

**CHEMICAL WARFARE, RISKS AND POLLUTION IN THE SOUTH VIÊT-NAM.  
CONTRIBUTION OF THE AMERICAN DATA AND MILITARY MAPS**

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Thirty years after the end of the conflict in 1975, the debate of the controversial use of herbicides in Viêt-Nam remains heated. The chemical component of this war carried was the program Ranch Hand (1961-1971), which aimed to the total destruction of the vegetational cover. At that time, the international scientific community already realized what would be the catastrophic environmental and medical consequences in the post-war period. The disappearance of very large areas of forests, mangrove forests and others plant communities durably endangered biodiversity. The soils and water were also polluted. Since 1974, reports of the American National Academy of Science have listed the number of air missions and the quantity of herbicides spread per military area and year. Although their statistics include variations errors and omissions, these sources give an idea of the extent of the phenomenon. Nowadays, the American Defense Department tends to open its files to researchers the few ones that are already available prove of priceless value for the history of defoliation and bring new dimensions. We can now weigh as a disturbance and locate the number of missions and the type and quantity of herbicides, which will eventually allow us to assess the impact of defoliation on ecosystems and people.

Although the harmful effects of the war on the environment were known for a long time, it is in connection with the massive use of the weedkillers that the international community managed from there to recognize the inacceptability of the military attacks against the ecosystems, as a strategy of war. The non-conventional types of war were thus defined - ABC, Atomic, Bacteriological and Chemical. The chemical warfare can aim two types of targets : people and animals on the one hand, plants and harvests on the other hand.

A historical retrospective is necessary to include and understand the origin and the impacts of this chemical war. The United States engaged in the wars of Indochina and Viêt-Nam without real awakening of the type of war which they should face and lead, to untie the persistent problems since the years 1950. Since 1961, the war americanised. With air engagement corresponding to the bombardments in the North Viêt-Nam and spreadings of weedkillers, the aim of the war became the destruction not of an army, but of a whole nation. The objective was to kill not only the very whole Vietnamese army soldier Viêt-Minh, but also the populations which helped it. The bombardments were supplemented by actions of modification of time and climate, an aspect of the war which remains very badly known. This objective of general destruction was clear, even if the historical documents show an ignorance more or less pretended by the American official authorities as for the effects with short and long-term of the chemicals on the environment and health of the people.

The scientific community of the geographers, especially of the American, Canadian and Vietnamese ecologists asked after war a continuous estimate, a monitoring and for an evaluation of the military impacts on the environment, and encouraged research on the interactions between safety and stability of the ecosystems on the various scales. She recommends a demilitarization of the ecologically important areas and asks for the prohibition of any shape of chemical war anti-vegetation. Lastly, this scientific community insists on the reinforcement of convention on the prohibition of the military use (or any other hostile use) of the techniques of transformation of the environment and that convention on the prohibition of the development and storage of the weapons bacteriological, biological, of toxins and on their destruction.

This article reconsiders one dark period of the American history (1961-1971) that much would wish to overlook. Although the facts are proven, the military sources remain still not very accessible. The interest of such a research is to find new data to bring a lighting, explanations on the chemical war, in spite of the character taboo of the subject. Our work of historical biogeography is on a South Viêt-Nam scale. Including the disturbances of the environment, methodology by Geographical Information System (GIS) was privileged, because it allows approaches by modeling and analyzes space the most complex phenomena. The contribution of civil and military archivist sources (topographic maps, pictomaps, air photographs) and of recent sources (images satellite, given ground) made it possible to use statistical methods, to carry out space geotreatments and analyses. To have part of the step and results obtained, we

will evoke initially the general context of military handling of the environment, then the program of defoliation, finally the sources historical concerning the possible operation Ranch Hand and their uses.

Against the North-Vietnamese army, which engages neither its aviation nor its armoured tanks, but uses the ground and the camouflage, disperses and gathers at high speed, seeks the body with body and tackles bases of artillery or aerodromes, the American command exploits the aeromobility. Also used for the transport of the infantry, helicopters and planes allow to free itself from the roads in a badly served country, to supply the bases semi-logistics and the units with operations. She gives to the command the possibility of extending the zone of influence of the infantry, to modify a plan of operation quickly, to locally obtain the superiority of fires in the delta cochinchinois and in mountainous region, even in rain season. As from 1967, the bombardments in the North Viêt-Nam have military aims and transportation roads without seeking to destroy the ports, the dams or the Doumer bridge on the Red River. The overall effectiveness of the bombardments was discussed. Impotent against an adversary with the simplified armament, the tactical air command can hardly fight against an underground war. In addition, the plane remains the vector of the droppings, in particular of chemicals. Military handling of the environment consequently takes an important place in the war.

