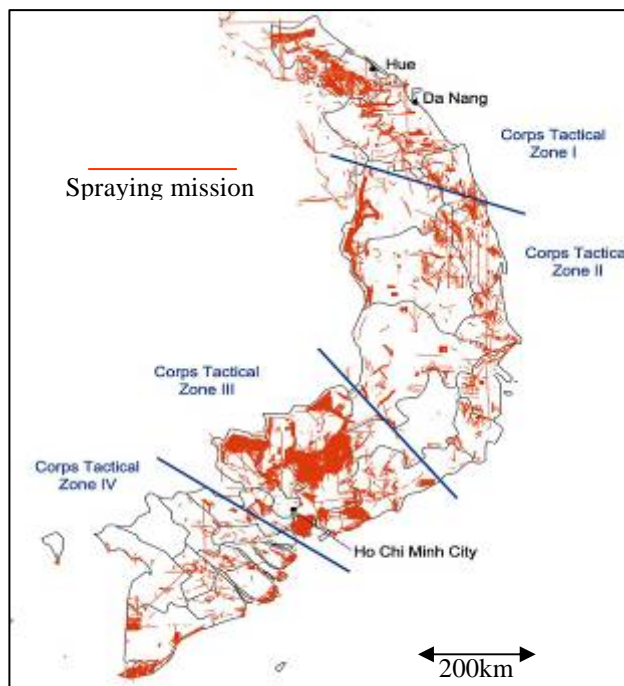


Figure 1. Herbicide spray mission map generated by HERBS Tape

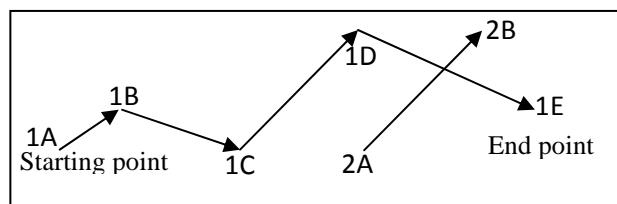


Figure 2. Designations of flight path of spraying mission (start and end point)

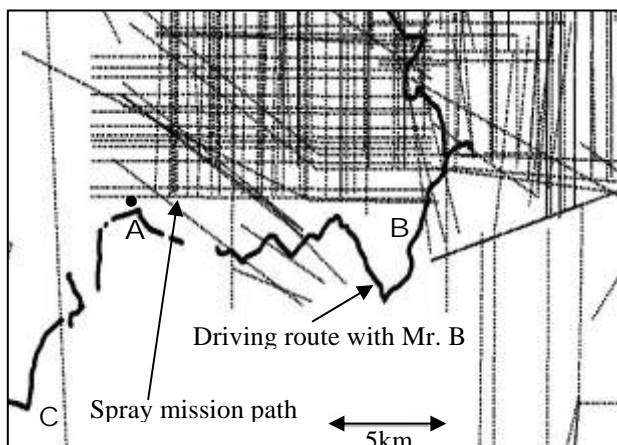


Figure 3. Reliability test by veterans interview
Center: 106° 53' 44"(LNG), 11° 5' 22"(LAT)

from the army's. We cannot know how they obtain additional data and the accuracy of the army's data, as of the moment.

3. Reliability examination of HERBS Tape

Today, position of on the earth can measure easily by GPS. We do not know how US Military Forces determined the values of coordinate in war period, however, accuracy of HBT will have to be examined. In order to confirm accuracy of HBT, we interviewed two veterans of Vietnam War to examine the locations of herbicide spray mission. One subject was Mr. A, born in 1930, having lived in Tan Uyen district since 1966. He was a Colonel in military when the war was finished. Another subject was Mr. B, born in 1945 in Tai Uyen district, working as an army doctor during the war. Both of them retain clear memories of flight routes of the aircrafts that sprayed herbicide.

