Methodology – World Drug Report 2017

Considerable efforts have been made over the years to improve the estimates presented in the *World Drug Report,* which rely, to a large extent, on information submitted by Member States through the Annual Reports Questionnaire (ARQ). Nonetheless, challenges remain in making such estimates because of data gaps and the varying quality of the available data. One major problem is the irregularity and incompleteness in ARQ reporting by Member States. Irregular reporting may result in absence of data for some years, and may influence the reported trend in a given year. Secondly, submitted questionnaires are not always complete or comprehensive, and thirdly, much of the data collected are subject to limitations and biases. These issues affect the reliability, quality and comparability of the information received.

1. Sources of information

Under the International Drug Conventions, Member States are formally required to provide national drug control related information annually to the 'Secretary General' of the United Nations (i.e. the Secretariat in the UNODC). For this purpose, the Commission on Narcotic Drugs in 2010 endorsed the revised Annual Reports Questionnaire (ARQ) that is sent to Member States each calendar year for submission of responses and information on the drug situation.

The World Drug Report 2017 is based on data primarily obtained from the ARQ returned by Governments to UNODC. The data collected in the current ARQ normally refer to the drug situation in 2015. Out of 199 potential respondents to the ARQ for 2015 (including 193 Member States), UNODC received 98 replies to its questionnaire on the "Extent and patterns of and trends in drug use (ARQ Part III)" and 101 replies to Part IV on "Extent and patterns and trends in drug crop cultivation, manufacturing and trafficking". The best coverage was from Europe (where 80 per cent of the respondents provided a reply), Asia (63 per cent) and the Americas (57 per cent). In the case of Africa, only 24 per cent of the Member States, and in the Oceania region, only two out of the 16 countries, responded to the Annual Report Questionnaire.

In general, the quantity of information provided on illicit drug supply is significantly better than that of information provided on drug demand. Analysis of responses to Part IV of the ARQ revealed that 79 per cent of them were 'substantially' completed compared to 67 per cent of Part III. (ARQs which were more than 50% completed were classified as having been 'substantially filled in'; less than 50% completion is classified as having been 'partially filled in'.)

In order to analyse the extent to which Member States provided information, a number of key questions in the ARQ were identified:

- For Part III, on the extent and patterns and trends of drug abuse, the key questions used for the analysis referred to: trends in drug use, for which 89 per cent of the respondents returning the ARQ provided information; prevalence of different drugs among the general population, for which 64 per cent of the respondents provided information; for prevalence of drug use among youth 59 per cent responded; for drug related mortality 65 percent and for treatment demand 86 per cent. The overall response rate of completion was 64 per cent for the countries which submitted Part III to UNODC, however this analysis does not take into account the completeness or quality of the information provided in response to each of the areas mentioned.

- For Part IV, on the extent and patterns and trends in drug crop cultivation, manufacturing and trafficking, the analysis included replies to the questions on: the quantities seized, for which 97 per cent of the Member States returning the ARQ provided the information; on trafficking of illicit drugs, for which 97 per cent of these Member States provided responses; on prices and purity 88 per cent of the Member States responded, and on persons brought into formal contact with the police and/or the criminal justice system in connection with drug-related offences, which 79 per cent of the Member States provided information. The overall analysis of these data revealed that 72 per cent of the Part IV responses were “substantially” completed. However this analysis does not take into account the completeness of responses of the quality of information provided in each of sections mentioned.

Information provided by Member States in the ARQ form the basis for the estimates and trend analysis provided in the World Drug Report. Often, this information and data is not sufficient to provide an accurate or comprehensive picture of the world’s drug markets. When necessary and where available, the data from the ARQ are thus supplemented with data from other sources.

As in previous years, seizure data made available to UNODC via the ARQ was complemented primarily with data from other government sources, such as other official communication with UNODC, official national publications, data provided to UNODC by the Heads of National Law Enforcement Agencies (HONLEA) at their regional meetings. and data published by international and regional organisations such as Interpol/ICPO, World Customs Organization, European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) and the Inter-American Drug Abuse Control Commission (CICAD). Price data for Europe were complemented with data from Europol. Demand related information was obtained through a number of additional sources, including the national assessments of the drug situation supported by UNODC, the drug control agencies participating in the UNODC’s ‘Drug Abuse Information Network for Asia and the Pacific’ (DAINAP), as well as various national and regional epidemiological networks such as the European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) or the Inter-American Drug Abuse Control Commission (CICAD). Reports published by National governments and academic research published in the scientific literature were also used as additional sources of information. This type of supplementary information is useful and necessary as long as Member States lack the monitoring systems necessary to produce reliable, comprehensive and internationally comparable data.

To this end, UNODC encourages and supports the improvement of national monitoring systems. Major progress has been made in the area of illicit crop monitoring over the last few years in some of the countries that have major illicit crop cultivations. In close cooperation with UNODC and with the support of major donors – these countries have developed impressive monitoring systems designed to identify the extent of, and trends in, the cultivation of narcotic plants. These data form a fundamental basis for trend analysis of illicit crop cultivation and drug production presented in the World Drug Report.

There remain significant data limitations on the demand side. Despite commendable progress made in a number of Member States, in the area of prevalence estimates for example, far more remains to be done to provide a truly reliable basis for trend and policy analysis and needs assessments. The work currently being done on the World Drug Report 2016 provides yet another opportunity to emphasize the global need for improving the evidence base available to the policy makers and programme planners.

2. Data on drug use and health consequences

Overview

UNODC estimates of the extent of illicit drug use in the world have been published periodically since 1997. Assessing the extent of drug use (the prevalence and estimates of the number of drug users) is a particularly difficult undertaking because it involves in most settings measuring the size of a 'hidden' population. Regional and global estimates are reported with ranges to reflect the information gaps. The level of confidence expressed in the estimates varies across regions and drug types.

A global estimate of the level of use of a specific drug involves the following steps:

1. Identification and analysis of appropriate sources (starting from the ARQ);
2. Identification of key benchmark figures for the level of drug use in all countries where data are available (annual prevalence of drug use among the general population aged 15-64) which then serve as 'anchor points' for subsequent calculations;
3. 'Standardization' of existing data if reported with a different reference population than the one used for the *World Drug Report* (for example, from age group 12 and above to a standard age group of 15-64);
4. Adjustments of national indicators to estimate an annual prevalence rate if such a rate is not available (for example, by using the lifetime prevalence or current use rates; or lifetime or annual prevalence rates among the youth population). This includes the identification of adjustment factors based on information from countries in the region with similar cultural, social and economic situations where applicable;
5. Imputation for countries where data are not available, based on data from countries in the same subregion. Ranges are calculated by considering the 10th and 90th percentile of the subregional distribution;
6. Extrapolation of available results for a subregion were calculated only for subregions where prevalence estimates for at least two countries covering at least 20% of the population were available. If, due to a lack of data, subregional estimates were not extrapolated, a regional calculation was extrapolated based on the 10th and 90th percentile of the distribution of the data available from countries in the region.
7. Aggregation of subregional estimates rolled-up into regional results to arrive at global estimates.

For countries that did not submit information through the ARQ, or in cases where the data were older than 10 years, other sources were identified, where available. In nearly all cases, these were government sources. Many estimates are needed to be adjusted to improve comparability (see below).

In cases of estimates referring to previous years, the prevalence rates are unchanged and applied to new population estimates for the year 2015. Currently, only a few countries measure prevalence of drug use among the general population on an annual basis. The remaining countries that regularly measure it - typically the more economically developed - do so usually every three to five years. Therefore, caution should be used when interpreting any change in national, regional or even global prevalence figures, as changes may in part reflect newer reports from countries, at times with changed methodology, or the exclusion of older reports, rather than actual changes in prevalence of a drug type.

