



UNITED NATIONS  
*Office on Drugs and Crime*

# **MYANMAR**

## **Opium Survey 2003**



**June 2003**

## **Abbreviations**

CCDAC	Central Committee for Drug Abuse Control
GOUM	Government of the Union of Myanmar
ICMP	Illicit Crop Monitoring Programme
UNODC	United Nations Office on Drugs and Crime
WADP	UNODC Wa Alternative Development Programme

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A special thought is dedicated to the two surveyors who passed away during the course of the survey:

- Pol. Second Lieutenant Tun Tun Naing of Langkho township
- U Ah Pho of WADP survey team

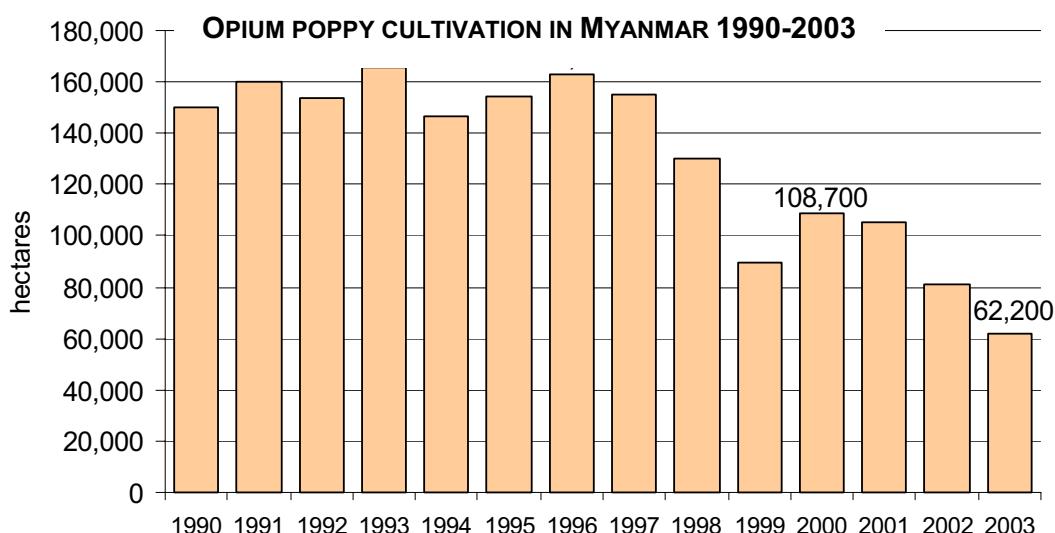
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## MYANMAR OPIUM SURVEY 2003

### Executive Summary

In Myanmar, the problem of opium and heroin production has deep historical roots that reach back to the 19<sup>th</sup> century. Second source of illicit opium and heroin in the world after Afghanistan during the last decade, the country has recorded an encouraging decline of illicit opium poppy cultivation since the mid-1990s.

Results of the extensive fieldwork and satellite imagery analysis conducted by the last UNODC-supported opium survey confirm the continuation of the positive trend in 2003. With a further one-year decline of 24%, opium poppy cultivation is now down to 62,200 ha (against 81,400 ha in 2002). Since 1996, cultivation has declined by more than 100,000 ha, or 62%.



The largest cultivation decrease this year took place in the Northern Shan State (- 50%). It is attributed to farmers' compliance with the Government's request not to plant opium poppy. Important decreases also took place in the Southwestern (-18%) and Southeastern areas (-26%) of the Shan State. By contrast, cultivation increased by 21% in the Wa Special Region 2, and 6% in the Central Shan region. As a result, the Wa Special region 2 now ranks first for opium poppy cultivation, with 34% of the national total, and the Northern Shan region second with 29%, in 2003.

Based on an estimated harvest of about 810 metric tons of opium, and a price of approximately 130 US\$/kg, the total farmgate value of the 2003 opium production in Myanmar would amount to around US\$ 105 million.

The estimated 350,000 households who cultivated opium poppy in the Shan State this year would earn an average of about US\$ 175 from the sale of their individual opium harvest. Although seemingly very small, this income makes opium by far the first source of cash for those families, accounting for 70% of their total annual cash income (about US\$ 230).

# Shan State - 2003 Survey Regions



Note: Administrative borders are approximate and only used for opium survey purposes

0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003



- |  |                     |
|--|---------------------|
|  | Northern Shan State |
|  | Wa Special Region 2 |
|  | Southwestern Shan   |
|  | Central Shan        |
|  | Southeastern Shan   |
|  | WADP project area   |

# Shan State - 2003 Distribution of Opium Poppy Cultivation over Agricultural Areas



Note: Administrative borders are approximate and only used for opium survey purposes

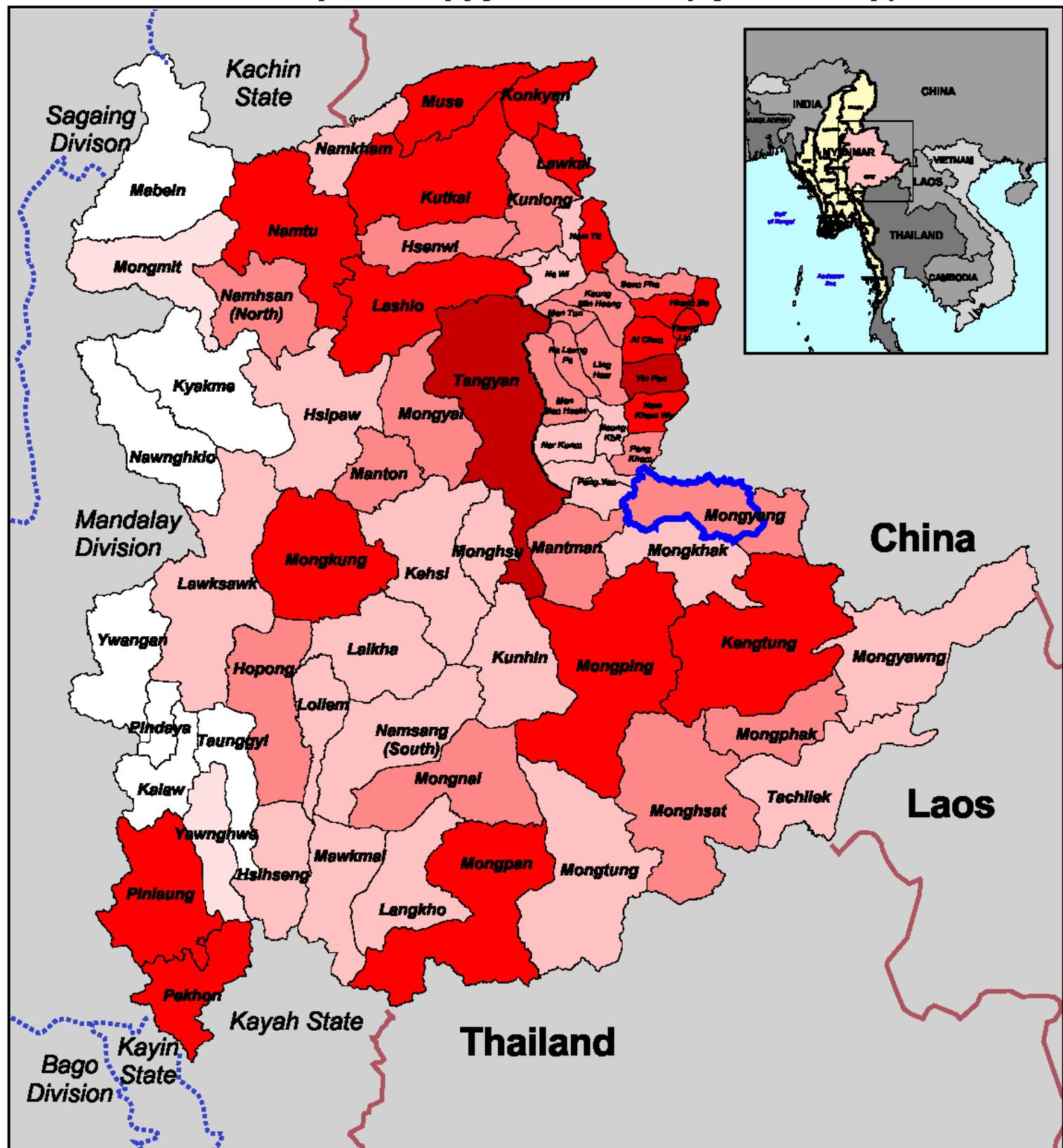
0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

## Opium Cultivation Intensity

- [Green square] No opium poppy
- [Light pink square] Low level
- [Pink square] Medium level
- [Dark red square] High level
- [Blue square] WADP project area

# Shan State - 2003 Opium Poppy Cultivation (by Township)



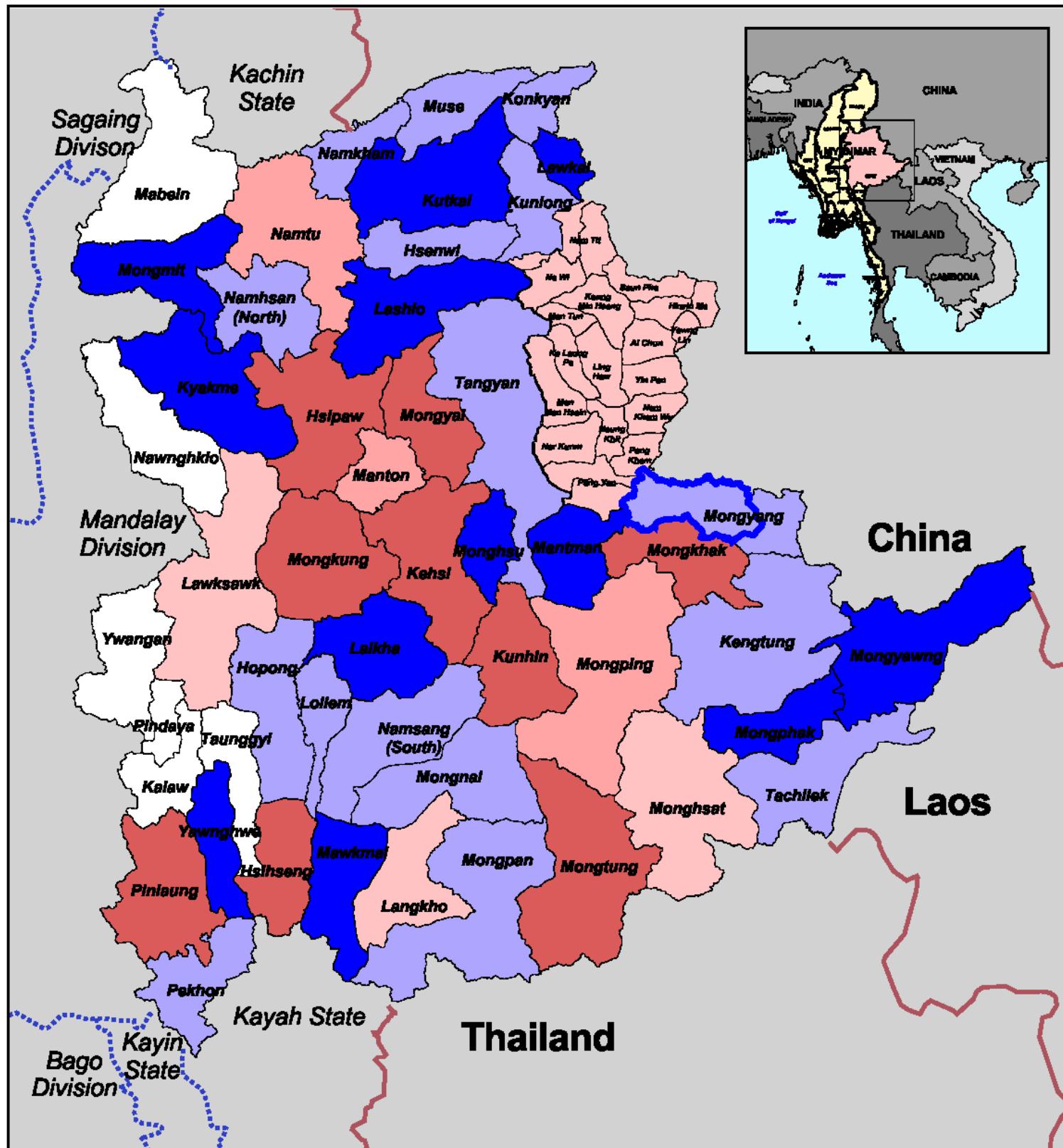
Note: Administrative borders are approximate and only used for opium survey purposes

0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

Opium Poppy Cultivation (ha)	
1 - 100	
101 - 500	
501 - 1000	
1001 - 3000	
3001 - 8000	
Considered Poppy Free	
WADP project area	

## **Shan State - Change in opium poppy cultivation 2002-03**



Note: Administrative borders are approximate  
and only used for opium survey purposes

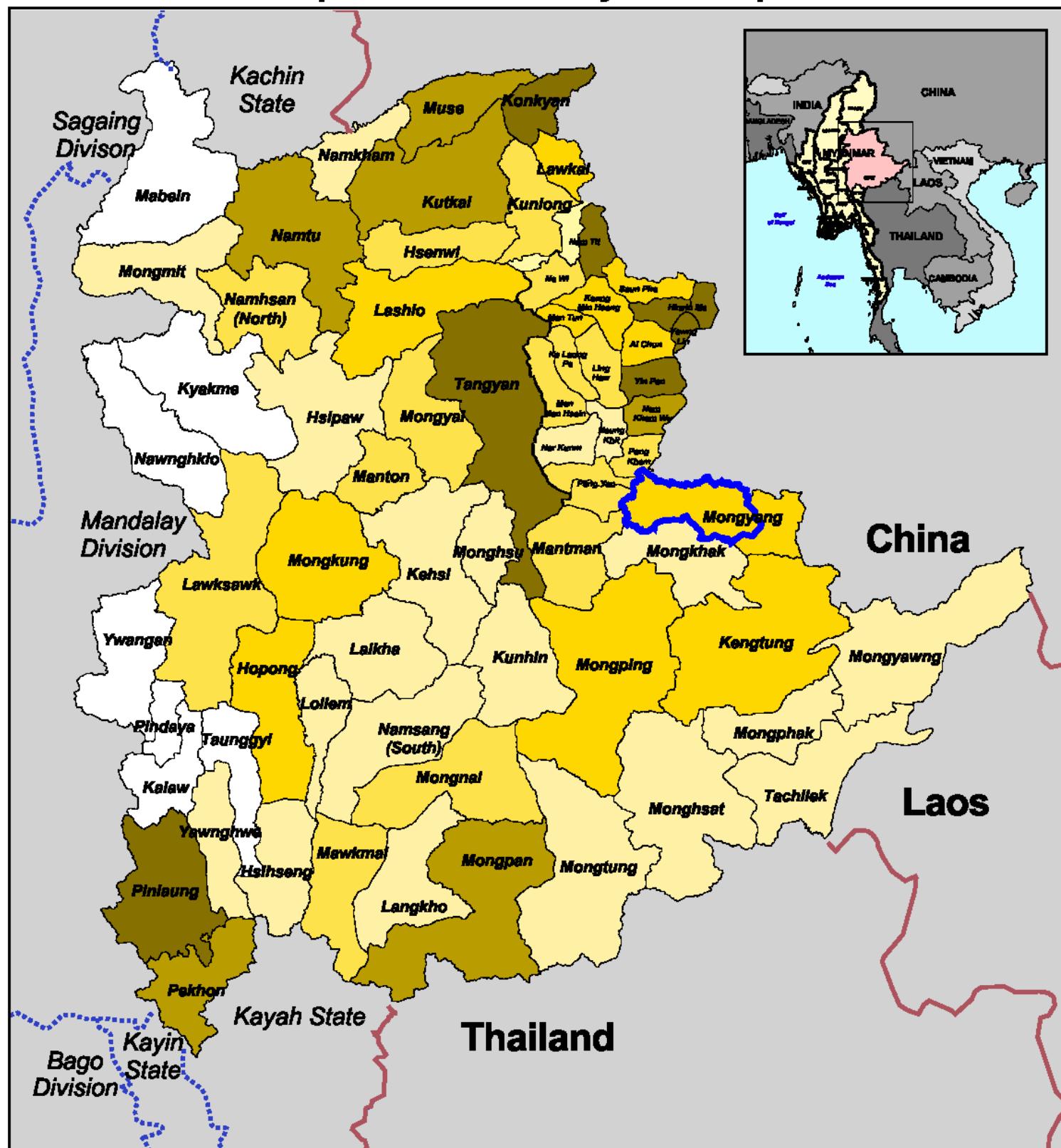
#### Townships' one-year change in cultivation area (%)