The environmental disasters are often collateral effects of military operations, but they can also be deliberately caused. Breaking the balance of an ecosystem or to exploit instability of it becomes a weapon. We speak then about Environmental Warfare. Work of Westing provides a very detailed definition of this concept and developments which the soldiers want to give him. This author, by illustrating his remarks by cases borrowed from conflicts passed, distinguishes two categories. Handling which implies the use of massive disturbances, with large scales, is for example the voluntary rupture of a dam or the fire of a forest. Those which generate small actions, scientifically controlled, can involve serious imbalances and disturbances during one given time and a space. Pulverization of chemicals, contamination by radioactive isotopes, destruction by explosions by energy, mechanical inputs (shell...) or thermics (incendiary bombs...), introduction of foreign species, sowing by pathogenic micro-organisms : as many techniques, easy to implement, of deterioration of the biocenoses and the biotopes.

During the war of Viêt-Nam, the intensive bombardments, the arsons and massive and repeated pulverizations weedkillers devastated thousands of km<sup>2</sup> of forest ecosystems. On very broad surfaces in Viêt-Nam, but also in Cambodia and Laos, the destruction of the forest settlements, faunistic and floristic impoverishments, the erosion of the grounds, the disorganizations of the trophic chains testified to the structural and functional ruptures in the ecosystems. The environment had really become a target. On the arable and forest lands, the objectives were the targeted and total destruction of vegetable cover, the natural resources, the voluntary modifications of the mediums, the durable disturbances and the deprivations of refuge. The techniques of war by air (spreading of weedkillers, dispersion of napalm, of bombs, iodide sowing of money, bad grasses) are on the matter more effective than the terrestrial way (bulldozers). They cause damage extended, on several hundreds of km<sup>2</sup>, durable (several months and even several years) and low registers.

The use of the weedkillers dated from the beginning of the year 1950. In 1961, the president of the South Viêt-Nam, Ngô Đình Diêm, request in the United States of America to lead in its country of the air operations of pulverization of weedkillers. In august, the missions of the South-Vietnamese air force start, with the assistance of the Americans. The request of Diêm however causes a debate of general policy within the US government. In november 1961, the president John Kennedy authorizes the use of the weedkillers, in limited experiments which require the Vietnamese participation and the agreement, mission by mission, of the American embassy, the command of the military aid in Viêt-Nam and the South-Vietnamese government.

The programm Hand Ranch, started in January 1962 against the forests, is extended in November to the destruction of the cultures. When it finishes nine years later, 70.000.000 l of chemicals approximately (Orange Agents for all the vegetation, Bleu for the cultures and Blanc for the forests) were pulverized on nearly 20 % of the total surface area of the South Vietnamese jungle, including 36 % of its forests of mangroves, that is to say approximately 26.000 km<sup>2</sup> touched. The littoral areas were abundantly sprinkled, in the military zones 1,2,3 and 4; zone 3 as a whole was the privileged target of the defoliation campaigns. These zones correspond little to the zones of bombardment, located more at north of the country, except around the 17th parallel. On the other hand, they are concentrated in the zones of strong population densities, from where an increase in the health hazards. The volumes poured in ten years border the 75.000.000 l according to Westing, with years with very strong spreadings in 1967,1968 and 1969 : 19,4,19,3 and 17,3 million l, is more of two thirds of the total quantities. The Orange Agent, with its 45,7,

White Agent and 1 million, with 20,6, 1 million are employed, with frequencies of passage of the planes above the forests estimated at one to four spreadings per site, more rarely beyond, up to ten.

This war thus used chemical means, of weeding employed here in ordinary time to fight bad grasses and to increase the output in agriculture. The amounts are much higher than the normal, which makes them incontestably toxic for the plants, the animals and the people. Failing to directly reach the adversary by the conventional weapons, it was necessary to destroy the vegetation which was used to him as refuge. Thus, the defoliated areas are copied about on the areas of battles listed in the files of the Department of Defence and the bases Vietnamese soldier Việt-Minh. To each military zone correspond of the quite precise camps, of air bases, the stock rooms of the barrels of weedkillers and the places of pumping. These data were provided by the American team of Stellman, which works on the epidemiologic consequences of the chemical war, proposing the dangerousness of dioxane contained in the Orange Agent.