Detailed information on drug use is available from countries in North America, a large number of countries in Europe, a number of countries in South America, the two large countries in Oceania and a limited number of countries in Asia and Africa. For the World Drug Report 2017 new estimates of prevalence of drug use among the general population were provided by 17 countries mostly in North America and and Western and Central Europe. One key problem in national data is the level of accuracy, which varies strongly from country to country. Not all estimates are based on sound epidemiological surveys. In some cases, the estimates simply reflect the aggregate number of drug users found in drug registries, which cover only a fraction of the total drug using population in a country. Even in cases where detailed information is available, there is often considerable divergence in definitions used, such as chronic or regular users; registry data (people in contact with the treatment system or the judicial system) versus survey data (usually extrapolation of results obtained through interviews of a selected sample); general population versus specific surveys of groups in terms of age (such as school surveys), special settings (such as hospitals or prisons), or high risk groups, et cetera.

To reduce the error margins that arise from simply aggregating such diverse estimates, an attempt has been made to standardize - as a far as possible - the heterogeneous data set. All available estimates were transformed into one single indicator – annual prevalence among the general population aged 15 to 64 – in most instances using regional average estimates and using transformation ratios derived from analysis of the situation in neighbouring countries.. The basic assumption is that though the level of drug use differs between countries, there are general patterns (for example, young people consume more drugs than older people; males consume more drugs than females; people in contact with the criminal justice system show higher prevalence rates than the general population, et cetera) which apply to most countries. It is also assumed that the relationship between lifetime prevalence and annual prevalence among the general population or between lifetime prevalence among young people and annual prevalence among the general population, except for new or emerging drug trends, do not vary greatly among countries with similar social, cultural and economic situations.

UNODC have suppressed the publication of estimates of the prevalence of drug use in countries with smaller populations (less than approximately 100,000 population aged 15-64) where the prevalence estimates were based on the results of youth or school surveys that were extrapolated to the general adult population.

Indicators used

The most widely used indicator at the global level is the annual prevalence rate: the number of people who have consumed an illicit drug at least once in the the twelve months prior to the study. Annual prevalence has been adopted by UNODC as one of key indicators to measure the extent of drug use. It is also part of the Lisbon Consensus on core epidemiological indicators of drug use which has been endorsed by the Commission on Narcotic Drugs. The key epidemiological indicators of drug use are:

1. Drug consumption among the general population (prevalence and incidence);
2. Drug consumption among the youth population (prevalence and incidence);
3. High-risk drug use (number of injecting drug users and the proportion engaged in high-risk behaviour, number of daily drug users);
4. Utilization of services for drug problems (treatment demand);
5. Drug-related morbidity (prevalence of HIV, hepatitis B virus and hepatitis C virus among drug users);
6. Drug-related mortality (deaths attributable to drug use).

Efforts have been made to present the overall drug situation from countries and regions based on these key epidemiological indicators.

The use of annual prevalence is a compromise between lifetime prevalence data (drug use at least once in a lifetime) and data on current use (drug use at least once over the past month). The annual prevalence rate is usually shown as a percentage of the youth and adult population. The definitions of the age groups vary, however, from country to country. Given a highly skewed distribution of drug use among the different age cohorts in most countries, differences in the age groups can lead to substantially diverging results.

Applying different methodologies may also yield diverging results for the same country. In such cases, the sources were analysed in-depth and priority was given to the most recent data and to the methodological approaches that are considered to produce the best results. For example, it is generally accepted that nationally representative household surveys are reasonably good approaches to estimating cannabis, ATS or cocaine use among the general population, at least in countries where there are no adverse consequences for admitting illicit drug use. Thus, household survey results were usually given priority over other sources of prevalence estimates.

When it comes to the use of opiates (opium, heroin, and other illicit opiates), injecting drug use, or the use of cocaine and ATS among regular or dependent users, annual prevalence data derived from national household surveys tend to grossly under-estimate such use, because heroin or other problem drug users often tend to be marginalized or less socially integrated, and may not be identified as living in a ‘typical’ household (they may be on the streets, homeless or institutionalized). Therefore, a number of ‘indirect’ methods have been developed to provide estimates for this group of drug users, including benchmark and multiplier methods (benchmark data may include treatment demand, police registration or arrest data, data on HIV infections, other services utilization by problem drug users or mortality data), capture-recapture methods and multivariate indicators. In countries where there was evidence that the primary ‘problem drug’ was opiates, and an indirect estimate existed for ‘problem drug use’ or injecting drug use, this was preferred over household survey estimates of heroin use. Therefore for most of the countries, prevalence of opioid or opiates use reported refers to the extent of use of these substances measured through indirect methods.

For other drug types, priority was given to annual prevalence data found by means of household surveys. In order to generate comparable results for all countries, wherever needed, the reported data was extrapolated to annual prevalence rates and/or adjusted for the preferred age group of 15-64 for the general population.

Extrapolation methods used

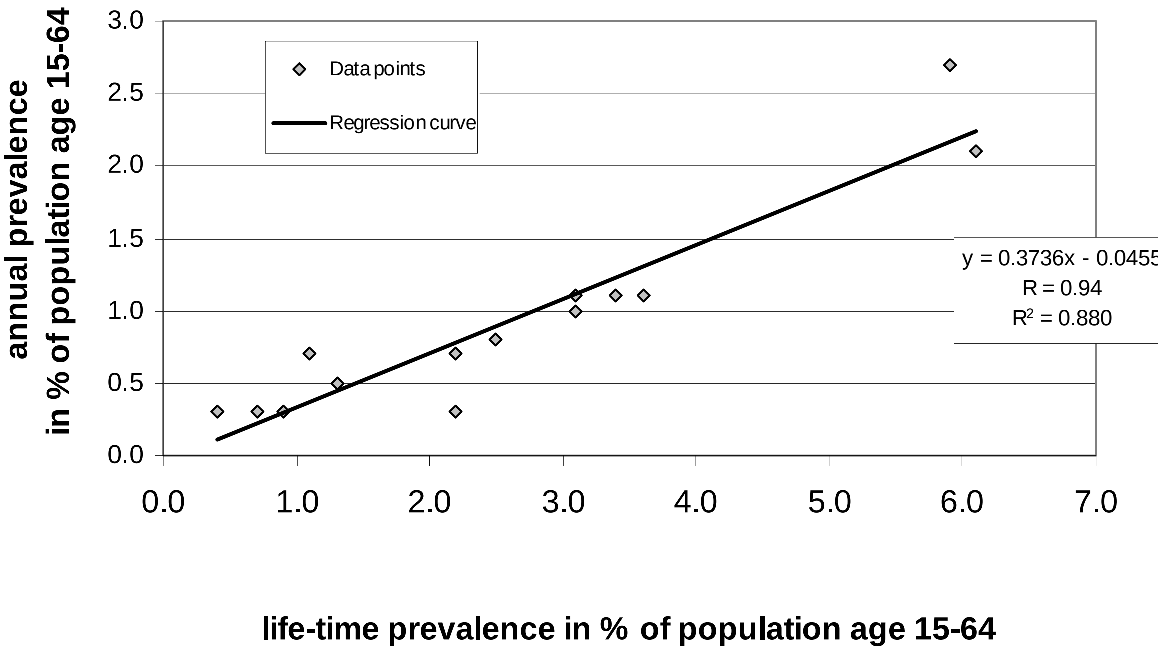
Adjustment for differences in age groups

Member States are increasingly using the 15-64 age group, though other groups are used as well. Where the age groups reported by Member States did not differ significantly from 15-64, they were presented as reported, and the age group specified. Where studies were based on significantly different age groups, results were typically adjusted. A number of countries reported prevalence rates or number of drug users for the age groups 15+ or 18+. In such cases, adjustments were generally based on the assumption that there was no significant drug use above the age of 64; the reported number of drug users based on the population age 15+ (or age 18+) was shown as a proportion of the population aged 15-64.

