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Myanmar Opium Survey 2021

Cultivation, Production, and Implications

UNODC Research

In Southeast Asia, UNODC supports Member States to develop and implement evidence-based rule of law, drug control and related criminal justice responses through the Regional Programme and aligned country programmes. This study is connected to the Mekong MOU on Drug Control which UNODC actively supports through the Regional Programme, including the commitment to develop data and evidence as the basis for countries of the Mekong region to respond to challenges of drug production, trafficking and use. UNODC's Research and Trend Analysis Branch promotes and supports the development and implementation of surveys globally, including through its Illicit Crop Monitoring Programme (ICMP).

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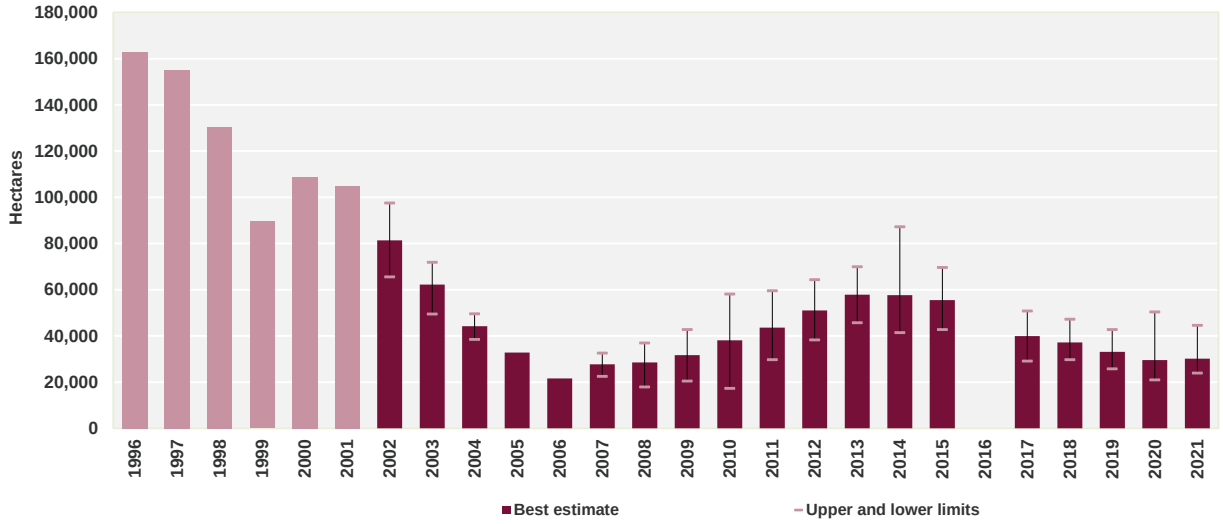
Key Findings

- In 2021, the area under opium poppy cultivation in Myanmar was estimated at 30,200 (23,900 to 44,600) hectares. In comparison to 2020, the area under opium cultivation has slightly increased by 2%, about 650 hectares. This points to a substantial stability, breaking the downward trend that had started in 2014.



- Higher increases were witnessed in Kachin and East Shan (17% and 12%, respectively), while significant reductions were observed in North Shan (-17%, compared to 2020), Kayah and Chin (-21% and -10% respectively, compared to 2018 levels). With a rise of 4%, poppy cultivation in South Shan can be considered stable.
- The average opium yield in 2021 was estimated at 14 kilograms per hectare.[1]
- Potential opium production was estimated at 423 metric tons in 2021. Shan State, supplying more than the 80% of the total, remained the main producing region with 341 tons.
- CCDAC reports indicate that eradication, for the first time since 2015, showed an increase of 129%, with 4,633 ha in 2021. Reported seizures of opium amounted to 2,110kg of raw opium and 2,003kg of heroin of unknown purity during the first ten months of 2021.
- With an estimated gross value ranging from US$ 0.5 to 1 billion, the illegal opiate market in Myanmar represented 0.6 – 1.4% of the 2020 GDP.
- Farmers cultivating opium earned some US$ 56 - 100 million in 2021, which is between 9 - 12% of the overall value of the opiate economy.
- The largest share of the 2021 opiate market value was generated by heroin consumption, manufacturing and trafficking. Domestic heroin consumption (6 tons of heroin) was valued between US$ 110 and 240 million, whereas exports of heroin (17 - 46 tons) were worth between US$ 310 and 820 million. Domestic opium consumption and exports accounted for a smaller share of the market value, US$ 13 million and US$ 32 million respectively.[2]

1 Average regional opium yields weighted by cultivation, based on yield data from Shan and Kachin States only.

2 The Southeast Asia region is almost exclusively supplied by heroin produced in Myanmar, and only marginal quantities of heroin originating in Afghanistan have been trafficked into the regional heroin market in recent years. Source: *Transnational Organized Crime in Southeast Asia: Evolution, Growth and Impact 2019* (TOCTA-EAP), (UNODC, 2019).

Fact Sheet

	Year 2020 (rounded numbers)	Year 2021 (rounded numbers)	Change 2020-2021
Total opium poppy cultivation (ha) [3]	29,500 (21,000 to 50,400)	30,200 (23,900 to 44,600)	2%
Opium poppy cultivation in Shan State (ha)	24,700 (16,400 to 36,600)	24,900 (18,900 to 32,500)	1%
Opium poppy cultivation in Kachin State (ha)	3,600 (1,800 to 8,800)	4,200 (2,400 to 9,000)	17%
Opium poppy cultivation in Chin State (ha)	630* (573 to 677)	560 (516 to 610)	-10%*
Opium poppy cultivation in Kayah State (ha)	570* (434 to 706)	450 (437 to 465)	-21%*
Total potential production of dry opium (metric tons) [4]	405 (289 to 685)	423 (334 to 626)	4%
Potential dry opium production in Shan State (mt)	331 (219 to 598)	341 (219 to 598)	3%
Potential dry opium production in Kachin State (mt)	58 (28 to 141)	68 (38 to 145)	17%
Potential dry opium production in Chin State (mt)	8.6 (4.9 to 17.5)	7.9 (7.0 to 8.8)	-8%*
Potential dry opium production in Kayah State (mt)	7.8 (4.0 to 16.1)	6.3 (5.8 to 6.8)	-19%*
Average opium yield (kg/ha) [5]	13.7 (12.7 to 14.8)	14.0 (13.1 to 15.0)	2%
Farm-gate price of fresh opium [6]	131 US$/kg (174,311 Kyat/kg)	153 US$/kg (219,000 Kyat/kg)	17% [7]
Farm-gate price of dry opium	144 US$/kg (190,620 Kyat/kg)	166 US$/kg (238,000 Kyat/kg)	15%[7]
Farm-gate value of opium in million US$	42 - 98	56 - 100	Stable
Value of the opiate economy (gross) in million US$	502 - 1,579	460 - 1,100	Stable
Value of the opiates economy (after the farm-gate) in million US$	444 - 1,481	410 - 1,000	Stable
Reported opium poppy eradication (ha)	2,460	4,633	129%

Numbers in the table are rounded, percentage changes are calculated with exact estimates.
*The data on area of opium poppy cultivation in Chin and Kayah reported for the year 2020 were collected in the year 2018, since they were the latest available before the 2021 Myanmar Opium Survey. The % of change for Chin and Kachin refers to the period 2018-2021.

3 The estimates may include areas eradicated after the acquisition date of the satellite images.
4 In 2021, due to mobility restrictions related to the COVID-19 pandemic, a yield survey was carried out only in East and South Shan with a reduced number of fields compared to previous years. To avoid a bias due to the small sample size, the multi-year average of all available yield data from 2014 onwards was used for each Shan State region, as in the 2020 Myanmar Opium Survey. For Kachin State, the 2020 yield estimate was used in absence of updated data for 2021. For Chin and Kayah States the national average yield was applied (see methodology chapter for further details).
5 Average opium yield of Shan and Kachin States weighted by cultivation. Due to using a multi-year average of yields for Shan State, percentage changes are indicative only.
6 National average weighted by regional production estimates. For 2021, the applied exchange rate MMK/US$ is the 2020 DCE alternative conversion factor provided by the World Bank (https://data.worldbank.org/indicator/PA.NUS.ATLS?locations=MM).
7 Changes have been calculated based on US$ prices, without adjusting for inflation. Due to changes in the exchange rate, the increase is larger in Kyat, with 26% and 25% for fresh and dry opium, respectively.

1. INTRODUCTION

1. Introduction

This report presents the results of the nineteenth Myanmar opium survey. Examining the 2020/2021 opium growing season, it reflects data collected between November 2020 and January 2021 (end of winter harvest). As the first cultivation season following the start of the COVID-19 pandemic, it helps to understand the possible impact of the pandemic on Myanmar's opium economy. However, it does not reflect the social, economic, security and governance disruptions that followed 1 February 2021.

Using a mix of local and global expertise of the UNODC's Illicit Crop Monitoring Programme (ICMP), the methodology used in this report combines the use of extensive satellite imagery and field verification, and yield surveys to evaluate the extent of opium poppy cultivation and production. 84 sample locations and three target areas in Shan and Kachin States, as well as, for the first time since 2018, cultivation sites in Kayah and Chin were surveyed with satellite imagery to understand the area under cultivation.[8] Specific focus was also given to Kachin, where cultivation patterns in recent years did not follow the overall downwards trend. A socio-economic survey of key cultivation areas in Kachin will be released later in the year.

In-line with past practice, the present survey compares cultivation levels to the preceding years, allowing for an observation of long-term trends. While there had been a sustained period of six years of year-on-year decline, the 2021 survey is the first one since 2014 to indicate a slight increase or levelling off in the area under cultivation. In the 2020/2021 season, the overall area of cultivation has been estimated at 30,200 hectares (ha), an increase of 2% over the 29,500 ha recorded in 2020. Although this increase is modest, and the area of cultivation falls short of the 57,600 ha recorded in 2014, it does suggest that the downwards trend observed since then has at least come to a halt. While Shan continues to be the most important area of cultivation by far, the combined areas of North, South and East Shan only show a minor increase of 1% as compared to an increase of 17% in Kachin.

8 Chin and Kayah States had last been included in the 2018 survey. Past surveys had utilized the 2018 estimates to calculate the total opium poppy cultivation area in order to maintain comparability with the earlier surveys. The current survey results should also be compared to the 2018 estimates for these two States.

Similarly, with 423 metric tons, the estimated overall amount of opium produced in 2021 shows an increase of 4% compared to 2020 when production levels were estimated at 405 tons. As with the cultivation area, the estimated production volume is far below – at less than half – the 879 tons estimated in 2013. However, it is a notable deviation from the downwards trend observed during past years, including the 2019 to 2020 year on year comparison when estimated production decreased by 20%.

As in previous years, Shan remained the most extensive cultivation area in 2020-2021, with 24,900 ha or 83% of the total area under cultivation, followed by Kachin covering 14% of the total area. While there are no figures for Chin and Kayah for 2019 and 2020, and hence no year-on-year comparison in 2021, a comparison of the 2021 results to 2018 shows a change comparable to the overall cultivation area over the same period. Furthermore, it is important to note that both Chin and Kayah continue to represent a relatively minor part of the area under cultivation, together making up around 3% (compared to 4% when last measured in 2018). This suggests that so far cultivation in both states has remained stable at low levels, although it will be important to continue monitoring and aim for a better understanding of potential cultivation in other areas such as Sagaing.

The slight increase in cultivation coincides with a significant increase in farm-gate prices of both fresh and dry opium, by 17% and 15% respectively, a first since 2016 and a break in the broader trend which had seen prices fall significantly over the past decades. While these are based on limited datasets – due to movement restrictions, only a reduced sample of priced data could be collected – and as such have to be interpreted with caution, the increase observed in conjunction with the slight expansion cultivation area may suggest a revitalization of the opium economy. While this is noteworthy in itself, it is critical to consider this development in the context of three broader trends:

First and foremost, the 2020-2021 harvest season coincided with a period of significant economic difficulty following the onset of the COVID-19 pandemic. Opium cultivation in Myanmar is closely linked to multi-dimensional poverty in rural

households and opium poppy cultivating villages face a significant development gap when compared to non-poppy villages.[9] The already dire livelihood situation in these rural areas likely worsened with the overall economic downturn observed during the first year of the pandemic.[10] Facing a more challenging economic situation and increased uncertainty in economic prospects some farmers may have abstained from further reducing opium cultivation, and others may have been motivated to take it up again, contributing to the halt in the downward trend of cultivation.

While it is too early for a more long-term assessment, this does not bode well for the 2021-2022 cultivation season which follows even greater economic disruption, including severe limitations on the formal economy and cash availability.[11] Targeted direct support to farming communities and their economic livelihoods will be critical to counter these developments, supporting farmers to maintain food security and basic livelihoods, and strengthening licit economic dynamics a key factor contributing to a sustainable shift away from opium cultivation.

Second, several countries in Southeast Asia have reported significant heroin seizures in 2021, exceeding volumes seen in previous years.[12] There are several possible factors contributing to this, including but not limited to increased interception rates, potential increases of opium production in Lao PDR (which has not been covered by a survey since 2015), or possible increased efficiency in heroin manufacturing or changes in purity. Either way, these developments need to be closely monitored, including renewed attention to monitoring opium cultivation in the region.

Third, it is important to note that the massive surge in synthetic drug production of recent years, which has coincided with the downwards trend in opium cultivation since 2014, has shown no sign of weakening. To the contrary, the trend has accelerated in the last few years with reported seizures reaching record levels year after year. While increased seizures do not necessarily equate to increased production, the volume and changes in the geographic pattern of seizures, combined with falling prices and stable or increasing purities of drugs available in consumer markets, point clearly towards an increased sophistication in production, trafficking and availability of synthetic drugs, especially methamphetamine. Combined with the slowdown and potential reversal of the downwards trend in opium cultivation, East and Southeast Asia – fanning out from the upper Mekong across ASEAN, to Australia and New Zealand, Japan and the Republic of Korea, as well as India and Bangladesh – is set to continue to face an expansion in illicit drug supply.

Only a fraction of the proceeds from the trade in illicit drugs is generated within Myanmar – this report estimates the local opium economy at around US$ 460 million to US$ 1.1 billion, while 2019 estimates put the regional market for heroin at US$ 8.7 to US$ 10.3 billion – but they are closely linked to insecurity and conflict in the country.

In general - whether plant-based or synthetic - there has long been a connection between drugs and conflict in Myanmar, with the drug economy fuelling conflict, and conversely conflict reinforcing the country's drug economy. An increasing trend in drug production and traffic would further accelerate and reinforce this logic, particularly in light of the current environment of increased insecurity and the absence of the rule of law.

