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Item ID Number	00307
Author	Carrier, Joseph M.
Corporate Author	National Academy of Sciences - National Research Cou
Report/Article Title	The Effects of Herbicides in Sounth Vietnam, Part B: Working Papers, February 1974: The Location of Herbicide Missions and Hickey's Informants in South Vietnam: An Appraisal
Journal/Book Title	
Year	1974
Month/Day	February
Color	[ ]
Number of Images	18
Description Notes	

Requested

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DESCRIPTION OF PUBLICATION: (AUTHOR, TITLE, PERIODICAL TITLE, VOLUME, YEAR, PAGE, ETC.)

Carrier, J. M.
[The location of herbicide missions and Hickey's informancts in South Vietnam: an appraisal.]
(The effects of herbicides in South Vietnam. Part B. Working papers. Washington, D.C.; National Academy of Sciences (1974), 15 pp)
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THE EFFECTS OF HERBICIDES IN SOUTH VIETNAM

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The Location of Herbicide Missions and Hickey's Informants in South Vietnam: An Appraisal."

JOSEPH M. CARRIER

NATIONAL ACADEMY OF SCIENCES - NATIONAL RESEARCH COUNCIL

WASHINGTON, D.C. 20418

The Location of Herbicide Missions and Hickey's Informants in South Vietnam: An Appraisal

JOSEPH M. CARRIER[a]

This report presents the available data on herbicide missions carried out in the vicinity of the villages of Highlanders used by Hickey[b] as informants for a paper on the perceived effects of herbicides in the highlands of South Vietnam (SVN). Some comments on mission objectives and support contained in herbicide proposals submitted by RVN province chiefs and in memoranda submitted by various U.S. officials are also presented.

LOCATION OF INFORMANTS' VILLAGES

All but one of Hickey's informants were originally from villages located in Kontum and Pleiku Provinces. One informant, a South Vietnamese Highlander who had returned south from North Vietnam in 1969, was stationed in an NLF food production area astride the border between Phu-Yen and Phu-Bon Provinces. Figures 1 and 2 show the approximate locations of informants' villages; Figure 3 indicates the location of the NLF food production area.

It is important to note that the location of informants' villages presented in Figures 1 and 2 are shown as being in an approximate "area"

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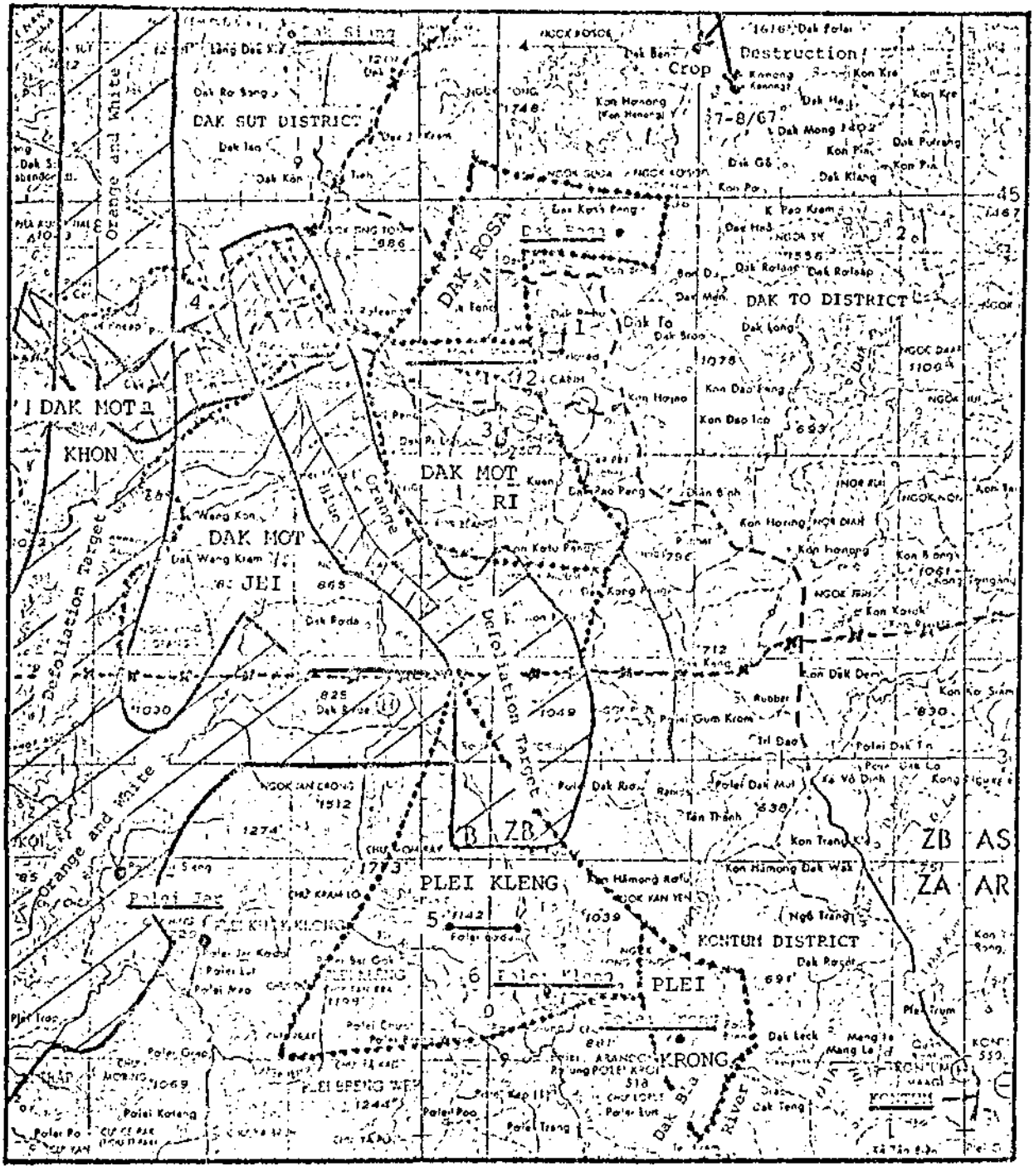
[a] Dr. Carrier was a Staff Officer with the Committee on the Effects of Herbicides in Vietnam. His present address is 17447 Castellammare Drive, Pacific Palisades, California 90272.