Extrapolation of results from lifetime prevalence to annual prevalence

Some countries have conducted surveys in recent years without asking the question whether drug consumption took place over the last year. In such cases, results were extrapolated to reach annual prevalence estimates. For example, country X in West and Central Europe reported a lifetime prevalence of cocaine use of 2%. As an example, taking data for lifetime and annual prevalence of cocaine use in countries of West and Central Europe, it can be shown that there is a strong positive correlation between the two measures (correlation coefficient R = 0.94); that is, the higher the lifetime prevalence, the higher the annual prevalence and vice versa. Based on the resulting regression line (with annual prevalence as the dependent variable and lifetime prevalence as the independent variable) it can be estimated that a country in West and Central Europe with a lifetime prevalence of 2% is likely to have an annual prevalence of around 0.7% (see figure). Almost the same result is obtained by calculating the ratio of the unweighted average of annual prevalence rates of the West and Central European countries and the unweighted average lifetime prevalence rate (0.93/2.61 = 0.356) and multiplying this ratio with the lifetime prevalence of the country concerned (2% * 0.356 = 0.7%).

Example of annual and lifetime prevalence rates of cocaine use in West and Central Europe



Sources: UNODC, Annual Reports Questionnaire Data / EMCDDA, Annual Report.

A similar approach was used to calculate the overall ratio by averaging the annual/lifetime ratios, calculated for each country. Multiplying the resulting average ratio (0.334) with the lifetime prevalence of the country concerned provides the estimate for the annual prevalence (0.387 * 2% = 0.8%). There is a close correlation observed between lifetime and annual prevalence (and an even stronger correlation between annual prevalence and monthly prevalence). Solid results (showing small potential errors) can only be expected from extrapolations done for a country in the same region. If instead of using the West and Central European average (0.387), the ratio found in the USA was used (0.17), the estimate for a country with a lifetime prevalence of cocaine use of 2% would instead amount to 0.3% (2% * 0.17). Such an estimate is likely to be correct for a country with a drug history similar to the USA, which has had a cocaine problem for more than two decades, as opposed to West and Central Europe, where the cocaine problem is largely a phenomenon of the last decade. Therefore, data from countries in the same subregion with similar patterns in drug use were used, wherever possible, for extrapolation purposes.

Both approaches—the regression model and the ratio model—were used to determine upper and lower uncertainty range estimates calculated at a 90% confidence interval among those aged 15-64 years in the given country. The greater the range, the larger the level of uncertainty around the estimates. The range for each country is reported in the statistical annex, where available.

Extrapolations based on school surveys

Analysis of countries which have conducted both school surveys and national household surveys shows that there is, in general, a positive correlation between the two variables, particularly for cannabis, ATS and cocaine. The correlation, however, is weaker than that of lifetime and annual prevalence or current use and annual prevalence among the general population. But it is stronger than the correlation between opiate use and injecting drug use and between treatment demand and extent of drug use in the general population

These extrapolations were conducted by using the ratios between school surveys and household surveys of countries in the same region or with similar social structure where applicable. As was the case with extrapolation of results from lifetime prevalence to annual prevalence, two approaches were taken: a) the unweighted average of the ratios between school and household surveys in the comparison countries with an upper and lower uncertainty range estimate calculated at a 90% confidence interval; and b) a regression-based extrapolation, using the relationships between estimates from the other countries to predict the estimate in the country concerned, with an upper and lower uncertainty range estimate calculated at a 90% confidence interval. The final uncertainty range and best estimate are calculated using both models, where applicable.

Extrapolations based on treatment data

For a number of developing countries, the only drug use-related data available was drug users registered or treatment demand. In such cases, other countries in the region with a similar socio-economic structure were identified, which reported annual prevalence and treatment data. A ratio of people treated per 1,000 drug users was calculated for each country. The results from different countries were then averaged and the resulting ratio was used to extrapolate the likely number of drug users from the number of people in treatment.

Making regional and global estimates of the number of people who use drugs and the health consequences

For this purpose, the estimated prevalence rates of countries were applied to the population aged 15-64, as provided by the United Nations Population Division for the year 2015.

In the tables presented in the World Drug Report for regional and global estimates, totals may not add up due to rounding.

Ranges have been produced to reflect the considerable uncertainty that arises when data are either extrapolated or imputed. Ranges are provided for estimated numbers and prevalence rates in the Report. Larger ranges are reported for subregions and regions with less certainty about the likely levels of drug use – in other words, those regions for which fewer direct estimates are available, for a comparatively smaller proportion of the region's population.

Countries with one published estimate (typically those countries with a representative household survey, or an indirect prevalence estimate that did not report ranges) did not have uncertainty estimated. This estimate is reported as the 'best estimate'.

To account for populations in countries with no published estimate, the 10th and 90th percentile in the range of direct estimates was used to produce a lower and upper estimate. For example, there are three countries in the North Africa subregion with sufficiently recent past year prevalence estimates for cannabis use: Algeria (0.52, a point estimate), Egypt (2.9 – 9.6, best estimate 6.2) and Tunisia (2.6). In order to obtain a best estimate for the subregion, the weighted average of the best estimates for prevalence over these three countries is applied to the population of the remaining countries in the subregion without prevalence data. In order to obtain a range for the subregion, the 10th percentile of the lower bounds of the uncertainty ranges (0.52, 2.9, and 2.6), namely 0.94, and the 90th percentile of the upper bounds (0.52, 9.6 and 2.6), namely 8.2, were considered. The percentages of 0.94 and 8.2 were applied to the population of the remaining countries without prevalence data, in combination with the national level data for Algeria, Egypt and Tunisia, to derive subregional lower and upper estimates of 1.7 and 7.1 per cent respectively.

In some cases, not all of a region's subregions had sufficient country-level data to allow the above calculations. In such cases, for the purposes of arriving at estimates at regional level, lower and upper estimates at the sub-regional level were derived based on the datapoints from the entire region, specifically by considering the 10th and 90th percentiles respectively of the lower and upper country-level estimates. These results were then combined with the other subregions to arrive at upper and lower estimates, and hence best estimates, at regional level.

This produces conservative (wide) intervals for subregions where there is geographic variation and/or variance in existing country-level estimates; but it also reduces the likelihood that skewed estimates will have a dramatic effect on regional and global figures (since these would most likely fall outside the 10th and 90th percentile).

One exception was South Asia's subregional opiate and cannabis estimates. In this case, India's population accounts for approximately 85% of total population of the six countries in the subregion, but recent reliable estimates of drug use for India were not available. Instead of using all prevalence estimates for Asia (that is, estimates from the Near and Middle East to East Asia) to determine India's contribution to the subregional uncertainty, it was determined that India's contribution was best reflected by its neighbouring countries.

Estimates of the total number of people who used illicit drugs at least once in the past year

This year's Report used the same approach as in the previous years. Two ranges were produced, and the lowest and highest estimate of each the approaches were taken to estimate the lower and upper ranges, respectively, of the total illicit drug using population. This estimate is obviously tentative given the limited number of countries upon which the data informing the two approaches were based. The two approaches were as follows:

<u>Approach 1</u>.

The global estimates of the number of people using each of the five drug groups in the past year were added up. Taking into account that people use more than one drug type and that these five populations overlap, the total was adjusted downward. The size of this adjustment was made based upon household surveys conducted in 26 countries globally including countries from North America (Canada, Mexico and the United States, Europe (including Italy, Germany, Spain and England and Wales), Latin America (Argentina, Brazil, Plurinational State of Bolivia, Chile, Peru and Uruguay), Asia and the Pacific (Israel, Indonesia, Philippines, and Australia) and Africa (Algeria), which assessed all five drug types, and reported an estimate of total illicit drug use. Across these studies, the extent to which adding each population of users over estimated the total population was a median factor of 1.12. The summed total was therefore divided by 1.12

<u>Approach 2</u>.

