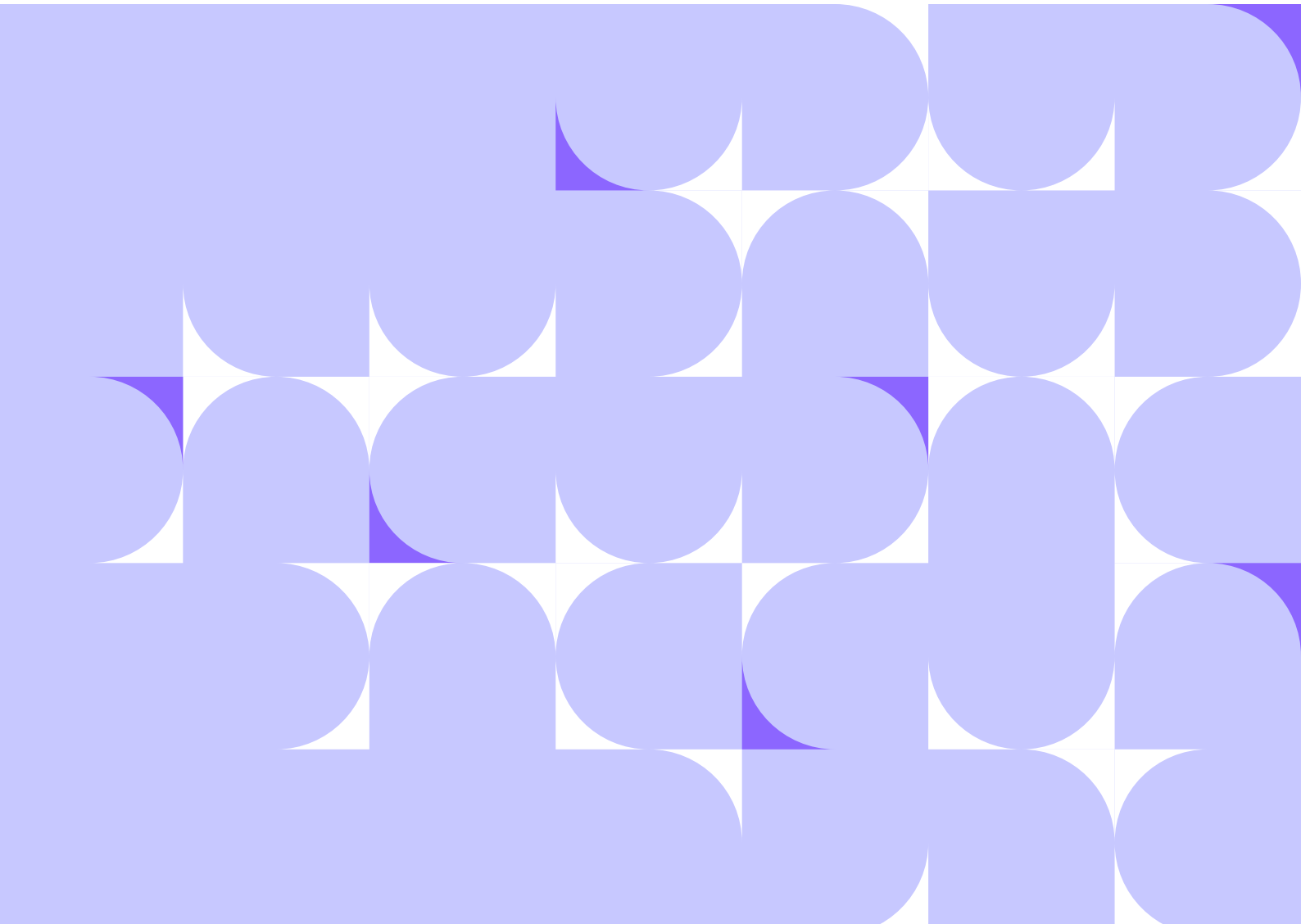
EUDA
EUROPEAN UNION DRUGS AGENCY

TECHNICAL REPORT

Drug production in Afghanistan and the region: innovative monitoring to better inform policy

October 2026



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Executive summary

Drug production in Afghanistan, historically the main source of heroin supplied to Europe, remains strategically significant because production systems adapt rapidly to political change, enforcement pressure and market demand. Taliban drug bans have reshaped, rather than removed, production, processing and storage, complicating monitoring and early warning. For policymakers, the core challenge is understanding how these systems evolve, relocate and absorb shocks before impacts are felt in European markets. This report clarifies what innovative data and methods can reliably indicate, where uncertainty remains, and why managing that uncertainty is central to effective policy.

Opiates: clearer trends, unresolved risks

Nationwide mapping of poppy cultivation is possible and provides a strong basis for tracking trends, displacement and the effectiveness and durability of bans. As a result, policymakers can be confident that large-scale cultivation dynamics can be better understood than before. However, uncertainty around opium yields remains a key issue, as it directly affects estimates of opium and heroin production. Yield uncertainty should therefore be treated as a strategic blind spot rather than a technical detail, warranting cautious interpretation of production figures.

Processing, adulteration and market resilience

Evidence points to significant adaptation in heroin processing, including greater specialisation, improved efficiency and more adulteration based on the demands from different markets. These shifts help explain why heroin remains available in Europe despite dramatically reduced cultivation, and why purity varies widely. For policymakers, this underscores that supply resilience is driven not only by cultivation levels, but by flexible processing and market segmentation, factors relevant for both enforcement and public-health responses.

Stockpiles: the key buffer

Large hidden opium stockpiles emerge as a central stabilising force in the system. These stores are concentrated in southwest Afghanistan, particularly in former desert areas where an area of approximately 237 000 hectares has been converted to agricultural use since 2003, supported by solar-powered deep wells. Farms in these former desert areas are large, and in the absence of viable legal alternatives, farmers have often dedicated up to half their land to poppy each year, thereby accumulating substantial stocks in the years prior to the imposition of the Taliban drug ban in 2022.

While inventories cannot be measured directly, multiple indicators suggest they remain substantial and have cushioned both Afghan producers and downstream markets against supply shocks. The policy-relevant signal is not stock size itself, but stock depletion. A rapid drawdown in stockpiles could provide an early warning of increased market volatility, supply pressure or incentives for substitution towards other opioids, including synthetic substances.

Relocation of cultivation to neighbouring countries

Afghan farmers have been at the forefront of increased poppy cultivation in the tri-border area between Pakistan, Iran and Afghanistan. Constrained by the Taliban drug ban, a growing number have relocated from southwest Afghanistan to lease or sharecrop land

largely in Balochistan in Pakistan and Sistan Balochistan in Iran, where they are increasingly monocropping poppy on large farms. Combined with the substantial stocks that remain in Afghanistan, this has put downward pressure on opium prices in the region and helped stabilise downstream supply. It is also leading to new areas of concentrated opium production and with it the risk of increased heroin processing.

Methamphetamine: high uncertainty, rising relevance

Methamphetamine production poses the greatest monitoring challenge. It is mobile, concealed and poorly captured by traditional monitoring indicators. While satellite imagery can identify ephedrine laboratories, producer dispersal limits national visibility, and no baseline estimate exists. Policymakers should therefore treat methamphetamine trends with greater uncertainty, but also as a growing strategic risk. Indicative national estimates are feasible, but only with sustained monitoring rather than one-off studies.

Policy implications

The key policy lesson is that early-stage monitoring of production environments, including cultivation patterns, processing behaviour, stock dynamics and precursor flows, offers greater strategic value than reliance on seizures or prices alone. Innovative methods should be used to provide more reliable trend analysis and early warning.

Policymaker take-aways (at a glance)

Afghan drug production adapts fast: Bans and enforcement reshape production, processing and storage rather than ending them, which reduces the value of static estimates.

Upstream signals matter most: Monitoring cultivation patterns, processing behaviour, stock dynamics and precursors provides earlier warning than seizures or prices.

Opiates remain buffered: Large stockpiles, improved processing and demand-driven adulteration help sustain supply to Europe despite reduced cultivation.

New areas of production are emerging: Opium production is increasingly concentrating in the tri-border area between Afghanistan, Iran and Pakistan.

Methamphetamine is a blind spot: Mobile and concealed production limits visibility; indicative estimates require sustained, repeatable monitoring.