0 50 100 Kilometers

- strong decline (51% to 100%)
  - decline (1% to 50%)
  - increase (1% to 50%)
  - strong increase (51% to 100%)
  - strong increase (over 100%)
  - considered poppy-free
  - WAPP project area

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

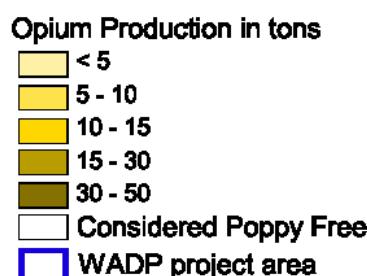
## **Shan State - 2003 Opium Production by Township**



Note: Administrative borders are approximate  
and only used for opium survey purposes

0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003



**Table of contents**

<b>1</b>	<b>INTRODUCTION .....</b>	<b>8</b>
<b>2</b>	<b>FINDINGS .....</b>	<b>8</b>
2.1	OPIUM POPPY CULTIVATION.....	8
2.2	YIELD AND PRODUCTION .....	10
2.3	OPIUM PRICES AND CASH INCOME.....	12
2.4	FIELD DAMAGE.....	15
2.5	ADDICTION.....	15
2.6	ERADICATION .....	17
<b>3</b>	<b>WA ALTERNATIVE DEVELOPMENT PROJECT SURVEY FINDINGS .....</b>	<b>18</b>
3.1	OPIUM POPPY CULTIVATION.....	18
3.2	OPIUM YIELD AND PRODUCTION .....	21
3.3	OPIUM PRICES.....	21
<b>4</b>	<b>METHODOLOGY .....</b>	<b>22</b>
4.1	ORGANISATION AND STAFF .....	22
4.2	OPIUM POPPY CULTIVATION ESTIMATES .....	26
4.3	YIELD ESTIMATION.....	38
<b>5</b>	<b>ANNEXES .....</b>	<b>39</b>

Annex 1 Satellite images used for the 2003 Opium Survey

Annex 2 Calculation for Opium Area Estimates

Annex 3 Opium Cultivation Area and Production by township

Annex 4 Opium Survey Results By Administrative Zones for 2002 and 2003

**Maps**

Map 1	2003 Survey Regions	2
Map 2	2003 Distribution of Opium Poppy Cultivation over Agricultural Areas	3
Map 3	2003 Opium Poppy Cultivation (by Township)	4
Map 4	Shan State - Change in Opium Poppy Cultivation 2002-03	5
Map 5	2003 Opium Production (by township)	6
Map 6	WADP townships	19
Map 7	Sampled village tracts in the Shan State	23
Map 8	Landsat7 and IKONOS map used for the 2003 Myanmar opium survey	29
Map 9	Shan State – Administrative Regions	40

## 1 Introduction

The objectives of UNODC's Illicit Crop Monitoring Programme are to establish methodologies for data collection and analysis, to increase the governments' capacity to monitor illicit crops on their territories and to assist the international community in monitoring the extent and evolution of illicit crops in the context of the elimination strategy adopted by the Member States at the General Assembly Special Session on Drugs in June 1998.

The 2003 Myanmar opium survey was the second consecutive annual opium survey implemented throughout the Shan State by the Central Committee for Drug Abuse Control (CCDAC), with the support and participation of UNODC.

## 2 Findings

### 2.1 Opium Poppy Cultivation

In 2003, the total area under opium poppy cultivation in the Shan State was estimated to range from 46,600 ha to 66,100 ha, with an overall mean estimate of 57,200 ha. This represented a decrease of 23% compared to last year's mean estimate of 74,600 ha.

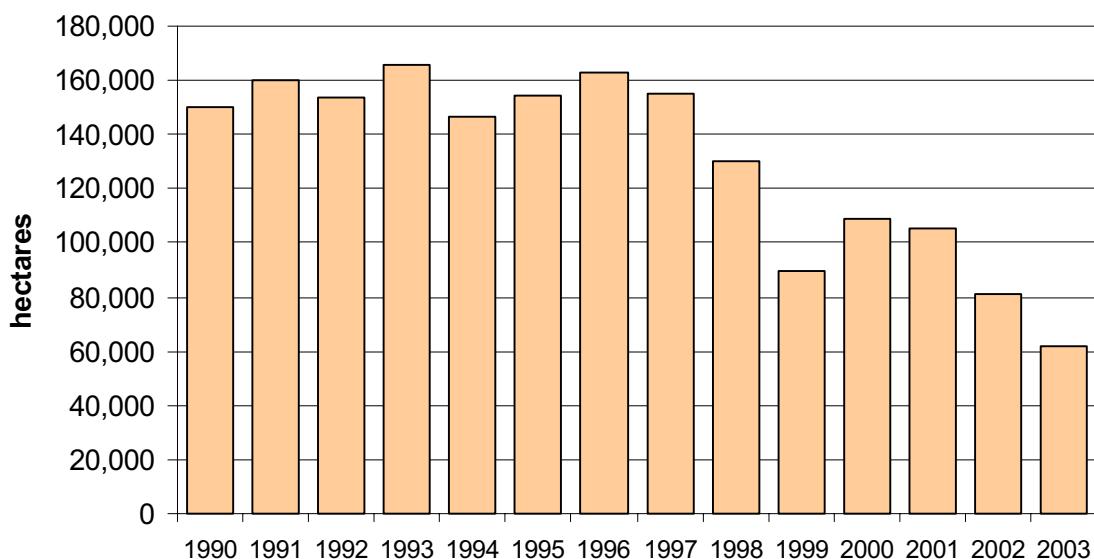
As in 2002, the Myanmar opium survey 2003 did not cover marginal growing areas outside of the Shan State. Based on eradication reports, it was estimated that about 8% of the cultivation took place outside of the Shan State in 2002. To establish a national figure, the survey analysts assumed that the proportion remained the same in 2003.

The total opium poppy cultivation in Myanmar in 2003 was therefore estimated to range from 49,500 ha to 71,900 ha, with an overall mean estimate of 62,200 ha. Compared to last year, this represented a decrease of 24% in opium poppy cultivation at the national level.

Table 1: Opium poppy cultivation 1990-2003

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
150,100	160,000	153,700	165,800	146,600	154,070	163,000	155,150	130,300	89,500	108,700	105,000	81,400	62,200

Figure 1: Opium poppy cultivation 1990-2003



Analysis of the geographical distribution of opium poppy cultivation showed that the largest decrease (- 50%) took place in the Northern Shan State. The reason for this decrease is attributed to farmers' compliance with the Government's request not to plant opium poppy. Significant decreases also took place in the southwestern (-18%) and southeastern areas (-26%) of the Shan State.

Table 2: Myanmar - Opium poppy cultivation in 2002 and 2003

Regions	2002 (rounded ha)	2003 (rounded ha)	% OF CHANGE 2002- 2003
Northern Shan State	35,700	17,900	-50%
Wa Special Region 2	17,600	21,300	+21%
Southwestern Shan	8,200	6,700	-18%
Central Shan	5,200	5,500	+6%
Southeastern Shan	7,300	5,800	-21%
Shan State	<b>74,600</b>	<b>57,200</b>	-23%
Outside Shan State	6,900	5,000	-28%
National total	<b>81,400</b>	<b>62,200</b>	-24%

By contrast, the largest increase in opium poppy cultivation was recorded in the Wa Special Region 2 (+21%). As a result, this region accounted for 34% of the opium poppy cultivation in 2003. The northern Shan State, which represented 46% of the total opium poppy cultivation in 2002, came down to 29% in 2003.

Table 3: Geographical distribution of cultivation 2002-2003

Regions	2002 cultivation (ha)	% of total	2003 cultivation (ha)	% of total
Northern Shan State	35,700	44%	17,900	29%
Wa Special Region 2	17,600	22%	21,300	34%
Southwestern Shan	8,200	10%	6,700	11%
Central Shan	5,200	6%	5,500	9%
Southeastern Shan	7,300	9%	5,800	9%
Outside Shan State	6,900	8%	5,000	8%
National total	81,400	100%	62,200	100%

Of the 21,300 ha of opium poppy cultivation estimated for the Wa Special Region 2, 70% were concentrated in the 8 northeastern townships of the region. They, alone, accounted for 24% of the national opium poppy cultivation estimate.

Table 4: Opium poppy cultivation in the Wa Special Region 2 (2003)

Wa Special Region 2 survey areas	Opium poppy cultivation (rounded ha)	% of total of the Wa Special Region 2
Nam Tit	1,400	
Saun Pha	900	
Hkwin Ma	2,500	
Lone Htan	1,600	
Yaung Lin	1,300	
Ai Chun	1,000	
Yin Pan	3,700	
Nam Kham Wu	2,600	
Northeastern Wa Special Region 2 total	15,000	71%
Rest of the Wa Special Region 2	6,200	29%
Total Wa Special Region 2	21,300	

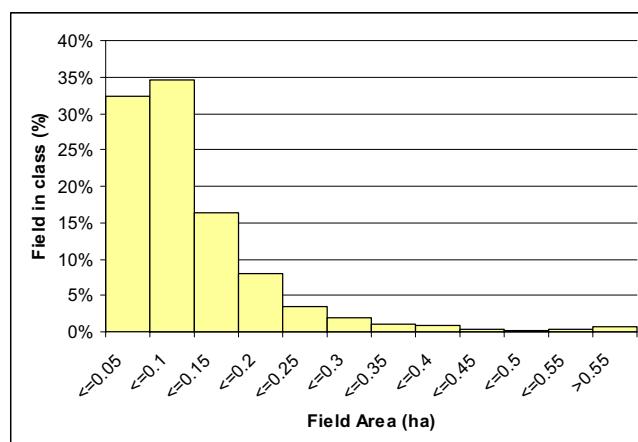
By contrast to the overall increase in opium poppy cultivation in the Wa Special Region 2, the survey showed an 18% decrease in Mongyang township where the UNODC Wa Alternative Development Programme (WADP) is implemented, from 1,100 ha in 2002 to 900 ha in 2003. In the villages where the WADP activities are implemented, the opium poppy survey census conducted by the project showed a 16% decrease, from 820 ha in 2002, to 720 ha in 2003.

The ground survey also provided information on poppy cultivation characteristics in the Shan State. The average size of the 1,473 fields measured was 0.10 ha in 2003, compared to 0.14 ha in 2002. As in 2002, the field size frequency distribution was skewed to the left. 83% of the fields were smaller than 0.15 ha. The largest field (1.19 ha) was found in the Wa Special Region 2, in Nam Kham Wu area.

The estimate of 0.14 ha to 0.17 ha per household matched reports from opium farmers. For the 2002 season, they declared an average harvest of 1.7 kg of opium (see below). As the average yield was 10 kg/ha in 2002, this result corresponded to 0.17 ha of opium poppy cultivation per household. Accordingly, the number of households involved in opium poppy cultivation in the Shan State could be estimated at about 440,000 in 2002 (74,600/0.17), against about 350,000 in 2003.

Table 5: Frequency distribution of field area

Class (ha)	Freq.	%
<=0.05	476	32%
<=0.1	510	35%
<=0.15	242	16%
<=0.2	117	8%
<=0.25	52	4%
<=0.3	27	2%
<=0.35	16	1%
<=0.4	12	1%
<=0.45	5	0%
<=0.5	2	0%
<=0.55	4	0%
>0.55	10	1%
<b>n=</b>	<b>1,473</b>	



## 2.2 Yield and Production

From a sample of 578 fields and 17,533 capsules measured, the national potential opium yield average was estimated to range between 9 kg/ha and 17 kg/ha, with a mean value of 13 kg/ha.

This potential yield may differ from the actual harvest, and does not include possible post-harvest losses, such as opium gum washed away by rain before being harvested. Compared to last year's average opium yield of 10 kg/ha, the 2003 result represented an increase of 30%.

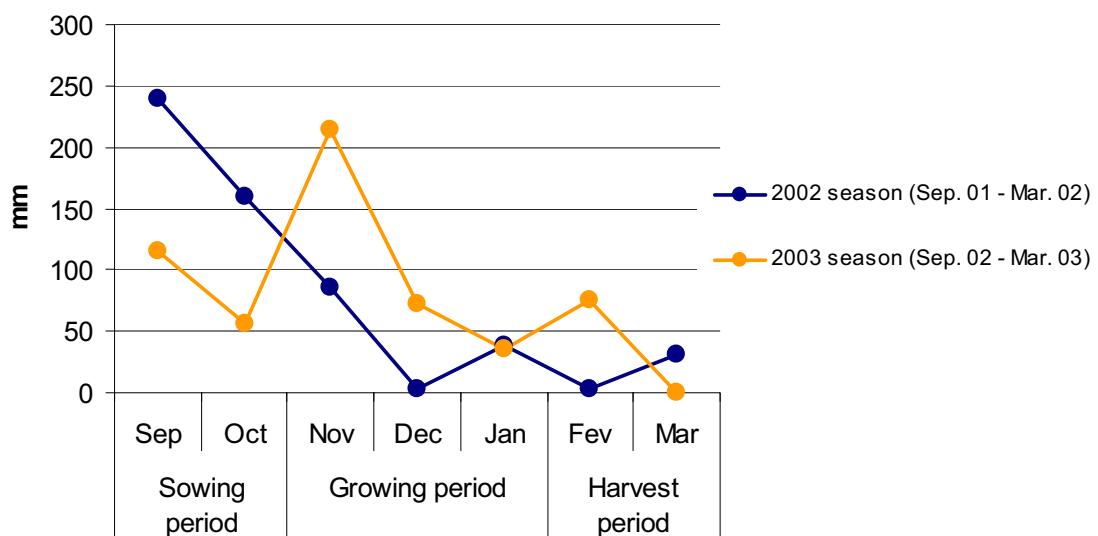
Data collected this year revealed a larger capsule volume per square meter compared to last year ( $317 \text{ cm}^3/\text{m}^2$ , compared to  $191 \text{ cm}^3/\text{m}^2$  in 2002) and a larger number of capsules per square meter ( $19 \text{ capsules/m}^2$ , compared to  $16 \text{ capsules/m}^2$ ).