This approach was based on the average proportion of the total drug using population that comprises cannabis users. The average proportion was obtained from household surveys conducted in the same countries as for Approach 1 Across all of these studies, the median proportion of total drug users that comprised cannabis users was 81 per cent. The range of cannabis users at the global level was therefore divided by 0.813.

The global lower estimate was the lower of the two values obtained from the two approaches, while the upper estimates was the upper value derived from the two approaches described.

Estimates of the number of 'problem drug users'

It is useful to make estimates of the number of drug users whose use is particularly problematic, as a proxy to those who could be diagnosed with drug use disorders, as this subgroup of drug users is most likely to come to the attention of health and law enforcement. Moreover, this subgroup's drug use has been estimated to cause the main burden of disease and public order.

The number of problem drug users is typically estimated with the number of people with drug use disorders. Sometimes, an alternative approach is used. The EMCDDA has been using 'injecting or long duration use of opioids, amphetamines or cocaine' to guide country-level indirect prevalence estimation studies of problem drug use.

In this Report, as in previous years, each of the five range estimates of the number of people using each of the five drug groups was converted into a 'heroin user equivalent'. This was calculated through the use of 'relative risk coefficients' (see below) derived from the UNODC Harm Index. This method enables the aggregation of results from different drugs into one reference drug.

Table: Relative risk coefficient

	Treatment index	IDU	Toxicity	Deaths index	Relative risk coefficient
		Index	Index		(average treatment, IDU, toxicity, death)
Opiates	100	100	100	100	**100**
Cocaine	85.3	47.8	88	18.5	**59.9**
Amphetamines	20.1	59.5	32	6.8	**29.6**
Ecstasy	3.8	6.1	20.7	1	**7.9**
Cannabis	9	0	1.5	0.6	**2.8**

A lower range was calculated by summing each of the five lower range estimates; the upper end of the range was calculated by summing the upper range of the five estimates.

To obtain an estimate of the number of 'problem drug users', these totals were multiplied by the corresponding proportion of past year heroin users in the United States National Survey on Drug Use and Health (range 53-68% over the recent rounds of this survey). Hence, the LOW estimate is the lower proportion (53%) multiplied by the lower estimated size of the heroin use equivalent population (29.3 million heroin user equivalents). The HIGH estimate is the higher proportion (68%) multiplied by the higher estimated size of the heroin use equivalent population (63.9 million heroin user equivalents). This gives a range of 15.5 to 43.5 million problem drug users globally.

Calculation of drug use perception indices

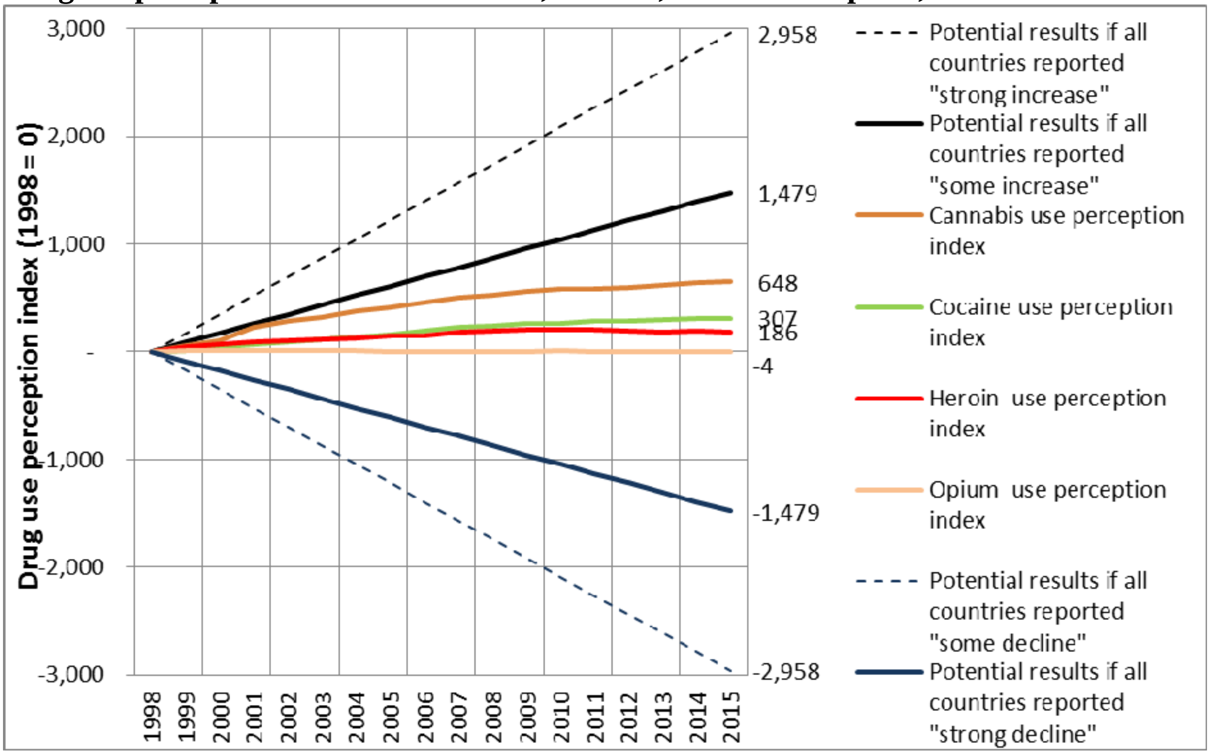
In addition to estimates on the extent of drug use, member states also provide UNODC with their perceptions of drug use trends. Such trends are typically based on a multitude of indicators, including general population prevalence data, school surveys, treatment data, emergency room visits, mortality data, reports by social workers, health care officials and law enforcement officers, arrest data, seizure data, media reports, etc.. Based on this information a simple index has been created. For reports of 'large increase' 2 points were allocated, for 'some increase' 1 point; for 'stable' 0 points; for some decrease 1 point was deducted and for 'large decrease' 2 points were deducted. The points were subsequently added to arrive the drug use perception index. The year 1998 (year of the UNGASS 1998) was chosen as the starting year of the index.

Calculation of global cannabis use perception trend index

Year	Points	Perception trend index (accumulated points)
1998		0
1999	59	59
2000	46	105
2001	118	223
…	…	…
2014	22	635
2015	13	648

The calculated cannabis use perception index reached 648 points by 2015, the cocaine use perception index 307 points, the heroin use perception index 186 points and the opium use perception use fell by 4 points until 2015. These index numbers suggest that cannabis, cocaine and heroin use increased over the 1998-2015 period while opium use marginally declined. In order to put these index numbers further into perspective, it may be interesting to note what would have happened if all countries had reported "some increase" or a "strong increase" of drug use every year. On average 87 countries per year reported drug use trends over the 1998-2015period to UNODC. Thus, if all countries had reported each year 'some increase', the index would have reached 1,479 points in 2015; in case all countries had reported 'large increases' the index would have attained 2,958 points in 2015.