Introduction

Drug production in Afghanistan remains a strategically important issue for Europe, not only because of its historical scale but because of the speed and sophistication with which production systems adapt to political change, enforcement pressure and market demand. For European policymakers, the central difficulty is not simply understanding how much is produced, but how production systems evolve, relocate and buffer downstream markets from supply shocks.

Despite a substantial body of historical research on drug production in Afghanistan, the availability of systematic, primary data has declined sharply since the Taliban takeover in August 2021. Long-standing insecurity, followed by political sensitivities after the April 2022 drug ban, has severely constrained independent reporting, international access and on-the-ground data collection, including for international organisations. Thus, the Taliban drug ban has exposed a set of structural challenges for monitoring, assessment and early warning. As a result, monitoring drug production now increasingly depends on adaptive, multi-method approaches to maintain credible reporting under restricted conditions.

This report addresses three interconnected challenges. First, much of drug production in Afghanistan now takes place in environments that have become more difficult to observe directly, whether because activities are concealed, geographically dispersed, in the case of ephedrine extraction and methamphetamine production, or reliant on wild-harvested ephedra rather than fixed cultivation. Second, traditional indicators such as seizures or survey-based estimates offer limited visibility into upstream changes and often reflect developments only after they have affected consumer markets. Third, different drug types pose fundamentally different measurement problems: opiate production increasingly lends itself to large-scale geospatial analysis, while methamphetamine production is more dynamic, mobile and far less observable using remote-sensing tools alone.

In response to these challenges, a growing body of work over the past decades has combined high-resolution satellite imagery, longitudinal field research, economic and livelihoods analysis, and operational modelling to refine what can be known about drug production in Afghanistan. These approaches do not eliminate uncertainty, but they substantially improve the ability to identify trends, assess adaptive behaviour and generate early warning signals relevant to Europe.

This report sets out what these innovative data sources and methods can realistically deliver for policymakers, where their limits lie, and why managing uncertainty is central to effective drug policy and monitoring in a rapidly evolving production landscape (see Limitations of innovative monitoring approaches).

Key challenges at a glance

Adaptive production systems: Drug production in Afghanistan responds rapidly to bans, enforcement and price signals, limiting the value of static estimates that are restricted within national boundaries.

Limited observability: Many critical dynamics, including yields, processing efficiency, stockpiles and methamphetamine production, are concealed or only partially visible through imagery.

Divergent measurement problems: Opiates and methamphetamine require fundamentally different monitoring approaches, complicating integrated assessment and comparison.

Late-stage indicators: Reliance on seizures and prices often captures changes only after they have affected European markets.

Limitations of innovative monitoring approaches

The methods described in this report provide important insights into cultivation patterns, production systems and market adaptation, but they also have limitations. Remote-sensing techniques can identify and monitor cultivated areas at scale, yet they cannot directly measure crop yields, stock levels, laboratory output or trafficking flows. Many of the estimates presented rely on combining geospatial analysis with interviews, field reporting and indirect modelling approaches, all of which are subject to a level of uncertainty and potential bias. For this reason, multiple methods of data collection are required to establish the veracity of findings.

The effective application of these approaches depends on field access, local contextual knowledge and specialist expertise in integrating geospatial, agricultural, economic and ethnographic sources of information. As with any monitoring framework, findings should therefore be interpreted alongside their underlying assumptions and considered as part of a wider body of evidence.

While innovative monitoring approaches can be resource-intensive, they can provide greater confidence in assessing illicit drug production and market dynamics. By integrating satellite imagery, field research and value-chain analysis, they can generate insights that may not be obtainable through conventional monitoring approaches alone.

Opiates production: multiple stages require different monitoring methods

The quality and robustness of the data required to monitor the production of opiates in Afghanistan vary significantly, with important implications for evidence-based policy development. Much of the available information continues to rely on in-country interviews, while the systematic use of innovative analytical techniques, particularly geospatial analysis using high-resolution satellite imagery, remains uneven. This heterogeneity affects the reliability, comparability and policy utility of estimates related to opium production and associated indicators.

Mapping poppy cultivation with confidence

Some indicators are particularly well suited to geospatial analysis. Estimates of poppy cultivation, for example, benefit from decades of methodological refinement, including the identification of the crop's distinctive visual signature, the differentiation of Afghanistan's multiple poppy growing seasons, and the ability to distinguish poppy from other crops. As a result, crop mapping based on satellite imagery provides a relatively robust empirical foundation for policy analysis in this area.

By contrast, other indicators pose significant methodological challenges. Estimates of opium yields and of heroin production are constrained by the limited availability of systematic ground verification, while variables such as conversion ratios lack any observable visual

signature and therefore cannot be derived directly from imagery. Similarly, concealed phenomena such as stockpiles remain inherently resistant to geospatial estimation. These gaps necessitate the continued use of derivative methods, increasing uncertainty and reducing the precision of downstream estimates, including heroin production.

For decades, both United Nations Office on Drugs and Crime (UNODC) and the United States Government's Crime and Narcotics Centre (CNC) produced estimates of poppy cultivation for major drug-producing countries. In Afghanistan these estimates often diverged at the national and provincial level because of differences in methods, including in the resolution and quantity of satellite imagery collected (Mansfield, 2017, 2018).

High-resolution satellite imagery was first incorporated into UNODC estimates in 2002, replacing earlier approaches based exclusively on visual field assessments. Over the years, imagery has been applied using different approaches across provinces, with distinctions made between major and minor poppy-growing areas, while ground-based surveys have continued in those categorised as 'poppy free' (UNODC, 2009, 2025). From 2015, UNODC utilised very high-resolution satellite imagery (spatial resolution of less than 0.5 metres) with collection in up to 28 of Afghanistan's 34 provinces.

In major producing provinces, where cultivation is geographically dispersed and widespread, UNODC's estimates of poppy cultivation are derived from a sample of images representing the total agricultural area. In those where cultivation is highly concentrated, satellite imagery collection focused on the parts of a province where poppy cultivation was reported. For the latter, imagery was only collected in high-risk areas, which along with the classification of 'poppy free provinces', creates the risk that some poppy-growing areas might be missed and that levels of poppy cultivation could be higher than those estimated (UNODC, 2024). This methodological distinction has persisted, with implications for confidence in national-level estimates ([1]).

Recent technological developments have important policy relevance. Declining costs of very high-resolution imagery, combined with advances in machine learning, now make it feasible to adopt a comprehensive 'census' approach to crop mapping. These methods, such as those developed by specialised geospatial providers, combine very high-resolution imagery and geotagged photography collected over many years to develop unique crop signatures, which, when combined with less granular imagery, support systematic mapping of cultivated land across Afghanistan using multiple rounds of imagery throughout the poppy growing season (Byrd, 2023). This approach can significantly reduce sampling bias, increase coverage and improve comparability across provinces with diverse agro-ecological conditions and cropping calendars.

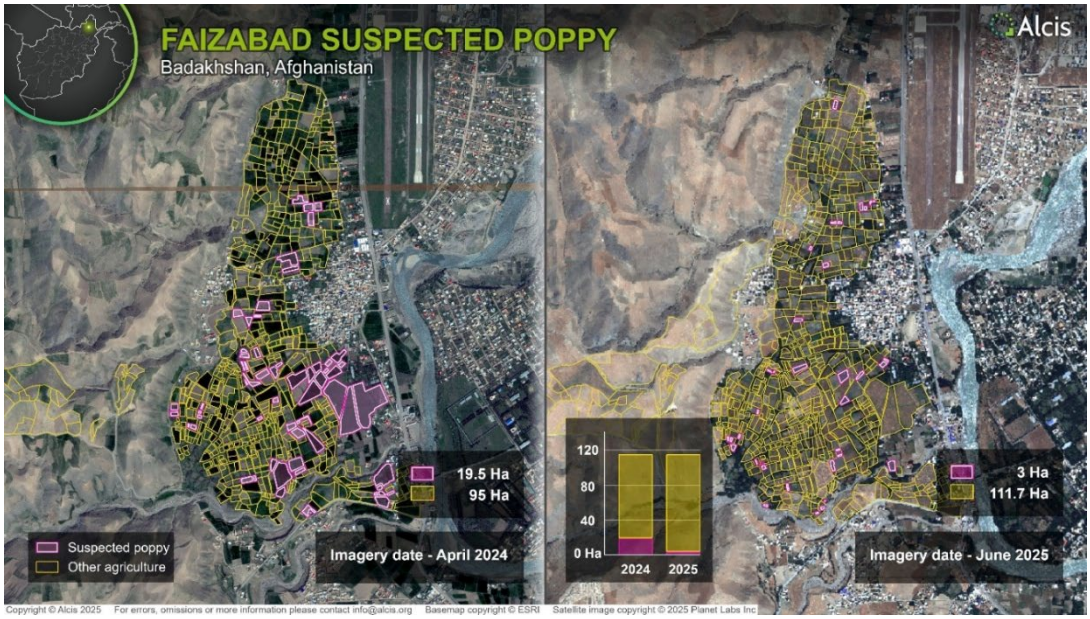
Ultimately, different methods come with different trade-offs: while lower resolution imagery might allow for cost saving and wall-to-wall mapping of multiple crops which can then be integrated with other geospatial datasets, it can also increase classification uncertainties. This is particularly the case where insufficient investment has been made in developing unique crop signatures. In contrast, very-high-resolution imagery does not allow for comprehensive mapping or capture all areas but can lead to higher accuracy in classification over the areas where imagery is collected.