Table 6: Number of capsules and capsule volume in 2002 and 2003

Year	Number of plots	Avg. number of capsules per $\text{m}^2$	Avg. volume ( $\text{cm}^3/\text{m}^2$ )	Avg. sample yield (kg/ha)
2002	6,390	16	191	10
2003	2,215	19	317	13

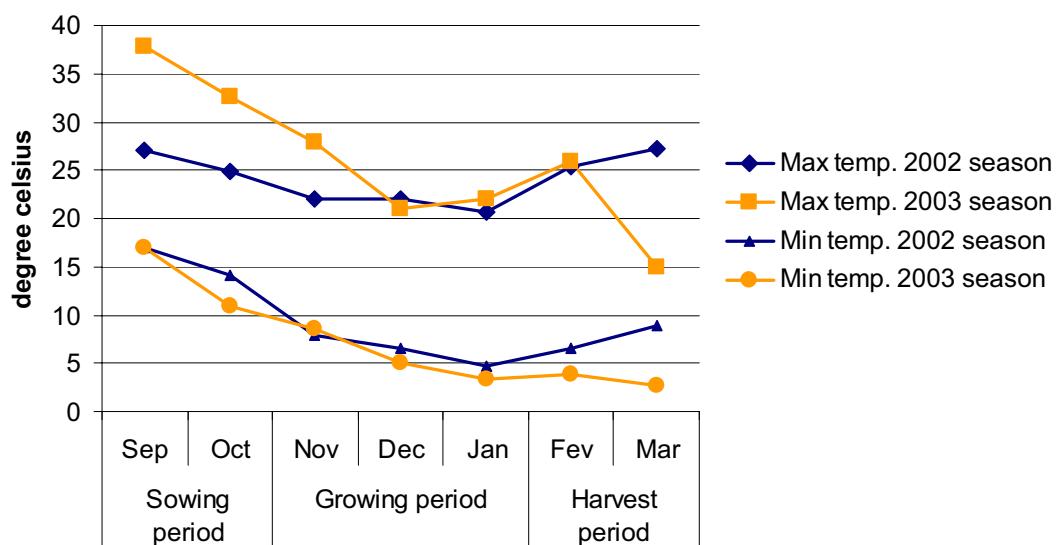
Systematic data on rainfalls and temperatures have been collected since 2001 at the weather station of the WADP. The comparison of the monthly rainfalls during the 2002 and 2003 opium seasons revealed that the rainfall pattern was more favourable for opium poppy germination and growth in 2003 than in 2002. The rainfalls in September and October 2002 were sufficient for opium poppy to germinate whereas in September and October 2001 opium seeds could have been washed away by heavy rains. The rainfalls from November 2002 to January 2003 enabled the opium poppy plants to better develop than last year's limited rainfalls. However, it is possible that the heavy rainfalls of February 2003 washed away some of the opium gum before the farmers could harvest it. This type of loss was not captured by the method used to estimate the potential opium yield. The actual opium production could thus have been significantly lower than the estimate established by the survey.

Figure 2: Graph of rainfalls recorded in the WADP from 2001 to 2003



The temperatures recorded between September 2002 and March 2003 were also favourable to opium poppy yield. In particular the minimum temperature did not reach freezing levels in Mong Pawk town.

Figure 3: Graph of temperatures recorded in the WADP from 2001 to 2003



The 2003 weather pattern could account for the relatively large capsule volume recorded this year and the higher potential yield estimated for the Shan State. Large variations were observed between the townships sampled. The lowest average opium yields of 4 kg/ha were obtained in the southeastern townships of Monghsat and Mongtung, while the highest average opium yield were obtained in the Wa Special Region 2 in the areas of Namtit (34 kg/ha) and Yaung Lin (37 kg/ha). (see annex for details)

At a regional level, the highest average opium yield was obtained from the Wa Special Region 2 (excluding the WADP target area) at 16 kg/ha, and the lowest in the southeastern Shan State at 8 kg/ha.

Table 7: Average regional yields (kg/ha)

Regions	Number of observations	Average opium yield (kg/ha)
Northern Shan State	0	11*
Wa Special Region 2	268	16
WADP (Mongyang Township)	230	11
Central Shan State	60	11
Southeastern Shan State	56	8
Southwestern Shan State	58	14
Shan State	672	13

\* Average opium yield of neighbouring Central Shan State used as best estimate.

The average townships yields applied to the township cultivation estimates provided the opium production estimates. For the townships were no data was collected, the regional opium yield average was applied. As no data on opium yield were collected in the Northern Shan State, the regional average of the neighbouring Central Shan State region was applied for the Northern Shan State. The average yield for the Shan State was applied as the best estimate of the opium yield outside the Shan State.

At the country level, the potential opium production was estimated to range between 560 and 1,060 tons, with a mean value of 810 tons. This represented a decrease of 4 % compared to last year.

Table 8: Potential Opium Production 1990-2003 (in tons)

1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1,621	1,728	1,660	1,791	1,583	1,664	1,760	1,676	1,303	895	1,087	1,097	828	810

### 2.3 Opium Prices and Cash Income

As the opium surveys took place during or shortly before the opium harvest, the opium prices that were collected in 2003 referred to the 2002 opium season. The weighted average farm gate price for one kilogram of opium in 2002 was about 107,000 Kyat or US\$ 115 (at the average 2002 exchange rate of 931 Kyat/US\$). During the 2003 opium survey, opium prices were collected for four periods of 2002. The highest prices in Kyat corresponded to the dry season, at the end of 2002, when most of the 2002 production had already been sold.

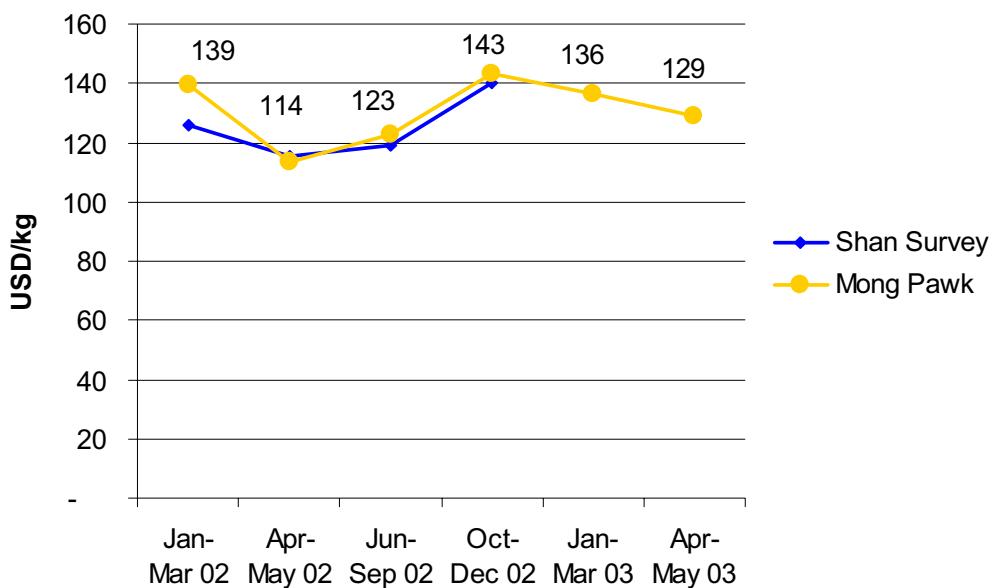
Table 9: 2002 opium prices

Period	Equivalent months range	Answers	Average weight of opium sold (kg)	Kyat/kg	USD/kg	Exchange rate (Kyat/USD)
Before harvest	Before Jan. 02	160	0.64	102,000	135	753
During harvest	Jan-Mar 2002	729	0.88	108,000	143	753
Just after harvest	Apr-May 2002	1,478	1.29	106,000	107	855
Rainy Season	Jun-Sep 2002	353	0.96	104,000	106	985
Dry Season	Oct-Dec 2002	272	1.04	120,000	110	1,090
For 2002		2,992		107,00	115	931

\* Average weighted by number of answers and average weight of opium sold for each period.

An indication of the 2003 opium prices could be derived from the monthly prices collected by the WADP on the Mong Pawk market. In 2002, the prices obtained from the Mong Pawk market and from the survey were very similar. Assuming that both prices continued to evolve similarly in 2003, the WADP price of 130 US\$/kg for April and May 2003 (i.e. when most of the opium is sold) could be used as the best estimate of the 2003 opium prices in the Shan State.

Figure 4: Evolution of Opium Prices in the Shan State and in Mong Pawk (WADP)



Combining the opium production estimates and the anticipated 2003 opium prices of 130 USD/kg, the total farm gate value of opium in Myanmar in 2003 would range from US\$70 to US\$ 140 million, with a mean value of US\$105 million.

The survey data also showed that, in 2002, 58% of the opium was sold shortly after the harvest, roughly between April and May.

It is worth noting that, contrary to other opium producing countries like Afghanistan where the phenomenon is widespread, only 3% of the farmers received cash for their opium before the harvest, as a mean of credit.

As noted during the previous opium survey, the opium prices in the southern townships are the lowest of the Shan State. It is said that opium from the southern Shan State is mostly

sold for the domestic market. In particular, mineworkers in the neighbouring Kayah State are reported as important drug consumers (of opium and amphetamines).

Most of the opium (97%) was sold to village outsiders, with 47% of the transactions reportedly taking place within the village and 50% at the market place. Only 3% of the opium was reportedly sold to other persons within the village.

Table 10: Opium buyers and place of transaction

Place of sale	In number of answers		In percent of total	
	Buyers		Buyers	
	Villagers	Outsiders	Villagers	Outsiders
Village	57	1,037	3%	47%
Market	11	1,097	0%	50%
Total answers	2,202		3%	97%

Through interviews and recollection of the distribution of opium from the 2002 season, the farmers indicated that on average they harvested 1.73 kg of opium in 2002. 95% of this quantity was sold for cash, creating an annual cash income of 176,000 Kyat (equivalent to US\$ 190 at the average exchange rate of 931 Kyat/US\$ in 2002). The farmers reported to use 2% of the harvested opium for their own use, and to barter 3%.

Table 11: Use of opium

Use of Opium	Average weight (kg)	% of Total Weight	Number of Answers
Sold before the harvest	0.06	4%	160
Sold during harvest	0.32	19%	729
Sold just after harvest	0.95	55%	1,478
Sold during rainy season	0.17	10%	353
Sold during dry season	0.14	8%	272
Barter	0.04	3%	204
For own use	0.04	2%	185
Left	0.00	0%	12
Total	1.73		3,393

Sample size: 2,002 interviews of opium farmers

On a separate set of questions, the opium farmers also provided data on their various sources of cash income. The average cash income from opium of 148,000 Kyat per year (160 US\$/year), was in the range of the derived estimation of 190 US\$/year obtained above. The analysis also revealed that opium was the first source (69%) of cash income for opium farmers. The sale of animal, representing 10% of the cash income, only came second. All other sources of income combined amounted to 21% of the total annual cash income.

Table 12: Annual source of cash income for opium farmers

Source of Cash Income	Annual cash income (in Kyat)	% of total income	Number of answers	Annual income (in USD)
Opium	148,000	69%	2,010	159
Cattle	22,000	10%	669	23
Other	13,000	6%	341	15
Upland	11,000	5%	388	12
Paddy	7,000	3%	247	8
Labour	7,000	3%	388	8
Vegetable	3,000	1%	265	3
Maize	3,000	1%	162	3
Total	216,000			232

Sample size: 2,426 interviews of opium farmers

## 2.4 Field Damage

Out of the 1,473 fields measured, farmers reported some kind of damages for 238 of them (or 16%). The causes of damage most often reported by the farmers in 2003 were the heavy rains (39%), followed by eradication (21%).

Table 13: Causes of damage to opium poppy crop in 2003

Damage	Answers	% total
Rain	92	39%
Eradication	50	21%
Animal	45	19%
Frost	35	15%
Other	10	4%
Drought	6	3%
Total	238	

## 2.5 Addiction

The data collected in 2003 showed that 0.65% of the population surveyed, age 15 and above, was smoking opium on a daily basis. This result should be interpreted with caution, as there might be a reluctance of respondents to report opium addiction in the context of the Government's efforts to curb it down. Village headmen reported that daily opium smoking took place in 25% of the villages surveyed in 2003 (out of a total of 1,561 villages)<sup>1</sup>. In those villages, the average prevalence rate amounted to 2% of the population age 15 and above (results by village vary from 0.1% to 34%). The same calculation for 2002 found an average rate of 2.4% for the Shan State.

Otherwise, the 2003 opium survey confirmed the main patterns of opium addiction in the Shan State previously found.

- 1) Opium smoking in the Shan State is mainly a male phenomenon (1.2% among the male population aged 15 and above, versus 0.1% among females). As in 2002, the proportion of male opium addicts was 90%, against 10% female addicts.

<sup>1</sup> The 2002 opium survey in the Shan State found that out of 2,182 villages surveyed, addiction was reported from 584 or 27%.

Table 14: Opium addiction in the Shan State by gender (2003)

Number of villages sampled	Total population above 15 years old	Male Population above 15 years old	Number of male addicts	% of opium addicts in male population age 15 and above	Female Population above 15 years old	Number of female addicts	% of opium addicts in female population age 15 and above.
1561	246,038	122,527	123,511	1,406	1.1%	145	0.1%

2) Opium smoking is more widespread in villages cultivating opium poppy (1.2%) compared to villages that are not involved in opium poppy cultivation (0.4%).

Table 15: Opium addiction in the Shan State in villages growing and non growing opium poppy (2003)

Villages grouping	Number of villages sampled	Total population above 15 years old	Number of addicts	% of opium addicts in population age 15 and above
Villages growing opium poppy	534	88,660	1,018	1.15%
Villages non growing opium poppy	1,027	157,378	533	0.34%
Total villages sampled	1,561	246,038	1,551	0.63%

3) The geographical distribution of addiction data showed a higher opium prevalence rate in the southern part of the Shan State, close to the border with Thailand, where prevalence rate were the highest at 1.8%.