Drug use perception index for cannabis, cocaine, heroin and opium, 1998-2015

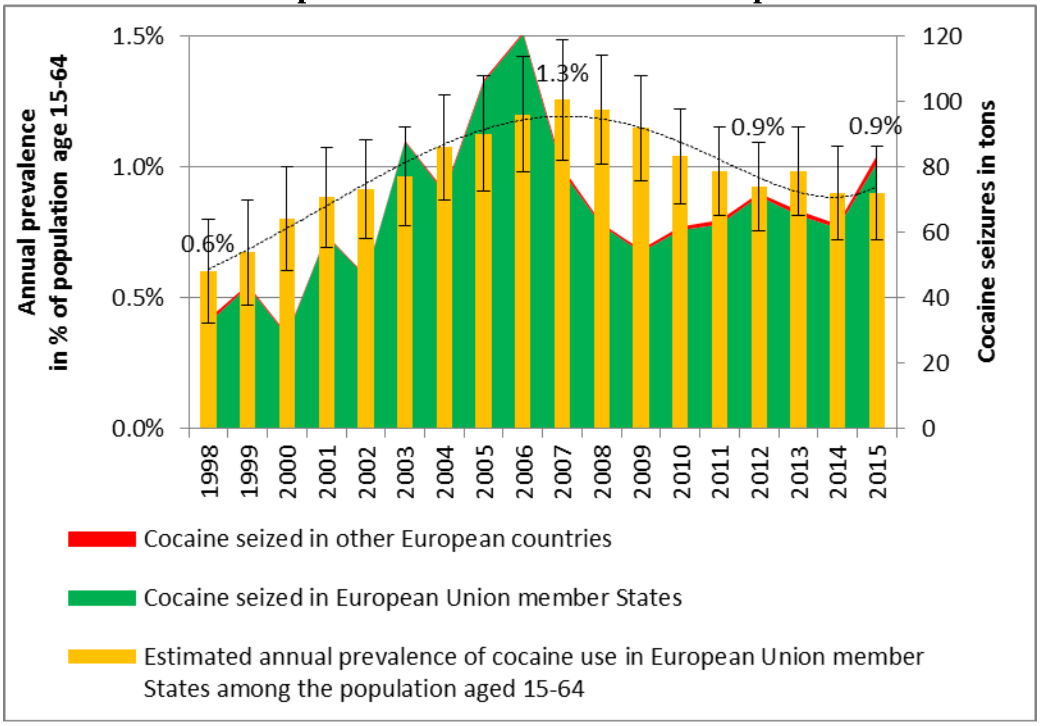


Source: UNODC, annual report questionnaire data.

Calculation of cocaine consumption trends based on waste-water analysis

Cocaine use trends, as reported in household surveys, showed an overall rather stable pattern in Europe over the 2011-2015 period while trends based on cocaine seizures, have been rising in Europe by more than 30 per cent over the 2011-2015 period.

Cocaine seizures and prevalence of cocaine use in Europe

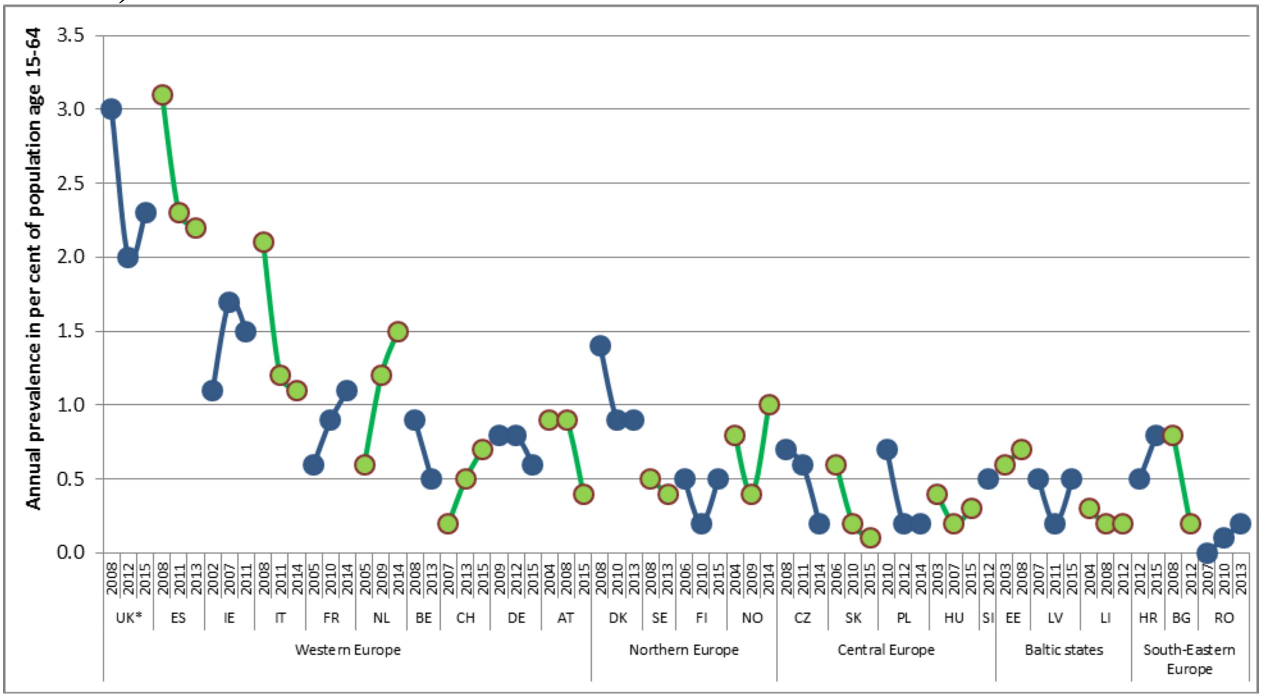


Sources: UNODC, annual report questionnaire data and EMCDDA.

Cocaine seizure data are rather comprehensive, covering practically all European countries and are reported each year. However, trends based on cocaine seizures reflect not only changes in the availability of cocaine in Europe but also changes in law enforcement activities and priorities. In other words, a rise in cocaine seizures may indicate a rise in availability, but it is certainly not sufficient as evidence of a rise in availability and/or consumption of cocaine.

Cocaine use trends based on household survey data are, in contrast, based on rather limited data. Individual countries continue to show a mixed picture with no clear overall trends emerging. Moreover, survey data available refer to different years which further limits the solidity of the results if used for describing trends in Europe as a whole.

Annual prevalence rates of cocaine use among European countries, 2005-2015 (or latest year available)



Sources: UNODC, annual report questionnaire data and EMCDDA.

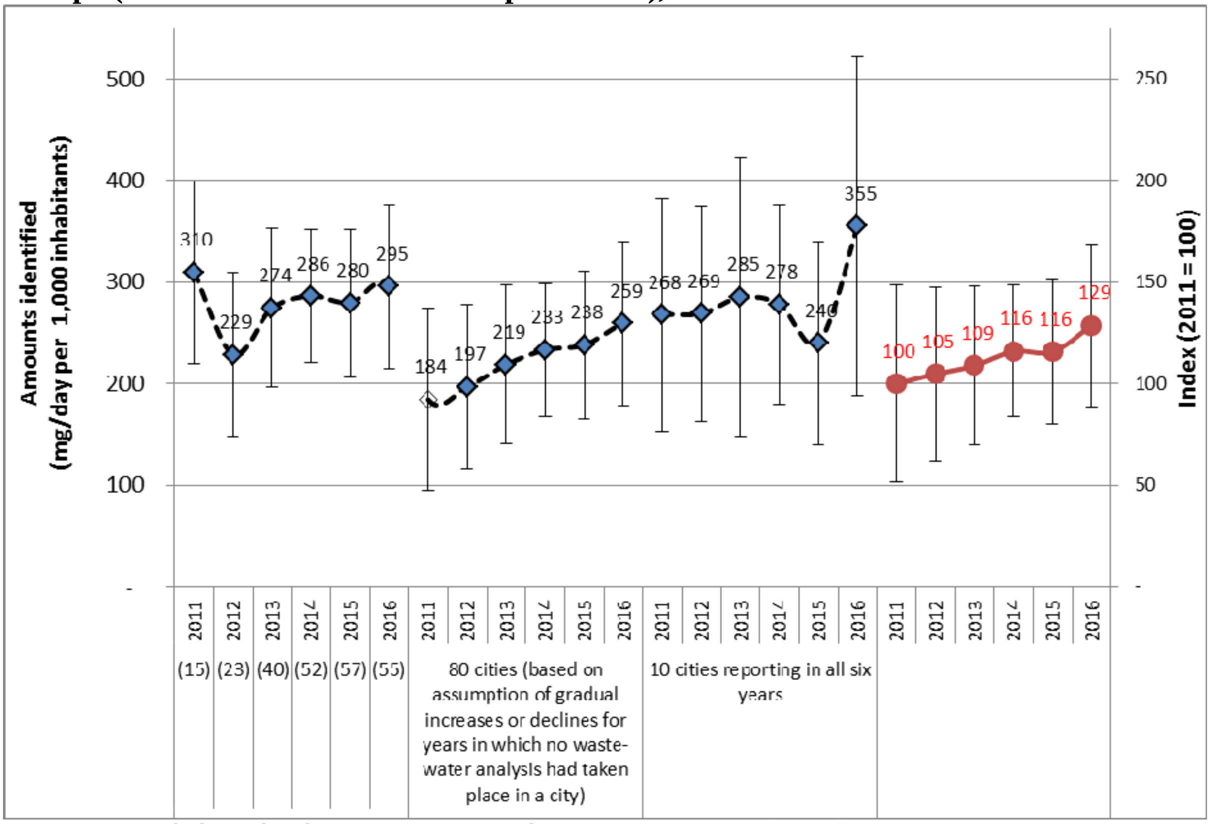
Against this background it was useful to look for alternative methods of measuring trends in drug consumption. One of such methods is the analysis of drug consumption based on the analysis of waste-water.