From a policy analysis standpoint, full-coverage crop mapping enables more granular and spatially explicit assessments. Identifying the precise location of poppy fields supports

([1]) See https://www.unodc.org/unodc/en/data-and-analysis/drug-cultivation-production-and-manufacture.html for detailed methodological descriptions.

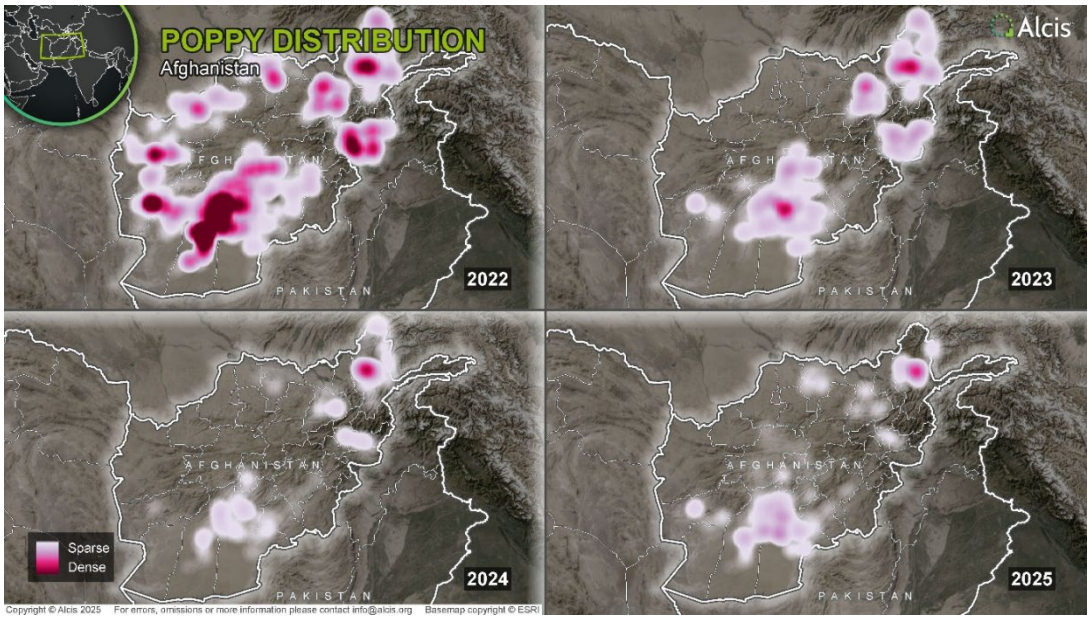
improved monitoring of cultivation dynamics, eradication efforts and displacement effects (see Figure 1). The creation of consistent, multi-year datasets (currently extending back to 2019) also allows for robust trend analysis and evaluation of policy interventions over time (see Figure 2). Importantly, the same techniques can be applied to alternative livelihood crops, such as orchards and vineyards, enabling policymakers to assess whether substitution strategies are being adopted and whether bans on poppy cultivation are likely to be sustained.

Figure 1. Satellite imagery of area around Faizabad airport, Badakhshan



Note: The imagery shows reductions in levels of poppy cultivation and expansion of 'other crops' between 2024 and 2025.

Figure 2. Census-based satellite imagery assessment of poppy cultivation in Afghanistan, 2022 to 2025



Note: The imagery analysis shows an overall decline in cultivation and increasing concentration in the northeastern region.

Moreover, the integration of additional data layers, such as household compounds, infrastructure, eradication activity and vegetation indices, such as normalised difference vegetation index (NDVI), enhances the analytical value of imagery-based data. These layered analyses support more sophisticated policy assessments, including estimates of the populations affected by cultivation and prohibition measures, and the broader socio-economic impacts of drug control interventions.

Yields and production: why imagery is not enough

Nevertheless, for most other indicators in this area, imagery plays only an indirect role. Estimates remain heavily dependent on the combination of imagery-derived cultivation figures with interviews and field observations conducted in situ. In this context, estimates of opium yields are a critical bottleneck, as they directly determine national estimates of opium production and, by extension, potential heroin production.

Uncertainty at the yield stage therefore propagates through multiple downstream indicators that are central to drug control policy and international assessments. Addressing these methodological constraints is essential to strengthening the overall policy relevance and credibility of the evidence base.

For decades, UNODC's yield estimates in Afghanistan have been based on poppy capsule measurements, which infer yield from capsule size, based on earlier work in Thailand and Pakistan, supplemented by farmer interviews (UNODC, 2001). In the past, UNODC also worked with the Afghan authorities to collect field data, but this has not been possible since the Taliban takeover in 2021. In 2024, in the absence of ongoing field data collection, UNODC adopted a remote-sensing-based yield measurement approach, adapting the Global Agriculture Monitoring System (GLAM) ([2]). As with any modelling approach, it has limitations in situations where field-based validation and access are limited, as the model would be ideally fed with up-to-date yields obtained from field measurements. The historical data fed into the model may also lead to underestimates of the yields obtained, since insecurity and restricted access in areas where poppy cultivation is most concentrated have limited data collection towards more secure locations, reducing its representativeness. Furthermore, improved farming practices may have led to increased yields over the years.

From a policy perspective, both approaches have limitations. Estimates derived from the poppy capsule method are consistently lower than those reported by farmers and traders directly involved in opium production within Afghanistan, as well as lower than yields reported in countries with broadly comparable environmental conditions, such as India and Pakistan. Although such interviews are subject to reporting and selection biases, the divergence merits further examination, particularly with regard to the geographic representativeness of the underlying data. One plausible explanation is sampling bias, driven by the limited number and geographic distribution of in-situ data collection. The difficulty of collecting capsule data under controlled conditions in the insecure southwest, where the majority of Afghanistan's poppy was cultivated and where more favourable environmental conditions and advanced farming practices are common, introduces further uncertainty in the national representativeness of these estimates.

([2]) University of Maryland, https://glad.umd.edu/projects/global-agriculture-monitoring-glam-project.

In theory, imagery-based yield estimation could help address some of these limitations. However, such an approach would still require extensive ground access for the measurement of capsules and validation across multiple agro-ecological zones and terrains.

This remains highly constrained due to the Taliban's unwillingness to cooperate with and give access to international organisations for drug-related data collection. As a consequence, UNODC continues to rely on datasets collected during the later years of the Afghan Republic period (2004-2021). While the use of historical datasets and geographically constrained field measurements provides a transparent and consistent basis for estimation, this has resulted in lower estimates of opium production in Afghanistan. This is relevant when considering projections regarding the pace of stock depletion and the potential duration of existing opium stocks (UNODC, 2026).

In 2024, UNODC sought to address these constraints by producing a 'yield forecast' that combined geospatial indicators (such as NDVI, precipitation and soil moisture) with historical yield estimates derived from the capsule method. While this represents an important methodological adaptation, the policy reliability of such forecasts remains contingent on the assumptions embedded in historical yield data obtained from the poppy capsule method.

In this context, longitudinal qualitative and quantitative data collected from farmers, traders and other key informants directly involved in the opium economy over many years are important. Evidence gathered across multiple locations, including data collected since the Taliban assumed power in 2021, has proven more resilient to access constraints and, in aggregate, offers a strong basis for estimating yields and total opium production. Much of this information derives from sustained research with farmers by the Afghan Research and Evaluation Unit (AREU) ([3]), prior to the collapse of the Afghan Republic and subsequent research following the Taliban takeover.