[b] See Hickey, G.C. Perceived effects of herbicides used in the highlands of South Vietnam, Part B of the Report on the Effects of Herbicides in South Vietnam.



Boundary:
District ---x---
Village .....

0 5 10
Kilometers

Scale: 1:250,000

FIG. 1. Informant settlement areas and herbicide missions in Kontum Province.

Key to special targets

August 1968	-	800 gallons White	- NLF cache site
August 1968	-	100 gallons White	- Military base perimeter
August 1968	-	100 gallons White	- Military base perimeter
August 1967	-	1100 gallons Blue	- Crop destruction
November 1968	-	200 gallons White	- Military base perimeter
May 1969	-	770 gallons White	- Military base perimeter

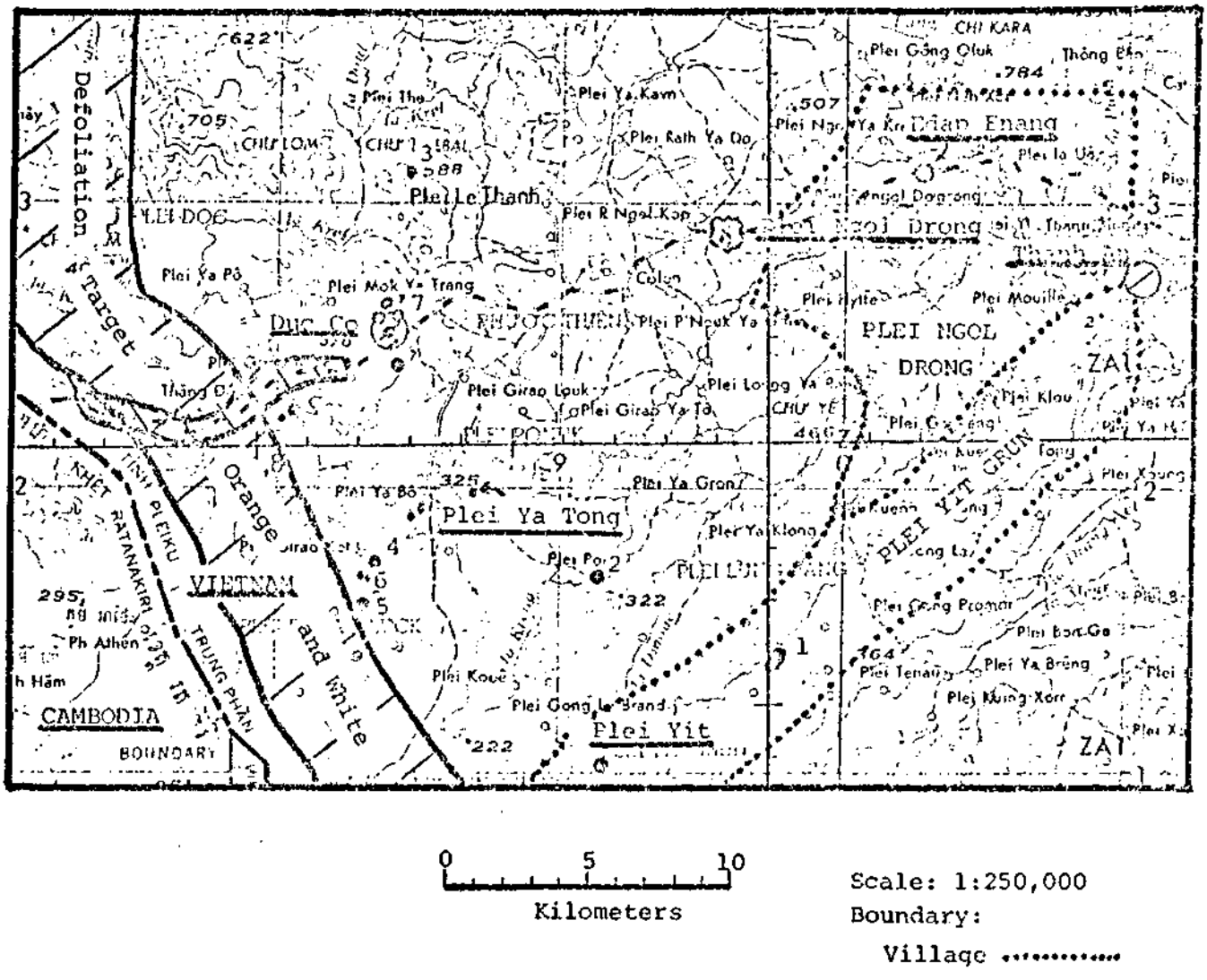


FIG. 2. Settlement Areas of Informants and Herbicide Missions in Pleiku Province.

Key to Special Targets

Agent Orange (5 missions)

1-5. November 6-30, 1965 - 5800 gallons - Defoliation near Highway

Agent White

6.	September 27, 1968	-	550 gallons	- Enemy cache site
7.	October 24, 1968	-	100 gallons	- Crop destruction
8.	October 28, 1968	-	100 gallons	- Military base perimeter
9.	October 29, 1968	-	100 gallons	- Military base perimeter
10.	November 1, 1968	-	100 gallons	- Military base perimeter
11.	June 10, 1969	-	220 gallons	- Military base perimeter

[a]Only one target coordinate given for each mission.