The development of analytical tools and methods for the waste-water analysis took place in recent years in Europe by waste-water research institutes under the umbrella of the COST (European Cooperation in Science and Technology) initiative, supported by the European Union under the EU Framework Programme Horizon 2020. Both EU and non-EU countries participate in this cooperation. In order to obtain – as far as possible – comparable data, waste-water in various cities has been analysed by the research institutes participating in the COST exercise over a 1 week period each year in spring. The amount of benzoylecgonine found each day in the waste-water was determined and a daily average was calculated. (This is important as cocaine use is typically more widespread during the weekend than during normal weak days). In a subsequent step the size of the population responsible for the waste-water in the respective waste-water catchment areas was determined and the results were shown in terms of average milligrams of benzoylecgonine per day found in waste-water per 1000 inhabitants.

Even though these results have been obtained applying high levels of scientific rigour, the subsequent analysis of the trends at the European level has remained, nonetheless, a challenge as different cities across Europe took part in this exercise in different years over the 2011-2016 period and differences of cocaine consumption across European cities continue to be huge which means that the inclusion or the exclusion of a specific city can have a significant impact on the overall average.

Thus, three averages (with the respective 95 per cent confidence intervals) were calculated: (i) an overall average of all cities participating each year in the study (15 cities in 2011, 23 in 2012, 40 in 2014, 52 in 2014, 57 in 2015 and 55 in 2016), (ii) an average of all 80 cities participating at least in one year in the study (applying some interpolation techniques to account for missing data) and (iii) an average of the 10 cities which participated each year in the study. In order to calculate an European average, the city results were always weighted by the respective population living in the respective waste-water catchment areas.

Benzoylecgonine (cocaine metabolite) found in waste-water per 1000 inhabitants in Europe (based on data from 80 European cities), 2011-2016*



Source: UNODC calculations based on SCORE, Sewage Analysis CORE Group Europe (SCORE)

Note: The waste-water analysis took place in 25 countries over the 2011-2016 period. All city results have been weighted by the population served by the respective drug treatment plants. The analysis in each city has been based on the amounts of benzoylecgonine identified in the waste-water over a 7 days period, which allowed for the calculation of a daily average of benzoylecgonine per 1000 inhabitants living in the area served by the respective waste-water treatment plant.

The main problem with the first approach of calculating and comparing the averages of the cities participating each year in the survey **(average i**) has been the rapidly expanding (and changing) number of cities participating in this exercise. This meant that a growing participation of cities with lower levels of cocaine consumption could well offset increases in overall cocaine consumption. Thus an overall stable trend, using this method, is not necessarily a fair reflection of actual underlying changes of cocaine consumption in Europe.

This problem can be overcome by simply analysing the results of those cities which participated each year in the exercise. This meant, however, basing the results on data from just 10 cities (**average iii**). Reducing the analysis to just 10 cities which participated each year in the waste-water project indicates a rather strong increase in cocaine consumption over the 2011-2016 period by some 33 per cent. However, changes in cocaine consumption in just

10 cities are, of course, not necessarily a reliable indicator for overall cocaine consumption trends for Europe as a whole.

Expanding the analysis to all 80 cities which participated in waste-water analysis over the 2011-2016 period (accounting for 7 per cent of the population of the participating 26 European countries) and filling in missing data with some interpolation techniques **(average ii)** suggests that overall cocaine consumption could have increased by close to 40 per cent over the 2011-2016 period. A broad range of possibilities to deal with missing data is discussed and proposed in the literature. They have all merits and shortcomings. This also applies to the interpolation techniques used for this exercise. Here it was assumed that between available data points of different years (e.g. 2013 and 2016) cocaine consumption gradually increased or declined; for this purposes the Excel Growth function was used which calculates the numbers of missing data between two data points based on an exponential growth curve model. In case of missing data at the end of the time series the latest reported data (e.g. data for 2015) was used as a proxy for the unknown situation in 2016; similarly, for missing data at the beginning of the time series it was assumed that the latest available data (e.g. data for 2012) could be a good proxy for the unknown situation in 2011.

Hypothetical sample: data of benzoylecgonine per 1000 inhabitants in four cities

	2011	2012	2013	2014	2015	2016
City A	80	78	75	80	92	
City B		55	60			85
City C	150	154			174	180
City D	140			115	120	125

Interpolation method used for dealing with missing data for calculating average (ii)

	2011	2012	2013	2014	2015	2016
City A	80	78	75	80	92	92
City B	55	55	60	67	76	85
City C	150	154	160	167	174	180
City D	140	131	123	115	120	125

The time series for each city were then weighted by the population in the respective catchment areas to calculate the overall average. For missing population data in specific years the same interpolation techniques as discussed before were applied.

Population living in waste-water catchment areas in cities A, B, C, D

	2011	2012	2013	2014	2015	2016
City A	120,000	125,000	126,000	128,000	130,000	130,000
City B	210,000	210,000	215,000	216,654	218,321	220,000
City C	60,000	65,000	68,176	71,506	75,000	77,000
City D	150,000	156,391	163,053	170,000	175,000	177,000

Based on these data the population weighted averages were calculated for the four cities. The calculation was done in Excel, using for each year the sumproduct function for benzoylecgonine found in the four cities and the population in the four catchment areas; the resulting total was then divided by the total population in the four waste-water catchment areas in the respective year to arrive at average ii.

Calculation of average ii of benzoylecgonine per 1000 inhabitants in four cities

	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Average (ii) for cities A, B, C, D	**95**	**93**	**95**	**98**	**105**	**110**

Finally, a **chained index** was established which took all city results into account once a city reported data in two subsequent years. The advantage of this method is that it is based entirely on reported data and does not require any explicit assumptions to be made about missing data. The calculated trends for Europe were based on the analysis of 14 cities over the 2011-2012 period, 22 cities over the 2012-2013 period, 26 cities over the 2013-2014 period, 42 cities over the 2014-2015 period and 40 cities over the 2015-2016 period.

The index suggested that cocaine consumption increased by some 30 per cent over the 2011-2016 period. The results, shown in the form of an index (basically reflecting accumulated growth rates) are, however, less intuitive then if actual averages are shown. Moreover, data from cities are excluded once no year-on-year comparisons are possible. The underlying problem is thus whether the comparison with the remaining cities reflects a fair sample of the overall trends in Europe.