It will therefore be critical to continue monitoring developments in the country's drug economy. The annual opium survey report is an essential tool for assessing the extent of opium poppy cultivation in Myanmar, as well as understanding changes in cultivation and production patterns and the links between illicit drugs, security, the rural economy, the livelihoods of farmers and their communities, and the regional and international illicit drug markets.

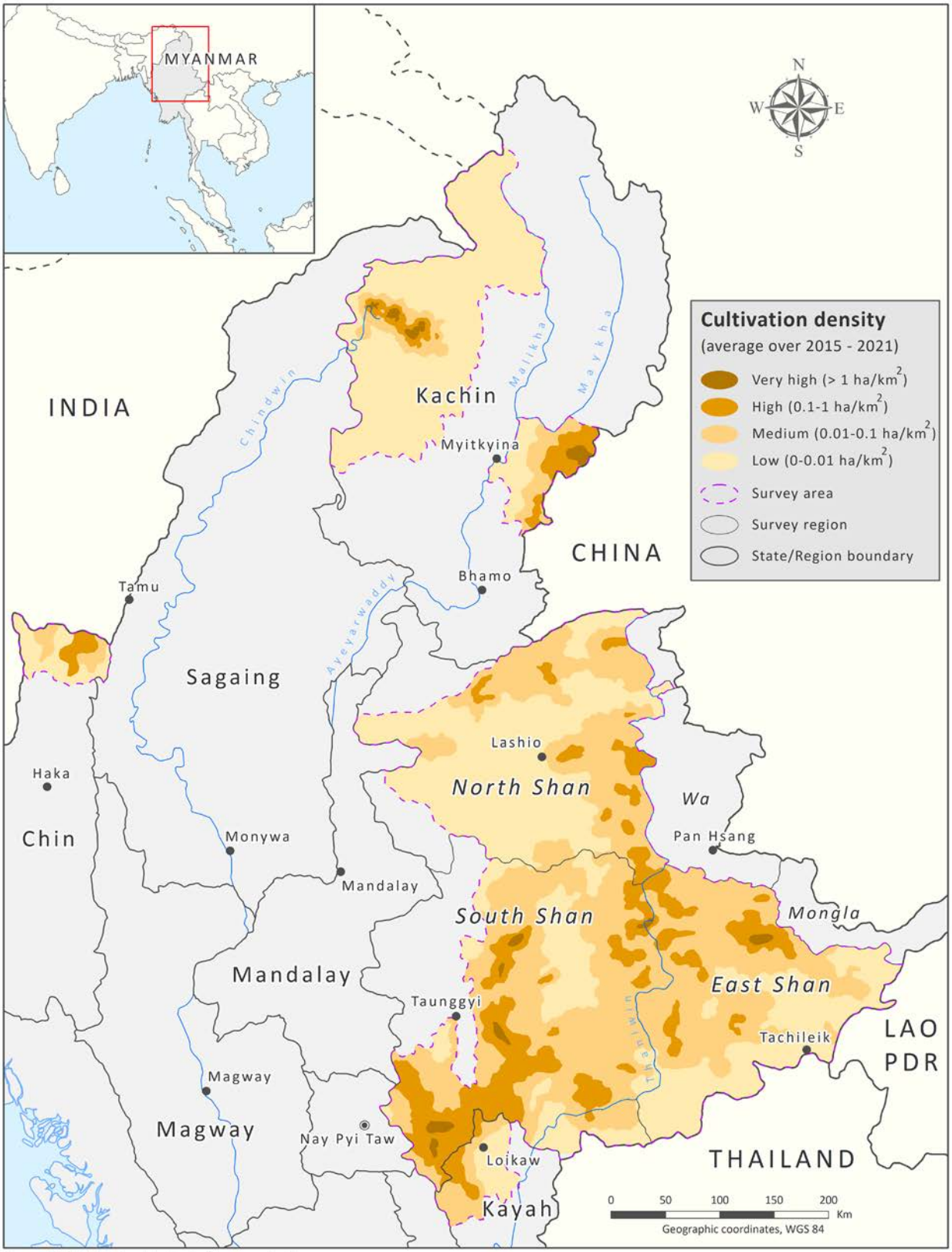
9 See for example UNODC, Opium poppy cultivation and sustainable development in Shan State, Myanmar 2019.

10 The World Bank, Myanmar Economic Monitor: Coping with COVID-19, December 2020

11 The World Bank, Myanmar Economic Monitor: Contending with Constraints – Special focus: Digital Disruptions and Economic Impacts, January 2022

12 During the first nine months of 2021, Thailand authorities seized 3.2 tons of heroin, double the amount seized in the preceding year. Myanmar also reported the record amount of heroin seizures in 2021 with 2.5 tons, marking nearly a 40 per cent increase compared to 2020.

Map 1: Opium poppy cultivation density in Myanmar (average over the period 2015-2021 in ha/km²)



Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

2. FINDINGS

2. Findings

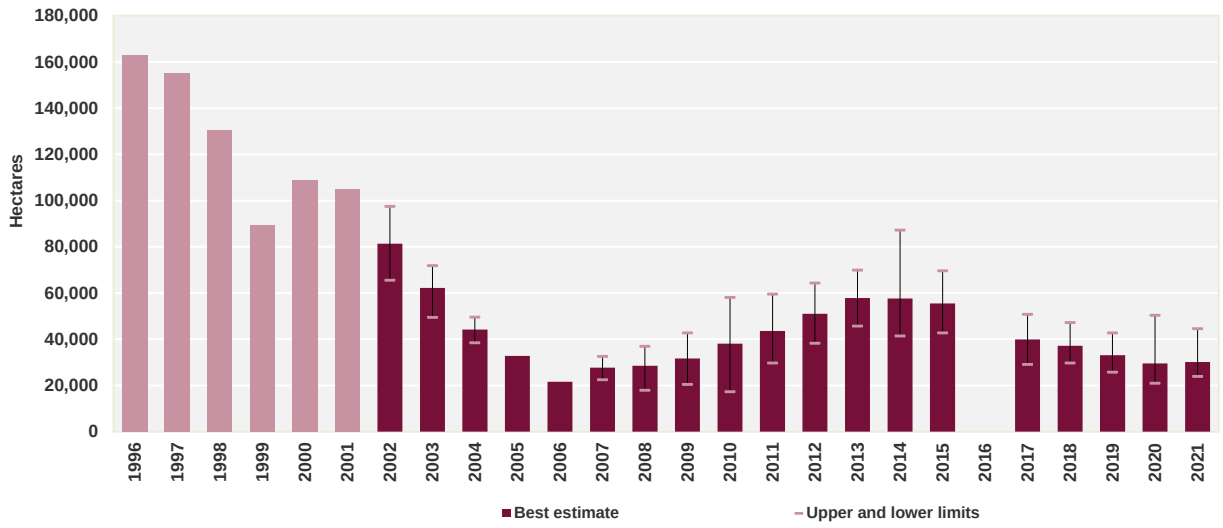
2.1 Estimated area under opium poppy cultivation

In 2021, the area under opium poppy cultivation in Myanmar was estimated at 30,200 (23,900 to 44,600) ha. This represents a minor increase in cultivation of 2% from its 2020 level, 29,500 ha. The national trend seems to stabilize after a continuous reduction started in 2014, when area under cultivation was estimated at 57,600 ha (Figure 1). The 2021 survey covered Shan, Kachin, Chin and Kayah states, which are believed to be the opium poppy growing regions in Myanmar.

At subnational level, the poppy cultivation trends were inhomogeneous. Compared to 2020, cultivation in Shan state was stable, with only 1% increase (235 ha). However, a significant decrease was observed in North Shan (-17%), compensated by increases in South (4%) and East (9%) Shan regions. In Kachin State, cultivation raised by 17% (almost 600 ha), with a peak of increase in Tanai region (34%). Reductions were observed in both Chin (-10%) and Kayah (-21%) states, compared to the levels assessed in 2018 (the latest available data for Chin and Kayah prior to this survey).

Shan continued to be the major cultivating state in Myanmar, accounting for more than the 80% (25,000 ha) of the overall opium poppy area (Table 1). The trend in Shan State has been declining since 2015 when the total cultivation area was estimated at 50,300 ha (Map 3). Within Shan State, the sub-regions of South, North and East Shan accounted for 38%, 18% and 27% of total cultivation in 2021, respectively. Kachin State accounted for 14% (4,200 ha), and Chin and Kayah States together for 3% (1,100 ha). (Figure 2)

Figure 1: Opium poppy cultivation in Myanmar, 1996-2020 (ha)



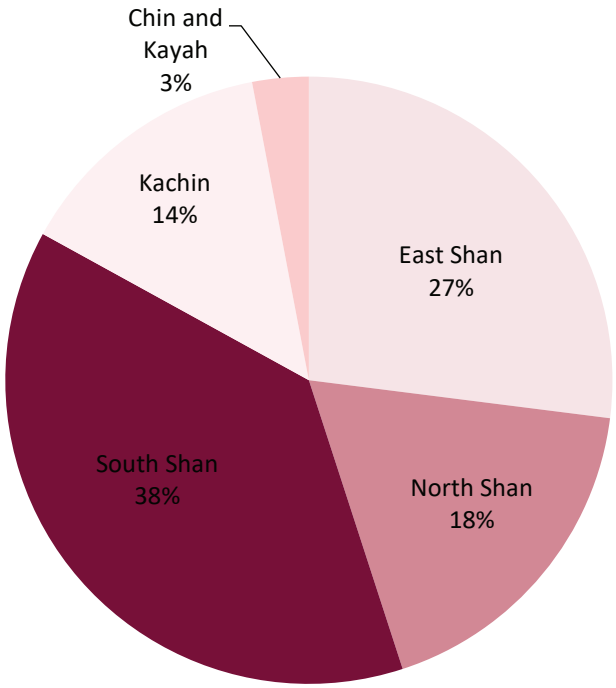
Sources: from 1996 to 2001 USG, from 2002 to 2021 UNODC. The surveys in 2014, 2015, 2018 and 2021 include cultivation estimates for Kayah and Chin States. In 2016 no area survey was conducted. The surveys in 2019 and 2020 used latest available estimates (2018) for Kayah and Chin States.

Table 1: Areas under opium poppy cultivation in Myanmar (ha), in 2020 and 2021

Region	Year 2020 (rounded numbers)	Year 2021 (rounded numbers)	Change 2020-2021
South Shan	10,900 (4,300 to 29,300)	11,300 (7,100 to 22,100)	4%
East Shan	7,300 (4,000 to 12,600)	8,200 (5,000 to 14,600)	12%
North Shan	6,500 (2,600 to 12,900)	5,400 (2,600 to 14,600)	-17%
Shan State total	24,700 (16,400 to 36,600)	24,900 (18,900 to 32,500)	2%
Kachin	3,600 (1,800 to 8,800)	4,200 (2,400 to 9,000)	17%
Chin	630* (573 to 677)	560 (516 to 610)	-10%*
Kayah	570* (434 to 706)	450 (437 to 465)	-21%*
National total	29,500 (21,000 to 50,400)	30,200 (23,900 to 44,600)	2%

Values in brackets indicate the 95% confidence interval. Numbers in the table are rounded, percentage changes are calculated with exact estimates.
*In 2020, the latest available cultivation data (2018) were used Chin and Kayah. The % of change refers to the period 2018-2021.

Figure 2: Regional distribution of opium poppy cultivation areas in Myanmar, 2021



Opium poppy cultivation is concentrated in areas characterised by a combination of specific topographical conditions, challenging socio-economic circumstances and a precarious security situation. Map 1 gives an overview of the average density of opium poppy cultivation during 2015-2021. It shows high density opium poppy cultivation in the south-western mountains of South Shan and mostly medium cultivation levels in East Shan State. The areas near the boundaries of East and South Shan, on both sides of the Than Lwin river, also present some extensive areas of poppy, although the cultivation is dispersed, and the density is slightly lower than in South Shan region. The majority of North Shan region presents areas with medium cultivation levels. In Kachin State, the north-western zone of Tanai town and the area east from Myitkyina city next to the international border with China show very high cultivation density.

In 2021, large areas with high to very high density of opium poppy cultivation were reported in the southwestern mountains of South Shan. Likewise, the eastern part of North Shan, bordering the Wa region, the north area of Kengtung city (north-eastern part of East Shan) as well as Tanai and the border area east from Myitkyina city in Kachin State showed high concentrations of poppy.

Map 2 and 3 show cultivation trends in the major producing states/regions.

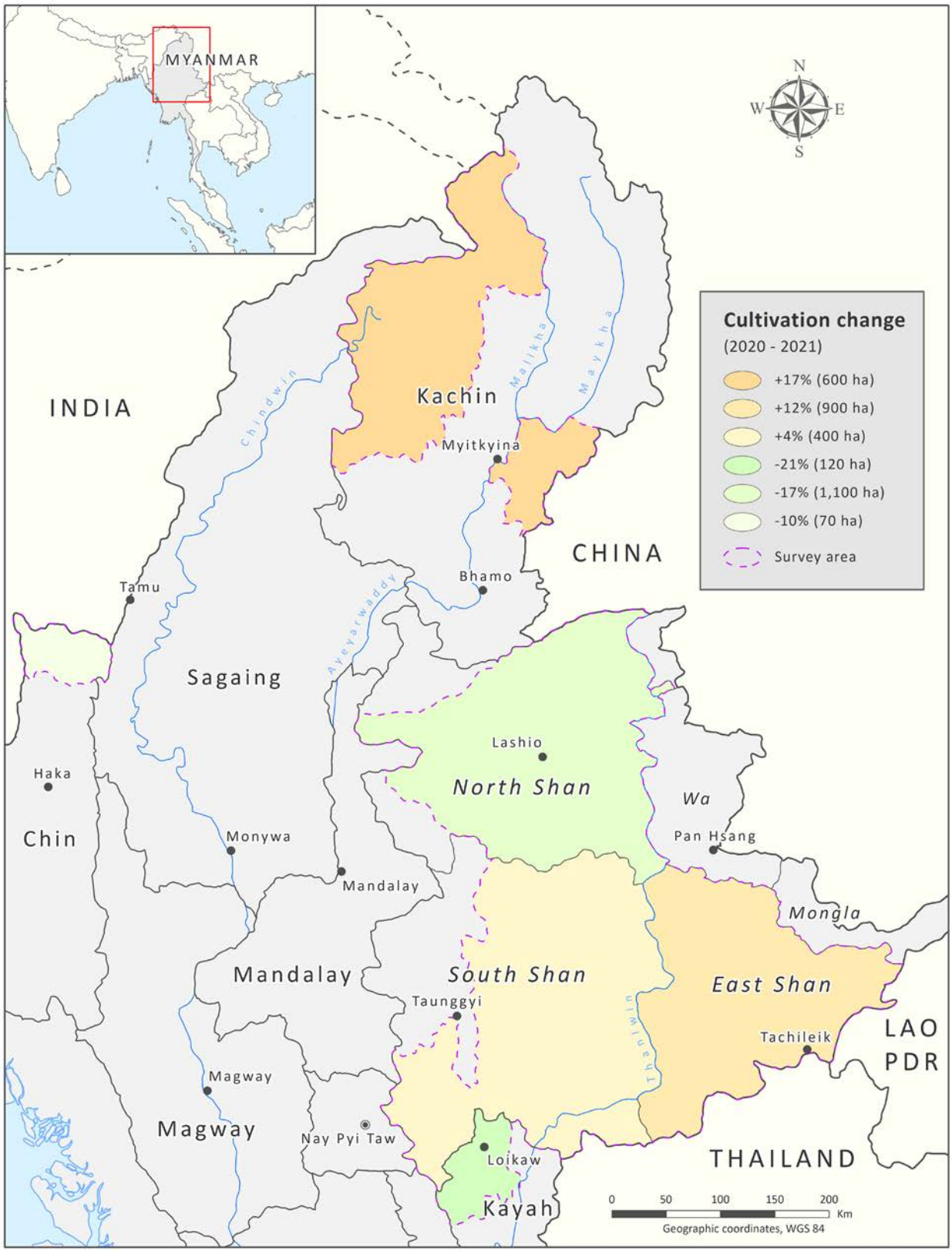
Figure 3: A flowering-stage healthy and well-organized poppy field systematically in South Shan, 2021

Figure 4: Weeding in an early-stage poppy field with drainage groves in South Shan, 2021

Figure 5: Sprinkler irrigation of a young poppy field in South Shan, 2021.