Table 16: Opium addiction in the Shan State by regions (2003)

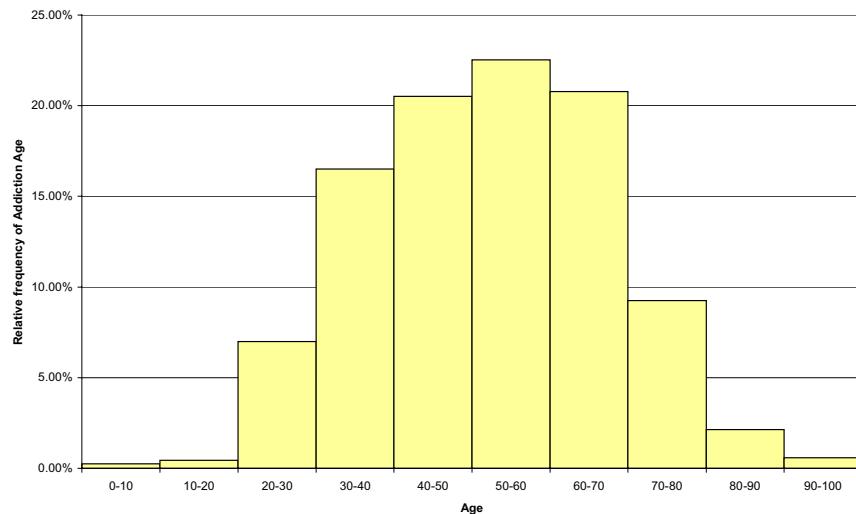
Regions	Number of villages sampled	Total population above 15 years old	Number of addicts	% of opium addicts in population age 15 and above
Northern Shan	373	73,041	263	0.4%
Wa Special Region 2	269	50,863	385	0.8%
Southwestern Shan	248	35,257	216	0.6%
Central Shan	361	53,753	94	0.2%
Southeastern Shan	310	33,124	593	1.8%
Shan State	1,561	246,038	1,551	0.6%

4) In contrast to the usual pattern of drug addiction, opium addiction in the Shan State is clearly a phenomenon associated with older adults. The highest proportion of addicts was found for the age groups 50-60, exceeding 20% of the total number of addicts.

Table 17: Demographic Distribution of Opium Addicts by gender and age in 2003

Age class	Man	Woman	Total	% of Total
<10	2	2	4	0.3%
10-20	4	3	7	0.5%
20-30	93	15	108	7.0%
30-40	231	24	255	16.5%
40-50	293	24	317	20.5%
50-60	325	23	348	22.5%
60-70	291	30	321	20.8%
70-80	129	14	143	9.3%
80-90	26	7	33	2.2%
90-100	7	2	9	0.6%
	<b>1,401</b>	<b>144</b>	<b>1,545</b>	

Figure 5: Demographic distribution of opium addicts by age



The data also indicated that opium addiction is still far more widespread than heroin and ATS addiction in the Shan State. Less than 2% of the village headmen reported cases of heroin addiction in their villages and less than 1% reported cases of ATS addiction.

## 2.6 Eradication

The opium survey was not designed to monitor or validate the results of opium poppy eradication campaign. However, the data on eradication as reported are presented here.

At the country level, eradication has been reported to reach a total of 638 ha. According to CCDAC, a total of 583 ha were eradicated in the country during the 2003 opium season. In addition, the Wa authorities have reported eradication of 55 ha in the target villages of the WADP. The break down is presented below.

Table 18: Eradication by region and state

State	Eradication (ha)
Northern Shan State	235
Southern Shan State	182
Eastern Shan State	91
WADP	55
Kachin State	56
Chin State	2
Kayah State	9
Mandalay Division	8
Total	638

The cultivation estimates were made after eradication.

### 3 Wa Alternative Development Project Survey Findings

#### 3.1 Opium poppy cultivation

In 2003, the census WADP opium poppy survey estimated that opium poppy cultivation amounted to 775 ha in all the 337 villages of the WADP. This represented a 19% decrease compared to last year. Soon after the opium poppy survey was conducted, the Wa authorities eradicated 55 ha of opium poppy in the Nam Lwee catchment of Mong Phen Township. The net figure for opium poppy harvested in 2003 is thus 720 ha. This represented a decrease of 16% compared to last years' net opium poppy estimate of 860 ha.

Table 19: Opium poppy cultivation and eradication in the WADP

Year	Cultivation (Ha)	Eradicated (Ha)	Net (Ha – rounded)
1999	1,211	0	1,200
2002	956	94	860
2003	775	55	720

The analysis of the results per WADP township revealed that the overall decrease was mainly due to the decrease in Mong Phen township, from 333 ha in 2002 to 186 ha in 2002 (or 44% decrease). The WADP townships are presented on the map next page. It should be noted that the notion of 'township' in the Wa Special Region 2 and in particular in the WADP area refers to smaller entities than elsewhere in the Shan State.

Table 20: Gross opium poppy cultivation by WADP township

WADP's township	1999	2002	2003	% of change 2002-2003
Mong Phen	295	333	186	-44%
Mong Pawk	477	303	285	-6%
Ho Tao	10	63	71	13%
Mong Kar	180	155	134	-14%
Nam Phai	247	100	98	-2%
<b>Total</b>	<b>1,211</b>	<b>956</b>	<b>775</b>	

Mong Pawk township accounted for the largest proportion (37%) of opium poppy cultivation in the project area.

# Wa Townships surveyed in 2003 by WADP

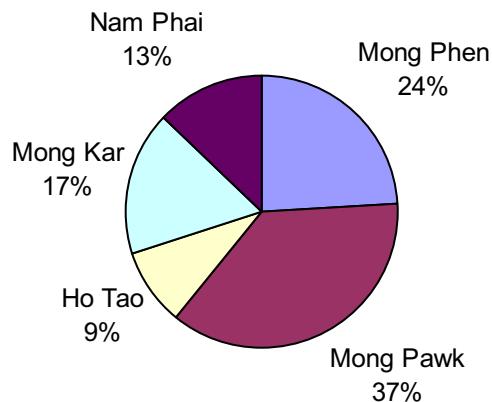


Note: Administrative borders are approximate  
and only used for opium survey purposes

0 15 30 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

Figure 6: Proportion of opium poppy cultivation in the WADP area



From the 337 target villages surveyed, 272 villages were found growing opium poppy. The average opium poppy cultivation area by village was 2.8 ha. The frequency distribution showed however that the majority of the villages (58%) cultivate less than 2 ha.

Table 21: Frequency distribution of opium poppy cultivation area by village

Opium poppy cultivation area by village	% of total number of villages
< 2 ha	58%
2 – 8 ha	35%
8 and 10 ha	2%
> 10 ha	5%

The distribution of opium poppy cultivation by village revealed that more than 26% of the opium poppy cultivation in the project area took place in only 15 villages. Important opium poppy cultivation was also noted in the Nam Lwee valley, along the Chinese border, but was eradicated before harvest. The remaining 258 villages accounted for 74% of the total opium poppy cultivation. Opium poppy cultivation was also reported within the urban area of Mong Pawk township.

Among the 12 ethnic groups represented in the project area, the Lahu ethnic group accounted for 50% of the population and the largest share (64%) of opium poppy cultivation.

Table 22: Distribution of population and poppy cultivation by ethnic group

Ethnic Group	Pop.	Total area	% of total
Lahu	22,253	495	63.8%
Akha	4,232	90	11.6%
Wa	5,356	75	9.7%
Shan	7,696	69	9.0%
Chinese	1,850	12	1.5%
Kachin	573	9	1.1%
Pa Laung	566	9	1.1%
Shan Kyan	600	9	1.1%
Akhe	293	3	0.4%
Loi	646	3	0.4%
Myaung Si	24	2	0.3%
Li Shaw	54	1	0.1%
<b>Total</b>	<b>44,143</b>	<b>775</b>	

As observed in previous project opium surveys, the level of opium poppy cultivation per household in cultivating villages remained at about 0.18 Ha. On average, a household had 1.6 opium fields.

Out of a total of 6,181 fields, 2,384 were physically measured using a FAO method with compass and tape meter. The average field size was 0.11 ha, with the largest field being 1.3 ha and the smallest 0.01 Ha.

### **3.2 Opium yield and production**

From a sample of 230 fields and 4,421 capsules measured, the potential opium yield average for the project area was estimated to range between 7 and 16 kg/ha, with a mean value of 11 kg/ha. The average projected capsule density was 15 per square meter plot and the average projected volume capsule was 221 cm<sup>3</sup>/m<sup>2</sup>. Based on the total area harvested of 720 ha, the potential opium production in the WADP ranged between 5 and 11 tons, with a mean estimate of 8 tons.

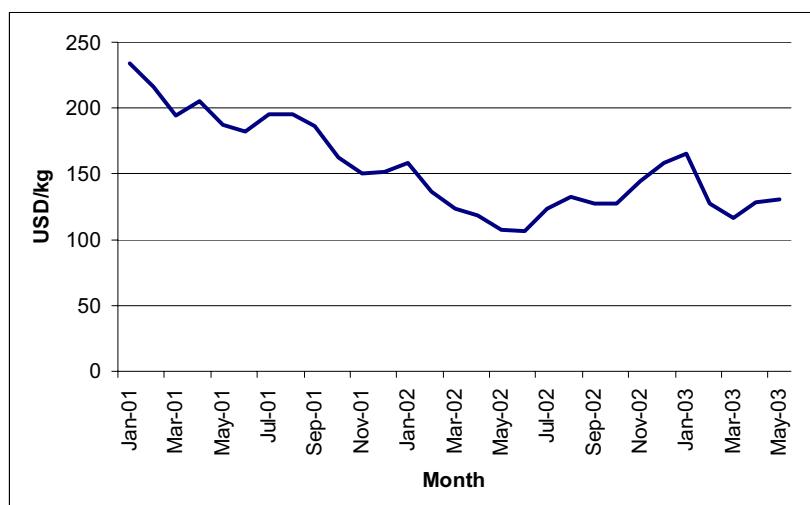
### 3.3 *Opium prices*

Opium prices collected during weekly market day in Mong Pawk during the last two years are presented below.

Table 23: Prices of opium on the Mong Pawk market (USD per kg)

<b>Month</b>	<b>2001</b>	<b>2002</b>	<b>2003</b>
January	234	158	165
February	216	136	127
March	194	124	117
April	205	119	128
May	187	108	130
June	182	107	
July	195	124	
August	195	132	
September	186	127	
October	162	127	
November	150	144	
December	151	158	

Figure 7: Prices of opium on the Mong Pawk market (USD/kg) since January 2001



The monthly opium market price recorded in Mong Pawk showed a downwards trends from 2001 to 2003 opium season. Using March 2003 as the best estimate for the 2003 opium season, and comparing it with opium price of March 2001, revealed a decrease of 40% in opium prices between the 2001 and 2003 opium season.

It should be noted that the opium price on Mong Pawk market are usually higher than the price reported from the farmers themselves.

It is also worth noting that a 10 % tax is collected by the local authorities as opium taxes. This practise has also been reported in other areas of the Shan State.

## 4 Methodology

The 2003 opium survey was implemented over the whole Shan State where most of the poppy cultivation in the Union of Myanmar takes place.

The Shan State covers 155,000 square kilometres, an area almost the size of Bangladesh, and is mostly mountainous with a limited road network. The size and limited accessibility of this area suggested the use of a sampling approach to estimate the extent of opium poppy cultivation. A random sample of villages and areas was therefore surveyed in detail and the findings were then extrapolated to the entire State.

Production of opium poppy was estimated by integrating an extensive ground survey and the interpretation of satellite images. Ancillary data on opium farm gate prices and opium addiction was also collected, as well as information on several agricultural practices related to opium poppy cultivation.

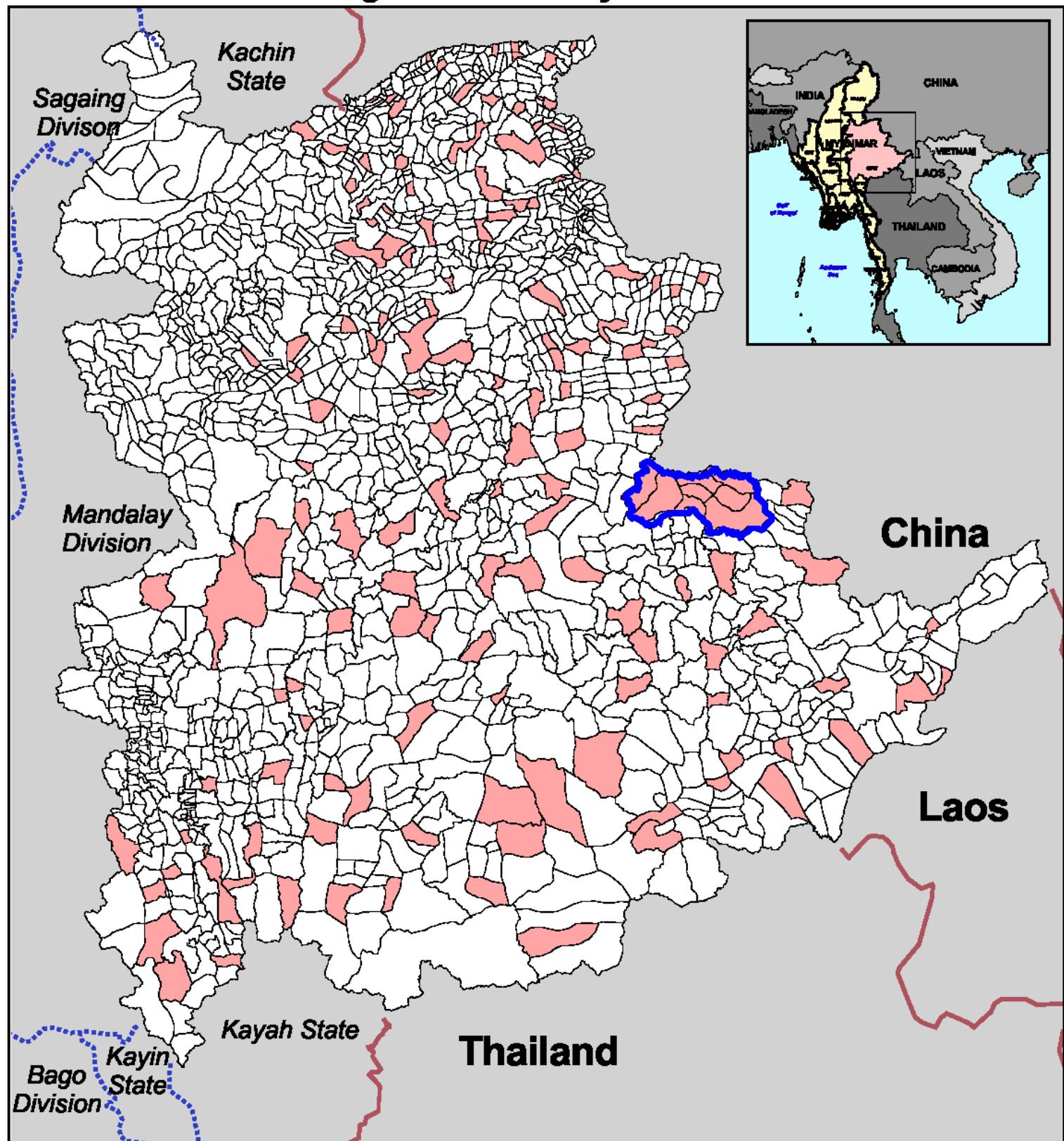
In the Wa Region, UNODC has been implementing an alternative development project, officially known as "Drug Control and Development in the Wa Region of the Shan State, AD/RAS/96/C-25", better known as the Wa Alternative Development Programme or WADP. The main objective of this project is the establishment of a sustainable, community-based approach to arrive at a gradual reduction and eventual elimination of the supply of and demand for opium. Within the WADP area, an annual opium poppy survey is conducted to gauge the impact of project activities. By contrast with the national survey, which is conducted on a sample basis, the opium survey in the WADP is a census survey conducted over all the project target villages. All poppy fields are counted and a large number of them physically measured to derive a precise estimation of the area under opium poppy cultivation.