From a policy standpoint, this reliance on long-term, multi-source informant data underscores both the adaptability of the monitoring system and its structural vulnerability. While such datasets enhance continuity and trend analysis, given their central role in shaping national and international drug control policy, they also highlight the need for future investment in methodologies that reduce dependence on insecure access and improve the empirical robustness of yield estimates.

From opium to heroin: rethinking processing and markets

Estimates of the amount of heroin produced in Afghanistan have largely been derived from interviews with a limited number of key informants regarding the conversion rate between opium and morphine base, morphine base to heroin base, and finally, heroin base to heroin hydrochloride. This conversion rate is then applied to the estimate of the total amount of opium produced in Afghanistan (poppy cultivation estimate multiplied by yield).

([3]) The Afghan Research and Evaluation Unit was an independent research organisation operating in Kabul, Afghanistan until 2025. It provided a firm basis for policy and practice in the country's rapidly changing environment by conducting in-depth, on-the-ground research across several sectors, including rural livelihoods and the opium economy.

Conversion rates under pressure

Forensic analysis of heroin production in Afghanistan has been restricted to an experiment conducted by Germany's Bundeskriminalamt (BKA) in Kabul in 2004. This involved two Afghan heroin processors producing heroin hydrochloride from seized opium under the supervision of the Counter Narcotics Police Afghanistan (CNPA) (Zerell et al., 2005). The output from each stage of the process was then weighed, and samples were sent to Germany for analysis. At the time, an expert witness recalls, the processors complained about the quality of the opium that they were given by the CNPA, suggesting it had affected the amount of morphine extracted. It is also possible that the conditions of the experiment affected the processors' performance, especially since it remains unclear whether they were under arrest or paid for their involvement. The conversion rate achieved under this experiment (18.5 kilograms of opium used to produce 1 kilogram of heroin hydrochloride) is used by UNODC in their methodology for estimating the potential amount of heroin produced from the Afghan opium crop, with a range offered for the purity for what is termed 'export quality' (UNODC, 2018).

However, the forensic analysis conducted by BKA is now two decades old, and data on the morphine content of Afghan opium are more than one decade old. Moreover, detailed economic analysis suggests that a conversion rate of 18.5 kilograms of opium to produce 1 kilogram of heroin hydrochloride would result in considerable economic losses for heroin producers given that opium prices in Afghanistan have increased at a much greater rate than the prices of its derivatives following the Taliban poppy ban in 2022 (EUDA, 2025) (see also Improved heroin production efficiencies and updated conversion rates, below).

Improved heroin production efficiencies and updated conversion rates (2025)

Research conducted in 2025 with heroin lab owners and processors indicates that conversion efficiencies have improved significantly compared with the 2004 BKA experiment, reinforcing earlier indications of adaptation in processing practices. These improvements appear to be driven primarily at the morphine base stage, which processors consistently identify as the critical bottleneck for both yield and downstream product quality. Reported gains are associated with higher quality opium inputs, access to good quality water, prolonged and more consistent processing, enhanced chemical inputs and upgraded equipment (e.g. electronic scales, hydraulic presses). Increased specialisation across production stages — reflecting a growing division of labour between processing steps — and the use of multiple extraction cycles further reduce waste and improve overall yields. These developments appear to reflect adaptive responses to changing conditions, notably the increase in opium prices following the Taliban's drug ban, with greater reliance on adulteration practices to manage margins and meet differentiated market demand. Taken together, these findings suggest that processing practices have evolved since the earlier experimental work undertaken by the BKA, and that conversion efficiency varies according to opium quality, processing conditions and production practices.

Opiates conversion rates

Stage¤	Conversion·rate·(range)¤	Notes¤
Opium·to·morphine·base¤	7.8–9.5:1¤	7.8–9.5·kg·of·opium·yields·1°kg·of·morphine·base¤
Morphine·base·to·heroin·base¤	1:0.70–0.77¤	1·kg·of·morphine·base·yields·↵ 0.70–0.77°kg·of·heroin·base¤
Heroin·base·to·heroin·hydrochloride¤	1:0.80–0.84¤	1·kg·of·heroin·base·yields·0.80–0.84°kg·of·heroin·hydrochloride¤
Opium·to·heroin·base·(derived)¤	10.2–13.6:1¤	10.2–13.6·kg·of·opium·yields·1°kg·of·heroin·base¤
Opium·to·heroin·hydrochloride·(derived)¤	12.8–16.7:1¤	12.8–16.7·kg·of·opium·yields·1°kg·of·heroin·hydrochloride¤

Adulteration and demand-driven opiates production

Recent research undertaken as part of this EUDA project has significantly reshaped policy-relevant understanding of how opiate markets linked to Afghanistan function, particularly regarding heroin processing and adulteration. Prevailing assumptions have long held that adulterants found in opium derivatives originating from Afghanistan were primarily the result of limited technical capacity among local heroin processors or were introduced downstream by traders seeking to maximise profits. Emerging evidence challenges this narrative and points to a more complex, demand-driven production system.

This research indicates that cross-border traders play an active and directive role in the processing stage. Rather than accepting a standardised product, traders commission derivatives from laboratories in Afghanistan and specify both the degree of adulteration and the precise mix of substances to be added. These decisions are shaped by the characteristics of destination markets, including consumer preferences, perceived quality, risk tolerance and the price point that end users can afford. From a policy perspective, this highlights a higher level of organisation and market responsiveness within Afghan-linked production systems than was once assumed.

Findings from EUDA research conducted in 2024 further underline this differentiation. Laboratories in different parts of Afghanistan were shown to use a wide and varied mix of adulterants, including active pharmaceutical ingredients (caffeine, for instance) in situations where heroin base was in limited supply. The research also documented a marked increase in orders for adulterated opium derivatives following the Taliban ban, coinciding with a sharp rise in opium prices. At the same time, derivatives destined for the European market were found to be less adulterated, reflecting the premium prices paid by traders supplying this route and the higher quality expectations of consumers. These dynamics underscore the existence of segmented markets with distinct production specifications rather than a single, homogeneous supply chain.

From a policy standpoint, these differentiated market structures help to explain two otherwise paradoxical developments: the continued availability of opiates in Europe despite the Taliban's prohibition on poppy cultivation, and the wide variation observed in the purity of heroin seized from Afghanistan-linked supply routes. They suggest that supply resilience is supported not only by stockpiles and trafficking adaptations, but also by flexible processing practices tailored to specific markets and price bands.

These findings also point to important gaps in current intelligence and monitoring approaches. They indicate that greater analytical value could be derived from systematic engagement with heroin processors and cross-border traders, particularly when combined with forensic and chemical profiling of seizures. A more detailed understanding of adulterant types, mixing practices and their geographical variation could provide actionable insights into production locations, trafficking routes and intended destination markets.

Recognising these opportunities, heroin processing practices and the use of adulterants were identified as priority areas for primary research. From a policy perspective, strengthening evidence in this field has the potential to improve supply-side threat assessments, inform targeted interventions along trafficking routes, and enhance the interpretative value of forensic data used by law-enforcement and public-health authorities.

Opium stockpiles: why hidden inventories matter for policy

Estimating how much opium is stored inside Afghanistan is one of the most difficult, yet policy-relevant, aspects of understanding the opiate market. Stockpiles have no visual signature and are deliberately concealed, meaning they cannot be measured directly. Farmer reporting provides only a partial picture: while farmers often acknowledge holding opium, they systematically understate quantities, primarily due to concerns about theft and, to a lesser extent, interdiction. Moreover, stocks are likely held along the entire supply chain.

Despite this, multiple independent indicators suggest that substantial volumes of opium remain stored. This challenges long-standing assumptions that most farmers sell their opium within a year of harvest. Evidence supporting the existence of large inventories includes geospatial analysis of cultivation patterns, detailed economic and livelihoods data, falling opium prices inside Afghanistan despite production bans, and the continued supply of opiates to Europe after three consecutive years of sharply reduced poppy cultivation.

An indirect but policy-relevant method

Given these constraints, in 2024 Alcis adopted an indirect but policy-relevant approach to estimating stockpiles (Mansfield, 2024). Rather than attempting to observe opium stocks directly, the analysis combined several layers of geospatial data — including household compounds, landholdings and historical poppy cultivation — across the former desert areas of southwest Afghanistan. There, an area of approximately 237 000 hectares has been brought into agricultural use since 2003. With an average size of 4.9 hectares, farms in these former desert areas are markedly larger than those in traditional surface-irrigated areas, enabling extensive household poppy cultivation and the accumulation of stocks each year. This allowed analysts to estimate how much poppy an average household cultivated between 2019 and 2023, how many households were involved, and the scale of production accumulated over multiple seasons. These geospatial insights were then combined with detailed livelihood and economic analysis to assess how households manage income under the Taliban poppy ban.