Figure 6: Rainfed poppy field in East Shan, 2021

Map 2: Cultivation changes between 2020 and-2021*

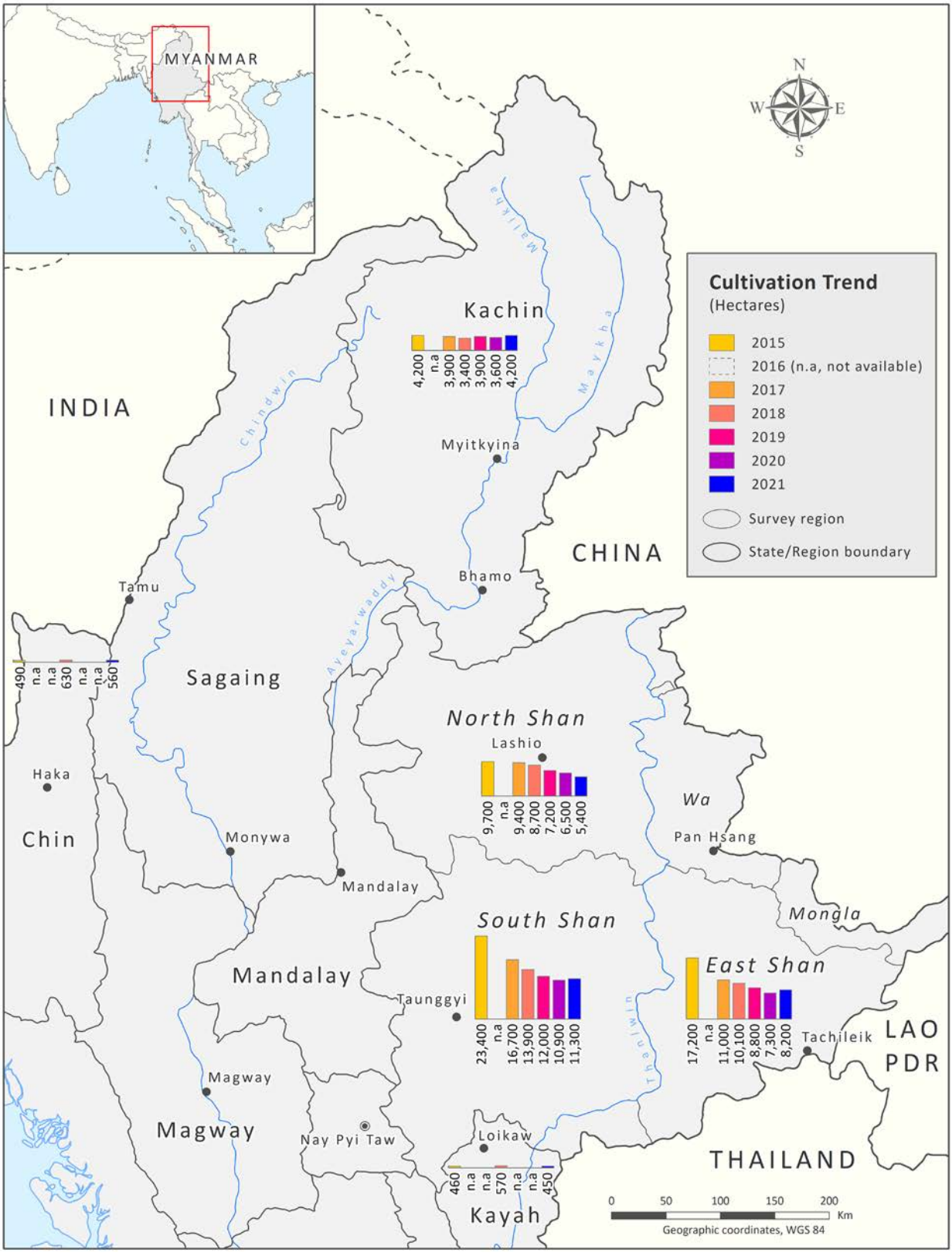


Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.
*For Chin and Kayah States actual changes refer to the period 2018-2021, since the latest data on cultivation for the two states before 2021 were collected in 2018.

Figure 7: Multi-stage poppy field observed in a village in South Shan, 2021

Figure 8: A harvested dry poppy field in South Shan, 2021

Map 3: Opium poppy cultivation trends in Myanmar, 2015-2021



Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

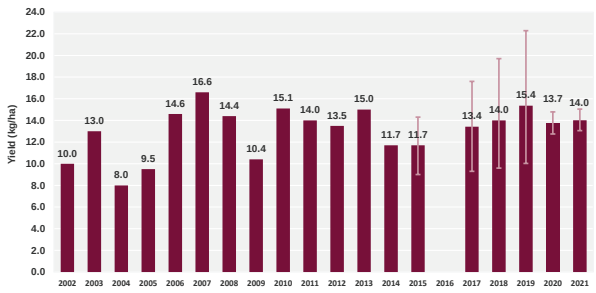
2.2 Opium yield and production estimates

For the present survey, due to mobility restrictions related to the COVID-19 pandemic and movement restrictions following 1 February, the yield survey was only carried out in East and South Shan and a reduced number of fields were visited compared to previous years. To avoid that the scarcity of data collected in 2021 would lead to a bias, the multi-year average of all available yield data from 2014 onwards was used for each Shan State region, using the same methodology as in the 2020 Myanmar Opium Survey report. For Kachin State, the 2020 yield estimate was used for calculating the production, since no yield campaign was carried out there in 2021. For Chin and Kayah States the national average yield was applied (see methodology chapter for further details).

Compared to 2020, updated 2021 figures are available for East Shan (12.75 kg/ha, -0.1%) and South Shan (13.87 kg/ha, +6%). (Table 2)

The national average yield in 2021 was estimated at 14 kg/ha[13], 2% higher than in the previous year. (Figure 9)

Figure 9: Average opium yield in Myanmar, 2002 – 2021



Average weighted by regional area estimates. In 2016 no survey was conducted. In 2021, a multi-year average was used to estimate yields in Shan State regions, which reduced the uncertainty ranges around the average yield, as a much larger sample size was available (see the methodology section for further details).

13 Average opium yield of Shan and Kachin States weighted by cultivation. See Methodology section for details.

Figure 10: Lancing stage healthy poppy capsules in South Shan, 2021

Table 2: Potential opium yield by region (kg/ha), in 2020 and 2021

Region	2020	2021	Change
Kachin	16.0 (14.1 to 17.9)	16.0* (14.1 to 17.9)	-
South Shan	13.0 (12.5 to 13.6)	13.9 (13.3 to 14.5)	6%
East Shan	12.8 (12.3 to 13.4)	12.8 (12.3 to 13.3)	-1%
North Shan	14.7 (12.9 to 16.6)	14.7* (12.9 to 16.6)	-
Average yield **	**13.7 (12.7 to 14.8)**	**14.0 (13.1 to 15.0)**	**2%**

*Because of no data collection in 2021 in the two regions, for Kachin yield estimate is based on 2020 data, for South Shan, is the multi-year average 2014-2020 (see methodology chapter).
** Average of Shan and Kachin States weighted by cultivation.
Values in brackets indicate the 95% confidence interval. Numbers in the table are rounded, percentage changes are calculated with exact estimates.

The resulting estimate of potential dry opium production in Myanmar in 2021 was 423 metric tons (Table 3). This can be considered a substantial stability compared with 2020 figure, with a minor increase of 18 tons (4%). It is worth noting that 2021 dry opium production interrupts a decreasing trend that had begun in 2014, although current production levels are not even at half of the levels exhibited in 2014(Figure 11).

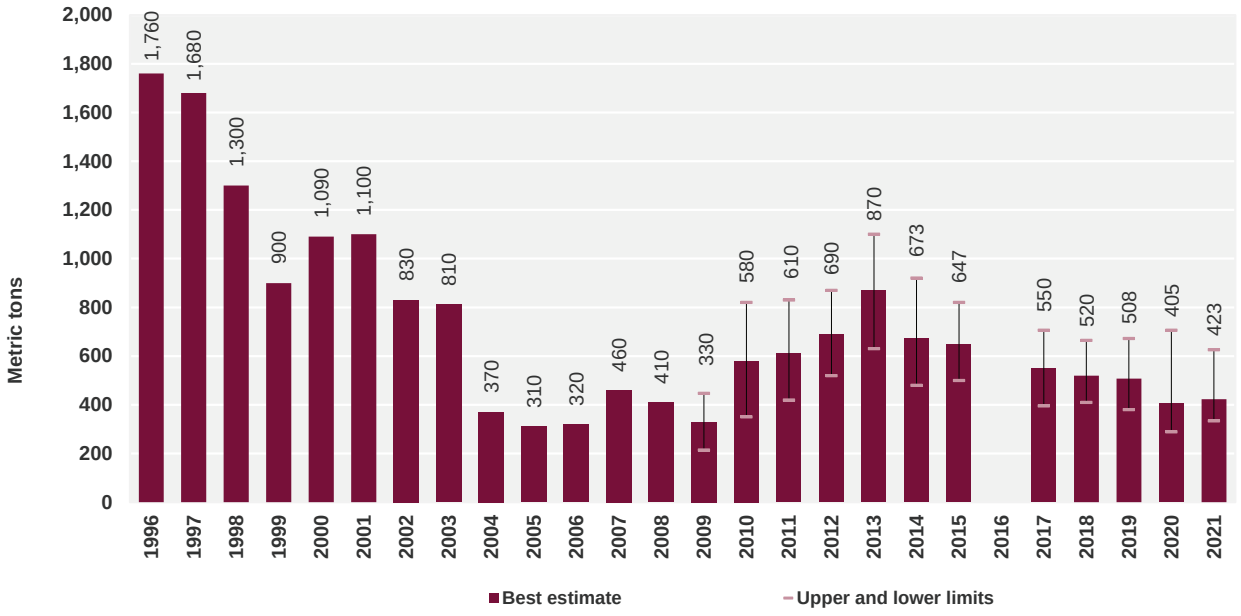
South Shan continues to be by far the main opium producing State, accounting for more than 80% of the national total. However, increasing levels of production are witnessed in Kachin State, accounting for 17% of the national total in 2021.

Table 3: Potential opium production by region and State (metric tons), in 2020 and 2021

Region	Potential production 2020	Potential production 2021	Change 2020-2021	2021 proportion by State
South Shan	142 (56 to 382)	157 (99 to 307)	11%	37%
East Shan	94 (52 to 162)	105 (64 to 186)	12%	25%
North Shan	95 (37 to 190)	79 (35 to 157)	-17%	29%
Shan State total	**331 (219 to 598)**	**341 (257 to 528)**	**3%**	**81%**
Kachin State	58 (28 to 141)	68 (38 to 145)	17%	16%
Chin State	8.6 (4.9 to 17.5)	7.9 (4.9 to 17.5)	-8%	2%
Kayah State	7.8 (4.0 to 16.1)	6.3 (4.0 to 16.1)	-19%	2%
Total	**405 (289 to 706)**	**423 (334 to 626)**	**4%**	**100%**

Values in brackets indicate the 95% confidence interval. Numbers in the table are rounded, percentage changes are calculated with exact estimates.

Figure 11: Potential opium production in Myanmar, 1996-2020 (metric tons)



Source: from 1996 to 2001 USG, from 2002 to 2021 UNODC. In 2016 no survey was conducted.

Figure 12: Lancing poppy capsules in a very healthy poppy field in South Shan, 2021

Figure 13: Poppy fields at harvesting stage in South Shan, 2021

2.3 Farm-gate price of opium

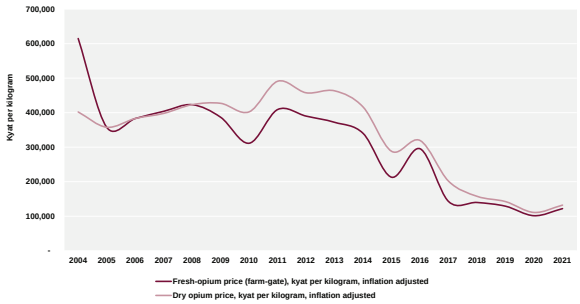
In 2021, only a limited number of fresh opium price data were collected in connection to the yield survey in South and East Shan regions. [14]

The average farm-gate prices[15] at harvest time of fresh and dry opium were assessed at 219,254 Kyat (US$ 153)[16] and 237,580 Kyat (US$ 166) per kilogramme, respectively.