### 4.1 Organisation and Staff

The survey implemented across the Shan State involved interviews of village leaders and household members as well as field measurements. 156 surveyors implemented it from 15 January 2003 to 30 March 2003.

The survey was conducted on a sample of 210 villages tracts (comprising a total of 1,625 villages) selected from 59 townships out of the 70 that were considered for the 2003 opium survey. Six townships known to be poppy free were not included in the survey. The selection of village tracts was made on the basis of the 2002 village tracts' baseline mapping and of the 2003 land cover. Due to the lack of updated administrative data, it should be noted that the village tracts and the township borders are only approximate.

# Shan State - 2003 Village Tracts Surveyed



Note: Administrative borders are approximate  
and only used for opium survey purposes

0 50 100 Kilometers

Village tracts surveyed  
WADP project area

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

The land cover information was used to group the village tracts of each township into two categories: village tracts with high potential for opium poppy cultivation and village tracts with low potential for opium poppy cultivation. In some townships, only one category was found.

For each township, at least two village tracts were randomly selected for each of the two categories, taking into account the geographical distribution. In every selected village-tract, all villages were surveyed. Due to the lack of updated administrative data, the exact number of villages within the village tracts was unknown before the survey. In total, 1,625 villages were surveyed.

The surveyors received a one-week training, in Taunggyi, Kengtung, Lashio and Pang Sang (also called Pang Kham). The training was organised by CCDAC and conducted by technicians recruited for the survey. The training covered interview techniques, description of the survey process, description of the questionnaire, the use of GPS, field measurement techniques, poppy capsule measurement techniques, and the random selection of household and opium poppy fields. A day and a half of field practice followed the theoretical part of the training.

The survey teams were staffed from the township administration and each team was composed of 3 persons, headed by a policeman. The other two team members usually came from the Myanmar Agriculture service and the Land Records or General Administration Departments.

In the WAPD, the surveyors were trained for three days to use survey instruments before being sent to villages where they worked continuously for seven weeks. At least 90% of surveyors had experience in the survey process since they had participated in the UNODC/Wa project socio-economic survey of 1999/2000, 2002/2003 as well as in the previous opium poppy survey.

Upon arrival in a village, the surveyors met with the village leader to explain the purposes of the survey. After securing the collaboration of the village leader, the surveyors followed a standardized interview protocol made of 3 parts: the village leader questionnaire, the household questionnaire and the opium poppy field measurement questionnaire. The forms are presented in annex.

During the village interview, surveyors collected data on the village demography, on the general weather conditions over the year and on addiction by gender and age. Surveyors were equipped also with GPS instruments to record the geographic location of the villages.

The interview itself was followed by the random selection of a sample of opium-growing households to be interviewed. The number of households to interview was determined according to the total number of households within the village as follow:

Table 24: Number of households to interview

Nr of hh in the village From	1	11	21	31	41	51	61	71	81	91
To	10	20	30	40	50	60	70	80	90	100
Number of households to interview	3	6	9	12	12	12	12	12	12	12

The number of households to interview was limited to a maximum of 12 per village, so that the surveyors would not spend more than one or two days within the same village and could therefore visit all the villages within the selected village tracts. On average, one village tract was made of 8 villages.

During the household interview, the surveyors collected data on cash income and expenditures, opium prices and opium sale practices, the costs associated with opium poppy cultivation and information on the opium poppy cultivation calendar.

All opium fields belonging to the selected households were measured and surveyed, and up to a maximum of eight fields per village was measured. The number of fields to survey was limited to a maximum of 8 per village so that the surveyors would not spent more than one or two days within the same village. The fields were measured with a tape-meter and compass. These data were computed in a programmed pocket calculator that gives the field area in hectare as well as the field measurement error (the closing error). Measurement showing an error greater than 3% had to be redone.

Crop conditions were collected for estimating the opium yield from up to 3 mature fields per village. A transect was laid randomly in the field and 5 plots of one square meter selected. From each plot the number of flowers, immature capsules and mature capsules were recorded, as well as the diameter and height of up to 10 opium poppy capsules. A set of data on the opium poppy agricultural practices was also collected at this stage.

All the survey forms were collected and brought back to the CCDAC office in Yangon where data entry took place in April and May 2003. International UNODC staff were sent to the northern, southern, eastern regions, as well as to the Wa Special Region to ascertain the quality of the survey implementation.

Table 25: 2003 Survey Meta-data

	Villages surveyed (Total)	Villages surveyed (growing poppy )	Fields surveyed (area measurement)	Fields surveyed (yield assessment)	Capsules measured (yield assessment)
<b>Shan Survey</b>	1,625	284	1,532	578	17,533
<b>WADP</b>	337	272	2,384	230	4,421
<b>Total</b>	1,962	556	3,916	808	21,954

#### The Interviews and Field Measurements

A ground based approach means that the data were collected by interviews with key informants and by physical measurement of the opium fields. The interviews were structured according to the questionnaire and were made up of the following 3 parts: the village leader interview, the opium growing farmer interview, and the field measurement.

- a) The Village Leader Interview: The main purpose of the village headman interview was to obtain first hand information on the village demography and the number of households growing opium poppy. This information was then used to crosscheck or complement the data provided by the district authorities. The village geographical co-ordinates were measured with GPS<sup>2</sup> instruments.
- b) The Opium Growing Farmers Interview: Approximately 6 to 10 poppy farmers were randomly selected an interviewed in each village, depending on the total number of farmers growing opium in the villages.

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<sup>2</sup> Global Positioning System

The main purpose of this interview was to collect data on the number of opium poppy fields cultivated by farmers and the opium farm gate prices.

c) The Field Measurement : Once the farmer's interview was completed, the farmer himself led the surveyors to the opium fields. A number of data were gathered directly from the surveyor's inspection of the field, as well as by additional questions to the farmer regarding the field being surveyed.

When the opium fields were matured i.e. when the plants were ready for harvest or being harvested, the surveyors also measured the capsule diameter and height. These data were used for the yield estimations.

## **4.2 Opium Poppy Cultivation Estimates**

The estimation of the opium poppy planted area during the 2003 season was attained through the use remote sensing techniques, using data from Landsat7 and IKONOS satellites.

The resolution of Landsat7 images (30 m) does not allow the discrimination of poppy fields, which are rather small in the Shan State, however it is possible, with this type of imagery, to distinguish agricultural land with potential for poppy cultivation. Furthermore, its relatively low cost made it possible to cover most of the Shan State.

By interpreting these images, the Shan State was subdivided into areas with similar opium poppy cultivation potential. These strata were sampled using high-resolution imagery from the IKONOS satellite (resolution 1 to 4 meter). Opium poppy cultivation was interpreted on these images and the results extrapolated to the landcover.

### Establishment of the Sampling Frame

The whole of the Shan State covers an area of 155,000 km<sup>2</sup>. The potential area for opium poppy cultivation established through the interpretation of the Landsat7 images covers around 11% of this, for a total of 9,033 km<sup>2</sup>. The areas that were not taken into consideration include the Mabein, Nawngio, Ywangan, Pindaya, Kalaw and Taunggyi townships, considered poppy free, as well as some marginal areas of Pekhon and Pinlaung township, not covered by the satellite images.

Most of the Landsat7 images were acquired in the fall 2002 at a time when the rice and maize summer crops have been harvested and while opium poppy fields are still being sown. At that time, most fields in the Shan State appear as bare soil and this provides a distinctive spectral reflectance that can easily be interpreted on the imagery. The list of the satellite images used for the 2003 survey and their acquisition dates is presented in annex.

The interpretation made a distinction between areas of similar and homogeneous land uses with respect to potential for poppy cultivation. These classes were used to stratify the sampling frame so as to decrease the variance of the estimate. The sample of high-resolution imagery was selected within those agricultural classes that showed a potential for opium poppy cultivation.

All images have been rectified to the UTM 47 North zone. After performing standard enhancement procedures, the images have been classified by using the utilities provided by the ERDAS Imagine™ image vector processing software.

The Landsat7 images were visually interpreted in December 2002 by a remote sensing expert familiar with the Shan State. The ground truthing information (4,585 GPS points)

collected during the opium survey 2002 (January to March 2002) also contributed to the interpretation of the images and the establishment of the land cover.

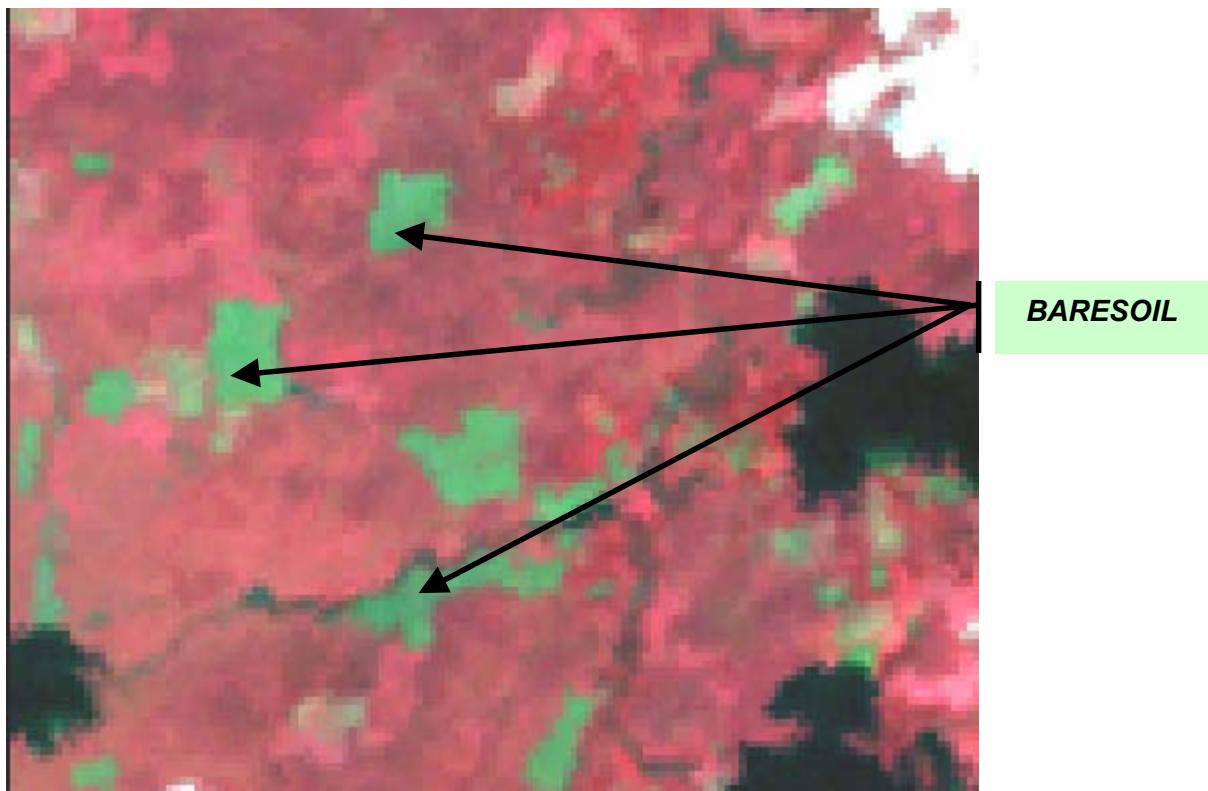
For the purpose of the opium survey, four land use classes have been defined:

1. Non-agricultural land: This class includes areas with permanent vegetation cover (grassland), all kinds of forests, urban areas, wetlands, bare-rocks, etc. This class was considered poppy free and therefore not included into the sampling frame.
2. Agricultural land of no potential for poppy cultivation: This class includes `the agricultural land where none or very little poppy cultivation is expected. It is mainly comprised of irrigated paddy fields and other agricultural land in plain areas close to urban centres and in river basins.
3. Agricultural land with low potential for poppy cultivation: This class includes cultivated areas over slopes and is made of large and continuous agricultural zones where low levels of opium poppy cultivation can be expected.
4. Agricultural land with high potential for poppy cultivation: This class includes cultivated areas over slopes with non-continuous patches of agriculture, where relatively higher levels of opium poppy cultivation are expected.

Table 26: Sampling frame

Strata	Km <sup>2</sup>	Percent
Agricultural land of low potential for poppy cultivation	4,308	48%
Agricultural land of high potential for poppy cultivation	4,725	52%
Total	9,033	

Figure 8: Appearance of bare agricultural land on a satellite image



To assess the accuracy of the land cover and consequently of the sampling frame, an additional 1,400 GPS measurements of opium poppy fields collected during the 2003 opium

ground survey were used. This assessment showed that 74% of the opium poppy fields measured where within the potential opium poppy area of the sampling frame.

### Sampling

Opium poppy cultivation was identified using high-resolution (4 m) multi-spectral satellite images over 659 km<sup>2</sup> of potential opium poppy area, representing 6 % of the total sampling frame.

The sample was made up of 28 blocks of 10 km by 10 km corresponding to the minimum size of the IKONOS multi-spectral imagery. This sample was selected randomly, geographically distributed throughout the Shan State so as to maximize the coverage of the different categories of land classes.