On July 26 and 27 in 2007, we interviewed about the location of herbicide sprayed to Mr. A and B. Mr. A was asked the location and direction of the herbicide spray in his own residence. He replied backyard direction of his house was frequently sprayed. "Backyard direction" means north. For Mr. B, we drove with him by a car equipped GPS and data recorder for about two hours. While driving with him, we sometimes asked "is herbicide sprayed around here or not?" We recorded his answer and when (hour, minute and second) he made his reply. After these interviews, position of Mr. A's house and driving path line were overlaid on the map generated from HBT (projection of the map made from HBT was converted to WGS84). GPS data contain not only longitude and latitude but also the time "when we were there", then we can know "where" Mr. B replied yes or no from the record of time "when" Mr. B made his reply.

Figure 3 shows the result of this examination. In this figure, the upper dot of character A shows the location of Mr. A's house. We can know that his house is just at the "fringe" of frequently sprayed area. While driving with Mr. B, when we were in northern area of point B, he continued to say that aircrafts were sprayed herbicide frequently around here. While driving between B to A, he told us that herbicide was seldom sprayed around here but northern direction was frequently sprayed. Driving from A to C, he told us herbicide was not sprayed. Both Mr. A and B's memories of location of herbicide missions were so clear, thus we can conclude the accuracy of HBT will be significantly dependable.

4. Landsat

Landsat is one the most "traditional" earth observing satellites and Landsat 1 was launched on July 23, 1972, during the war. The first image of herbicide sprayed area that we can obtain today was taken on October 22, 1972.

Figure 4 shows the Landsat MSS (Multi Spectral Scanner) image (central coordinate: 107° 00' 00" LNG, 19° 41' 41" LAT) in Tan Uyen district near Tri Ane Lake. Figure 5 shows the same area and vertical and horizontal lines in this figure represent the herbicide spray missions made from HBT. Image of Figure 4 is made from the green band of MSS (0.5~0.6 μ m wavelength), then the darker area shows the higher density of vegetation.

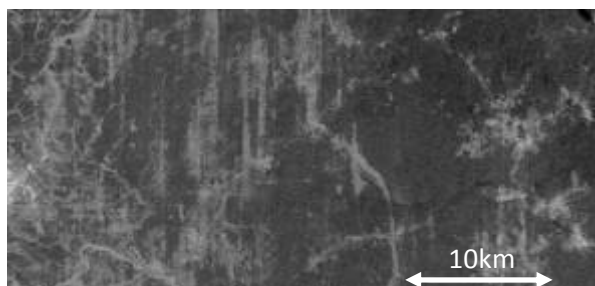


Figure 4. Landsat MSS image taken on Oct. 22, 1972

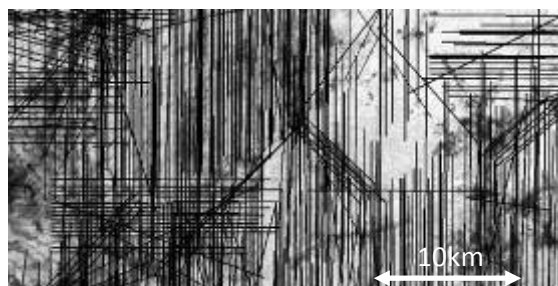


Figure 5. Herbicide sprayed missions in Figure 4.

This area is one of the typical “filled with spraying mission” areas then significant volumes of herbicides supposed to be sprayed. We can see so many clear vertical and horizontal “scratches” in figure 4. If this area has the same directional terrestrial valleys or ditches, scratch like “white shadows” will appear. However, there are no valleys, ditches or rivers in the same area that can be observed from 3D topological analysis.

5. Time line observation

After 1972 of the first launch of earth observing satellite, lots of satellites have been launched and keep to take images of the earth surface. Figure 6 to 13 show the same area of the corner of upper left is at $106^{\circ} 50' 00''$ LNG, $11^{\circ} 26' 30''$ LAT and lower right corner is at $107^{\circ} 15' 00''$ LNG, $11^{\circ} 00' 00''$ LAT.