From 2020 to 2021, average farm-gate prices for fresh and dry opium increased by about 20%, not taking inflation into account. When considering inflation, the corresponding prices increased by about 25%.[17]

2021 is the first year that farm-gate prices of fresh and dry opium showed a significant increase since 2016 (Figure 14). Because of the small amount of price data collected in 2021, it is important to be cautious when interpreting this trend reversal. However, the turnarounds in both cultivation and price trends might suggest that the opium market in Myanmar is somehow revitalizing.

Figure 14: Inflation-adjusted farm-gate prices (weighted average) of fresh and dry opium in poppy-growing villages, Myanmar, 2004-2021, (Kyat per kilogram)



Prices were adjusted for inflation on the basis of the Consumer Price Index information provided by the World Bank (base 2010=100). The Consumer Price Index for 2021 was linearly extrapolated from the 2004-2019 series.

2.4 Opium economy in Myanmar

Every year, hundreds of tons of opium are harvested in Myanmar and further commercialised. Opium can be either consumed as raw opium or further processed into heroin. Both raw opium and heroin reach the end-consumer markets in and outside Myanmar (Table 4).

14 Prices of dry opium were estimated based on collected price data for fresh opium and the ratio between the fresh and dry opium prices collected in 2019 survey, the latest whit available prices of both fresh and dry opium.

15 Weighted average based on opium production in South and East Shan.

16 Applied MMK/USD exchange rate is the 2020 DEC alternative conversion factor provided by the World Bank (https://data.worldbank.org/indicator/PA.NUS.ATLS)

17 Change calculated in Kyat. Prices were adjusted for inflation on the basis of the Consumer Price Index information provided by the World Bank (base 2010=100). The Consumer Price Index for 2021 was linearly extrapolated from the 2004-2019 series.

Table 4: Estimated quantities of the different opiate market components, 2021

Opium production 2021	Domestic demand for unprocessed opium	Domestic demand for heroin	Unprocessed opium for consumption potentially available for export	Heroin potentially available for export
423 tons (334 to 626)	22 tons	6 tons	55 tons	26 tons (17 to 46)

Note: A ratio of 10:1 is used for converting opium to heroin of unknown purity.

Table 5: Estimated values of the opiates economy, 2021

	Gross value Millions of US$	Value in relation to GDP (%)
Value of the opiates economy (gross) **	460 – 1,100	0.6 - 1.4
Value of opiates potentially available for export	340 - 850	0.4 - 1.1
Raw opium	32	
Heroin	310 - 820	
Value of the opiates market for domestic consumption	120 - 260	0.2 - 0.3
Raw opium	13	
Heroin	110 - 240	
Farm-gate value of opium	56 - 100	0.1
Value of the opiate economy after farm-gate	410 – 1,000	0.5 - 1.3

GDP 2020. Source: World Bank.
The gross value of opiates is the sum of the value of the domestic market and the value of opiates believed to be exported. Numbers in the table are rounded, percentages are calculated with exact estimates. Ranges are calculated based on lower and upper bounds of opium production and on assumptions about the different purities of exported and domestic heroin. See more details in the Methodology chapter.

The farm-gate value of opium is an important measure of the gross income of farmers generated by opium poppy cultivation, and it was estimated to range between US$ 56 to 100 million, corresponding to about the 0.1% of the national GDP of the year 2020 (Table 5). These values were calculated using information on farm-gate prices collected in South Shan and East Shan regions during yield survey activities and the amount of potential opium production.

Taking into account reported seizure data, it was estimated that 77 tons of raw opium and some 23 to 52 tons of heroin reached the illicit market.[18] Out of the 77 tons of opium, 22 tons were destined for domestic consumption, with a value of US$ 13 million; the remaining 55 tons of opium were exported with a value of US$ 32 million.

The main value of the opiate market was generated by consumption, manufacturing and trafficking of heroin. In 2021, considering both domestic and foreign heroin markets, an income between US$ 420 million and 1.1 billion was estimated for Myanmar traffickers, equivalent to a 0.5 - 1.4% share of the 2020 national GDP.[19]

The value of manufacturing and trafficking after farm-gate up to the border of Myanmar ranged between US$ 410 million and 1 billion. This value represents the income generated by traffickers after deducting the cost of buying raw opium from the farmers.

These estimates have some limitations. There is great uncertainty around the conversion ratio of opium to heroin, which depends on three main factors: the morphine content of opium, the efficiency of traffickers to extract morphine from opium and convert morphine to heroin, and the purity and price of the heroin estimated.[20] None of these factors are well researched in the context of Myanmar but can have a strong impact on the

18 See more in Methodology chapter.

19 Source: World Bank.

20 For a detailed description of the calculation of conversion ratios see "*UNODC/MCN Afghanistan opium survey 2014*" and "*UNODC/MCN Afghanistan opium survey 2017 – Challenges to sustainable development, peace and security*".

estimated values of the opiate economy. Estimates on demand in the region are based on 2010 data and may have changed since then. Moreover, the estimates presented are gross estimates before deducting any cost, e.g. costs for precursor substances, such as acetic anhydride, which can substantially reduce the profits of manufacturers and traffickers of heroin. To assess the profits made, other cost components such as transportation, labour costs and costs of bribery also need to be considered.

The estimates presented here need to be understood as an indication of the order of magnitude rather than as precise measurements. UNODC is working on improving the accuracy of the estimates.

3. ERADICATION AND SEIZURES

3. Eradication and Seizures

3.1 Eradication

By the end of 2021, CCDAC reported that 4,633 ha of opium poppy had been eradicated, representing an increase of 129% compared to 2020 (Table 6), and the first increase since a downwards trend started in 2015 (Figure 15). According to the data, most of the eradication, 4,438 ha (96%), occurred in Shan State and particularly in the South Shan region (4,226 ha, 91%).

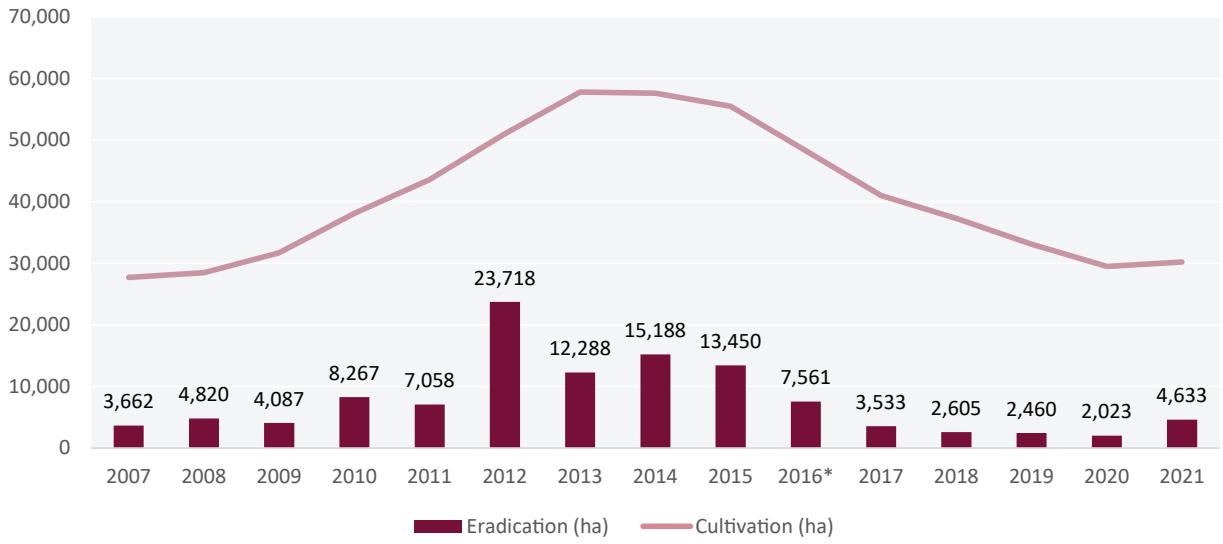
The opium poppy cultivation estimates presented in this report reflect data based on satellite images taken at certain points in 2020 and 2021. Therefore, any eradication carried out after the satellite image acquisition dates is not reflected in the estimated cultivation figures. Eradication information may also include activities during the monsoon poppy season, prior to the main growing season when the remote sensing survey was implemented. The eradication figures included in the report were not verified by UNODC.

Table 6: Reported eradication in Myanmar (ha), 2006-2021

Region	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	2018-2019	2019-2020	2020-2021
East Shan	1,101	1,249	702	868	1,230	1,257	537	356	378	482	264	224	100	106	85
North Shan	916	932	546	1,309	1,315	977	532	337	532	69	97	29	44	179	127
South Shan	1,316	1,748	1,466	3,138	3,579	21,157	10,869	13,696	10,715	4,947	3,019	2,209	2,000	1,571	4,226
Shan State total	**3,333**	**3,929**	**2,714**	**5,315**	**6,124**	**23,391**	**11,939**	**14,389**	**11,625**	**5,498**	**3,381**	**2,462**	**2,144**	**1,856**	**4,438**
Kachin	189	790	1,350	2,936	847	83	250	395	1,495	1,504	28	65	126	75	90
Kayah	12	12	14	13	38	84	59	67	54	16	47	12	3	0	0
Magway	45	0	1	1	0	4	7	60	8	9	47	44	19	25	18
Chin	10	86	5	2	10	110	32	277	267	534	28	22	50	35	81
Mandalay	0	3	2	0	39	45	0	0	0	0	1	0	0	0	0
Sagaing	9	0	1	0	0	0	2	1	0	0	0	0	118	31	31
Other States	64	0	0	0	0	0	0	0	0	0	0	0	0	0	0
National total	**3,662**	**4,820**	**4,087**	**8,267**	**7,058**	**23,718**	**12,288**	**15,188**	**13,450**	**7,561**	**3,533**	**2,605**	**2,460**	**2,023**	**4,633**

Source: CCDAC information.

Figure 15: Eradication versus opium poppy cultivation in Myanmar (ha), 2007-2021



*Opium poppy cultivation for the year 2016, when survey was not conducted, was plotted with linear interpolation.

3.2 Seizures

Table 7 shows seizure amounts of different opium products reported by CCDAC from 1988 to 2021. Figure 16 highlight the seizure trends from 2007 onward.

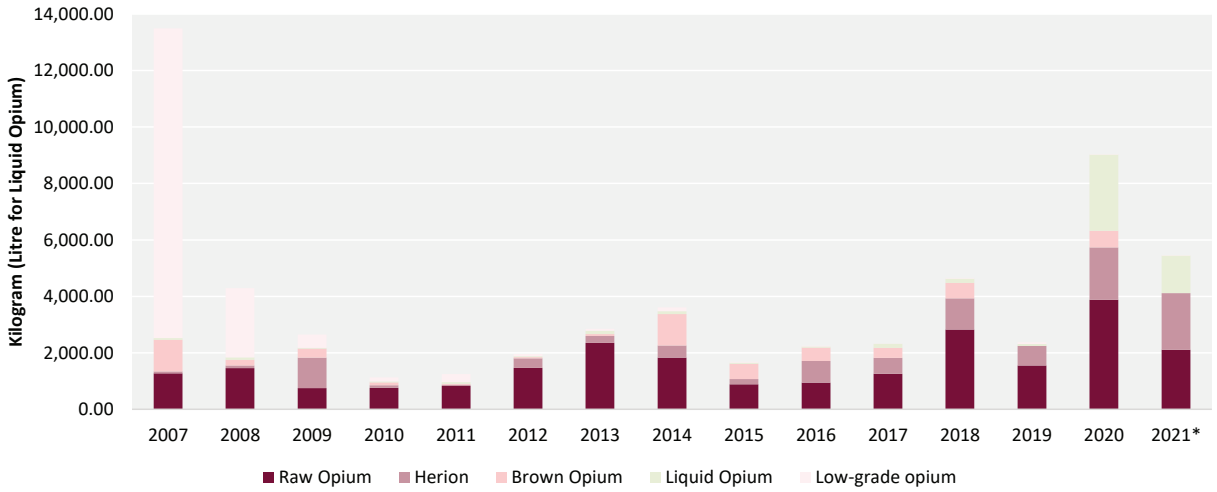
Table 7: Seizures of drugs (opiates) in Myanmar (kg), 1988-2021*

Year	Raw Opium	Heroin	Brown Opium	Liquid Opium	Low-grade opium
1988-1997	22,992	3,722	186	118	306
1998	5,394	404	96	206	312
1999	1,473	245	24	333	314
2000	1,528	159	23	16	245
2001	1,629	97	7	19	142
2002	1,863	334	314	18	126
2003	1,482	568	156	52	204
2004	607	974	59	39	396
2005	773	812	44	21	128
2006	2,321	192	1,371	29	6,154
2007	1,274	68	1,121	56	10,972
2008	1,463	88	206	80	2453
2009	752	1,076	326	27	465
2010	765	89	98	35	147
2011	828	42	37	60	282
2012	1,470	336	46	29	81
2013	2,357	239	72	115	66
2014	1,828	435	1,109	102	134
2015	889	186	539	38	35
2016	944	769	472	47	22
2017	1,256	754	348	146	6
2018	2,829	1,099	554	146	30
2019	1,553	690	6	65	66
2020	3,883	1,853	523	2,694	22
2021*	2,110	2,003	0	1,334	21

Source: CCDAC information.

* Figures for 2021 correspond to 1 January – 31 October.

Figure 16: Seizures of opiates in Myanmar (kg), 2007-2021*



Source: CCDAC information.
* Figures for 2021 correspond to 1 January – 31 October only.

4. METHODOLOGY

4. Methodology

The 2021 opium survey included three components:

1. Estimation of opium poppy cultivation area throughout North Shan, East Shan, South Shan, Kachin, Chin and Kayah. The area estimation survey was based on the use of satellite images as the primary source of data, which was supplemented by field surveys to provide ground-truthing that supports the interpretation of opium poppy fields;
2. Crop yield estimation survey throughout South Shan and East Shan. Due to mobility restrictions after 1 February, crop yield measurements could not be conducted in North Shan and Kachin during the 2021 crop harvesting period. Crop yield data collection had been conducted throughout Kachin State in the previous 2020 opium survey;
3. A socio-economic (village) survey in poppy growing areas of Kachin State. An in-depth analysis of the results will be presented in a separate report, expected to be available later in 2022.