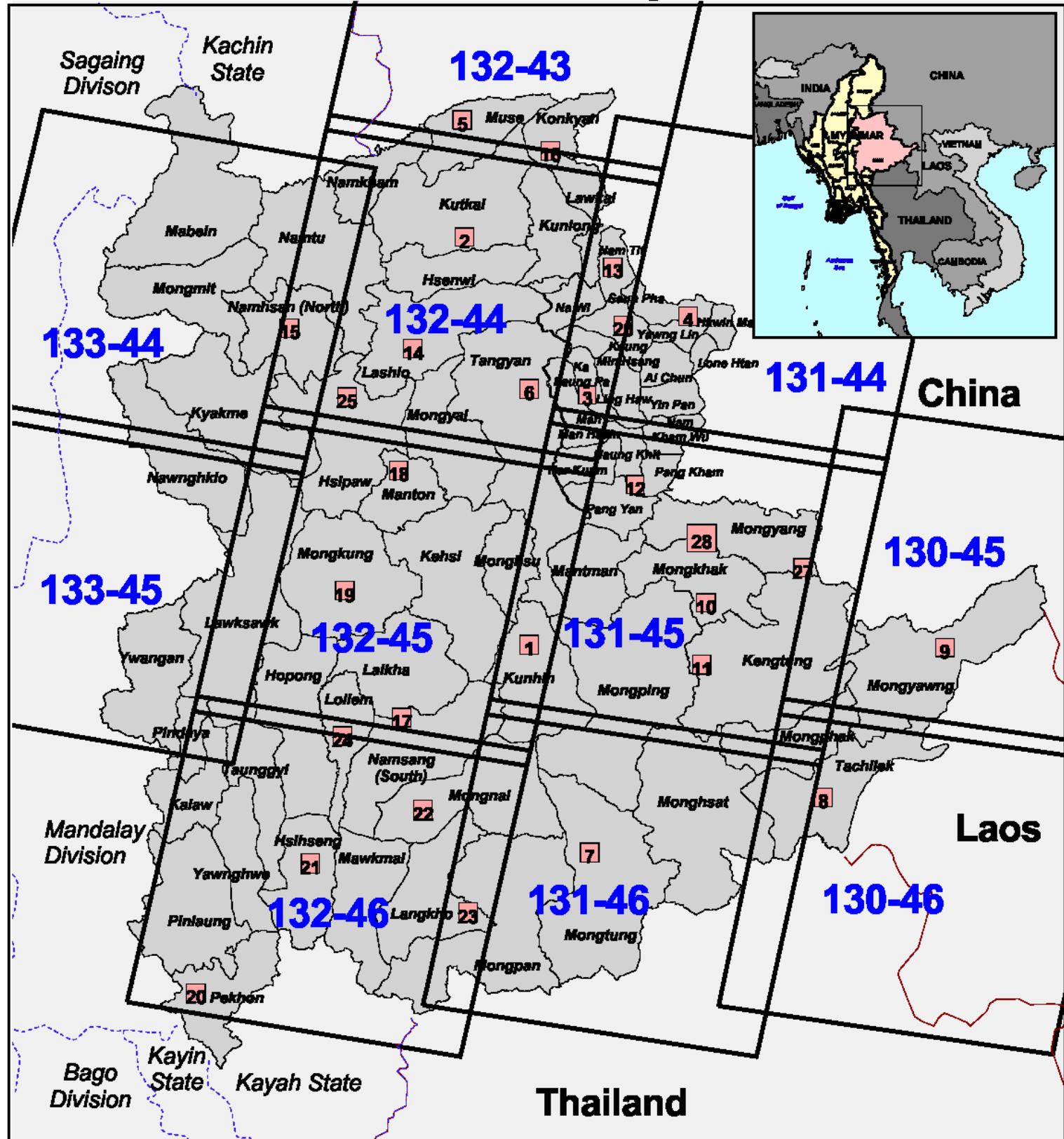
Table 27: Sample meta-data

Strata	Sampling frame (km <sup>2</sup> )	Sample (km <sup>2</sup> )	Sample ratio
Agric. land of low potential for poppy cultivation	4,308	282	7%
Agric. land of high potential for poppy cultivation	4,725	419	9%
<b>TOTAL</b>	<b>9,033</b>	<b>701</b>	<b>8%</b>

To ensure the geographical distribution of the sample, the townships were split into 5 regions: northern Shan State, Wa Special Region number 2, southeastern Shan State, southwestern Shan State and Central Shan State. These regions are presented on a map in annex.

# Shan State - 2003 Opium Poppy Survey

## Frames of Landsat TM7 and IKONOS images



Note: Administrative borders are approximate and only used for opium survey purposes

0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

path-row	1st date	2nd date
133-45	1 Sep 2002	
133-44	1 Sep 2002	
132-43	1 Sep 2002	10 Dec 2002
132-44	2 Mar 2002	10 Dec 2002
135-45	2 Mar 2002	10 Dec 2002
132-46	2 Mar 2002	26 Feb 2003
131-44	2 Jul 2002	
131-45	2 Jul 2002	
131-46	11 Jun 2002	2 Jul 2002
130-45	3 Apr 2002	
130-46	3 Apr 2002	14 Oct 2002

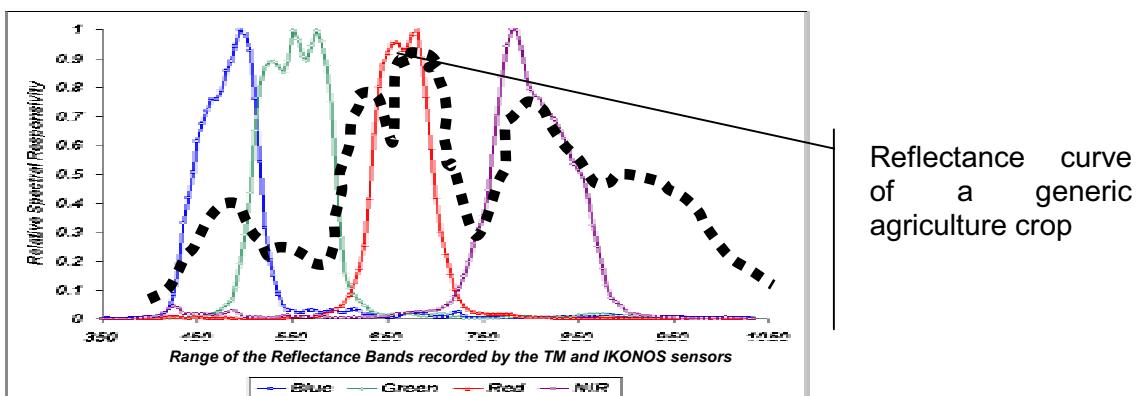
Landsat TM7 Frames  
**130-46** Path and Row of the Landsat TM7 image and acquisition date

IKONOS frames and reference code

## Processing and analysis of the images

The remote sensing exercise to estimate opium poppy cultivation area was initially planned to be based on the exclusive use of the four-meter resolution sensor Space Imaging IKONOS™. A total of 56 images over 28 areas (multi-temporal approach : two images from different dates cover the same area) were to be acquired to provide the means to identify poppy fields.

Figure 9: Spectral characteristics of the satellite sensors<sup>3</sup>



As can be deduced from the above figure, agricultural crops and vegetation in general, reflect or absorb light, within specific spectral bands. The use of separate bands gives the possibility to identify land cover types and even discriminate crops by playing on the differences in the specific reflectance curve shape.

The capability of these sensors to discriminate ground features gives the possibility to "classify" or associate a specific combination of band reflectance<sup>4</sup> values to specific land cover classes. In our specific case, opium poppy fields and any other type of land cover that can be associated or surround these (e.g. forest, fallow, bare soil, ploughed land, etc.).

The criterion that has been adopted for the selection of the images is that of having a multi-temporal coverage of the interest area so as to investigate at least two distinct moments in the agricultural cycle of poppy cultivation. Fields are usually ploughed and prepared for seeding between November and December while "lancing"<sup>5</sup> and harvest takes place between late February and March. At the end of March the crop is generally dry and the fields are cleaned up and prepared for summer crops. The availability of any two images within this period helps better identify the opium crop.

The classification process of an image relies on what is defined as "spectral signature of the crop". The use of these "spectral signatures" however, is in most cases, not conclusive, especially given the size of poppy fields (0.1 Ha) and in the particular environmental conditions in the Shan State.

The use of images in two distinct periods of the cycle of opium poppy improves the identification of the crop by introducing "time" and the logical sequence of cultivation events as a further variable for evaluation.

<sup>3</sup> Source: [www.spaceimaging.com/products/Ikonos/spectral.htm](http://www.spaceimaging.com/products/Ikonos/spectral.htm)

<sup>4</sup> Reflectance is the ratio of incident light upon a surface which is "reflected".

<sup>5</sup> Lancing: The process of extracting the opium latex from the incised poppy capsule.

Due to a persistent cloud cover over the area of interest, it was possible to acquire a second IKONOS coverage image for only 18 areas. The sequence of images that was used in the 2003 survey was Landsat7 for the October period and IKONOS for the period ranging from January to mid-February and when available IKONOS from January and IKONOS from February-March. The Landsat-TM7 images, while not replacing the IKONOS, enabled the survey analysts to use a substitute multi-temporal approach.

The IKONOS and the Landsat7 TM sensors, differ from each other in terms of technical characteristics. The data provided by Landsat7 TM has 3 ground spatial resolutions<sup>6</sup>. The highest is the panchromatic band (band 8) at 15 meters. The visible and near-infrared bands (1-5 and 7) all have 30 meter pixel<sup>7</sup> sizes. The satellite flies a polar, sun-synchronous, orbit and covers the same geographic area, on average, every 16 days. The IKONOS collects black and white (panchromatic) images with 1-meter resolution and multi-spectral imagery with 4-meter resolution, covering the same geography every 3 days.

Table 28: Spectral characteristics of the satellite sensors used in the survey

<b>Sensor</b>	<b>Bands</b>	<b>Spectral Range (mm)</b>	<b>Ground Resolution (Pixel size, m*m)</b>	<b>Area Covered (Km*Km)</b>	
<i>Space Imaging <b>IKONOS</b></i>	<i>Panchromatic (Band 5)</i>	<i>0.45 - 0.90</i>	<i>1*1</i>	<i>10*10</i>	
	<i>Multi-spectral (Bands 1-4)</i>	<i>0.45 - 0.52 (Blue) 0.51 - 0.60 (Green) 0.63 - 0.70 (Red) 0.76 – 0.85 (Near-Infrared)</i>	<i>4*4</i>		
<i>Landsat 7 <b>TM7</b></i>	<i>Panchromatic (Band 8)</i>	<i>0.5 – 0.90</i>	<i>15*15</i>	<i>185*185</i>	
	<i>Multi-spectral (Bands 1-4)</i>	<i>0.45 - 0.52 (Blue) 0.52 - 0.60 (Green) 0.63 - 0.69 (Red) 0.76 – 0.90 (Near-Infrared)</i>	<i>29 * 29</i>		
	<i>Near infrared (Bands 5-7)</i>	<i>1.55 – 1.75 2.08 – 2.35</i>			

<sup>6</sup> Spatial resolution is the resolving power of an instrument needed for the discrimination of features and is based on detector size, focal length, and sensor altitude

<sup>7</sup> Pixel: Minimum resolution unit of a satellite image

Figure 10: Example of IKONOS Scene (left) and of the Landsat TM7 Scene (right) of the same area.

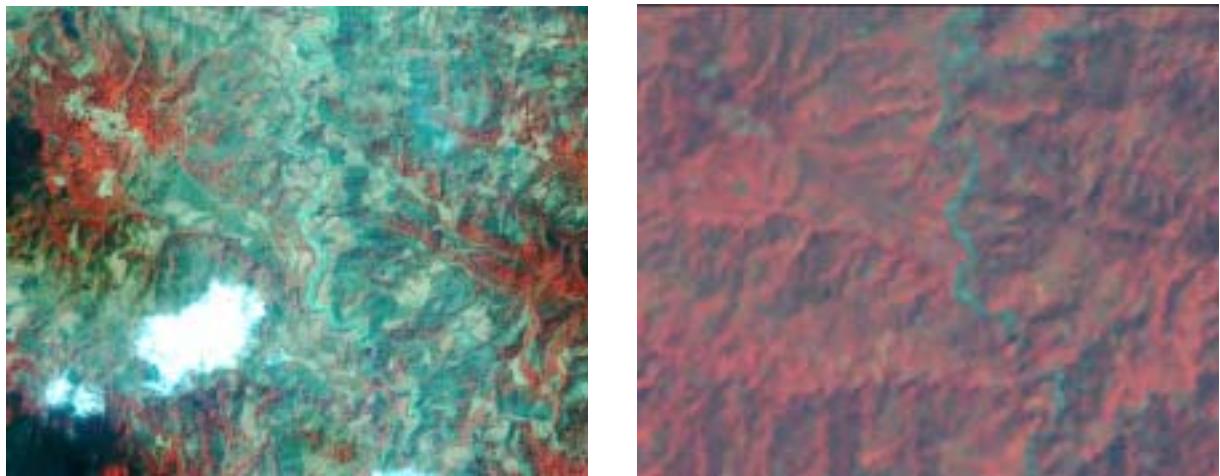
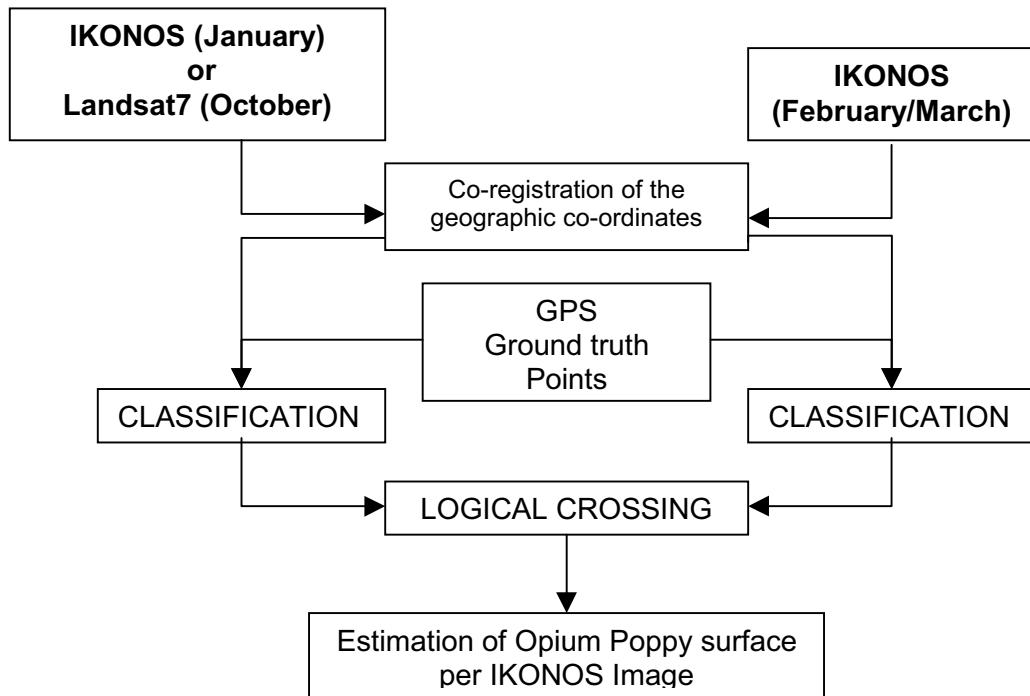


Figure 11: Procedure Flow Chart



The processing of the remote sensing data (both IKONOS/IKONOS and Landsat7/IKONOS combinations) used similar approaches. This procedure is illustrated in the figure above and briefly described here:

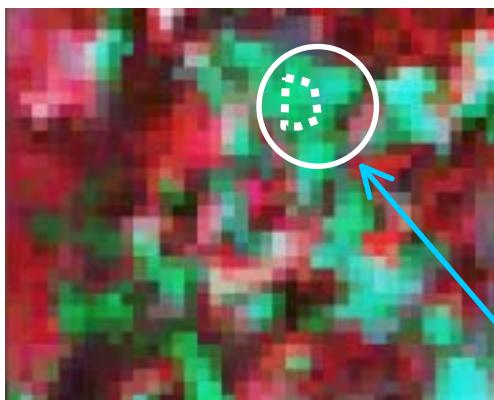
- Images co-registration: As a first step, the IKONOS first date images and second date images or the Landsat7 TM first date images and the IKONOS second date images were co-registered to the same geographic reference grid, in order to have a full and undistorted overlay of the images.
- In the case of the Landsat7/IKONOS approach, creation of "sub-sets" of the Landsat7 TM scene: The portions of the Landsat7 TM scenes corresponding to the areas covered by the IKONOS scenes were cut out (sub-setting) in order to create a multi-temporal pair of the same areas where to perform the supervised classifications.
- Independent supervised classification of the two dates: The IKONOS first date images and IKONOS second date images or the Landsat7 TM first date images and the IKONOS second date images were independently classified. The interpretation was guided by the presence of “ground truth” points collected by surveyors in the course of their ground campaign and associated with GPS measurements (supervised classification).
- Multi-temporal analysis: This step consisted in a series of processing of the classified images. The first date images were overlaid with the classified second date images so as to maintain the information of the originals. In the resulting new image, defined as “Matrix”, the specific combination of classes of the two original images was analysed, pair by pair, in a matrix (hence the definition) to define the re-coding criteria for the new image.