Linking stockpiles to household survival

The livelihoods analysis examined household expenditures in detail, including the income needed to meet basic subsistence (using the international poverty threshold at the time of USD 2.15 per person per day) as well as major, socially important costs such as marriage expenses, vehicles or replacement of irrigation infrastructure. These expenditure requirements were compared with income generated from legal crops after the imposition of the ban.

Where legal crop income fell short, the analysis assumed households would draw on opium stocks to meet their needs, an assumption reinforced by the dramatic increase in opium prices following the ban. This framework shifts the focus from abstract tonnage estimates to how stockpiles function as a financial buffer for rural households (Mansfield, 2024).

Scale of inventories and why they persist

Using this approach, the analysis estimated that very large volumes of opium, approximately 13 700 tonnes, were stored by farmers in former desert areas of the southwest in 2023. This reflects structural factors that policymakers need to understand, such as large average landholdings, high levels of poppy cultivation per farm, and a long history of accumulated production in these areas.

Additional inventories were estimated in surface-irrigated areas with smaller landholdings, bringing the total estimated stock in the southwest alone to around 16 550 tonnes in 2023. While precise figures remain uncertain, the analysis supports the conclusion that substantial inventories were present and capable of buffering supply over an extended period. The duration of that buffering effect depends on rates of release, processing and demand.

Different methods, different conclusions

In 2025, UNODC estimated opium stockpiles at 13 200 metric tonnes (at the end of the 2022 season), most of which were held by traders rather than farmers (UNODC, 2025) ([4]). However, these estimates rely on older yield data and farmer interviews conducted in 2019,

([4]) In June 2026, UNODC estimated that any remaining stocks in Afghanistan would run out by the end of the year (UNODC, 2026).

at a time of lower opium prices and in regions where landholdings and incentives to store opium were fewer.

From a policy perspective, the key issue is less about which estimate is numerically higher and more about the assumptions and data sources underpinning each assessment. While both approaches indicate the existence of substantial opium stocks following the ban, differences in methodology can lead to different conclusions regarding their size, distribution and rate of depletion.

Why stockpiles matter inside Afghanistan — and for Europe

Opium inventories have played a stabilising role inside Afghanistan. High prices and accumulated stocks have insulated land-owning farmers in the southwest from the economic impacts of the Taliban's drug ban. This has been politically consequential: these areas form part of the Taliban's core support base and have supplied many of its fighters. As long as inventories remain substantial, there is limited economic pressure on these farmers to oppose the ban or to revert immediately to large-scale cultivation. At the same time, research and high-resolution imagery have shown that land-poor farmers who no longer hold inventories are increasingly moving to Balochistan in Pakistan (Mansfield, 2025), as well as Sistan-Baluchestan in Iran (Mansfield, 2026a), to cultivate poppy there (see Figure 3 and Figure 4).

For Europe, despite signals of reduced supply in some places, the existence of stockpiles helps to explain why heroin supply has not collapsed despite the sharp reduction in poppy cultivation in Afghanistan. Inventories have acted as a buffer in upstream markets and may also have delayed or reduced pressure towards more abrupt market shifts such as increased consumption of synthetic opioids. Increased cultivation in Pakistan and Iran will also go some way to offset reduced cultivation in Afghanistan and mitigate the threat of shortages in opiates to downstream markets, including in Europe.

Figure 3. The geographic spread of poppy cultivation in Balochistan, Pakistan in 2025

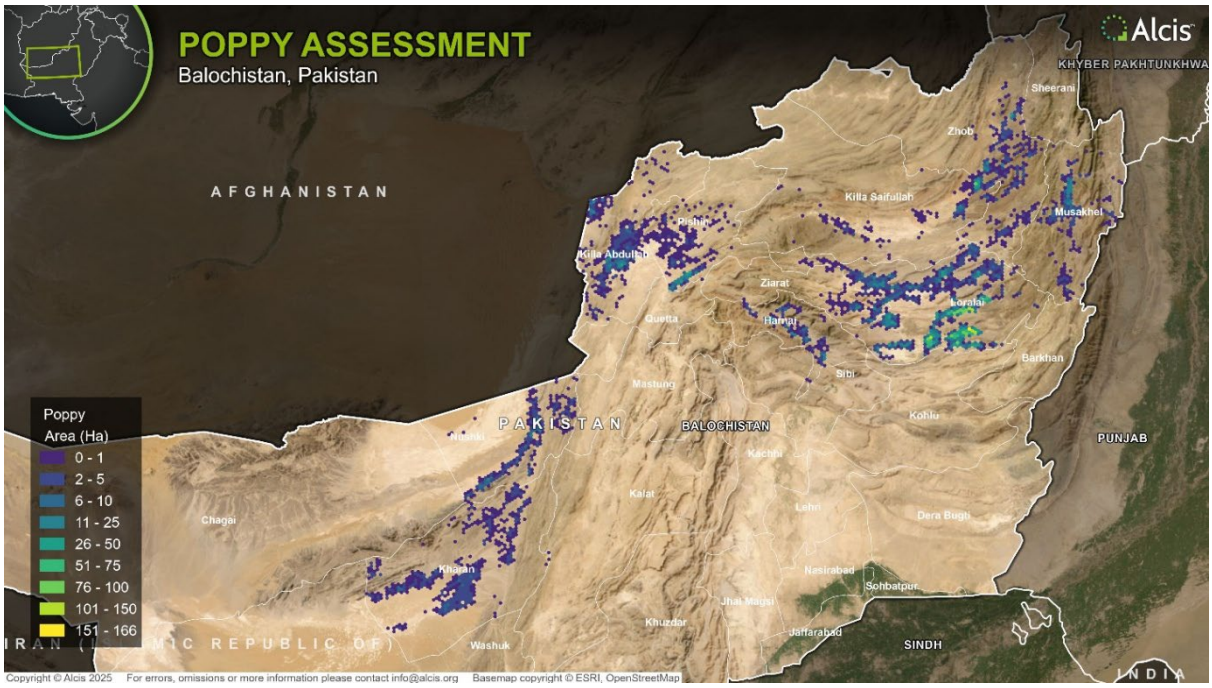
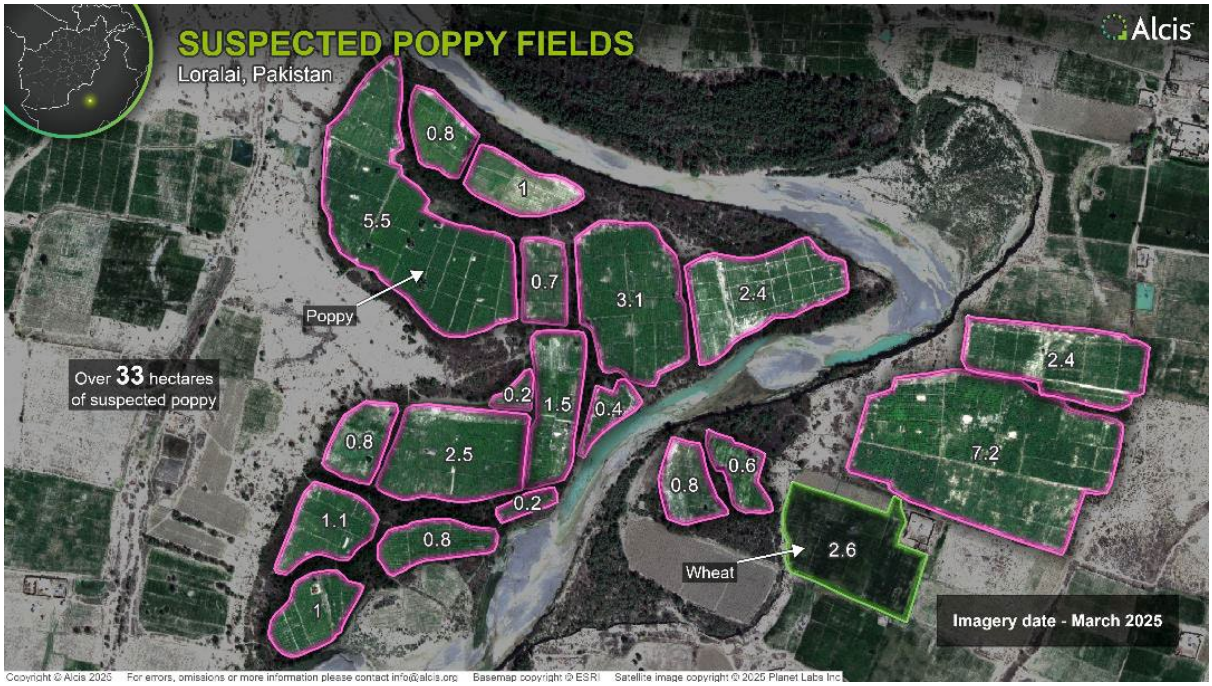


Figure 4. Satellite imagery showing concentrated poppy cultivation in Loralai in Balochistan, Pakistan

Note: Some fields are in excess of 7 hectares.