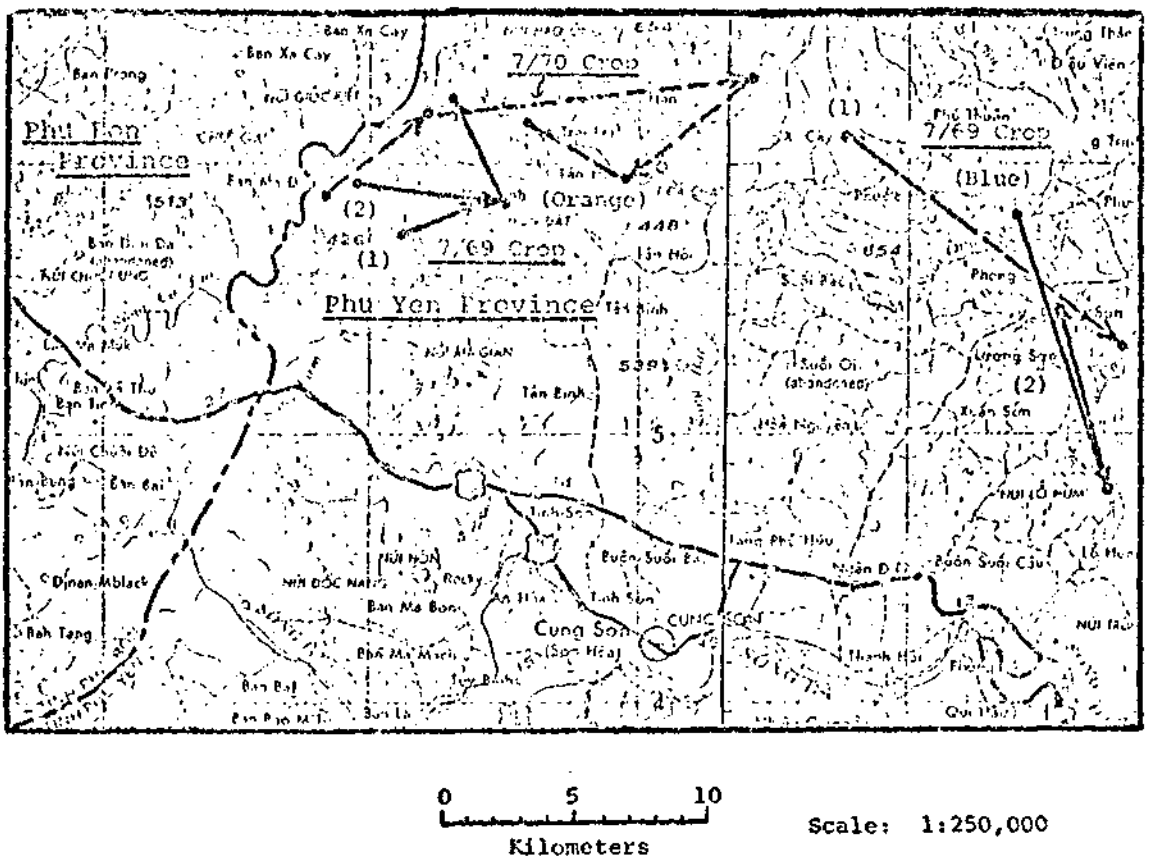


FIG. 3. The NLF Food Production Area Phu Yen/Phu Bon Border Region.

rather than at a specific site. This was necessary for several reasons. First, during the period of intensive herbicide spraying from 1967 to 1970, many of the informants had to move from their native villages because of the intense fighting that enveloped them or occurred nearby--several more than once. (In Kontum, one-half of the province's population was reported to have been resettled as refugees by the end of 1970; in Pleiku, close to one-third.) Second, there is the problem of phonetically transcribing the names of villages elicited verbally from informants. Maps showing the names of villages have employed several different phonetic transcription systems. One cannot be absolutely sure, therefore, that a given map name and elicited name--even if quite similar--represent the same village site. Third, and last, the elicited names, transcription problems aside, may not pinpoint the exact site of the informants' villages. The principal reason for this is the historical fact that both the French and ethnic Vietnamese used different naming systems in establishing administrative control over the people of the highlands. Province and district names assigned to specific geographic areas present no problem. Subunits, however, created by the French and Vietnamese as a controlling device between the district administrative unit and the traditionally named highland settlement, do add to the difficulty of locating a given named site. The French divided the "districts" they created into several "cantons." Each canton enclosed a number of villages and was named after one of the important villages enclosed. The ethnic Vietnamese then superimposed their system, which subdivided