In 1966, whereas a flood of Orange Agent falls on the South Vietnamese forests, some responsible for the US government declare themselves hostile with the use of this product, while at the same time its dangerousness is not proven: they think that it exposes the United States to a charge of chemical war. The convention of the Hague (1907) prohibited the use of poisons and of poisoned weapons, that of Geneva (1925) proscribed pollutant gases and all the similar liquids, matters and toxic devices. The Americans considered finally that the convention of Geneva did not apply to the weedkillers and the chemicals used to the United States, in Soviet Union and in other countries to destroy bad grasses in the cultures. The United Nations did not divide this opinion at the time of the war of Việt-Nam : she considered that convention related to all the weapons. Was it legitimates to devastate almost 1/7 of the area of a allied country and to use weapons of which the long-term effects were not foreseeable ?

Ten years after the end of the operations of pulverization, some sectors of jungle were covered with forests of bamboos, which made the afforestation difficult ; in other sectors, fire and erosion had hardened the ground so much so that very begun again spontaneous was compromised. Grounds were scraped and shaven with the bulldozer, of vast extended from forests burned using matters flammers like napalm. The number of bomb and shell holes is estimated at more than 20 million, for an total surface area of 1.400 km<sup>2</sup> ; sometimes broad 12 m and major of 6 m, these funnels, filled up rainwater, became places of reproduction of mosquitos vectors of infectious illness. In the areas where violent ones engagements were held, the metal fragments and the not exploded ammunition are so numerous that the peasants do not dare any more to turn over in their fields. In the forests, much of trunks, sifted metallic lustres, rotted.

After the publication of a study on the residual effects of the operation Hand Ranch, American National Academy of Science concluded that, any good considered, the harmful effects of the program on South Vietnamese public health seemed to have been less important than one could have feared it. No manifest proof of directly ascribable physiological disorders to the weedkillers was found. Today, 30 years later, 32.000 requests for disablement pensions deposited by Vietnamese veterans and based on the use of the Orange Agent are in suffering. Up to now, the American ministry of the War veterans granted none of these requests.

That it is during or after defoliation, research on the effects of the weedkillers never really ceased, although it is difficult for the American researchers to reach the defoliated sites, even bombarded. The absence of access to the data always limits the progress of the work. The archivistic sources occupy of this fact in research a very particular place. However, their consultation is possible in general only at the end of several decades. For our study, we mobilized sources collected in France with the Historical Service of Defense, the Center of the files of overseas and in certain specialized libraries, like that of the Academy of Science of overseas, but also with the Public records of Hô Chi Minh-Ville. It is thus to Việt-Nam that we had found maps dating from the French or American presence in Việt-Nam and informing about specificities of the ground, the vegetation and the frame. Worked out, for some, by the cartographic Service of the Army to fine soldiers, they are of a paramount interest, in particular for the constitution of the GIS. We also used writings of the American researchers, mobilizing difficult to reach military sources, even if some tend to open.

To reconstitute defoliation on the scale, at least, of the province, it is necessary to return to the sources of the air force. That makes it possible to better understand the process and to really realize of the affected regions. The statistics of the McLeod report/ratio of the American Department of Defence refer however only to the years 1967 to 1971, which does not cover all the period of defoliation. Moreover, only the Agents Orange, Blanc and Blue were retained. This report/ratio was made to us available by the American team from Stellman, which was based on these data for its own work. These researchers are leaning on the direct effects of the weedkillers on the populations. Indeed, the increase in the number of cancers is related

to the exposure to the Orange Agent. Our own research was based on these archivist sources, by also using the daily reports/ratios of the Air Force.

The step suggested in our work is similar to that of the American researchers : only the finalities change, since in fact here the environmental impacts are studied. It differs from that of the Scientific committee in the years 1970, more centered on the data of ground. For us, it was initially necessary to find the old administrative limits. The data are attached to the province and not to the area or the district, this is why the scale of the province was preserved. However the limits did not cease changing during the history, just as the surfaces, the names and the capitals of the provinces. Starting from the chart of the military regions and administrative divisions about 1967, it was possible to identify the 48 provinces. The cartographic documents were scanned, géoréférencés in geographical coordinates and were digitized. It was necessary to then to associate them the data reconstituted on the missions. The team of Stellman started ten years ago, to reconstitute file HERBS (Weedkiller System Reporting), mission after mission. This one had been made up since 1970, at the request of the Division of the American chemical operations, which had called upon US Army Data Agency Management to preserve its monthly data. It is easy with the research team to reach the whole of the military data, since the Department of Defence is initially associated with the research project. Nearly 200 missions of defoliation before august 1965 were found. The team thus could propose a new estimate of volume and types of weedkillers used between 1961 and 1971. Its objective is then to evaluate the populations exposed to the weedkillers. A database entitled Hamlet Evaluation System thus counts 20.585 villages, of which nearly 3.000 directly and were seriously touched.