4.1 Area estimation

Remote sensing imagery

The area estimation to monitor the extent of opium poppy cultivation in Myanmar was carried out by means of remote sensing techniques. North, East and South Shan regions in Shan State, Tanai area and the eastern zone of Kachin State, poppy cultivation areas of Chin and Kayah States were surveyed. Satellite imagery were acquired following two approaches (Map 5):

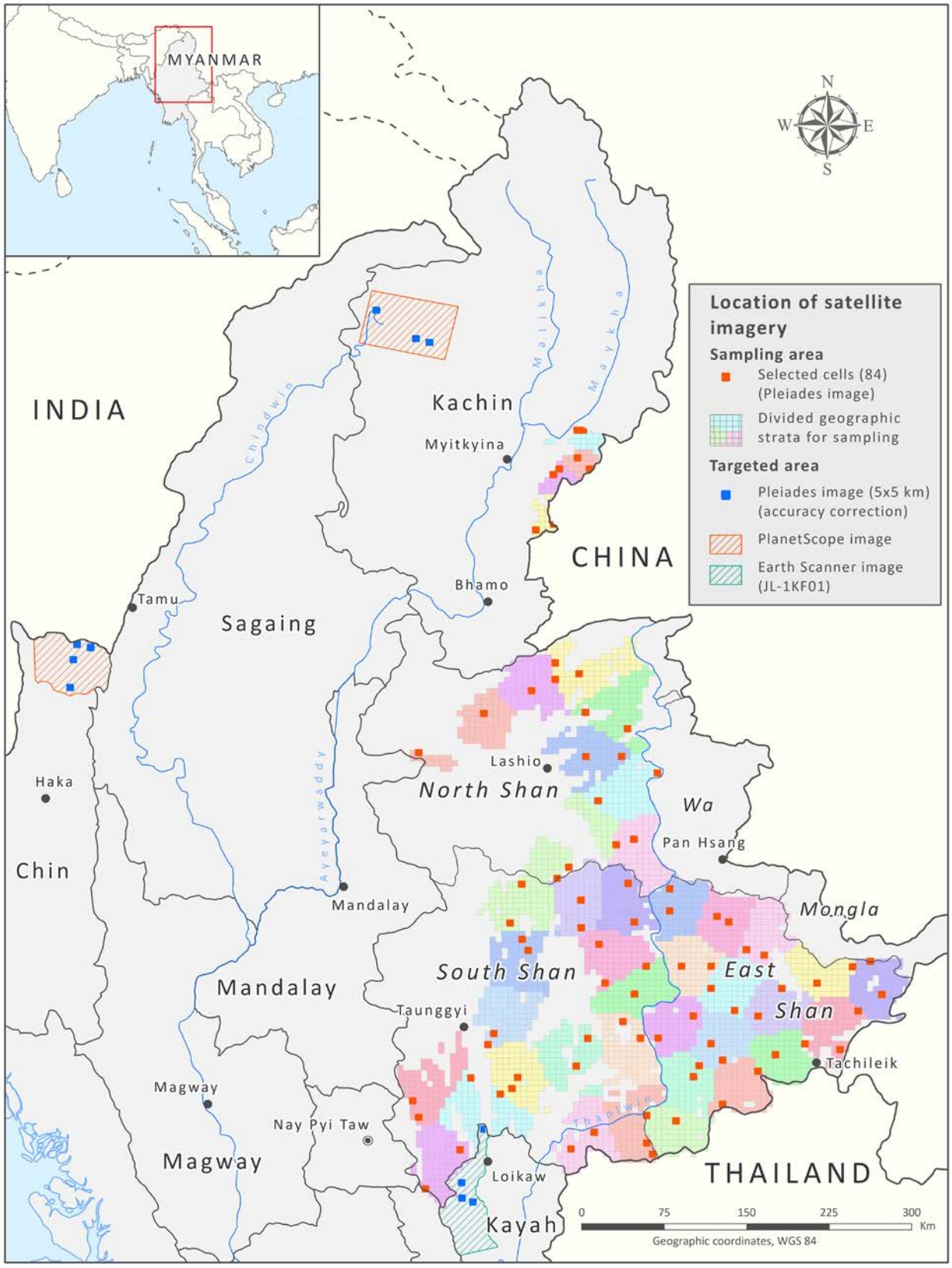
1. A sampling approach with a selection of randomly selected squared segments; this was used for the three Shan State regions and the south-eastern part of Kachin State (see *Sampling approach, sample size and sample selection* section);
2. A full coverage approach with larger, targeted images; this was applied for the Tanai area of Kachin State, northern part of Chin State and north-western part of Kayah State (see *Target area selection and interpretation* section).

The images used for the sampling areas were very high resolution (VHR) satellite images, whilst both VHR and high resolution (HR) images were used for the targeted areas.

The VHR images at the sample locations were acquired by Pleiades satellites, which provide images of 2 metre ground resolution with four spectral bands (blue, green, red and infra-red) and a 50-centimetre panchromatic band. For each location (sample segment), two images were acquired with an approximate five-week interval; first image was taken in December/January and second one in February/March. The two acquisition dates correspond to the poppy pre- and post-harvest time, thus facilitating the identification of poppy fields and their discrimination from other land cover classes. To determine the image acquisition dates, the regional differences between the crop calendars were considered.

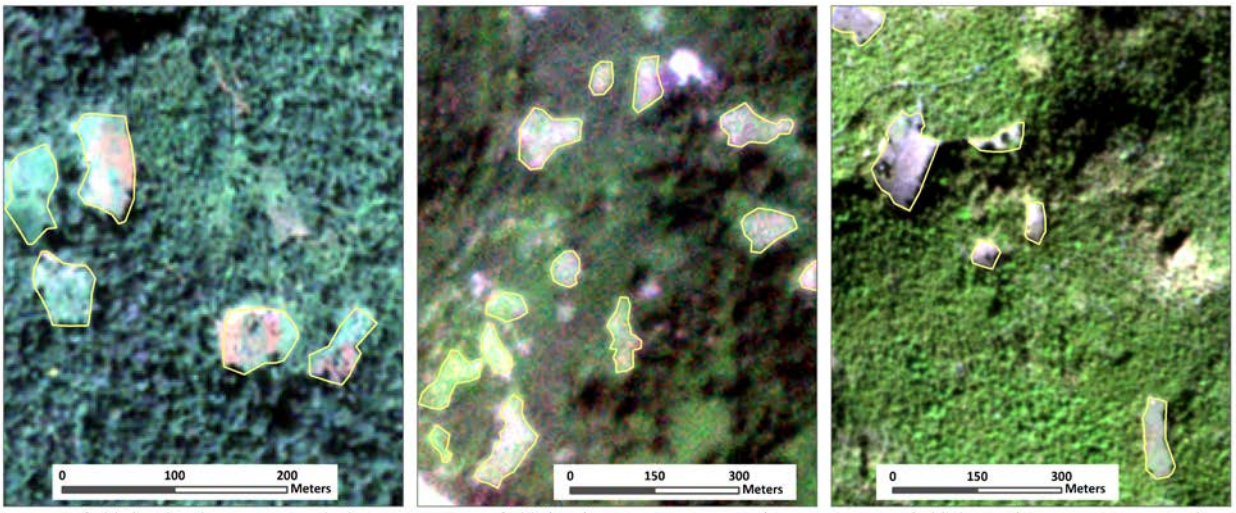
The images covering the Tanai area in Kachin State and the target area in northern part of Chin State were acquired by PlanetScope satellites, with 3 metre (approx.) ground resolution for orthorectified products. They consist of four spectral bands, ranging from blue to near infrared wavelength. A set of three 5x5 km segments and four 5x5 km segments with Pleiades VHR images were acquired within the same target areas in Kachin and Chin respectively, to evaluate for interpretation results by the PlanetScope data. By interpreting both image types independently, a factor was determined that provides the difference in area estimates from a PlanetScope image compared to Pleiades VHR images. This factor was applied to the fields that were only covered by the PlanetScope images, to correct for the differences in spatial resolution. The images covering the target area in north-western part of Kayah State were acquired by EarthScanner (JL-1KF01) satellite which provides 2 metre ground resolution with four spectral bands (blue, green, red, and infra-red) and a 50-centimetre panchromatic band.

Map 4: Different satellite imagery and approaches used for the survey, 2020



Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Figure 17: Poppy fields observed on different satellite images



Poppy fields by Pleiades image, South Shan
Image date - 31 Dec 2020

Poppy fields by PlanetScope image, Kachin
Image date - 16 Feb 2021

Poppy fields by EarthScanner image, Kayah
Image date - 29 Dec 2020

Risk area and sampling frame for the selection of satellite image locations

A risk area describes the geographic area considered in the area estimation survey. Basically, the risk area for the opium survey was developed by the combination of the following factors:

1) Land Cover;
2) Altitude;
3) Opium poppy free[21] areas according to ground information.

Land cover was the first important factor in defining the sampling frame. From the 2012 survey onwards, a land cover map, which was developed by classifying 5 DMC images with 22 metre resolution, acquired in February 2011, was used. From this map, large agricultural areas were extracted and considered to be poppy-free, since the cultivation of opium poppy was practised in small agricultural areas, often surrounded by natural vegetation. Wetlands and settlements were also excluded. Other classes of land use were considered to have the potential for opium poppy cultivation.

Prior to 2013, only altitudes between 800 and 1,800 metres were to be considered within the risk area. This was based on survey findings which had revealed that 95% of opium poppy was cultivated at such altitudes. However, later evidence showed the existence of poppy fields at 600 metre altitude and above, without a specific higher limit. Consequently, the sampling frame for the selection of the sample locations was updated since 2013 using this finding.

Several opium poppy-free areas were identified based on ground information. The special regions; Wa (former SR 2), Mongla (former SR 4), and Kokant (former SR 1); were excluded from the sampling frame. The townships; Mabein, Kyaukme, Nawnghkioand Kunlong in North Shan; and Kalaw, Pindaya, Lawksawk and Ywa Ngan in South Shan; were excluded from the sampling frame for the same reason. A 10-km buffer zone along the border with Thailand, which were considered opium poppy-free in earlier surveys, was included again in sampling frame since 2013 because ground information from the 2012 survey indicated a certain poppy risk.

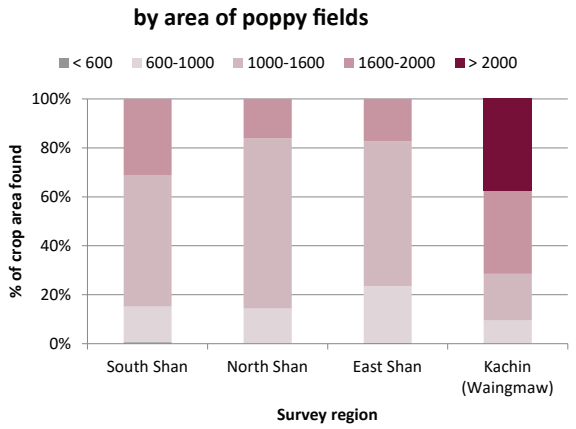
The above-mentioned factors were combined in a Geographic Information System (GIS) to calculate the sampling frame in Shan State. The sampling frame for Waingmaw township in Kachin State was developed only considering an altitude factor of more than 800 metres.

21 Opium poppy free in the sense of no indication for significant levels of opium poppy cultivation.

Table 8: Sample size allocation in 2021

Region	Sample size 2020	Sample size 2021	Number of geo-strata 2020	Number of geo-strata 2021
East Shan	14	30	7	15
South Shan	16	30	8	15
North Shan	8	26	4	8
Kachin	8	8	4	4
Total	**46**	**84**	**23**	**42**

Figure 18: Altitude ranges (metres) of area of poppy fields detected in satellite images, 2020/2021



Sampling approach, sample size and sample selection

Because of the dispersed distribution of poppy cultivation in the North, East and South Shan regions and in southern Kachin, a sampling approach is the most cost-efficient method given the required accuracy.

The sampling frame for this survey was a set of 5x5 km segments used to select the locations for obtaining satellite imagery. For that purpose, a 5x5 km regular grid was superimposed on the risk area. To increase the efficiency of the sample (thus to reduce the number of images purchased that only cover a small part of the risk area), a threshold of a minimum of 30% of risk area was set: if a segment contained less than 30% of risk area (e.g. is a cell at the boundary of the risk area), it was not included in the sampling frame. Nevertheless, in the extrapolation, the whole risk area is considered, with the underlying assumption that the area outside of the frame behaves on average as the area inside the sampling frame.

Since 2010, a simple random sampling within geo-strata has been applied. Firstly, the frame was separated by region. Here, each segment had to be assigned to exactly one per region: if most of the risk area was within that region, the segment was assigned to that region. Therefore, regional boundaries were in some sense generalised to fit the 5x5 km grid. Secondly, each sub frame (region) was divided into compact geographical strata of approximately equal area. In former surveys the definition of the strata was done manually but a clustering algorithm ("k-means") in the statistical software *R*[22] *package Spcosa* was applied since the 2014 survey. In each stratum, two sampling locations were selected by simple random sampling. This sampling method provides a geographically well distributed sample and allowed the variance (uncertainty) to be estimated in an unbiased manner. See for more details the Myanmar Opium Survey of 2015.[23]

In 2021, the total number of satellite images chosen for the sampling approach was set to 84 (Table 8). In Kachin the same number of samples and sample locations were kept as in the previous year. In Shan, 76 sample locations were selected, keeping the same number of samples as 2019 (in 2020, the number of sample units in Shan had been halved due to budget constraints). Areas in Chin, Kayah, as well as Kachin's Tanai area were surveyed based on a target area approach (see p 34).