the cantons. The Vietnamese conceptualize a "village" as covering a relatively large geographic area containing three or more settlements. Cantons were thus divided into Vietnamese-defined villages, each of which enclosed several Highlander settlements. The Vietnamese-created "village" was named after one of the settlements enclosed. The outcome of all these administrative subdivisions is that a name elicited from an informant may be the traditional name of the settlement and/or the subunit name imposed either by the French or ethnic Vietnamese. The following are shown in Figures 1 and 2 both as names of settlements and village areas: Dak-Rosa, Plei-Kleng, Plei-Krong, and Plei-Ngol-Drong.

LOCATION AND TIMING OF HERBICIDE MISSIONS

The location and timing of herbicide missions in the vicinity of Hickey's informants are presented in Figures 1-3 and Tables I-IV. Both the List of 202 Tasks Realized from January 1962 to September 1965 and the DOD computer printout of herbicide missions from the fall of 1965 to the end of the program (File Tape No. C274) were searched for missions carried out in the vicinity of the informants. The MACV mission files were also searched for relevant information. They contain the herbicide proposals made by RVN province chiefs, responses and comments made by U.S. officials (USARV, CORDS, USAID, Embassy, etc.), maps showing flight patterns, after-flight spray reports, and other miscellaneous items.

The available data show that the spray missions in the vicinity of the informants' village areas took place from 1965 to 1970. The major

Table I.

Herbicide missions near Ben-Het/Dak-Mot-Kram area (Kontum Province).

A. Defoliation Missions
(Number of gallons)

Agent	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Orange	1967	0	2400	0	1860	4150	0	0	0	0	0	0	7900	16310
	1968	8500	0	0	0	0	0	0	0	0	0	7000	0	15500
	1969	2100	9000	9000	3000	0	0	0	0	0	0	11800	50200	85100
	1970	47650	7900	3000	0	0	0	0	0	0	0	0	0	58550
Blue	1968	0	0	0	0	0	0	0	0	0	0	8800	4400	13200
	1969	0	0	0	0	0	0	0	0	0	0	22600	12200	34800
White	1969	11700	0	3000	3000	0	0	0	0	0	0	0	0	17700
T o t a l		69950	19300	15000	7860	4150	0	0	0	0	0	50200	74700	241160

B. Crop Destruction Missions

Agent	Gallons	Month	Year
Blue	2300	August	1967
Orange	1460	July	1967

C. Miscellaneous Missions

Agent	Gallons	Month	Year	Mission
White	800	August	1968	NLF Cache Site
White	200	August	1969	Military Perimeter

Table II.