Our own study uses the McLeod report, resulting from file HERBS. The initial data comprise the name of the province, the type of agent, the number of gallons transformed into liters for the quantities For each province, we have translate the number of missions in circles proportional: this reveals that the greatest number is of 695 in area 3 (province of Long Phuoc); then the littoral comes from area 1 (Thua Thien, Binh Dinh). For each type of agent, the missions were then represented separately, in order to evaluate the weight of each one in the full number of the 6.542 missions. The configuration of the Orange Agent is copied on that of defoliation, whereas the Blue Agent is present along the littoral and in aarea 3, and the White Agent especially in the latter. For the three agents, the strongest concentrations appear in the provinces of Quang Tri, Thua Thien, Gia Dinh, Bien-Hoa, Long Khanh, Phuoc Long, Binh Duong, Tay Ninh and Long Year.

A partly comparable work was completed by the American team, which had access to the primary sources. She concludes from it that 7 million liters of weedkillers was not entered: those used on an experimental basis by the French before 1961 and those poured by the Americans in Laos and Cambodia. In fact the access to the notebooks of flight of the pilots (of the thousands of flight plans) made it possible to know what did not appear in program HERBS : the detail of the objectives of the missions. The Stellman team also could gather the missions by number of project, passing from a chronological file to a vision related to the targets (however partial), because of the gaps of the preserved files.

Starting from these files, American and Vietnamese researchers worked out a map of defoliation in the Mekong delta. The spatialization of the air transects of defoliation, located by their geographical coordinates, makes it possible to realize that only the zones of mangrove and back-mangrove were the subject of intense campaigns. Others transects more scattered must correspond to the transportation routes. It was not possible for us to consult the entirety of the military documents visualizing the layout of these transects of defoliation for the totality of the South Viêt-Nam, except for some sites, of which the district of Càn Giò and the peninsula of That Mau. The analysis of the two sites thus could be thorough on a scale finer than that of the province.

Starting from the statistics of the McLeod report, with their limits, and thanks to the installation of the GIS, it is however possible to draw the more general conclusions on the characteristics of the various agents. The data were created starting from the information. Indeed, on each layout corresponding to a black feature are indicated the day, the month, the year and the quantity of the agent expressed in gallons as well as the type of agent materialized by a letter (W : White, B : Blue and O : Orange). The quantities quoted in the tables were converted into liters. Each line of the table takes again a layout of vol. the fields correspond to the information indicated on each layout of vol. For the needs for the géotraitements, an additional column was created informing the complete date (day, month and year). These data thus prepared can be charged in the GIS.

To know the effects in the ecosystem and long-term of the chemical war on the flora and the fauna of the South Viêt-Nam requires thorough studies and of long life. The first research was observations on the spot, under difficult conditions of war. Although insufficient, they were used as bases with new appreciations more pushed in the laboratories. It is very difficult to define with precision the prolonged effects of the

weedkillers. For lack of a precise knowledge of the conditions under which pulverizations were carried out, a detailed analysis of the repercussions of these interventions on the evolution of the threatened ecosystems is almost impossible. It would also be necessary to integrate in any research of knowledge on ecological balances. Approximately 30 % of the grounds of Viêt-Nam were laterized, the process becoming very fast as soon as the ground is exposed to direct solar radiations and the wind in consequence of the disappearance of vegetable cover. Moreover, the micro-organisms which maintain, by the decomposition of the organic matter, the reserve out of rock salt of the ground are active only under given conditions (moisture, temperature, pH). The destruction of vegetable cover thus modifies the conditions of humidification, the physicochemical properties of the ground as well as the biogeochemical chains where these micro-organisms intervene. The impoverishment of the soil returned delivered it unsuitable to any culture, to a physical destruction where erosion has a paramount role (a all the more fast and dramatic erosion the relief is accentuated more). If the action on the vegetable settlement has effects on the ground, it is necessary to also examine the consequences on the other trophic levels.

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