What to monitor going forward

Because opium stockpiles cannot be observed directly, there is limited value in extending geospatial analysis at this stage. Instead, the most policy-useful mixed-method monitoring strategy combines:

- geospatial analysis of household compounds, land sizes and cropping patterns,
- livelihoods and economic analysis of household income gaps,
- estimates of how much opium must be sold annually for households to meet basic and extraordinary expenses, and
- assessments of household coping strategies in the face of shocks and the degree to which some crops are stored.

Integrated with other indicators such as trafficking flows, prices and heroin processing trends, this approach can provide early warning signals of stock depletion.

Methamphetamine: a newer, less visible production system

Compared to opiates, methamphetamine production in Afghanistan represents a recent development within the country's illicit drug economy and remains significantly understudied, with clear implications for policy formulation and threat assessment. The limited empirical evidence available to date has been generated primarily through targeted research initiatives rather than through routine international monitoring mechanisms. Much of the existing primary data has been generated through a limited number of targeted research initiatives by the lead author of this report in collaboration with Alcis, with funding from organisations including the EUDA, Overseas Development Institute (ODI) and the London School of Economics and Political Science (LSE). Alcis has also provided further insights into the effects of the Taliban's drug ban on methamphetamine production. This concentration of expertise and data generation underscores both the progress made and the fragility of the current evidence base.

UNODC has also contributed to the evidence base by modelling the theoretical amounts of various inputs needed to produce 1kilogram of methamphetamine. UNODC estimated that approximately 2 kilograms of industrial-grade (pseudo)ephedrine, compared with around 200 kilograms of dried ephedra, would be required to produce 1 kilogram of pure methamphetamine (UNODC, 2023).

UNODC's assessment highlighted the potential role of industrial-grade (pseudo)ephedrine and pharmaceutical preparations in methamphetamine manufacture. However, the primary evidence on the extent to which these inputs are currently used in Afghanistan remains elusive. In addition, the assessment was produced under significant constraints on access and primary data collection and therefore relied mainly on desk-based analysis and available secondary sources, which did not include an analysis of the ephedrine content of ephedra plants grown in Afghanistan. The assessment also included high-resolution imagery of ephedra, although this component focused on a low-lying area in Kyrgyzstan. This differs from Afghanistan, where ephedra is largely harvested from wild plants in the mountains. Field reporting undertaken for the project suggests that ephedra harvested from shaded, higher-altitude locations in Afghanistan contains higher concentrations of ephedrine and commands higher prices (see Figure 5). Overall, expanding the knowledge of the scope of methamphetamine manufacture in the region will be important to improve the understanding of the sourcing and supply of the drug.

Figure 5. Ephedra growing wild at high altitude in Afghanistan



Note: The best quality crop grows in high altitude areas in the shade. In these areas, harvesters cut new growth that is green-red in colour and will attract higher prices.

From a policy perspective, this reflects the broader challenges associated with analysing a rapidly evolving and relatively new drug market under conditions of restricted access. The absence of repeated assessments using aligned methodologies reduces the scope for systematic trend analysis, impact assessment of enforcement measures and early identification of shifts in production and trafficking patterns. It also affects the degree of comparability between methamphetamine estimates and the more established and mature evidence base available for opiates, pointing to an area where further methodological development and data integration could enhance the overall analytical framework as the drug market landscape continues to evolve.

The limits of satellite imagery

Efforts to use satellite imagery to estimate methamphetamine production volumes in Afghanistan face significant structural challenges. Ephedra grows wild across extensive and ecologically diverse areas, often intermingled with other vegetation, making it extremely difficult to identify reliably using remote sensing (see Figure 6). Unlike cultivated crops with distinctive visual signatures, ephedra does not lend itself easily to large-scale imagery-based quantification. Furthermore, methamphetamine laboratories are typically embedded within residential compounds, with production taking place indoors and generating minimal visible waste. As a result, illicit laboratory locations are largely indistinguishable from civilian structures using imagery alone.

Figure 6. Ephedra growing wild in low-lying areas



Note: Ephedra growing in low-lying crop areas in direct sunshine will have much of its ephedrine content leached and attract much lower prices, and may not even sell.

These constraints highlight a broader policy challenge: existing remote-sensing approaches that have proven effective for monitoring poppy cultivation cannot be straightforwardly transferred to methamphetamine production. Without scalable means of observing precursor availability and production infrastructure, assessments of methamphetamine output remain highly uncertain. This increases reliance on indirect indicators and expert judgement, while also reducing the confidence with which policymakers can evaluate the effectiveness of bans, precursor controls and alternative livelihood interventions.

Taken together, these limitations point to a critical need for sustained investment in primary research, mixed-method approaches and longer-term monitoring programmes focused specifically on methamphetamine in Afghanistan. Strengthening this evidence base is essential if policy responses are to keep pace with the diversification of Afghanistan's drug economy and to avoid blind spots that could undermine both regional security and public-health strategies further along trafficking routes and in consumer markets.

Where imagery does work: ephedrine laboratories

Compared to methamphetamine production itself, there has been considerably greater success in using high-resolution satellite imagery to identify the laboratories where ephedra is processed into ephedrine, the main precursor used to manufacture methamphetamine in Afghanistan. From a policy perspective, this represents an important analytical leverage point. Ephedrine production requires large volumes of ephedra, specialised equipment, and generates solid and liquid waste, all of which increase its observable footprint relative to downstream methamphetamine synthesis. These characteristics make ephedrine

laboratories more amenable to detection via remote sensing than methamphetamine laboratories embedded in residential compounds ([5]).

When combined with empirically derived conversion ratios between ephedra and ephedrine, and between ephedrine and methamphetamine, the identification of ephedrine laboratories has enabled the derivation of indicative estimates of ephedrine output, potential methamphetamine production, and the volume of ephedra required to sustain the industry. While indirect, this approach has provided one of the few scalable methods for estimating methamphetamine production in Afghanistan in the absence of systematic access on the ground.

Nonetheless, this methodology comes with significant resource and capability requirements. Reliable identification of ephedrine laboratories depends on very high-resolution imagery, typically at 30 cm per pixel or higher, as well as the availability of highly skilled and experienced imagery analysts. These prerequisites have cost and capacity implications that limit scalability, particularly across Afghanistan's vast and varied terrain.