The guiding criteria in interpreting these pairs differed depending on whether the pairs were IKONOS/IKONOS or Landsat7/IKONOS:

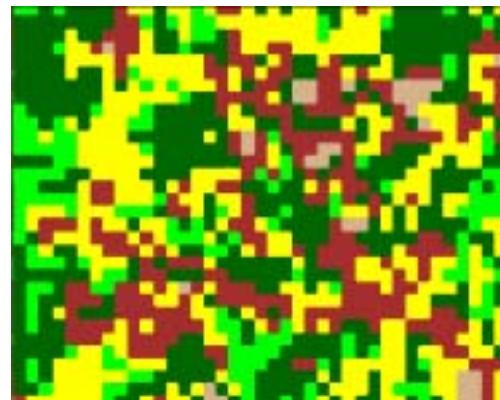
- In the case of IKONOS/IKONOS, the most probable identification of poppy cultivation was provided by the association of vegetation in full bloom over the first images and withering vegetation on the second images.
- In the case of Landsat7/IKONOS pairs, the most probable identification of poppy cultivation was the association of area classified as ploughed in October and then as poppy in February. Any ‘forest’ or ‘fallow’ or ‘grassland’ surface changing to poppy is most probably a error of commission due to spectral confusion and is consequently recoded to either ‘generic agriculture’ or “rangeland”. Similarly any “changing situation” of ‘bare soil’ to ‘fallow’, ‘forest’ or ‘grassland’, clearly defines human activity and consequently is recoded to ‘agriculture’.

Figure 12: Classification process of the same area on Landsat TM7 and IKONOS

Landsat7 TM - 10/10/2002



Classified Landsat7 TM

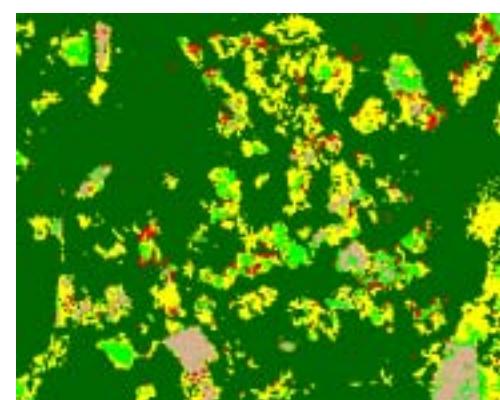


*Location of the “training areas” (dotted polygons) for the spectral signature of Poppy (IKONOS scene) and ploughed land (Landsat7 TM scene)*

IKONOS scene - 25/02/2002

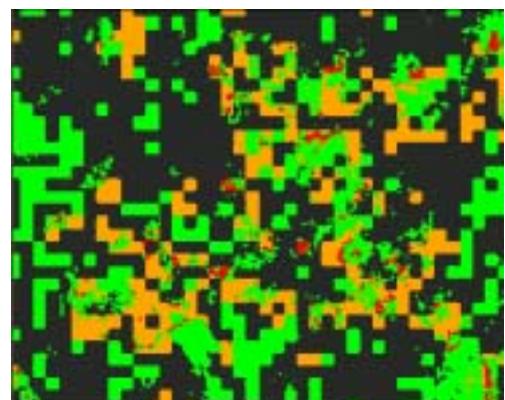


Classified IKONOS scene



#### LEGEND

Potential Opium poppy	
Bare soil	
Forest/Rangeland	
Fallow land/Shifting Agric.	
Ploughed land	
Grassland	
Agriculture/Other crops	
Opium poppy	



### Ground truthing

Data collected during field visits, referred to as ground truthing, enabled calibrating the classification of the multi-spectral images and measuring its accuracy.

Ground-truthing required the acquisition of one-meter resolution pan-chromatic IKONOS images in addition to the multi-spectral image. The pan-chromatic and the multi-spectral images were merged to produce base-maps of one-meter resolution in colour, called pan-sharpened images. These images allowed for a clear identification and delineation of the fields from the ground.

In 2003, segment ground-truthing was implemented over 5 IKONOS images of 100 km<sup>2</sup>. This exercise was scheduled on 8 sub-sets of images of 200 m x 200 m by image, called segments. The locations of these segments were selected randomly and geographically distributed over the images. Some segments could not be visited due to security reason. In total, there were 26 segments.

The surveyors were sent to the field with segment base-maps made from pan-sharpened imagery. They then delineated field boundaries on the base-maps, took photographs, recorded GPS locations of the fields and completed a data record sheet. A sample segment base-map and photograph is presented below.

Segment ground truth information enabled to precisely define all features boundaries and could then be overlaid exactly over the IKONOS multi-spectral images, even though the GPS coordinates and the IKONOS image geo-referencing have a certain margin of approximation.

Figure 13: Example of segment base maps (segment number 4, i.e. S4)

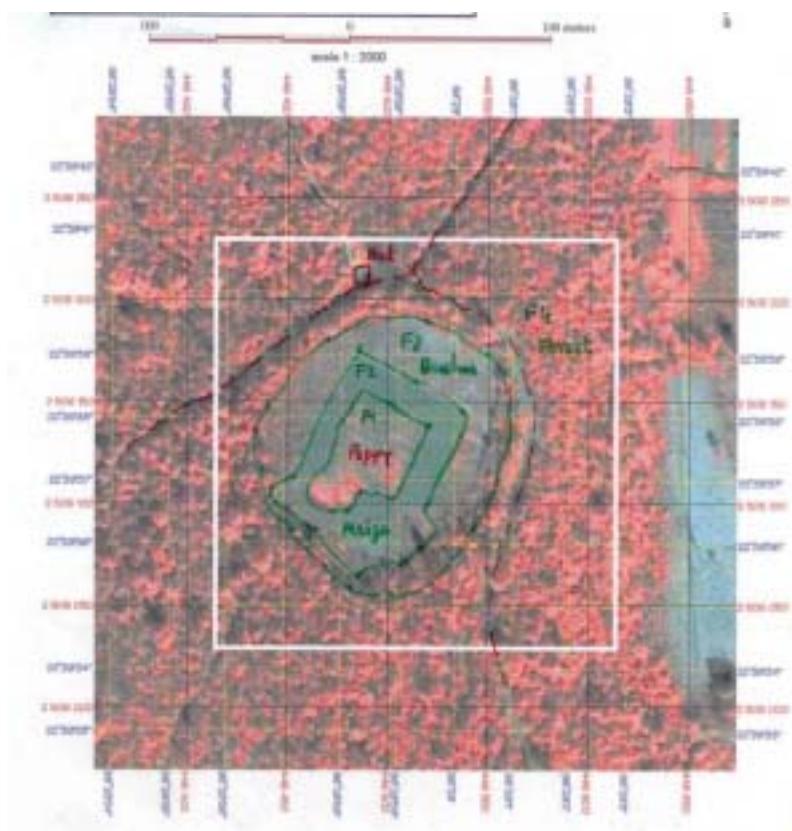


Figure 14: Picture of opium field (F1) on the base map of segment 4 (S4)



### Poppy estimation Procedure

The total potential agricultural land in each township was:

$$N = N_1 + N_2$$

where:

$N_1$  = area of low potential for poppy cultivation in the sampling frame

$N_2$  = area of high potential for poppy cultivation in the sampling frame.

s representing the index for the strata 1 and 2, the same formula could also be noted

$$N = \sum N_s$$

The total potential agricultural land in one sample area covered by IKONOS image is noted:

$$n = \sum n_s$$

where:

$n_s$  = area of potential for poppy cultivation in strata s of one sample area

The poppy area resulting from the classification of one sample area, i.e. one IKONOS block, ( $x$ ) is:

$$x = \sum x_s$$

where:

$x_s$  = opium poppy area resulting from the classification procedure in the strata s of one sample area.

The proportions of opium poppy cultivation over each stratum ( $p_s$ ) within one sample were calculated as follow:

$$p_s = \frac{x_s}{n_s}$$

The extrapolation of opium poppy cultivation to the strata of the sampling frame ( $X_s$ ) derived from the following formula:

$$X_s = p_s * N_s$$

And the total township opium poppy cultivation estimate was given by:

$$X = \sum X_s$$

The standard error of p was obtained as follow:

$$Sp = \sqrt{\frac{1}{N^2} \sum_s N_s (N_s - n_s) \left( \frac{p_s (1 - p_s)}{n_s - 1} \right)}$$

and the approximate 95% confidence interval of the population proportion was given by:

$$95\% CI = (p_s \pm 1.96 Sp_s) * N_s$$

The extrapolations of opium poppy cultivation to the sampling frame were made by township. In the townships where no sample where available, the average proportions of poppy cultivation the sample was used. Based on last year opium poppy cultivation estimates, a distinction was made between high and low risk townships. The values for  $N_s$ ,  $n_s$ ,  $p_s$  and the 95% confidence interval by township are presented in annex.

### Accuracy Assessment

The accuracy assessment was performed over 5 IKONOS images over which segment ground truth information was available. Overall, 26 segments of 200 m x 200m were used.

The following table indicates horizontally for the first row how many hectares classified as poppy were found from the ground truthing to be actually 'poppy' or 'forest' or 'other land use'.

The "Ground" column indicates how many hectares of land were identified as poppy, forest or 'other' land use.

Table 29: Accuracy assessment of opium poppy classification

		Classification			
		Forest	Other	Poppy	Total
Ground	Forest	44.7	18.4	-	63.1
	Other	8.9	23.0	0.0	31.9
	Poppy	0.0	0.0	0.3	0.3
	Total	53.6	41.4	0.3	95.3

The overall classification accuracy, including all three classes, was 71%, whereas the user accuracy for the poppy class was found to be 94% and the producer accuracy for the poppy class was found to be 91%.

### **4.3 Yield Estimation**

Practical field procedures used to collect data (number, and height and diameter of poppy capsules) to estimate opium gum yield are based on the "Guidelines for Yield Assessment of Opium Gum and Coca Leaf from Brief Field Visits"<sup>8</sup> prepared by UNODC. The guidelines provide for practical field procedures and for options to calculate yield from capsule volume using different formulae.

Opium gum yield for Myanmar in 2003 was calculated using a linear correlation between capsule volume per one square metre ( $\text{cm}^3/\text{m}^2$ ) and oven dry gum yield (kg/ha):

$$Y = 1.89 + 0.0412 * VC$$

where:

Y = dry gum weight (kg/ha)

VC = projected mature capsule volume per square metre ( $\text{cm}^3/\text{m}^2$ )

During the 2003 opium survey, 808 fields were randomly selected and surveyed. Yield estimates were calculated at the square metre-plot level, based on the above formula, and at the field level and then national level. Yields at field level are simple averages of the figures for individual square-metre plots (five per field). From the average field yield, the field production was calculated. The sum of the sampled fields production divided by the sum of the sampled fields areas gave the sample national yield.

While it may be convenient to use an existing formula, it should be understood that any correlation formula has to be tested to establish whether it is applicable to the locally obtained data.

<sup>8</sup> ST/NAR/33, United Nations, New York, 2001.

## **5 Annexes**

- Annex 1 Satellite images used for the 2003 Opium Survey
- Annex 2 Calculation for Opium Area Estimates
- Annex 3 Opium Cultivation Area and Production by township
- Annex 4 Opium Survey Results By Administrative Zones for 2002 and 2003

## Annex

Satellite images used for the poppy cultivation estimate

Sensor	Frames	Date of Acquisition			
Landsat 7 TM	130-45	03/04/2002			
	130-46	03/04/2002 & 14/10/2002			
	131-44	02/07/2002			
	131-45	02/07/2002 & 26/02/2003			
	131-46	11/06/2002 & 02/07/2002			
	132-43	02/03/2002 & 10/12/2002			
	132-44	02/03/2002 & 10/12/2002			
	132-45	02/03/2002 & 10/12/2002			
	132-46	02/03/2002			
	133-44	01/09/2002			
	133-45	01/09/2002			
Space Imaging	Code	Frames	Acquis.	1 <sup>st</sup> batch	Acquis.
IKONOS	1	Ka Laung Pa	19/01/2003	4MS+1pc	14/04/2003
	2	Kutkai	29/01/2003	4MS+1pc	24/03/2003
	3	Yaung Lin		4MS	14/04/2003
	4	Tangyan	19/01/2003	4MS+1pc	06/04/2003
	5	Mongyawng	27/01/2003	4MS+1pc	
	6	Kengtung	19/01/2003	4MS+1pc	
	7	Pekhon	30/12/2002	4MS+1pc	24/03/2003
	8	Loilem	30/12/2002	4MS+1pc	24/03/2003
	9	Mongyang (WADP)	29/01/2003	4MS+1pc	
	10	Kunhin	27/01/2003	4MS	14/04/2003
	11	Muse	02/01/2003	4MS	24/03/2003
	12	Mongtung	19/01/2003	4MS	4MS
	13	Tachilek	29/01/2003	4MS	4MS
	14	Mongkhak	29/01/2003	4MS	4MS
	15	Pang Yan	29/01/2003	4MS	14/04/2003
	16	Lashio	27/12/2002	4MS	24/03/2003
	17	Namsan (North)	02/01/2003	4MS	06/04/2003
	18	Konkyan	30/12/2002	4MS	06/04/2003
	20	ManTon	30/12/2002	4MS	
	21	Mongkung	30/12/2002	4MS	06/04/2003
	22	Hsihseng	31/12/2002	4MS	06/04/2003
	23	Mongnai	19/01/2003	4MS	14/04/2003
	24	Langkho	19/01/2003	4MS	14/04/2003
	25	Hsipaw	02/01/2003	4MS	24/03/2003
	26	Kaung Min Hsang	27/12/2003	4MS	14/04/2003
	27	Mongyang (Special Region 4)		4MS	14/04/2003
	28	Namsang (South)		4MS	06/04/2003
	29	Nam Tit	30/12/2002	4MS	