While each of the methods used to identify consumption trends has its merits as well as shortcomings, it may be still interesting to note that (except for average i) the calculation of the average ii, average iii and the chained index indicated increases in the European cocaine consumption of some 30-40 per cent over the 2011-2016 period. Similarly cocaine seizures rose by more than 30 per cent in Europe over the 2011-2015 period.

The calculation of the chained index for a hypothetical sample of four cities is shown below:

Hypothetical sample: data of benzoylecgonine per 1000 inhabitants in four cities

	2011	2012	2013	2014	2015	2016
City A	80	78	75	80	92	
City B		55	60			85
City C	150	154			174	180
City D	140			115	120	125

Data sets used for the calculation of growth in benzoylecgonine consumption

	Change 2012		Change 2013		Change 2014		Change 2015		Change 2016	
	2011	2012	2012	2013	2013	2014	2014	2015	2015	2016
City A	80	78	78	75	75	80	80	92		
City B			55	60						
City C	150	154							174	180
City D							115	120	120	125

Population

	Change 2012		Change 2013		Change 2014		Change 2015		Change 2016	
	2011	2012	2012	2013	2013	2014	2014	2015	2015	2016
City A	120,000	125,000	125,000	126,000	126,000	128,000	128,000	130,000		
City B			210,000							
City C	60,000	65,000							75,000	77,000
City D							170,000	175,000	175,000	177,000

Calculation of chained index of benzoylecgonine consumption for four cities

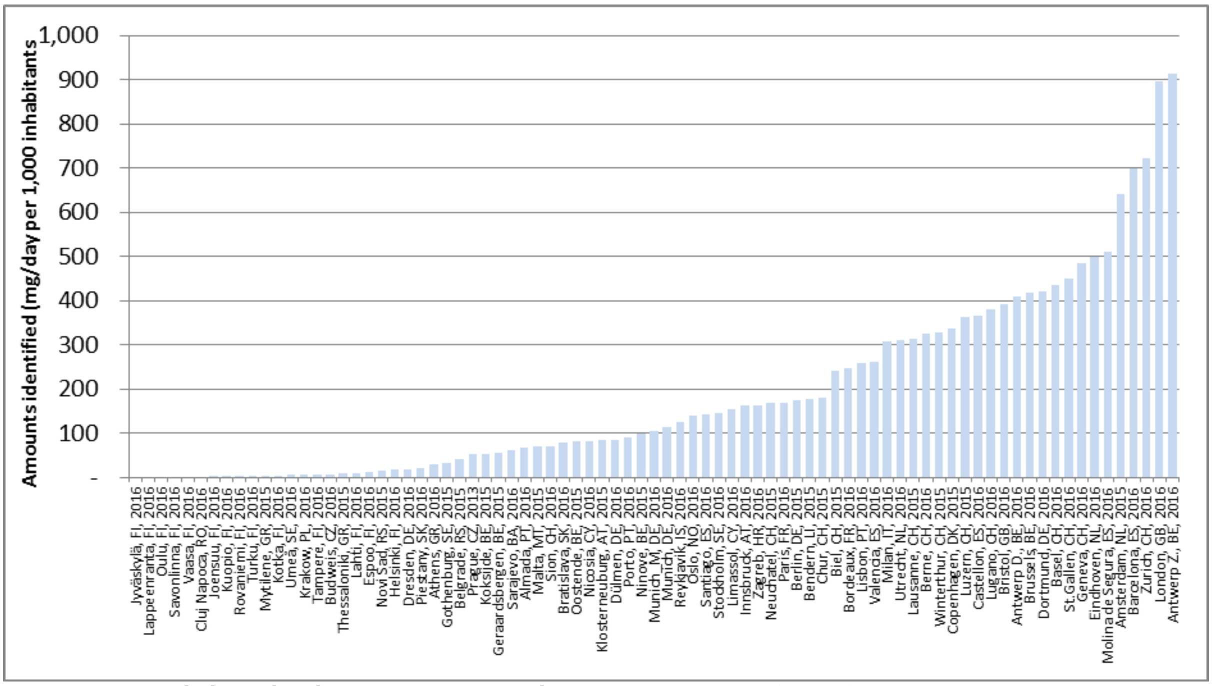
	Change 2012		Change 2013		Change 2014		Change 2015		Change 2016	
	2011	2012	2012	2013	2013	2014	2014	2015	2015	2016
Population weighted average	103	104	64	75	75	80	100	108	136	142
Growth	1.006		1.180		1.067		1.081		1.040	
Index (2011 = 100)	101		119		127		137		142	

Calculation of the extent of cocaine consumption in Europe based on waste-water analysis

Estimates of the size of the European cocaine market based on waste-water analysis

The analysis of waste-water in 80 European cities[1] in 2016 (or latest year available), covering a population of some 37 million people (equivalent to around 7 per cent of the total population of the countries where such analyses took place (504 million)) suggest that , on average, some 259 mg of benzoylecgonine per 1000 inhabitants per day could be found in waste-water in Europe (CI: 179-340 mg).

European cities covered by analysis of benzoylecgonine in waste-water, 2016 or latest year available



Source: UNODC calculations based on SCORE, Sewage Analysis CORE Group Europe (SCORE)
The detailed city results per year can be found in the methodology section under xx.

Using such per capita figures for the EU, EFTA and non-EU Balkan countries (with a total population of 538 million people) and using the multipliers ("correction factors") found in the literature, to convert benzoylecgonine found in waste-water into cocaine consumption equivalents, ranging from 2.3 to 3.59[2], the cocaine consumption in Europe may have ranged from 117 tons of pure cocaine (based on a correction factor of 2.3) to some 183 tons of pure cocaine (based on a correction factor of 3.59) in 2016. The average of these estimates would amount to a **consumption of 154 tons of pure cocaine per year.**

[1] The participating cities in waste-water analysis in which data on benzoylecgonine was measured, can be seen in figure xx
[2] EMCDDA, *Assessing illicit drugs in wastewater*, Lisbon 2016, pp. 37-39.

Estimates of cocaine consumption in Europe in 2016 based on waste-water data – prior to adjustments							
	mg / day / 1000 inhabitants			Population (EU, EFTA and Balkan countries)	Annual totals in tons		
	Best	min	max	(in million)	Best	min	max
Benzoylecgonine found in waste-water	259	179	340	537.7	50.8	35.1	66.7
				"Correction factors" (found in literature)			
Cocaine consumed	Conversion into cocaine			2.3	116.9	80.7	153.5
Cocaine consumed	Conversion into cocaine			3.0	152.5	105.3	200.2
Cocaine consumed	Conversion into cocaine			3.2	162.7	112.3	213.5
Cocaine consumed	Conversion into cocaine			3.59*	182.5	126.0	239.5
Average of estimates of cocaine consumed					153.7	80.7	239.5

*Correction factor recommended by EMCDDA (based on a literature review).

Sources: UNODC calculations based on SCORE, Sewage Analysis CORE Group Europe (SCORE) and EMCDDA, *Assessing illicit drugs in wastewater,* Lisbon 2016, pp. 37-39.

While much progress has been made in recent years in the waste-water analysis as such, the identification of the correct "**correction factor**" to convert calculated benzoylecgonine found in waste-water into the actual amounts of cocaine consumed by the drug users remains, nonetheless, a challenge.