Herbicide missions near Plei-Jar/Plei Kleng area (Kontum Province).

A. Defoliation Missions
(Number of gallons)

Agent	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Orange	1968	0	0	0	0	0	0	3000	0	0	0	14600	6000	23600
	1969	3000	12000	6000	5000	0	0	0	0	0	0	7900	5000	38900
	1970	39600	31400	28800	0	0	0	0	0	0	0	0	0	99800
White	1968	0	0	0	0	0	0	0	0	0	7000	0	3000	10000
	1969	11000	0	3000	0	1500	0	0	0	0	0	0	0	15500
Blue	1970	3000	0	0	0	0	0	0	0	0	0	0	0	3000
T o t a l		56600	43400	37800	5000	1500	0	3000	0	0	7000	22500	14000	190800

B. Miscellaneous Missions
(Agent White)

Gallons	Month	Year	Mission
200	November	1968	Military Perimeter
770	May	1969	Military Perimeter

Table III.

Herbicide missions near Duc-Co/Plei-Ngol-Drong area (Pleiku Province).

A. Defoliation Missions: Vicinity Highway 19
(Number of gallons)

Agent	Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Orange	1965	0	0	0	0	0	0	0	0	0	0	5800	0	5800
	1967	0	0	0	0	0	1860	0	0	0	0	6850	0	8710
	1968	0	4750	0	0	0	0	0	0	0	0	10000	0	14750
	1969	5000	3000	0	0	0	0	0	0	0	0	0	0	8000
White	1967	0	0	0	0	19530	0	2000	0	0	10500	7750	13300	53080
	1968	0	0	0	6000	14700	8000	3000	0	0	0	0	0	31700
T o t a l		5000	7750	0	6000	34230	9860	5000	0	0	10500	30400	13300	122040

B. Miscellaneous Missions
(Agent White)

Gallons	Month	Year	Mission
550	Sept	1968	NLF Cache Site
100	Oct	1968	Crop Destruction
200	Oct	1968	Military Perimeter
100	Nov	1968	Military Perimeter
220	Jun	1969	Military Perimeter

Table IV.

Herbicide missions near Phu-Yen/Phu-Bon border area.

Crop Destruction Missions Since 1969			
Agent	Gallons	Month	Year
Blue	3000	July	1969
Orange	2000	July	1969
Orange	1900	July	1970

spraying effort, however, began in 1967 and ended in 1970. This confirms the consensus of Hickey's informants that "...there had been many spraying operations in [their areas] since 1967."

As shown by Tables I and II, the majority of missions in the relevant areas of Kontum were for defoliation, used Agent Orange, and were carried out during the dry season (November to March). The majority of the relevant missions in Pleiku were also for defoliation, as shown by Table III, but Agent White made up 69 percent of the gallons sprayed, Agent Orange comprising the other 31 percent. Missions using Agent White were carried out in both wet and dry months; Agent Orange was used essentially only in dry months. The crop sequence in both provinces, according to Hickey, is as follows. The fields are prepared during January and February. Depending on the beginning of the rainy season, the planting of crops occurs from mid-April to early May. The harvesting of most crops takes place from mid-July to the end of October--depending on when planted and time required for ripening--but some fruits and vegetables are harvested into November and December. With respect to the possible spray damage of crops, it is of interest to note that MACV established the following rates for herbicide agents used in crop destruction missions in Kontum and Pleiku: rice, Agents Blue or Orange, 3 gal/acre; broadleaf crops, Agents Blue or Orange, 1-1/2 gal/acre; The established rate for defoliation missions was 3 gal/acre.

WERE THE INFORMANTS SPRAYED?

A comparison of spray runs with areas inhabited by the informants suggests that they were living in relatively close proximity to areas targeted for defoliation and/or crop destruction. The most distant any group of settlements appear to have been from target coordinates is about 15 km. However, because at the time of spraying the location of the informants and their settlements and swiddens cannot be precisely determined, and because there is no way of proving that the spray runs were made exactly along the paths outlined by the coordinates given, there is no way of determining whether Hickey's informants were or were not exactly in the paths of actual spray missions or whether they were or were not close enough to have been affected by spray drift.

As noted above, the major objective of the relevant spray missions in Kontum and Pleiku was defoliation. Judging from the herbicide proposals made by the province chiefs and the memorandums of U.S. officials, an effort was made to prevent the sprayed chemicals from affecting the crops of "friendly" Highlanders. Contained in every province proposal was a signed pledge by the province chief "....to pay compensation for damages to the crops of the people affected by the spraying of defoliants." This was meant to apply, however, only to the crops of people living in RVN-controlled areas. In several RVN herbicide proposals this was explicitly stated.