Ground truth data collection

Before 2019, the ground truth data collection was conducted in collaboration with the Remote Sensing and GIS Section of the Forest Department,

22 http://www.r-project.org/ and package http://cran.r-project.org/web/packages/spcosa/index.html

23 https://www.unodc.org/documents/crop-monitoring/sea/Southeast_Asia_Opium_Survey_2015_web.pdf

Figure 19: "Ground truthing" in South Shan and East Shan, 2021

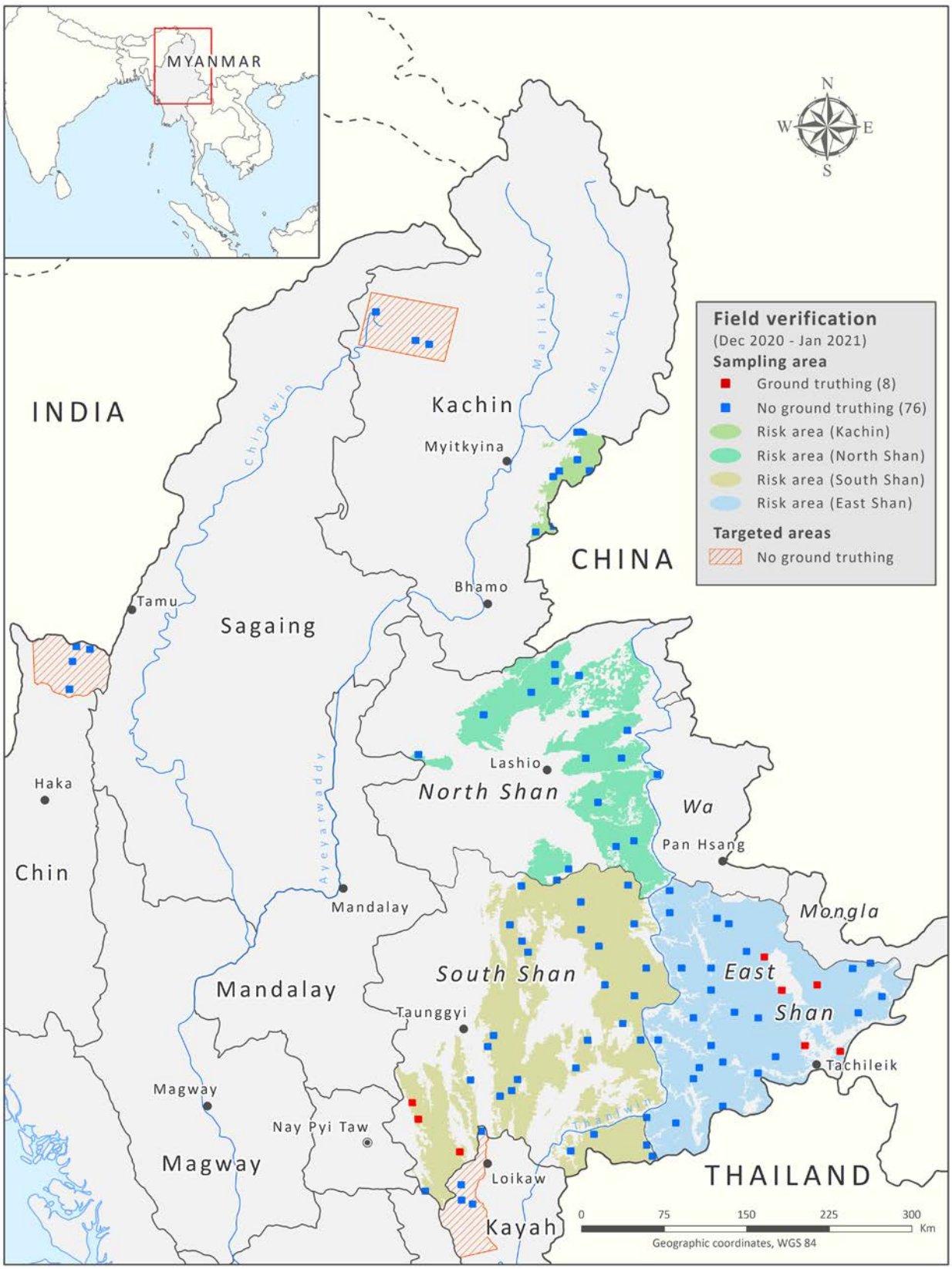
Ministry of Natural Resources and Environmental Conservation. Each year, field teams organized by the Department carried out ground truthing at the selected sample locations. From 2019 onwards, the Forest Department was not involved any longer in the opium survey activities. A technical team from UNODC Myanmar office, composed by four members, visited 5 sites in Shan and 3 sites in Kachin to collect ground truth data (Table 9). The team visited areas corresponding to sample satellite images footprint, during the period of December 2020 to January 2021 (Figure 19), although field visits were limited due to COVID-19-related mobility restrictions. Planned field visits after 1 February 2021 could also not be carried out.

The ground verification teams visited locations selected in opportunistic manner, with printouts of the corresponding satellite image (see Map 6). They collected GPS coordinates taking field photos from 5 selected satellite image sites in East Shan and 3 sites in South Shan. Subsequently, the collected field data complemented the visual interpretation of poppy fields executed by a national expert in the UNODC Myanmar Office. The results were verified, and standard quality control procedures were applied by international experts at UNODC Headquarters, Vienna.

Table 9: Ground truth data collection, 2007-2021

Survey Year	Satellite image VHR	No. of segments in Shan	Segment size (km)	Segments visited in Shan (ground truth)	Ground truth % in Shan	No. of segments in Kachin	Segments visited in Kachin (ground truth)	Ground truth % in Kachin	VHR images area (km²)
2007	Ikonos	22	8x8	17	77%	--	--	--	2,816
2008	Ikonos	28	8x8	19	68%	--	--	--	3,584
2009	Ikonos	40	8x8	34	85%	--	--	--	5,120
2010	GeoEye, World-View	40	6.5 x 6.5	32	80%	3	--	--	3,634
2011	World-View, QuickBird	51	6 x 6	40	78%	3	--	--	3,888
2012	GeoEye, World-View	58	5x5	47	81%	8	--	--	3,300
2013	GeoEye, World-View	66	5x5	46	70%	8	--	--	3,700
2014	GeoEye, World-View, QuickBird	76	5x5	49	64%	8	--	--	4,200
2015	Pleiades	76	5x5	47	62%	8	--	--	4,200
2016	No survey	--	--	--	--	--	--	--	--
2017	Pleiades	38	5x5	3	8%	8	--	--	2,300
2018	Pleiades	76	5x5	30	39%	8	--	--	4,200
2019	Pleiades	76	5x5	32	42%	8	--	--	4,200
2020	Pleiades	38	5x5	12	32%	8	3	38%	2,300
2021	Pleiades	76	5x5	8	11%	8	--	--	4,200

Map 5: Field verification status of the survey with satellite images, 2021



Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Target area interpretation and correction factors

The area estimates for Tanai area in Kachin, the northern part of Chin and the north-western part of Kayah States were based on a so-called target approach (full coverage survey). [24] Target areas in Kachin and Chin were fully covered by high resolution (HR) satellite imagery (PlanetScope). In addition to the PlanetScope images, very high resolution (VHR) EarthScanner (JL-1KF01) images were acquired for the target area in Kayah State (Map 5).

In 2021 survey, a set of 5x5 km segments with very high resolution (VHR) Pleiades images were acquired for target areas in Kachin and Chin to estimate the omission/ commission and geometric errors that stem from the use of lower resolution imagery**.** To that end, the area of opium poppy fields was first interpreted on the PlanetScope imagery (full coverage) and then on the Pleiades images (three selected locations in Kachin and four selected locations in Chin target areas). The difference between the areas of the two interpretations was used to calculate a correction factor that was applied subsequently to the estimates interpreted with the PlanetScope images (Table 11)[25]**.**

Satellite image processing and interpretation

The collected ground truth data, namely the geotagged field photos, were used as reference information to visually identify, interpret and delineate poppy fields. This task was conducted by a national expert in the UNODC Myanmar Office, with a long-time experience in poppy detection and interpretation of field data.

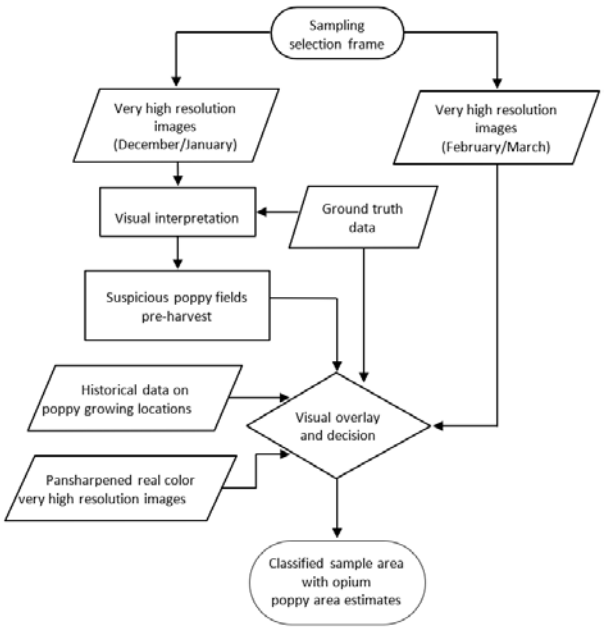
The classification procedure of the VHR images is illustrated in the flowchart below (Figure 20). Before the interpretation phase, the acquired imagery is pre-processed through a number of steps into a stable, uniform format for the visual analysis.

The main pre-processing step is pan-sharpening (merging) of the Pleiades high resolution panchromatic and lower resolution multispectral imagery resulting in a pansharpened VHR imagery with the spatial resolution of the panchromatic band (50 cm) and with all multispectral bands. This is a fundamental step to better discriminate poppy fields from other landcover classes. In addition, visual enhancement procedures are applied, when appropriate.

The satellite image interpretation was conducted in a visual manner. The latest ground truth data, historical ground truth data, data collected from the yield measurements and eradication activities were used as reference material during the interpretation process. In visual interpretation, accuracy and precision of the result vary with the experience and the skills of those conducting the interpretation. Therefore, interpretation keys (decision rules) were used that bring the interpreters to a comparable level of knowledge, experience and notion of the topic. The interpretation keys use features of poppy fields such as tone, colour, shape or texture, in addition to context information and knowledge about the area.

The images acquired in the second phase were used to observe changes in possible poppy-growing fields. If there was an apparent change that corresponded to the harvesting of the poppy, it was used to confirm that the field was indeed a poppy field. Since the images were not geometrically corrected an automated classification and change detection process was not possible due to the possible displacements of the fields in question.

Figure 20: Satellite image interpretation flowchart

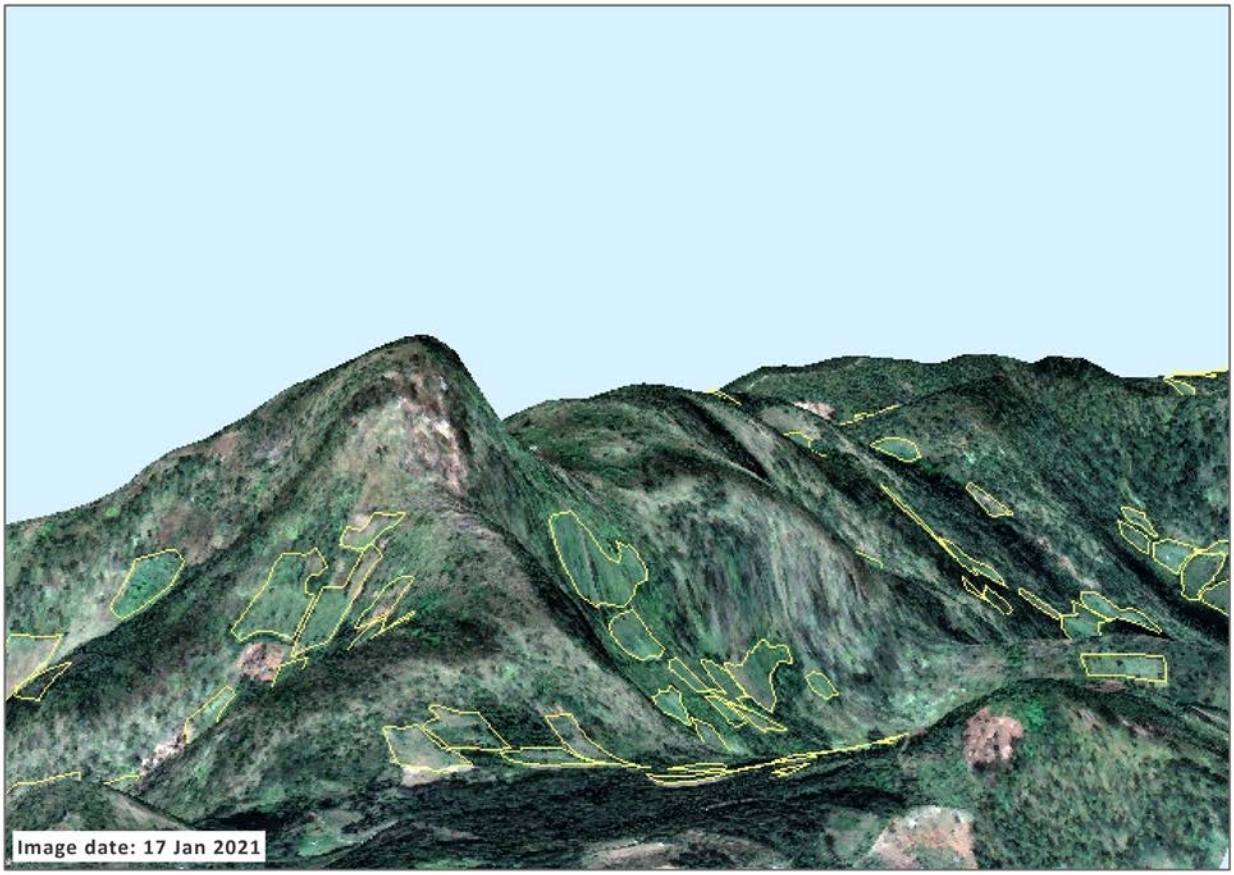


24 The target area was defined based on information on poppy cultivation from previous surveys since 2009.

25 95% confidence intervals for each targeted area were calculated assuming a t-student distribution and two degrees of freedom. See https://www.itl.nist.gov/div898/handbook/mpc/section5/mpc552.htm for further information on the method to calculate the standard deviation.

The decision rules can vary by region and stage of poppy cultivation. However, the most commonly applied rule was that potential poppy in the first image, when classified as bare soil in the second image, meant that it was opium poppy. Historical data on poppy cultivation, three-dimensional (3D) terrain visualisation and real colour pansharpened VHR images were used to facilitate the decision-making (Figure 21).