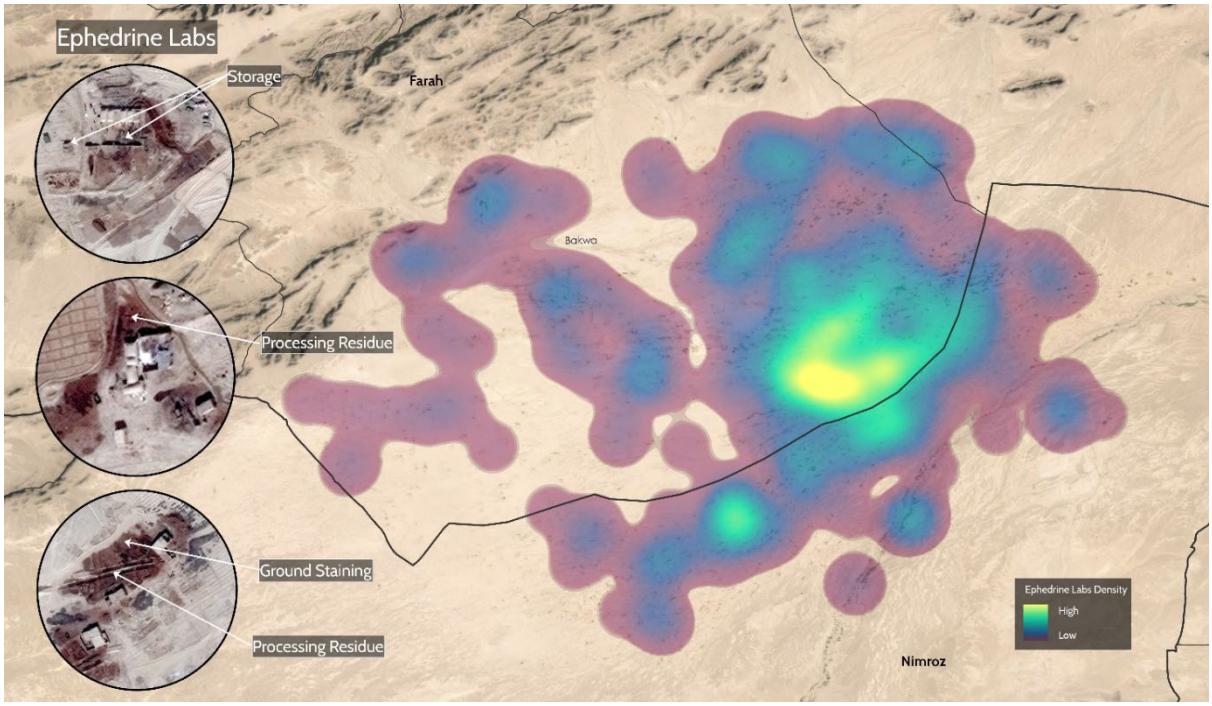
The EUDA's support for the first such assessment in 2020, focusing on Bakwa district, then a major hub for ephedrine and methamphetamine production, demonstrated the feasibility of this approach, with a total of 329 ephedrine facilities identified in the district (EMCDDA, 2021). Subsequent work for ODI in 2021 expanded coverage to the neighbouring district of Khashrod and identified an additional 119 facilities, bringing the total to 448 ephedrine laboratories in Bakwa and Khashrod (Figure 7). At the time, these facilities were assessed as having the potential to produce, per year, approximately 1 586 tonnes of ephedrine, convertible into an estimated 1 064 tonnes of methamphetamine, requiring roughly 47 880 tonnes of ephedra ([6]).

From a policy standpoint, these findings underscored both the industrial scale of ephedrine production at that time and the shortcomings of assessments limited to single districts or provinces.

([5]) In contrast, use of higher purity, industrial-grade precursor chemicals or ephedrines extracted from cold medications allow for more efficient production of methamphetamine which is easier to conceal (UNODC, 2023). Field research from several years ago noted the use of cold medication remedies as starting material for methamphetamine manufacture in Afghanistan, but research funded by the EUDA found that this method was largely abandoned in 2017 because ephedra-based production proved both more cost-effective and better suited to large-scale manufacture (EMCDDA, 2020; UNODC, 2023). This does not exclude the potential use of pharmaceutical or industrial-grade precursors, although evidence of large-scale methamphetamine production using these precursors in Afghanistan remains elusive.

([6]) Subsequent research suggests that conversion rates between ephedra and ephedrine have improved since the imposition of the Taliban ban (Mansfield, 2026b).

Figure 7. High-resolution imagery analysis showed 448 ephedrine laboratories in Bakwa and Khashrod in 2021



Further analysis by Alcis revealed structural dynamics with direct policy relevance. Very high-resolution imagery from other regions showed that ephedrine production had begun to relocate as early as 2018, with laboratories dispersing into districts in the central highlands and western Afghanistan, indicating that the 2021 estimates for Bakwa and Khashrod captured only a partial picture, and that significant production was already occurring elsewhere. Following the Taliban's closure of the main production hub in Bakwa district in late 2022, ephedrine production became even more geographically dispersed, with laboratories moving into central highland areas characterised by difficult terrain, sparse infrastructure and wide spatial coverage (Mansfield, 2023). This has substantially increased the cost and complexity of imagery-based monitoring, as larger areas must now be covered with very high-resolution imagery to detect a smaller number of facilities.

From a policy perspective, this dispersion reflects adaptive responses by producers to enforcement pressure. As the Taliban extended the drug ban into the central highlands, laboratories relocated to more remote valleys and adjusted practices, including more discreet waste disposal. These changes have reduced detectable signals, increasing the effort required for identification.

Overall, this highlights both the value and the limits of imagery-based monitoring. While ephedrine laboratories remain one of the few observable points in Afghanistan's methamphetamine supply chain, ongoing adaptation and geographic dispersal are progressively reducing visibility. This underscores the need for continued use of high-resolution imagery, specialist analytical capacity and complementary data sources to sustain effective monitoring as production strategies evolve.

Geographic dispersal and monitoring implications

The unexpected trajectory of Afghanistan's methamphetamine industry, its rapid geographic dispersion in response to the Taliban's drug ban and the demanding imagery requirements have resulted in a persistent national-level data gap. To date, there has never been a comprehensive estimate of the total number of ephedrine laboratories operating across Afghanistan from which national methamphetamine production estimates could be derived. This represents a significant limitation for policymakers attempting to assess the scale of the Afghan synthetic drug economy and the effectiveness of prohibition measures.

In the absence of comprehensive imagery-based coverage, much of the analytical leverage comes from conversion rates linking ephedra, ephedrine and methamphetamine. These indicators are derived from interviews with ephedrine and methamphetamine processors, laboratory owners and traders engaged in the trade. From a policy perspective, this represents one of the few viable means of anchoring production estimates in empirical realities under conditions of restricted access. Additional monitoring and research may also be warranted to detect changes in production methods and chemicals used, as well as production in nearby countries.

This work has shown that conversion rates between ephedra and ephedrine vary considerably, primarily as a function of the quality of the ephedra used. Higher yields are associated with new growth harvested from plants growing in shaded environments at altitudes of 2 500 metres or above. These findings have important policy implications, as they suggest that environmental factors and harvesting practices play a significant role in determining production efficiency and therefore overall output. However, these factors are not captured in simple area-based estimates or desk-based models.

By contrast, conversion rates between ephedrine and methamphetamine appear to be more stable. Although methamphetamine laboratories are difficult to identify and monitor, the facilities documented to date are concentrated largely in the districts of Bakwa and Bahramcha in the southwest. This apparent concentration may partly explain the lower variability observed in conversion efficiency.

Taken together, these dynamics highlight a central policy challenge. While district-level and regional analyses provide critical insights into production practices and adaptive responses, the absence of a national baseline limits the ability to quantify aggregate output, compare the methamphetamine trade with other illicit drug markets, and assess the macro-level impact of the Taliban's ban. Addressing this gap, through expanded imagery coverage, enhanced modelling or sustained research, remains essential for strengthening the strategic evidence base underpinning both Afghanistan-focused interventions and broader regional drug policy responses.

What can realistically be estimated

It is technically possible to derive indicative estimates of national ephedrine and methamphetamine production by integrating multiple data streams. Specifically, combining empirically grounded conversion rate data with information on seasonal duration in surveyed districts, laboratory operating frequency, typical batch sizes and an expanded ephedrine laboratory count, covering a sufficiently large area, would allow for the estimation of total output and the volume of ephedra required to sustain production.

From a policy perspective, this demonstrates that credible production estimates can be derived even without full national imagery coverage, by combining field data, geospatial inputs and operational assumptions. This could significantly improve situational awareness and help address the current lack of national methamphetamine estimates. At the same time, there are limitations: such estimates would apply to a single year only. Given the rapid adaptation of the methamphetamine industry to enforcement pressure, including the emergence and growth in the number and size of laboratories in Balochistan, Pakistan (see Figure 8 and Figure 9), one-off estimates risk becoming outdated quickly and offer limited insight into longer-term trends (Mansfield, 2026b, c).