Judging from the herbicide proposals and memoranda in the mission files, it was a known fact that Highlander settlements and swiddens were located in or near the targeted areas. The decision to go ahead with a

given defoliation mission in spite of the Highlanders present was based on a belief generally held by RVN and U.S. officials that the importance of the mission outweighed the consequences to the human inhabitants. The decision was also rationalized in part by the fact that the target areas were believed to be sparsely populated. And, as one U.S. official put it, not only are the target areas sparsely populated but the Highlanders "... living in or adjacent to the targets are under enemy control and have been for a number of years." The implication of being controlled by the NLF/NVA, as one RVN province official noted, is that the Highlanders were being encouraged "...to increase production of rice and foods for them." As there was an existing herbicide program which targeted the destruction of crops in NLF/NVA territory, the fact that the inhabitants in a defoliation target might lose their crops was perhaps considered a bonus for such missions. Finally, it is relevant to note that neither RVN nor U.S. officials believed the sprayed chemicals to be harmful in any way to human beings or their domestic animals. This was explicitly stated in all province herbicide proposals and in a MACV directive "525-1" dated February 15, 1966.

FACTORS OTHER THAN HERBICIDES

Assuming that the settlements and swiddens were directly in the paths of herbicide runs or were hit by spray drift as described by the informants, their perceptions of what happened as a result of exposure to chemicals must be evaluated by a number of possible factors, the effects of which cannot be known with any certainty at this point in time. Hickey

notes for example, that:

> "A difficult area of inquiry concerned possible deaths due to the herbicides. Sickness and death are common occurrences in highland villages, and infant mortality is particularly high."

Wiersma (1970) suggests another factor:

> "A complicating factor in Vietnam is the possibility that the Vietnamese peasants are less resistant to toxins in their environment than people who are living on protein-rich diets."

PROPAGANDA

Still another factor is propaganda. The Highlanders have been subjected to conflicting stories about the effects of chemicals both by the RVN and the NLF since 1962 when herbicides were first tested in the field in SVN. In response to an RVN/U.S. test of Agent Blue on 750 acres of crops in the Highlander province of Phuoc-Long on November 21 and 23, 1962, the NLF on the 29th of November reported the destruction of 1,000 hectares of crops because of the spraying and claimed "...more than 100 people suffered from sore eyes, that many persons were afflicted with beriberi, and that a child had died." Later, on December 1, the DRVN broadcast that: "[the RVN/U.S.] spread noxious chemicals to destroy crops, kill cattle, and poison the people with the aim of forcing them into concentration camps." A North Vietnamese professor, Tran-Huu-Tuoc, in an article published in Nhan-Dan in December 1962, set forth the basic belief held about the effects of herbicides on human beings and domestic animals:

> "Persons affected by the chemical are asphyxiated, vomit, faint, or fall sick for 20 hours, and some even four days.

> Affected children are seriously ill, suffer hemorrhages, or die. Poultry, pigs, dogs, and other animals that drink chemical-poisoned water die, too."

Another DRVN/NLF assertion dealing with the use of chemicals was that "poison was put into the people's water jars for the purpose of killing them."

The RVN countered with their own propaganda about herbicides. Every province herbicide proposal contained a "Psywar/Civic Action Annex" which outlined a plan of action. The basic objective of the plan was to explain and demonstrate the harmlessness of the chemical agents on human beings and animals. A countercharge was also supposed to be made to the NLF/NVA "poison" charge. In a Kontum herbicide proposal it was stated as follows:

> "The population will be urged to be vigilant against the enemy schemes: he may secretly put poison into the wells or in the food, then charge the government with using poisonous defoliants when some local residents are killed by the poison."

OVERVIEW

Judging from the available evidence, there can be no dispute about the fact that Hickey's informants came from areas in Pleiku and Kontum Provinces that were severely affected by the military compaigns which took place between the beginning of 1965 and the end of 1970. As reported by the RVN government, 51,474 refugees in Kontum and 58,477 refugees in Pleiku had been resettled as of the end of 1970. As shown by the mission files, large areas of the relevant parts of both provinces were sprayed with herbicides: close to 438,000 gal in Kontum and a little over 123 000 gal in Pleiku. However, because of the uncertainties

involved in locating the settlements of the informants at the time of spraying and in locating the spray run tracks, the question of whether or how much the informants were directly or indirectly exposed to the sprayed herbicides cannot be definitively answered.

REFERENCES

Wiersma, G.B. 1970. Ecological impact of antiplant agents and implications for future use. U.S. Army, Combat Development Command, Institute of Land Combat.