Figure 21: Poppy interpretations on Pleiades imagery and visualised in 3D, 2021



3D visualization of interpreted poppy fields on Pleiades image draped on SRTM Digital Elevation Model (DEM)

Figure 22: Changes of poppy field observations between 2015 and 2021, Tanai area

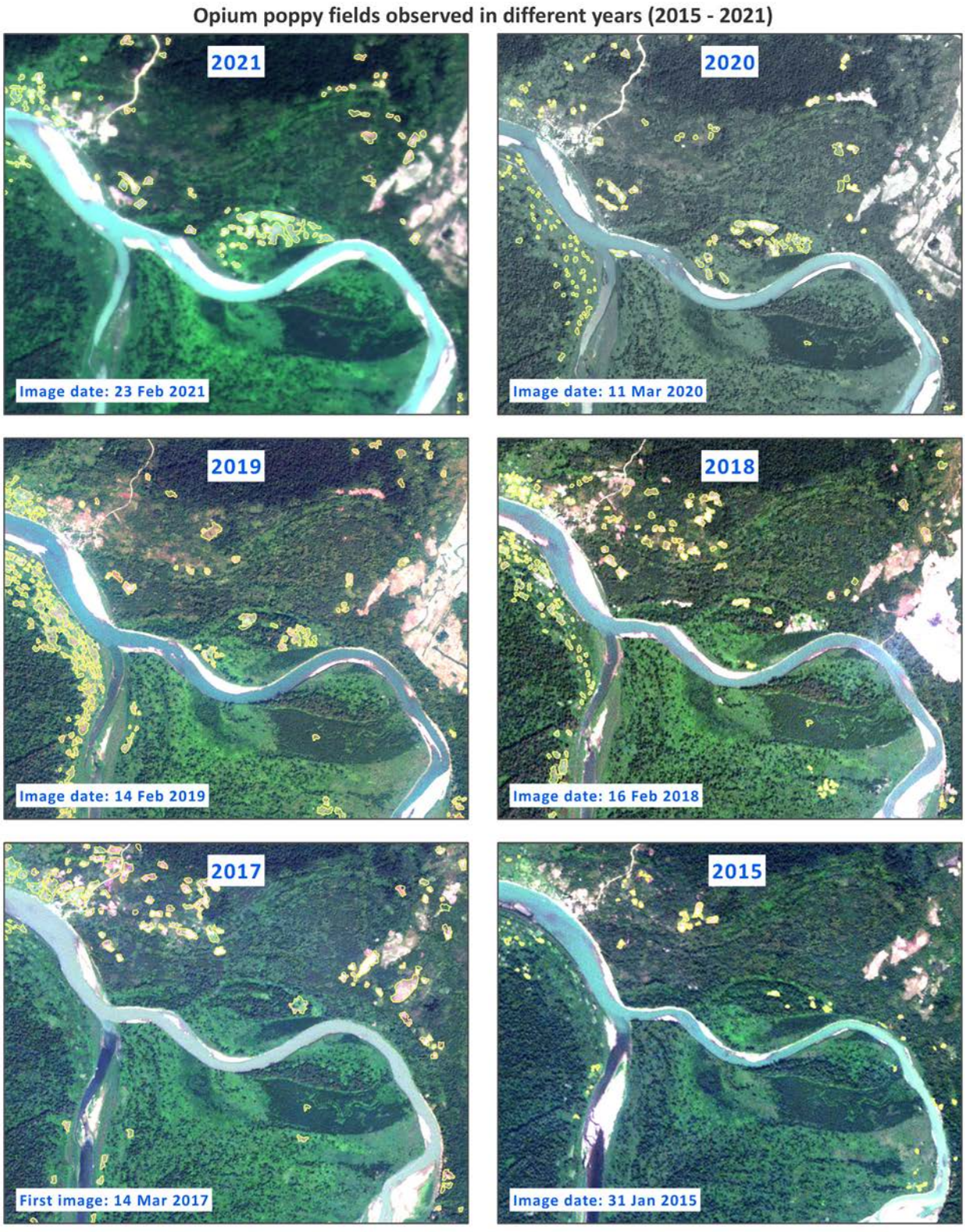


Figure 23: Satellite image interpretations with the corresponding ground truth data, poppy fields, 2021

PLEIADES satellite images (pansharpened, true colour composite), includes material © CNES (2020, 2021), Distribution Airbus DS, all rights reserved.

Figure 24: Satellite image interpretations with the corresponding ground truth data, non-poppy fields, 2021

Terrace paddy field observed in satellite image

Flowering-stage mustard field observed in satellite image

Avocado plantation field observed in satellite image

Harvested upland paddy fields observed in satellite image

Crop threshing patches observed in satellite image

Harvested corn field observed in satellite image

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Area estimation methods in 2021

The area estimation consisted of a sampling estimate and a target area estimate (Table 10). The final national estimate is the exact sum of the regional estimates, in other words poppy estimated in the sample regions of Shan and Kachin States and the estimate obtained from the target areas of Tanai in Kachin[26]. The following section describes the sampling estimation method. The sample area estimation of the extent of opium poppy cultivation at the national level is a combined ratio estimate using risk area as an auxiliary variable. The estimation was done separately for the strata containing segments where opium poppy was identified in the past and for the strata that were free of opium poppy (but containing risk area because of their biophysical features). The total is a sum of these two separate estimates. At the regional level, a simple combined ratio estimate was calculated. The ratios were then extrapolated to risk area outside the frame. In 2021, the sample mean was calculated as

$$\bar{y}_{st} = \sum_{h=1}^{k} \frac{N_h}{N} \bar{y}_h \; ; \bar{x}_{st} = \sum_{h=1}^{k} \frac{N_h}{N} \bar{x}_h .$$

where k is the number of stratum, $\bar{y}_h$ is the sample mean of poppy in stratum h; $\bar{x}_h$ is the sample mean of the risk area in stratum h; N_h is the number of sampling units in stratum h, and N is the population size.

The combined ratio estimate of the area under poppy cultivation then is given by

$$\bar{Y}_{RC} = \frac{\bar{y}_{st}}{\bar{x}_{st}} \bar{X}$$

where $\bar{X}$ is the total risk area in the sampling frame. Bootstrapping[27] was performed to estimate the confidence intervals of the regional estimates. This was necessary as the heavily skewed distribution of opium poppy in the samples led to unrealistic confidence intervals when applying the standard methods. Although bootstrapping is considered to be an appropriate choice in such situations, UNODC is undertaking further research to assess if this is the case in all situations. The confidence interval of the national estimate combines the uncertainty of the regional estimates.

Table 10: Estimated poppy cultivation areas for the sampled areas in 2020 and 2021

Region	2020	2021	Difference 2020-2021
South Shan	10,867	11,315	4%
East Shan	7,327	8,229	12%
North Shan	6,497	5,381	-17%
Kachin	2,503	2,716	9%
Total	**27,194**	**28,091**	**3%**

Table 11: Estimated poppy cultivation areas for the target area in 2021

Target area	Interpreted poppy area (ha) before correction factor	Correction factor 2021	Interpreted poppy area (ha) after correction factor
Tanai (Kachin State)	1,568	-2.98%	1,506
Chin	553	0.88%	563
Kayah	478	-2.89%	451

4.2 Yield and potential opium production estimation

Collection of yield data

The 2021 yield data collection was conducted by opportunistic manner in East Shan and South Shan[28] (Map 7). A field team, composed by three experts from the UNODC Myanmar Office, collected yield data in 33 poppy growing villages in Pinlaung, Pekon, Mongping, Kengtung Townships and Naungtayar, Pinlon Sub-Townships during the period of 7 to 31 January 2021.

The villages were selected opportunistically, according to accessibility and security. Field measurements were normally taken from three poppy fields in each village.

26 Chin and Kayah States were not covered in 2020 and latest available area estimates (2018) were used to calculate the total national estimate.

27 http://cran.r-project.org/web/packages/boot/index.html.

28 In 2021, 36 fields were surveyed in 14 villages in East Shan and 57 fields in 18 villages in South Shan. Out of a total of 93 fields visited, only 69 had capsule measurements, since the remaining 24 poppy fields were not at the capsule stage yet. The total number of measured capsules was 2,121.

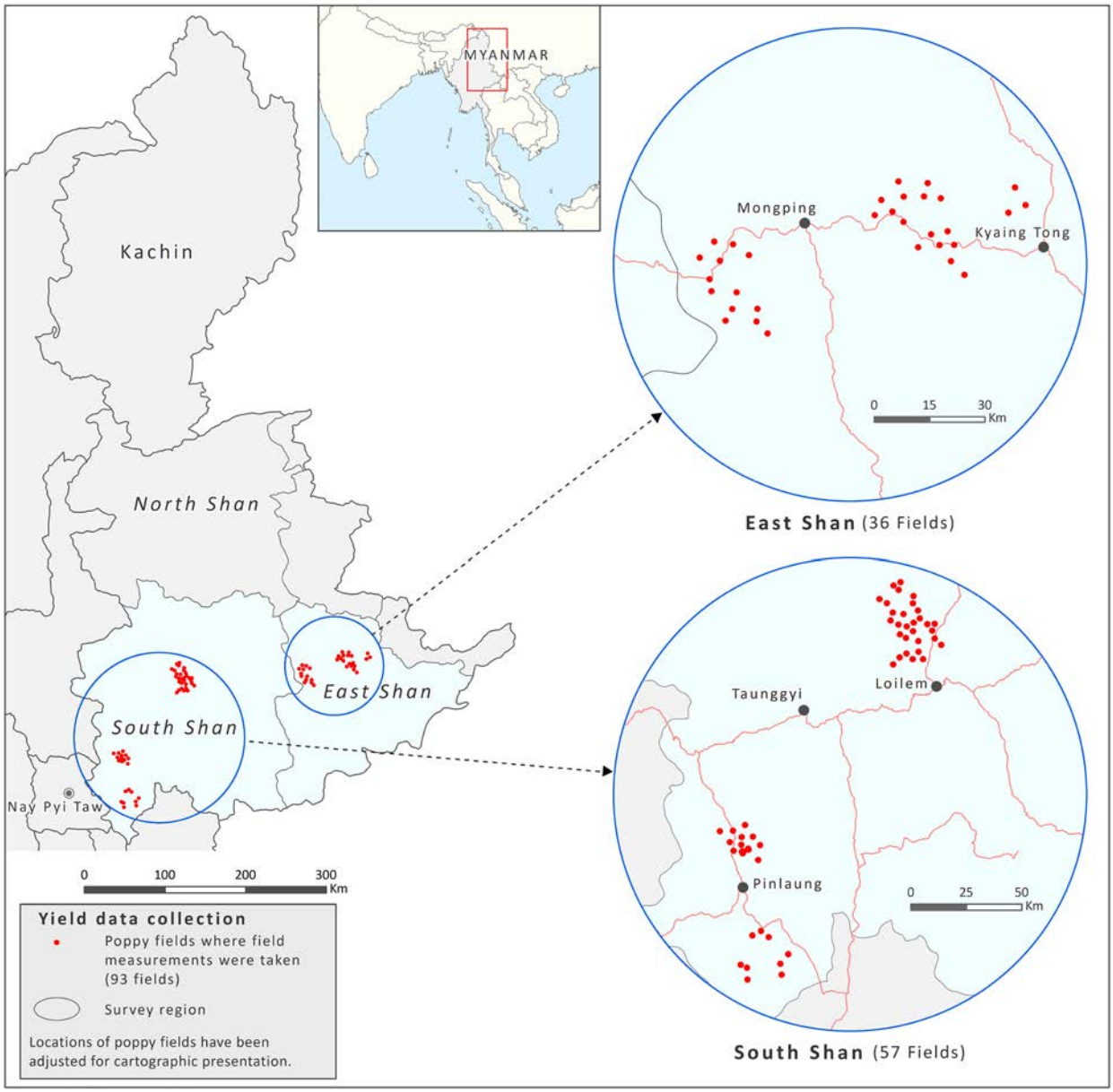
The field team followed the UNODC Guidelines for yield assessment.[29] The team selected mature opium poppy fields close to the village and selected a good, an average and a bad field from those mature fields. Once a field was selected, a transect was drawn through the field, along which three 1 m^2 sample plots were defined. In each plot, the numbers of flowers buds, flowers, immature capsules and mature capsules expected to yield opium were counted, and the diameter and height of 10 to 14 lanced capsules were measured with a digital calliper (Figure 25). All the measurements were recorded by digital cameras to check for data quality assurance.

Figure 25: Measuring poppy capsule in South Shan, 2021

29 https://www.unodc.org/unodc/en/scientists/guidelines-for-yield-assessment-of-opium-gum-and-coca-leaf.html

Figure 26: Yield data collection in South and East Shan, 2021

Map 6: Location of fields visited in the yield surveys in South and East Shan, 2021



Source: UNODC Illicit Crop Monitoring Programme in Myanmar.
The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations.

Table 12: Opium cultivation calendar Myanmar, 2020-2021**

Region	Township	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Kayah	1.Loikaw, 2.Demawso, 3.Fruso		Monsoon cultivation										
				Round 1									
					Round 2								
South Shan	1.Pekon, 2.Pinlaung, 3.Hsi Hseng, 4.Nyaung Shwe		Monsoon cultivation										
				Round 1									
					Round 2								
								Irrigated late crop					
	5.Maukmai, 6.Hopong, 7.Monae, 8.Nam Sang, 9.Linkhay				Round 1								
						Round 2							
									Irrigated late crop				
	10.Mong Pan, 11.Loilem, 12.Kun Heing, 13.Leicha, 14.Mong Shu, 15.Kyae Thee, 16.Mong Kaing				Round 1								
						Round 2							
							Round 3						
East Shan	1.Mong Ton, 2.Mong Hsat, 3.Tachileik, 4.Mong Hpyat				Round 1								
						Round 2							
								Irrigated late crop					
	5.Kyaing Tong, 6.Mong Yawng, 7.Mong Pyin, 8.Mong Hkat, 9.Metman				Round 1								
						Round 2							
							Round 3						
North Shan	1.Tang Yang, 2.Mong Yai, 3.Thibaw, 4.Kyaukme, 5.Lashio, 6.Theinne				Round 1								
						Round 2							
							Round 3						
									Irrigated late crop				
	7.Moemit, 8.Nam Hsang, 9.Namtu, 10.Kutkai, 11.Manton, 12.Kunlon, 13.Muse, 14.Nam Hkam					Round 1							
							Round 2						
								Round 3					
Kachin	1.Waingmaw						Round 1						
								Round 2					
									Round 3				
	2.Tanai						Round 1						
								Round 2					
Chin	1.Tunzan					Round 1							
							Round 2						

* Round 1, 2 and 3 refer to staggered planting on different fields at different times to spread the harvest over a longer period. Since the opium poppy plants are growing at different stages, at the time of gum collection in the first field, the second fields will not yet be at flowering stage. Therefore, labours needs are better distributed.

Estimating potential opium yield

The capsule volume per square metre is derived from field measurements and entered into the formula for the yield calculation. Each plot thus provides one yield observation. The simple average of the three plots in a field is considered the field yield. The yield by State is calculated as the simple average of all fields in a State.

For estimating potential opium yield, a relationship between poppy capsule volume per square metre and dry opium yield is used. The relationship is based on extensive field research and is described as:

$$Y = 1.89 + 0.0412\ V$$

where *Y* is dry opium weight (kg/ha) and *V* is the mature capsule volume (cm^3/m^2).

This formula has been developed based on data collected in Thailand and emphasizes the lower end of observed capsule volume. It is based on data varying between 0 and 900 cm^3/m^2.