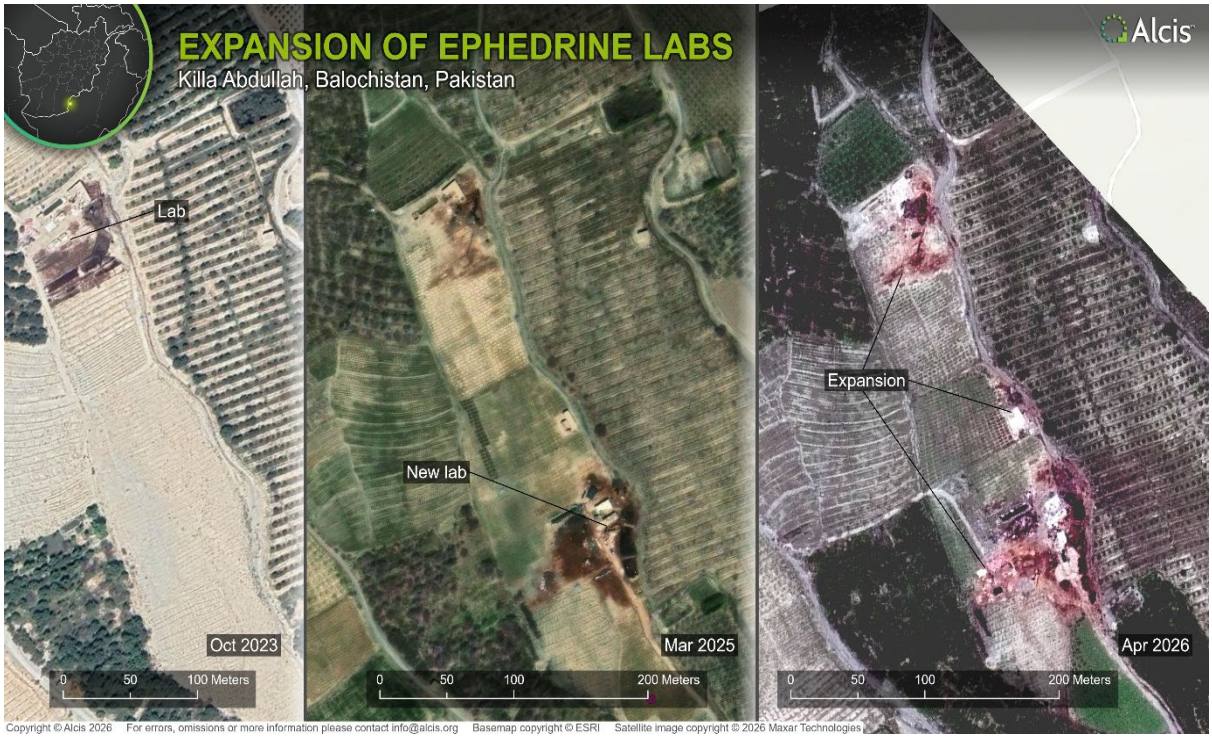
For monitoring and evaluation purposes in support of effective policy analysis, the exercise would need to be repeated at regular intervals to capture changes and fluctuations in ephedrine and methamphetamine output. Without repetition, policymakers would lack the longitudinal data needed to assess the impact of the Taliban's drug ban, detect displacement effects, or evaluate whether observed changes reflect real reductions in production rather than strategic adaptation by producers.

This would provide a framework for developing repeatable monitoring, clarifying data requirements, trade-offs and resource implications. The main policy challenge is therefore not technical feasibility but securing sustained investment and institutional commitment to ensure estimates remain consistent and relevant in a rapidly evolving drug-production environment.

Figure 8. Imagery showing relative sizes of ephedrine laboratories in Afghanistan prior to and after the Taliban drug ban, and in Balochistan in Pakistan in 2025



Figure 9. High-resolution imagery of ephedrine laboratories in Balochistan, 2023 to 2026



Note: The imagery shows an increase in both the size and the number of laboratories over a short time period.

Conclusions

Several clear policy-relevant conclusions emerge from this analysis. First, drug production in Afghanistan has demonstrated strong adaptive capacity, even under stringent bans. In the opiate economy, accumulated stockpiles, improvements in processing efficiency and differentiated adulteration strategies have buffered both domestic producers and downstream markets from immediate supply shocks. The emergence of concentrated areas of opium production in the border areas of Pakistan and Iran is also helping to maintain supply and put downward pressure on prices. In the methamphetamine sector, rapid geographic dispersal and improved conversion rates have limited the effectiveness of localisation-based enforcement and complicated national-level measurement.

Second, innovative methods have significantly strengthened the evidence base, but only when used appropriately. High-resolution imagery and machine-learning techniques now allow nationwide measurement of poppy cultivation and more sophisticated analysis of production environments. Indirect, mixed-method approaches have also made it possible to estimate hidden dynamics such as stockpiles and ephedrine production, even where direct observation is problematic. However, these advances do not eliminate uncertainty, particularly around opium yields, conversion rates and methamphetamine output, and one-off estimates are insufficient in highly adaptive systems.

Third, the analysis highlights why early-stage monitoring matters for Europe. Indicators closer to production, such as cultivation patterns, processing behaviour, stock depletion,

precursor dynamics and adulteration practices, often provide earlier and more credible warning of future market change than seizures or retail prices alone. This is particularly important for anticipating supply instability, purity fluctuations or accelerated substitution towards synthetic opioids.

For Europe, the policy implication is clear. The objective of innovative monitoring is to generate credible trend analysis, produce plausible estimates of the order of magnitude of an illegal activity, identify structural shifts and provide early warning of potential impending drug market changes. Sustained investment in geospatial capabilities, primary research, analytical integration and repeatable monitoring frameworks is therefore essential, not only to understand Afghanistan and Southwest Asia's evolving drug economy, but to ensure that European drug policy remains anticipatory rather than reactive in a rapidly changing global market.

Recommendations for policymakers

These recommendations aim to assist European drug policymakers in remaining anticipatory rather than reactive. They support credible trend analysis and informed responses to rapid changes in Afghanistan and Southwest Asia's evolving drug economy.

In addition, they are offered for consideration only; they do not bind EU Member States, the EUDA or any other EU institution.

1. **Avoid assuming that reduced cultivation will lead directly to reduced heroin availability in Europe**

The sharp reduction in poppy cultivation in Afghanistan should not be interpreted in isolation or assumed to produce a rapid or proportionate reduction in European heroin availability. Stockpiles, more efficient processing, differentiated adulteration and increased cultivation in neighbouring countries continue to buffer downstream markets. European preparedness should therefore address the possibility that harms persist or change as supply chains, product composition and criminal networks adapt.

2. **Treat Afghanistan, Pakistan and Iran as an interconnected regional drug-production system**

Particular attention should be given to emerging concentrations of opiates and methamphetamine-related production in the Afghanistan-Pakistan-Iran border region. Drugs, people and expertise continue to move extensively across national borders, making a wider regional perspective essential. This approach can help identify changing production centres, trafficking routes and criminal opportunities before their effects become visible in European markets.

3. **Prepare for adaptation and displacement, not only for reductions in supply**

Enforcement and prohibition can reshape production without necessarily eliminating it. Policymakers should anticipate relocation of drug production and trafficking to less observable areas, changes in processing and waste-disposal practices, the emergence of new actors and routes, and greater differentiation of products according to destination market. Responses should therefore be flexible enough to address evolving trafficking flows

rather than remain tied to historically important locations or established supply-chain assumptions.

4. **Link supply-side change more closely to law-enforcement and public-health preparedness**

Changes in processing efficiency, adulteration, purity and market segmentation may alter risks even where overall heroin availability remains relatively stable. Production-side intelligence and forensic and chemical profiling should be brought together to identify changes in source, composition, trafficking routes and intended destination markets. This can support more timely threat assessments, targeted enforcement and public-health responses based on changing risks.

5. **Apply different approaches to the monitoring of opiates and methamphetamine**

Poppy cultivation can be monitored through comprehensive crop mapping, although yield, processing and stock estimates remain uncertain and often require a mixed-methods approach that includes in-depth fieldwork. Methamphetamine production based on ephedra, a plant harvested from the wild, is more difficult to quantify and is becoming increasingly dispersed. Apparent gaps or reductions in observed methamphetamine-related activity should therefore not be interpreted automatically as reduced production. Monitoring for any evidence of production of methamphetamine from alternative sources should also continue. Consequently, monitoring frameworks should be tailored to the specific characteristics of each drug market, ensuring that the choice of indicators, analytical methods and evidence sources reflects the realities of how production, processing and trafficking are organised in practice.

6. **Establish decision-relevant early-warning triggers**

Monitoring efforts should identify combinations of indicators that would warrant closer assessment or preparedness measures, including accelerated stock depletion, sustained price changes, changes in heroin purity or adulteration, altered conversion practices, precursor developments and displacement of production or trafficking activity. The triangulation of such indicators may signal emerging supply instability, changing harms or increased risk of substitution towards other substances, such as synthetic opioids.

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