Vietnam statistical yearbook, Vol. 16. 1970. Number of war refugees, 1967 to 1970, Table 324, p. 391. National Institute of Statistics, Republic of Vietnam. 410 pp.

Delmore, F.J. and C.E. Minarik. 1962. Destruction of Viet Cong crops, RVN: attack of target 2-1, 21 and 23 November 1962. US/MACV, 3110, Ser. 00333, 26 Dec. 1962.

Hanoi. 1962. VNA broadcast in English to Europe and Asia 0639 GMT 10 Dec. 1962, concerning an article in Nhan-Dan by Prof. Tran-Huu-Tuoc.

and cotton seedlings from 2.25 kg/ha. Wheat and cucumber seedlings were unharmed. BE

ANALYSIS AND RESIDUES

328 McKone, C. E.; Cotterill, E. G. **Extraction of picloram residues from a sandy loam soil.** *Bulletin of Environmental Contamination and Toxicology* (1974) **11** (3) 233-237 [En, 8 ref.] ARC Weed Res. Org., Yarnton, Oxford OX5 1PF, UK.

The recovery was examined of low levels of picloram (0.01 to 0.1 ppm.) at pH levels >7 from soil fortified in the laboratory and from the same soil containing residues from a dose of 1.5 lb/acre applied 67 weeks before sampling. A series of KOH concns. were prepared in 10% KCl as extractant. Aliquots were shaken with 25 g of the soil to give filtrate pH's in the range 7.2 to 11.6. The filtrate was acidified to adjust the pH to <2,, partitioned into chloroform containing 5% ethanol (see *WA 21*, 477) and methylated with diazomethane. The methyl ester was determined using a 1.5 m × 4 mm (internal diam.) glass column packed with 1.5% XE 60 on Chromosorb W and fitted with a ^{63}Ni electron capture detector. Operating conditions were [temps. in °C]: column 180, injection port 215, detector 300, carrier gas 80 ml/min oxygen-free N_2. The quantities of picloram extracted were below the limit of detection (0.001 ppm.) where the KOH solution was <pH 8. Above pH 8 the extractable picloram increased almost linearly to 0.038 ppm. at the highest pH. With the fortified soil recovery was obtained at all pH levels which ranged from 60% at pH 7.2 to 96% at pH 11.6. In another experiment using $Ca(OH)_2$ as extractant, selected as it conveniently buffered soils of varying pH to pH 12.4, recovery from soil fortified with picloram in the range 0.01 to 1 ppm. slightly exceeded 100%; $Ca(OH)_2$ (at pH 12.4) also accounted for a considerable increase in extractable picloram in field weathered residues compared with KOH at pH 9.35. JLM

329 Zawadzka, H.; Adamczewska, M.; Elbanowska, H. **[Determination of simazine, atrazine and prometryne in natural water and sewage by thin-layer chromatography.]** *Chemia Analityczna* (1973) **18** (2) 327-331 [Pl] 6 ref. From *Health Aspects of Pesticides 73* – 3003.

The best conditions for the detection of small amounts of simazine, atrazine and prometryne were determined in a series of experiments. Abbott's method for the determination of triazine herbicides [see *WA 14*, 1273] did not lend itself to the detection of these substances in natural waters and municipal sewage because of interfering impurities. The method was modified by introducing an intermediate step of extract purification consisting of column chromatography with basic Al_2O_3 as the stationary phase and elution with ethyl ether. The thin layer chromatographic results were improved by the addition of fluorescein to the silica gel used for coating of plates, u.v. irradiation of plates and reading under a quartz lamp with a 254 nm filter. Detection of 2.5 ppb. of atrazine and simazine and of 0.5 ppb. prometryne was possible.

330 Bruns, V. F.; Carlile, B. L.; Kelley, A. D. **Responses and residues in sugarbeets, soybeans, and corn irrigated with 2,4-D or silvex-treated water.** *Technical Bulletin, Agricultural Research Service, United States Department of Agriculture* (1973) No. 1476, 32 pp. [En, 28 ref.] Irrig. Agric. Res. Ext. Cent., Prosser, Washington 99350, USA.