However, high volumes exceeding 900 cm^3/m^2 were observed (particularly in Kachin). The formula was not validated for these ranges and would supposedly overestimate yields. To avoid overestimation, an alternative formula was used for fields where at least one plot exceeded said volume. This formula was calibrated with combined data from Pakistan and Thailand, and reads as

$$Y = \frac{[(V + 1{,}495) - ((V + 1{,}495)^2 - 395.259\ V)^{0.5}]}{1.795}$$

A range was calculated to express the uncertainty of the yield estimate due to sampling with the 95% confidence interval.[30]

In 2021, because of mobility restriction caused by the COVID-19 situation and the inability to visit fields after 1 February, yield data collection in the Shan State regions was limited. No fields were visited in North Shan and only 97 in South and East Shan together, a reduced number compared to previous years. To avoid that the data could bias the estimates and maintain the comparability with the previous estimates, a multi-year average yield of data from 2014 onwards was calculated, same as for the 2020 Myanmar Opium Survey, when data from Shan State were not collected.

The time frame for calculating the multi-year average was based on data quality. Starting from 2013, thorough data quality measures were introduced, and the yield survey methodology was adapted to be in line with international data quality assurance measures, applied in other countries, too, e.g. in Afghanistan. From 2014, photo evidence was collected in the fields, which allowed to accurately verify measurements. Available data from 2014 onwards fulfilled all data quality measures[31] and was thus used to calculate a multi-year average for each Shan State region.

For Kachin state the latest available data (from the 2020 yield survey) were used, and no multi-year average was applied, since the last yield survey before 2020 was carried out in 2015.

It has not been possible to conduct yield surveys in Kayah State since 2014 and not at all in Chin State and hence, yield values were derived from the national average yield (see following section).

Estimating national average yield

In 2021, national average yield was calculated based on the average yield of Shan and Kachin States and then weighed by cultivation estimate of the respective States. Hence, the national average yield is a combination of estimates derived from the yield measurement data collected in Kachin in 2020, and multi-year average estimates for each Shan State region.

Estimating opium production

Opium production was calculated by region/State as the result between the estimated area under opium cultivation and the corresponding opium yield. The total national potential opium production is a sum of regional estimates, weighted by cultivation.

All opium estimates in this report are expressed in oven-dry opium equivalent, i.e. the opium is assumed to contain 0% moisture. The same figure expressed in air-dry opium, i.e. opium under "normal" conditions as traded, would be higher as such air-dry opium contains some moisture.

30 $Y \pm 1.96 \frac{\sigma}{\sqrt{n}}$, where *Y* is the point estimate, *n* is the number of samples and σ is the standard deviation.

31 See Afghanistan opium survey report 2012, https://www.unodc.org/unodc/en/crop-monitoring/index.html.

The uncertainties of the opium production estimate in 2021 combine those due to sampling for the area under poppy cultivation and those related to the yield estimate. These uncertainties were calculated by using the standard method for error propagation. The point estimates and uncertainties of the area under poppy cultivation and yield can be expressed as $a_p \pm \Delta a$ and $y_p \pm \Delta y$ respectively, where the uncertainty is determined from the 95% confidence intervals. These uncertainties will impact on the estimate of production ($p_p \pm \Delta p$, or equivalently expressed as the range $[p_p - \Delta p, p_p + \Delta p]$), where the best estimate is $p_p = a_p y_p$. Therefore,

$$\frac{\Delta p}{p_p} = \sqrt{\left(\frac{\Delta a}{a_p}\right)^2 + \left(\frac{\Delta y}{y_p}\right)^2}$$

expresses the error in production (Δp), resulting from uncertainty in the estimates for cultivation area and yield.

The 2021 ranges around average national yield were calculated by using the uncertainty around yield estimates, that is the national lower/upper bounds are the averages of the regional lower/upper bounds weighted by the point estimates of the area estimates.

4.3 Estimating the value of opium economy in Myanmar

Estimating the value of Myanmar opium economy implies evaluating the amounts of raw opium and heroin which are used either for the domestic consumption or for export, along with their prices at every link of the chain. This means estimating and then combining multiple factors, using the best available data.

Due to the scarcity of reliable and/or updated data, especially on purity and conversion factor, the degree of uncertainties is significant and infers the use of range rather than point estimates.

The key components of the opium economy which have been estimated to derive the gross and net values of the opium economy in Myanmar are:

- The farm-gate value;
- The amounts of raw opium and heroin reaching the illicit end-consumer markets;
- The value of opiates market for domestic use;
- The value of opiates potentially available for export.

The farm-gate value

The farm-gate value is derived directly from the potential production of dry opium.[32] The national price per kilogram of dry opium used for the calculation is the weighted average of the farm-gate prices at harvest time of the two main producing regions of Shan State.[33] The lower and upper bounds of the farm-gate value reflect the range of the potential opium production estimate.

The amounts of raw opium and heroin reaching the illicit end-consumer markets

Opium can be either consumed as raw opium or further processed into heroin. Starting from the production figures, the estimate of the share of unprocessed opium entering the illicit markets is based on the direct opium consumption in the Southeast Asia region[34] and the comparison of the opium production levels between Myanmar and Lao PDR[35], which are supposedly the only opium providing countries in the region.[36] The remaining opium, after discounting opium seizure data, is deemed to be processed into heroin. A ratio of 10:1 is used for converting opium to heroin of unknown purity[37] and, after subtracting the reported heroin seizures, the amount of heroin reaching the end-consumer markets is obtained.

32 In this survey, price information was collected on fresh opium only. Farm-gate prices, however, were calculated for both fresh and dry opium to maintain comparability with the previous surveys. Farm-gate prices for dry opium were calculated on the basis of the ratio between fresh and dry opium prices of collected data in 2019. The applied exchange rate MMK/US$ is the 2020 DCE alternative conversion factor provided by the World Bank (https://data.worldbank.org/indicator/PA.NUS.ATLS?locations=MM)

33 Farm-gate prices at harvest time of fresh opium in East Shan and South Shan regions were collected during the yield surveys.

34 Source: *Transnational Organized Crime in Southeast Asia: Evolution, Growth and Impact 2019* (TOCTA-EAP), (UNODC, 2019).

35 Source: *Southeast Asia Opium Survey 2015 – Lao PDR, Myanmar* (UNODC, 2015).

36 The assumption is that the ratio between total opium production and unprocessed opium is the same for the two countries. Sources: *World Drug Report 2020* (UNODC, 2020), *Transnational Organized Crime in East Asia and the Pacific – A Threat Assessment (*UNODC, 2013) and *Transnational Organized Crime in Southeast Asia: Evolution, Growth and Impact 2019*, UNODC.

37 For countries other than Afghanistan, a traditional conversion ratio of opium to heroin of 10:1 is used. Source: *World Drug Report 2020, Booklet 3, p.79* (UNODC, 2020).

The value of opiates market for domestic use

The value of the domestic opiates market is given by:

(annual estimated domestic opium consumption x *typical retail opium price)*

+

(annual estimated domestic heroin consumption x typical retail heroine price adjusted for purity)

The estimates of opium and heroin consumed in Myanmar are based on:

- The prevalence of opiate use[38] in the country
- The respective proportions of opium and heroin users[39]
- The Myanmar population between 15 and 64 years old[40]
- The annual heroin[41] and opium[42] average consumption rates

The retail price of opium and the retail price of heroin in Myanmar is based on CCDAC data from 2021. The street price for heroin has been adjusted for purity, resulting in a range due to the uncertainties related to the purity of the retail market's heroin.[43]

The value of opiates potentially available for export

The amounts of opiates potentially available for export are derived by subtracting the domestic consumption from the opiates reaching the illicit market. The obtained opium and heroin quantities are then multiplied by the respective wholesale prices and summed to each other to find the value of the opiates export.

38 Annual prevalence for opiates is 0.8%. Source: UNODC, 2010 (https://dataunodc.un.org/data/drugs/Prevalence-general).

39 Heroin users represent the 90.5% of opiates users, opium users the 9.5%. Derived from 2020 treatment data reported by the CCDAC in 2021.

40 Source: World Bank.

41 The global annual average value of 22g of heroin is used, obtained from data from Australia's wastewater analysis (Source: https://www.unodc.org/documents/southeastasiaandpacific/Publications/2019/SEA_TOCTA_2019_web). The value was used to calculate the heroin market size in the region.

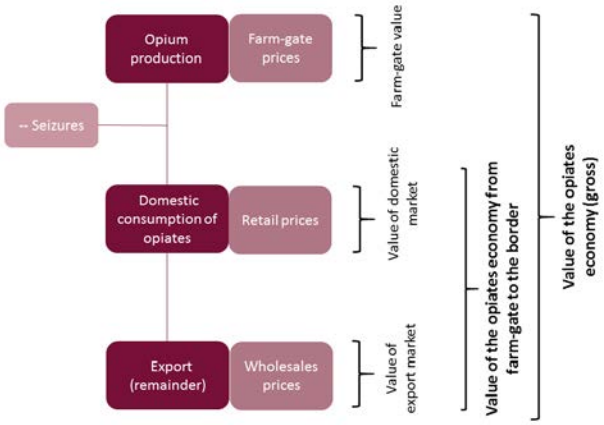
42 A value of 770g of opium for yearly consumption is used. Source: *Drug Use in Afghanistan* (Afghanistan Ministry of Counter-narcotics/ Afghanistan Ministry of Health/ UNODC, 2009).

43 Due to the lack of data on street heroin's purity in Myanmar, Thailand 2020 figure, reported at the 2020 SMART Regional Workshop, was used, which recorded a retail purity ranging from 42 to 92%.

Gross and net values of opiates economy in Myanmar

The gross value of the opiate economy is the sum of the value of the domestic market and the value of opiates believed to be exported.[44] The estimate of the value of manufacture and trafficking of opiates to the border excludes the farm-gate value, which is paid by first level traffickers to the farmers. A detailed analysis of the profits made at each stage need to consider other costs associated to the illicit drug business, for instance those related to manufacture and distribution, most importantly precursor substances. Due to lack of data it was not possible to include the above-mentioned components in this analysis.

Table 13: Workflow diagram of the analysis of the opiates economy's components



Uncertainties

There is a significant uncertainty around these estimates. While confidence in the opium production estimates is high, uncertainties around the conversion ratio from opium to heroin[45] stem mainly from the wide range of possible purities of the product and from the lack of data on the efficiency of the conversion from opium to heroin (i.e., how much opium is needed to produce 1kg of heroin; also see text box on page XY). Uncertainties around the demand estimate are mainly associated with the assumptions around annual opium consumption per user.

44 The gross value of opiates economy includes several components (e.g., costs associated to precursor substances, transports, processing, etc.), which are not considered in this analysis.

45 The amount of raw opium needed for producing 1kg of heroin depends on two main factors: i) the average morphine content of opium and ii) the efficiency of the heroin labs. To date there are no available studies that focus on opium's morphine content and/or heroin labs efficiency in Myanmar.

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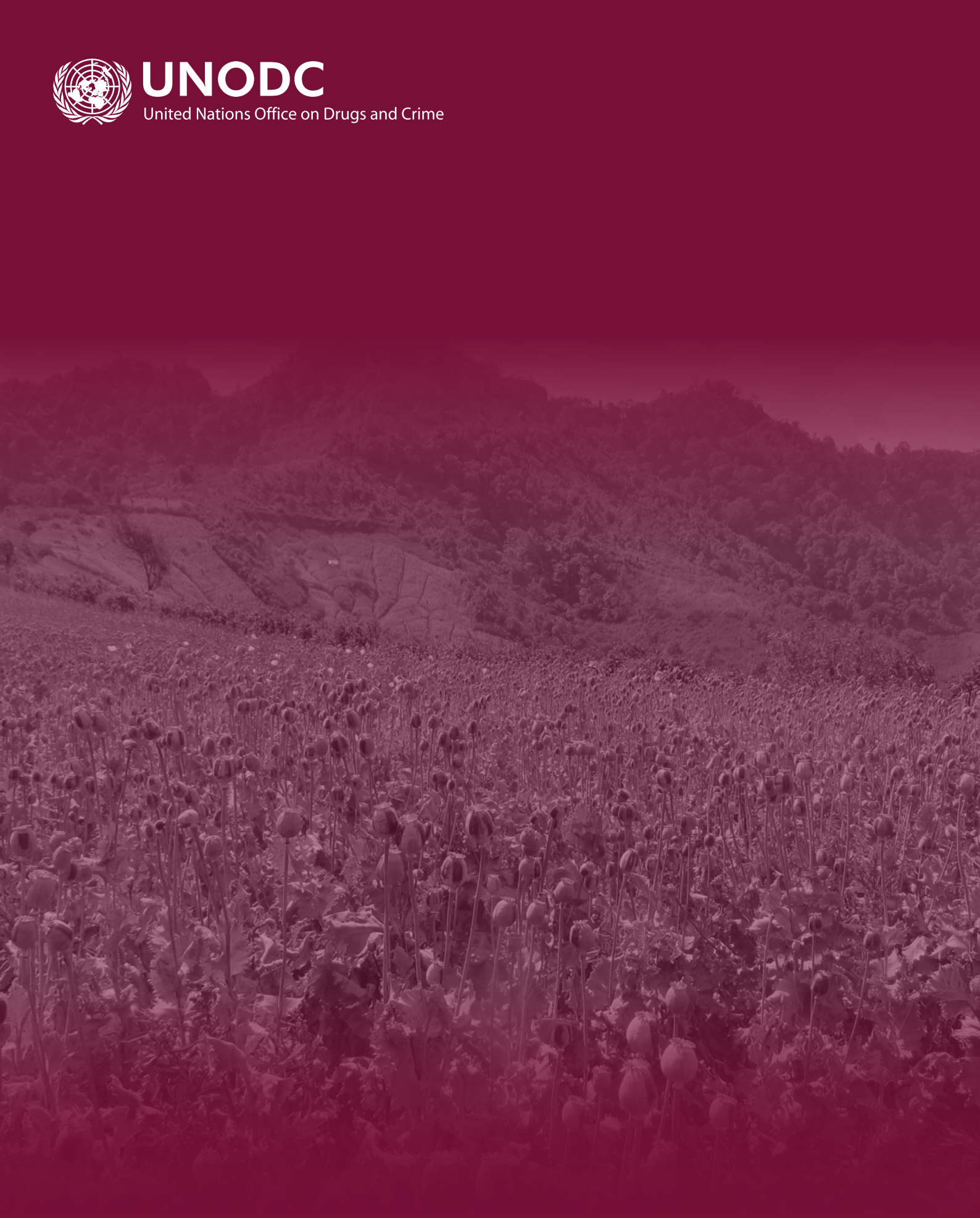

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