Figure 6. 1972-10-22

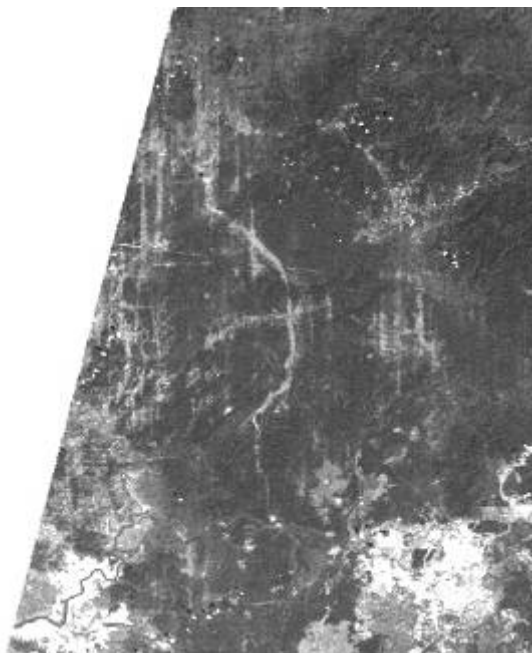


Figure 7. 1973-01-01

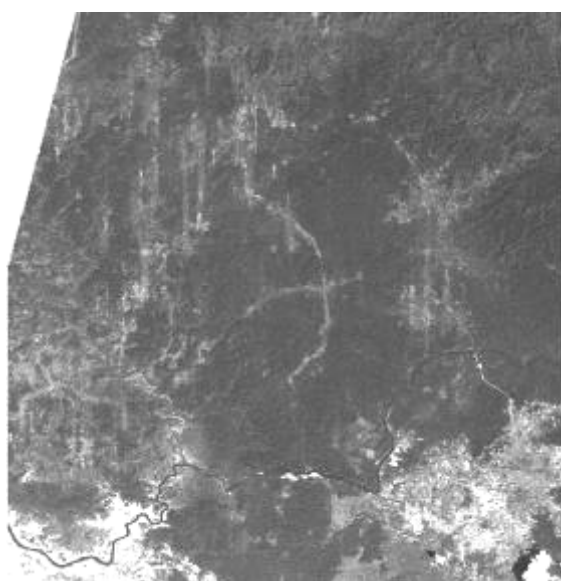


Figure 8. 1976-01-03

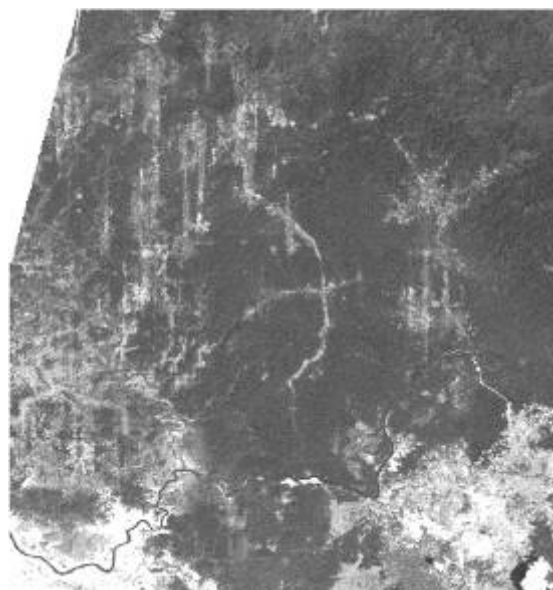


Figure 9. 1979-10-22

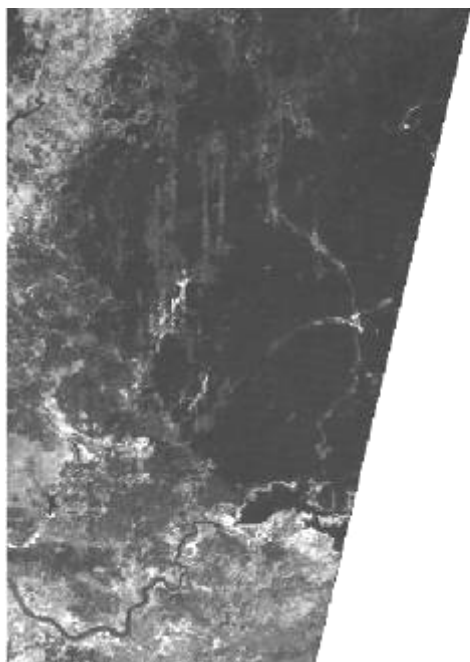


Figure 10. 1989-01-24

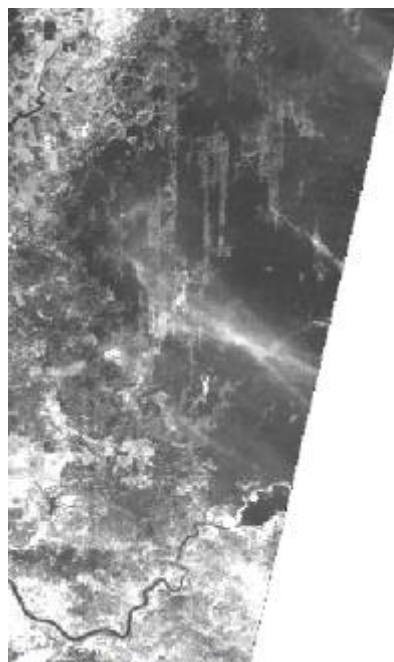


Figure 11. 1990-01-27



Figure 12. 1993-02-04

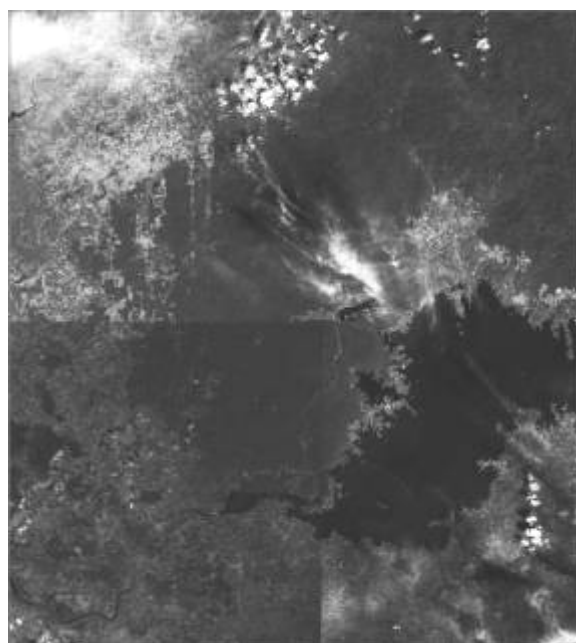


Figure 13. Today

Results and discussion

We have to consider how herbicide was impacted to the vegetations and forests. Committee on the Effects of Herbicides in Vietnam reported the comparison of sprayed and unsprayed ratio of vegetations in Rung Sat in 1958 (before spraying) and in 1972 (after spraying)⁸.

For trees in 1958, sprayed area had 55% of forestation, but it reduced as to 15.3% after sprayed in 1972. Unsprayed area had 5.6 % of forestation in 1958 and this area kept 6.7% in 1972.

Figure 14 was taken in 1971 to examine effect of herbicide spray to mangrove vegetation in the Ca Mau Peninsula. White stripes shown in this picture are lack of vegetation and dark areas are the remaining of it. Spread swath of the herbicide is said to be 74 to 86 meters wide under normal wind condition⁹ then the effect of herbicide spray is thought to be arisen like “streak” of lack of forestation.

In mangrove and flat area, after herbicide spray has finished, vegetation has become recovered quickly because surface soil keeps stable and sediment is saturated. On the other hand, some mountainous or steep areas with rocky ground bed, surface soil was eroded then impacts last longer. Some scientific reports on the fate of herbicide deny long-term environmental impacts, however, they ignore the fact that vegetations prevent migration of surface soil.



Figure 14. Herbicide treated mangrove area in the Ca Mau Peninsular in 1971. (from reference No. 8)

Conclusion

We can still see some unnatural exposed rock beds on the surface ground in heavily herbicide sprayed areas close to Cambodia and Laos border and some mountainous areas in southern Vietnam. In the prior studies of herbicide spraying and environmental impacts, most of them have been focusing on the fate of chemicals in natural environment. However, behavior of herbicide in natural environment is so completed and integrated then physical and geological features of sprayed areas will have to be considered carefully. Once surface vegetations are lost, top soil will be easily moved, subsequently, soil erosion occurs. Current “scratches” appeared on satellite images can be concluded as one of the typical and clear evidences of environmental impacts arisen by deforestation that were caused by herbicide spray during the War.

Acknowledgements

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