See also WA 22, 2690. Analytical methods for determining 2,4-D and silvex (fenoprop) residues in water, soil and plant material were studied, tested, and modified in preliminary laboratory experiments. The basic method used involved the conversion of the alkanolamine salts of 2,4-D and the propylene glycol butyl ether (PGBE) ester of fenoprop to the methyl ester by esterification with boron trifluoride in methanol, and the derivatives were measured on a gas chromatograph equipped with an electron capture detector. Residues detected were as low as 0.000 01-0.000 04 ppm. in water, 0.0005-0.002 ppm. in soil and 0.005 ppm. in plant material. In field trials, herbicides at 0.22-5.51 ppmw. in 2 acre-inches of water (0.1-2.5 lb/acre) were applied by furrow irrigation on a fine sandy loam soil and concns. of 0.02-2.21 ppmw. were also applied by sprinkler irrigation. In general, no edible parts of crops treated with 0.22-1.1 ppmw. by furrow irrigation or with 0.02-0.22 ppmw. by sprinkler irrigation contained detectable amounts of free 2,4-D or fenoprop residues at harvest time. At the highest concns. residues were detected but were many times less than the official tolerance limits; irrigation with fenoprop-treated water before adequate degradation has occurred should probably be avoided. From summary. PK

TOXICOLOGY

See also abst. 298.

331 Wiese, A. F. **Are herbicides environmental contaminants?** In *Proceedings 27th Annual Meeting Southern Weed Science Society.* (1974) 1-7 [En, 28 ref.] Texas Agric. Exp. Stn., Bushland, USA.

The author refutes assertions that herbicides cause long-term contamination of the environment by outlining behaviour patterns of herbicides in the air, plants, soil and water, and submits that the economic and other benefits accruing from their use outweighs any possible undesirable short-term effects. JLM

332 Blaszyk, P. **[Chemical weed control in and near drainage ditches from the point of view of agriculture.]** *Schriftenreihe des Vereins für Wasser-, Boden- und Lufthygiene* (1972) **37**, 187-192 [De] Pflanzenschutzamt Oldenburg, Landwirtschaftskammer Weser Ems, German Federal Republic. From *Pesticides Abstracts* 74 – 0609.

See also *WA 22*, 2077. The complex effect of chemical weed control in and near drainage ditches in the Weser-Ems region is assessed. The use of herbicides over 10 years did not result in any damage to domestic animals even though such animals were given water exclusively from drainage ditches with chemical weed control. The use of herbicides in unfavourable conditions or not in the proper manner caused a few fish deaths and adverse effects on birds.

333 Hickey, G. C. **Perceived effects of herbicides used in the highlands of South Vietnam.** The effect of herbicides in South Vietnam. Part B: Working papers. Washington, D.C., USA; National Academy of Sciences. (1974) 23 pp. [En] SE Asia Program, Cornell Univ., Ithaca, New York 14850, USA.

Local informants on herbicide effects were interviewed. Replies alleging the deleterious effects of the use of herbicides were not anticipated; informants suggested that there were some harmful effects on humans, animals and fish. The study has been preliminary, however, and considerably more investigation should be conducted. PK

334 Carrier, J. M. **The location of herbicide missions and Hickey's informants in South Vietnam: an appraisal.** The effects of herbicides in South Vietnam. Part B: Working papers. Washington, D.C., USA; National Academy of Sciences. (1974) 15 pp. [En, 4 ref.] 17447 Castellammare Drive, Pacific Palisades, California 90272, USA.

Appraisal of the data on herbicide effects collected in the area surveyed by G.C. Hickey in the above paper stresses the difficulties involved in locating the settlements of the informants at the time of spraying and the uncertainties of ascertaining the degree of direct or indirect exposure to the chemicals. JLM

335 Bolier, G.; Maas, H. L. van der; Bootsma, R. **The toxicity of the herbicide dichlobenil to goldfish (*Carassius auratus*).** [Paper in] 25ste Internationaal Symposium over Fytofarmacie en Fytiatrie. Part I. *Mededelingen Fakulteit Landbouwwetenschappen Gent* (1973) **38** (3) 733-740 [En, 9 ref.] Inst. Vet. Pharmacology & Toxicology, Univ. Utrecht, Netherlands.

Goldfish of average length 10 cm were maintained in aquaria containing 6.4, 1.6, 0.4 and 0 mg dichlobenil/litre for 3 months. During this period none died but those in the 6.4 mg/litre aquarium lost weight and exhibited abnormal behaviour. Autopsies were carried out at the end of the trial. Serum glutamine-pyruvate transaminase and alkaline phosphatase levels were unaffected by exposure to the herbicide, except for a significant increase in the level of the latter enzyme at the 1.6 mg dichlobenil/litre concn. Glucose-6-phosphatase activity of liver homogenates was significantly decreased at the 6.4 mg/litre concn. and significantly though unexpectedly increased at the 0.4 mg/litre concn. Considerable accumulation of residue in the body tissues was found; concns. here were 15-20 times higher than in the water. At the 6.4 mg/litre and 1.6 mg/litre concns., several fish developed ascites which was taken by the authors as the first indication of dichlobenil toxicity and led them to recommend a concn. of 1 mg dichlobenil/litre as being safe