## Annex

## Opium Poppy Cultivation and Production Estimates, 2003

Township	Poppy Area (ha)	Yield (kg/ha)	Production (kg)
<b>Northern Shan State</b>			
Kunlong	896	11 *	9,856
Kutkai	1,433	11 *	15,763
Konkyan	2,864	11 *	31,504
Tangyan	4,318	11 *	47,498
Namkham	119	11 *	1,309
Namhsan (North)	710	11 *	7,810
Nantu	1,755	11 *	19,305
Muse	2,606	11 *	28,666
Lashio	1,030	11 *	11,330
Hsenwi	766	11 *	8,426
Lawkai	1,321	11 *	14,531
Hopang	37	11 *	407
Mabein			
<b>TOTAL</b>	<b>17,855</b>		<b>196,405</b>
<b>Wa Special Region 2</b>			
Nam Tit	1,410	34	47,940
Na Wi	402	17	6,834
Man Tun	560	21	11,760
Kaung Min Hsang	752	16 **	12,032
Saun Pha	874	17	14,858
Hkwin Ma	2,457	19	46,683
Lone Htan	1,563	28	43,764
Yaung Lin	1,314	37	48,618
Ling Haw	663	10	6,630
Ka Laung Pa	588	9	5,292
Ai Chun	1,085	11	11,935
Yin Pan	3,727	9	33,543
Man Man Hsain	639	8	5,112
Naung Khit	260	16 **	4,160
Nam Kham Wu	2,619	7	18,333
Nar Kunm	372	9	3,348
Pang Kham	652	8	5,216
Pang Yan	388	16 **	6,208
Mongyang	938	11	10,318
<b>TOTAL</b>	<b>21,263</b>		<b>342,584</b>
<b>Central Shan</b>			
Kunhin	260	11 **	2,860
Kehsi	167	11 **	1,837
Namsang (south)	310	13	4,030
Mongmit	21	11 **	231
Mongkung	1,077	11 **	11,847
Monghsu	168	11 **	1,848
Mongyai	751	11 **	8,261
Lawksawk	489	11 **	5,379
Laikha	164	14	2,296
Loilem	230	5	1,150
Hsipaw	346	8	2,768
Hopong	843	12	10,116
ManTon	651	11 **	7,161
Kyaukme			
Nawnghkio			
<b>TOTAL</b>	<b>5,477</b>		<b>59,784</b>

## Annex

## Opium Poppy Cultivation and Production Estimates, 2003

Township	Poppy Area (ha)	Yield (kg/ha)	Production (kg)
<b>Southwestern Shan</b>			
Hsihseng	419	10	4,190
Yawnghwe	26	14 **	364
Pinlaung	2,353	14 **	32,942
Pekhon	1,302	14 **	18,228
Mongnai	629	9	5,661
Mongpan	1,392	17	23,664
Mawkmai	380	23	8,740
Langkho	248	5	1,240
Kalaw			
Taunggyi			
Pindaya			
Ywangan			
<b>TOTAL</b>	<b>6,749</b>		<b>95,029</b>
<b>Southeastern Shan</b>			
Kengtung	1,309	10	13,090
Tachilek	233	8 **	1,864
Mongkhak	214	10	2,140
Monghsat	738	4	2,952
Mongtung	324	4	1,296
Mongping	1,551	8 **	12,408
Mongphak	536	8 **	4,288
Mongyawng	166	8 **	1,328
Mant Man	740	9	6,660
<b>TOTAL</b>	<b>5,811</b>		<b>46,026</b>
<b>Rounded total Shan State</b>	<b>57,200</b>		<b>740,000</b>
<b>Outside Shan State (8%, rounded)</b>	<b>5,000</b>	<b>13</b>	<b>65,000</b>
<b>National Rounded Total</b>	<b>62,200</b>		<b>810,000</b>

\* average yield of central Shan

\*\* average regional yield

Annex

Calculation of opium poppy cultivation area

	Group	ID	N1	N2	x1	x2	n1	n2	p1	p2	X1	X2	X	CI lower value	CI upper value
		bloc ID	Low potential area of sampling frame	High potential area of sampling frame	Poppy in low potential area of sample	Poppy in high potential area of sample	Low potential area in sample	High potential area in sample	% poppy low potential area in sample	% poppy high potential area in sample	Total poppy low potential area of sampling frame	Total poppy high potential area of sampling frame	Total poppy in sampling frame	Confidence interval	
			km2	km2	ha	ha	ha	ha	%	%	ha	ha	ha	ha	ha
<b>Northern Shan State</b>															
Kunlong	1		30	173					2%	5%	58	838	896	785	1,002
Kutkai	2	2	215	104		141		2,408	4%	6%	822	611	1,433	1,165	1,603
Konkyan	2	18	70	188	-	351	-	2,542	4%	14%	268	2,596	2,864	2,535	3,130
Tangyan	2	4	637	299		111		1,763	4%	6%	2,434	1,884	4,318	3,267	4,899
Namkham	1		-	25					2%	5%	-	119	119	106	133
Namhsan (North)	1	17	110	103		187		3,851	2%	5%	212	498	710	594	809
Namtu	1		155	300					2%	5%	298	1,458	1,755	1,506	1,979
Muse	2	11	15	160	33	155	876	978	4%	16%	59	2,547	2,606	2,208	2,983
Lashio	1	16	427	43	88		4,560		2%	5%	820	210	1,030	842	1,218
Hsenwi	1		71	130					2%	5%	137	629	766	656	864
Lawkai	2		100	95					4%	10%	383	937	1,321	1,214	1,411
Hopang	1		14	2					2%	5%	27	10	37	24	51
Mabein	p.f.														
<b>TOTAL</b>			<b>1,846</b>	<b>1,622</b>	<b>121</b>	<b>946</b>	<b>5,437</b>	<b>11,543</b>					<b>17,855</b>	<b>14,901</b>	<b>20,082</b>
Regional p value for group 2															
Regional p value for group 1															
									Group 2	4%	10%				
									Group 1	2%	5%				

\* See map "Frames of Landsat TM7 and IKONOS images"

Myanmar opium survey 2003

Annex

Calculation of opium poppy cultivation area

	Group	ID	N1	N2	x1	x2	n1	n2	p1	p2	X1	X2	X	CI lower value	CI upper value
		bloc ID	Low potential area of sampling frame	High potential area of sampling frame	Poppy in low potential area of sample	Poppy in high potential area of sample	Low potential area in sample	High potential area in sample	% poppy low potential area in sample	% poppy high potential area in sample	Total poppy low potential area of sampling frame	Total poppy high potential area of sampling frame	Total poppy in sampling frame	Confidence interval	
			km2	km2	ha	ha	ha	ha	%	%	ha	ha	ha	ha	ha
<b>Wa Special Region 2</b>															
Nam Tit	1	29	11	147		230		2,397		10%	-	1,410	1,410	1,245	1575
Na Wi	1		-	41						10%	-	402	402	355	448
Man Tun	1		-	57						10%	-	560	560	495	624
Kaung Min Hsan	1	26	-	122		71		1,146		6%	-	752	752	583	921
Saun Pha	1		-	90						10%	-	874	874	774	975
Hkwin Ma	2		-	100						25%	-	2,457	2,457	1,821	3092
Lone Htan	2		-	64						25%	-	1,563	1,563	1,159	1968
Yaung Lin	2	3	-	53		45		183		25%	-	1,314	1,314	974	1654
Ling Haw	1		-	68						10%	-	663	663	587	740
Ka Laung Pa	1	1	-	80		105		1,430		7%	-	588	588	403	773
Ai Chun	1		-	111						10%	-	1,085	1,085	960	1210
Yin Pan	2		-	152						25%	-	3,727	3,727	2,763	4692
Man Man Hsain	1	1	-	73		36		414		9%	-	639	639	554	725
Naung Khit	1		-	27						10%	-	260	260	230	290
Nam Kham Wu	2		1	106						25%	-	2,619	2,619	1,941	3296
Nar Kunm	1		-	38						10%	-	372	372	330	415
Pang Kham	1		17	67						10%	-	652	652	577	727
Pang Yan	1	15	0	52		37		500		7%	-	388	388	267	509
Mongyang	1	9	-	76	60	452	1,260	3,663	5%	12%		938	938	763	1,028
<b>TOTAL</b>			<b>29</b>	<b>1,525</b>	<b>60</b>	<b>976</b>	<b>1,260</b>	<b>9,733</b>			<b>-</b>	<b>21,264</b>	<b>21,264</b>	<b>16,781</b>	<b>25,661</b>
<b>Regional p value for group 2</b>															
<b>Regional p value for group 1</b>															

Annex

Calculation of opium poppy cultivation area

	Group	ID	N1	N2	x1	x2	n1	n2	p1	p2	X1	X2	X	CI lower value	CI upper value
	bloc ID	Low potential area of sampling frame	High potential area of sampling frame	Poppy in low potential area of sample	Poppy in high potential area of sample	Low potential area in sample	High potential area in sample	% poppy low potential area in sample	% poppy high potential area in sample	Total poppy low potential area of sampling frame	Total poppy high potential area of sampling frame	Total poppy in sampling frame	Confidence interval		
		km2	km2	ha	ha	ha	ha	%	%	ha	ha	ha	ha	ha	
<b>Southwestern Shan State</b>															
Hsihseng	1	22	239	5	130		7,946		2%	5%	391	28	419	354	484
Yawnghwe	1		11	2					2%	5%	18	8	26	21	31
Pinlaung	2		274	32					6%	22%	1,627	726	2,353	1,835	2,872
Pekhon	2	7	-	58		249		1,108	6%	22%	-	1,302	1,302	1,171	1,433
Mongnai	2	23	97	2	43		722		6%	22%	575	54	629	460	799
Mongpan	2		-	62					6%	22%	-	1,392	1,392	1,252	1,531
Mawkmai	2		54	3					6%	22%	319	62	380	284	477
Langkho	1	24	-	49		29		577	2%	5%	-	248	248	163	332
Kalaw	p.f.		186	32											
Taunggyi	p.f.		43	15											
Pindaya	p.f.		16	-											
Ywangan	p.f.		-	-											
<b>TOTAL</b>			<b>674</b>	<b>214</b>	<b>173</b>	<b>278</b>	<b>8,668</b>	<b>1,685</b>			<b>2,929</b>	<b>3,819</b>	<b>6,749</b>	<b>5,538</b>	<b>7,959</b>
<b>Regional p value for group 2</b>															
<b>Regional p value for group 1</b>															
<b>Central Shan State</b>															
Kunhin	1	10	117	33	87		4,648		2%	1%	220	39	260	177	314
Kehsi	1		135	2					1%	1%	165	2	167	91	210
Namsang (south)	2	28	122	24					1%	7%	149	161	310	229	361
Mongmit	1		3	15					1%	1%	3	18	21	11	31
Mongkung	2	21	305	107		282		4,607	1%	7%	371	706	1,077	850	1,230
Monghsu	2		25	21					1%	7%	30	138	168	143	187
Mongyai	2		89	97					1%	7%	109	642	751	649	832
Lawksawk	2		194	38					1%	7%	236	253	489	362	570
Laikha	2		42	17					1%	7%	51	113	164	132	186
Loilem	1	8	21	172		17		1,437	1%	1%	26	204	230	124	331
Hsipaw	1	25	239	46	49		6,555		1%	1%	291	55	346	190	426
Hopong	2		119	106					1%	7%	145	698	843	720	928
ManTon	2	20	30	79		149		1,909	1%	8%	37	614	651	534	742
Nawngkhio	p.f.		21	-											
Kyaukme	p.f.		310	248											
<b>TOTAL</b>			<b>1,441</b>	<b>758</b>	<b>136</b>	<b>448</b>	<b>11,203</b>	<b>7,953</b>			<b>1,832</b>	<b>3,643</b>	<b>5,476</b>	<b>4,212</b>	<b>6,347</b>
<b>Regional p value for group 2</b>															
<b>Regional p value for group 1</b>															

\* See map "Frames of Landsat TM7 and IKONOS images"

Myanmar opium survey 2003

## Annex

## Calculation of opium poppy cultivation area

	Group	ID	N1	N2	x1	x2	n1	n2	p1	p2	X1	X2	X	CI lower value	CI upper value
		bloc ID	Low potential area of sampling frame	High potential area of sampling frame	Poppy in low potential area of sample	Poppy in high potential area of sample	Low potential area in sample	High potential area in sample	% poppy low potential area in sample	% poppy high potential area in sample	Total poppy low potential area of sampling frame	Total poppy high potential area of sampling frame	Total poppy in sampling frame	Confidence interval	
			km2	km2	ha	ha	ha	ha	%	%	ha	ha	ha	ha	ha
<b>Southeastern Shan State</b>															
Kengtung	2	6	101	88	29	159	665	1,607	4%	10%	445	864	1,309	1,047	1,596
Tachilek	1	13	37	82		76		3,818	2%	2%	69	164	233	193	318
Mongkhak	1	14	37	29	19	31	1,017	619	2%	5%	69	145	214	111	286
Monghsat	2		43	55					4%	10%	191	548	738	604	880
Mongtung	1	12	22	83		168		4,900	2%	3%	40	284	324	289	367
Mongping	2		37	141					4%	10%	162	1,389	1,551	1,310	1,798
Mongphak	2		34	39					4%	10%	151	385	536	437	642
Mongyawng	2		6	14					4%	10%	26	140	166	137	193
Mant Man	2			75					4%	10%	-	740	740		
<b>TOTAL</b>			<b>318</b>	<b>606</b>	<b>48</b>	<b>434</b>	<b>1,681</b>	<b>10,944</b>					<b>5,810</b>	<b>4,127</b>	<b>6,080</b>
Regional p value for group 2															
Regional p value for group 1															
<b>GRAND TOTAL</b>			<b>4,308</b>	<b>4,725</b>	<b>538</b>	<b>3,081</b>	<b>28,249</b>	<b>41,858</b>					<b>57,153</b>	<b>45,560</b>	<b>66,129</b>

\* See map "Frames of Landsat TM7 and IKONOS images"

Myanmar opium survey 2003

## **Annex**

### **Opium Survey Results By Administrative Zones for 2002 and 2003**

For internal administrative purposes, the results of the survey are presented below using a different administrative breakdown. The townships of the Shan State are grouped into four regions instead of the five used in the implementation of the 2003 survey (see map next page).

Table 1: Opium Poppy Cultivation in 2002 and 2003 by Administrative Zones (in hectares)

<b>Administrative Zones</b>	<b>2002</b>	<b>2003</b>	<b>% change</b>
Eastern	7,843	5,811	-26%
Northern	37,500	20,664	-45%
Southern	11,630	9,380	-19%
Wa	17,583	21,300	21%
Total Shan State (rounded)	74,600	57,200	-23%
Other State (rounded)	6,800	5,000	-26%
National Total (rounded)	81,400	62,200	-24%

Table 2: Opium Production in 2002 and 2003 by Administrative Zones (in metric tons)

<b>Administrative Zones</b>	<b>2002</b>	<b>2003</b>	<b>% change</b>
Eastern	95	46	-52%
Northern	395	226	-43%
Southern	103	125	21%
Wa	167	343	105%
Total Shan State (rounded)	760	740	-3%
Other State (rounded)	70	65	-7%
National Total (rounded)	830	810	-2%

# Shan State - Administrative Regions



Note: Administrative borders are approximate and only used for opium survey purposes

0 50 100 Kilometers

Sources CCDAC - UNODC/ICMP  
Myanmar Opium Survey 2003

- [Teal Box] Northern Shan State
- [Light Teal Box] Eastern Shan Shan
- [Lavender Box] Southern Shan State
- [Orange Box] Wa Special Region
- [Blue Box] WADP project area