Applying a "correction factor" of 3.59, as recommended by EMCDDA,[3] total cocaine consumption would have reached 183 tons in 2016 (CI: 126-239 tons), up from 130 tons in 2011 (CI: 67-193 tons) using the same "correction factor". The latter estimate is basically in line with previous UNODC estimates which – based on prevalence data and estimates of per capita consumption - arrived at a figure of around 129 tons (105-149 tons) for the European cocaine market in 2009, or 127 tons (103-147 tons) once East Europe was excluded.[4] EMCDDA's minimum estimates for the size of the European cocaine market have been lower (91 tons for 2013 (72–110 tons)).[5]

It should be noted that "**traditional" cocaine market estimates** are far from being reliable. There is always a risk of under-reporting in household surveys; moreover, average per capita use is not well understood and is usually based on a very limited number of studies. Furthermore, the average can vary dramatically over the course of a drug epidemic. But, results based on waste-water data, extrapolated to the European level, also face a number of challenges - despite of being based on truly 'objective measurements'.

Apart from issues related to **pharmacokinetics,** i.e. the identification of the actual excretion of cocaine from the human body in the form of benzoylecgonine which can differ quite substantially from person to person, depending on a person's metabolism, the body mass, the length of time a person has used cocaine, gender, the administration of the drug etc. which are all reflected in the 'correction factor' (which thus differs quite substantially in the literature), there are also a number of additional problems. For instance, there is a potential

[3] EMCDDA, *Assessing illicit drugs in wastewater,* Lisbon 2016, p. 39.

[4] UNODC, Illicit Financial Flows, Estimating illicit financial flows from drug trafficking and other transnational organized crime, Vienna 2011, p. 59.

[5] EMCDDA, *EU Drugs Market Report*, Lisbon 2016, p. 98.

problem that commuters may inflate the per capita city results. This problem is being discussed and some efforts have been made to solve this problem.

Even more important, there is a problem related to the **"sampling" of the waste-water plants** in this exercise. The selection, in general, has not been based on a random sampling approach. This renders extrapolations to the European level difficult, requiring at least a number of adjustments ("**ex-post stratifications")** to obtain meaningful results.
For instance, a majority of the 80 cities where waste-water analyses took place have been in countries of Western Europe. In some of these countries cocaine consumption is known to be rather high.

This potential bias can be addressed, e.g. by calculating the average amounts of the city results per country which are then subsequently weighted by the population of each country. (A similar approach is done by UNODC for the calculation of regional prevalence estimates). For countries that had not participated in waste-water analysis (which accounted for 6 per cent of the overall population) the unweighted average is used as a proxy for the calculations. Based on such a model the 'best estimate' of benzoylecgonine in waste-water would fall from 259 mg/day/1000 inhabitants to 247.5 mg/day/1000 for the year 2016. The estimates based on different 'correction factors' would then range from 112 tons to 174 tons of cocaine, with a an overall average of **147 tons,** down from 154 tons**.**

There is still another important problem. A number of studies (based on household and law enforcement data) indicate that **cocaine use in Europe and elsewhere is more an urban than a rural phenomenon**. As waste-water analyses have mostly taken place in urban environments, this may create a potential upward bias once such data are extrapolated to the European level. The problem may not be as acute for Europe as for other regions as, on average, 74 per cent of its population already lives in an urban environment.[6] Nonetheless, some adjustments for the remaining 26 per cent of rural population may be required.

Such "**rural population correction factors**" may, however, differ from country to country - and such data, for the time being, are not readily available across Europe. Based on limited information currently available , one can only develop a few scenarios to assess the likely orders of magnitude of such required corrections. First, it should be noted that for some countries with low prevalence rates, the corrections identified may be too small to be reflected in data. This has been, e.g. the case for Austria.[7] For countries with higher prevalence rates such 'rural population correction factors' can be identified. In the United States, a country outside Europe though with a long history of cocaine use and thus availability of detailed data, urban cocaine use was found to be more than 40 per cent higher than rural cocaine use.[8] Nonetheless, given the high proportion of its citizens living in an urban environment, the overall annual cocaine prevalence rate was found to be just 4 per cent

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[6] United Nations, Population Division, Urbanization, Data/Interactive Data / Urban and rural Population http://www.un.org/en/development/desa/population/theme/urbanization/index.shtml

[7] Data for Austria for 2015, e.g. show that annual prevalence of cocaine use is higher in urban areas (0.3 per cent) than in rural areas (0.2 per cent). Nonetheless, the rate in urban areas turns out to be the same as for Austria as a whole (0.3 per cent). (Gesundheit Österreich, *Bevölkerungserhebung zu Substanzgebrauch 2015; Bank 3: Kreuztabellen*, pp. 204.-207).

[8] This was based on a comparison of the situation in 'large metropolitan and small metropolitan' areas compared with the situation in 'non-metropolitan areas'. (SAMHSA, *Results from the 2015 National Survey on Drug Use and Health: Detailed Tables*, Rockville, Maryland,2016).

lower than the urban rate in 2015.[9] In the case of England and Wales , annual urban cocaine use rates (2.5 per cent in 2014/15) were found to be almost twice as high as rural cocaine use rates (1.3 per cent); nonetheless, the overall cocaine prevalence rate for England and Wales (2.3 per cent) turned out to be only 8 per cent lower than the urban rate[10]. Applying the latter "rural population correction factor" for the group of EU, EFTA and non-EU Balkan countries, the European consumption estimates would have to be reduced from 147 tons to **135 tons** with a range from 103 to 161 tons.

Alternatively, one can restart the calculations as follows: 259 mg/day/1000 inhabitants of benzoylecgonine found in waste-water; adjusted for the bias of having more West European cities investigated lowers the rate to 247.5 mg/day/1000 inhabitants of benzoylecgonine (range: 179-340). Applying the 'recommended correction factor' of 3.59 by EMCDDA to the annual benzoylecgonine estimate – would result in an annual cocaine consumption estimate of 174 tons of cocaine (range 126-240 tons). Assuming then – based on data from England and Wales - that rural cocaine use in European countries may be, on average, just half as high as urban cocaine use and taking Europe's urbanisation rate into account (74 per cent in 2015), the "rural population correction rate" would rise to around 13 per cent. The European cocaine consumption estimate would then have to be reduced from 174 tons to **152 tons** with a range from **110 to 208 tons**. (Or, based on the average of all benzoylecgonine to cocaine conversion ratios found in the literature, the estimate would fall from 147 tons to 128 tons with a range from 97-151 tons).

Given the lack of actual information on the most appropriate "rural population correction factor" to be applied , one could also argue that the calculation of an **unweighted average** of the benzoylecgonine rates per 1000 inhabitants found in the various European cities might be still, for the time being, a better proxy for the actual levels of cocaine consumption as weighted averages give – *ex definitione* - more weight to the results of larger cities – and they are – most likely – over-represented in the sample. In other words, even so a weighted average certainly provides more correct information on the benzoylecgonine found in the waste-water of the 80 cities investigated, it may not necessarily be the best measure for extrapolating the results to the population at large. Within the existing waste-water data set, analysis shows that there is a slightly positive correlation between the population size of a city and per capita benzoylecgonine levels found in waste-water (r = 0.22). Calculations based on unweighted city results would give an average rate of 188.6 mg of benzoylecgonine per day per 1000 inhabitants for the 80 cities (based on data from 2016 or the latest year available). This would translate – based on the "recommended correction factor" by EMCDDA of 3.59 – into an annual level of cocaine consumption estimate of around **133 tons** (range: 100-166 tons) for Europe (EU, EFTA and non-EU Balkan countries). (Using all of the "correction factors" found in the literature, the best estimates would range from 85 to 133 tons with an overall range from 64 to 166 tons)**.**

In short, the information currently available suggests that the initially calculated figures of some 154 tons, with best estimates of 117 to 183 tons (and an overall range of 81-240 tons) are probably an over-estimate as cities were not randomly selected. Applying some ex-post stratifications with regard to the location of the cities (as most of the cities are in Western

[9] This is based on a comparison of the situation in 'large metropolitan and small metropolitan' areas as compared to the United States as a whole. (SAMHSA, *Results from the 2015 National Survey on Drug Use and Health: Detailed Tables*, Rockville, Maryland,2016.

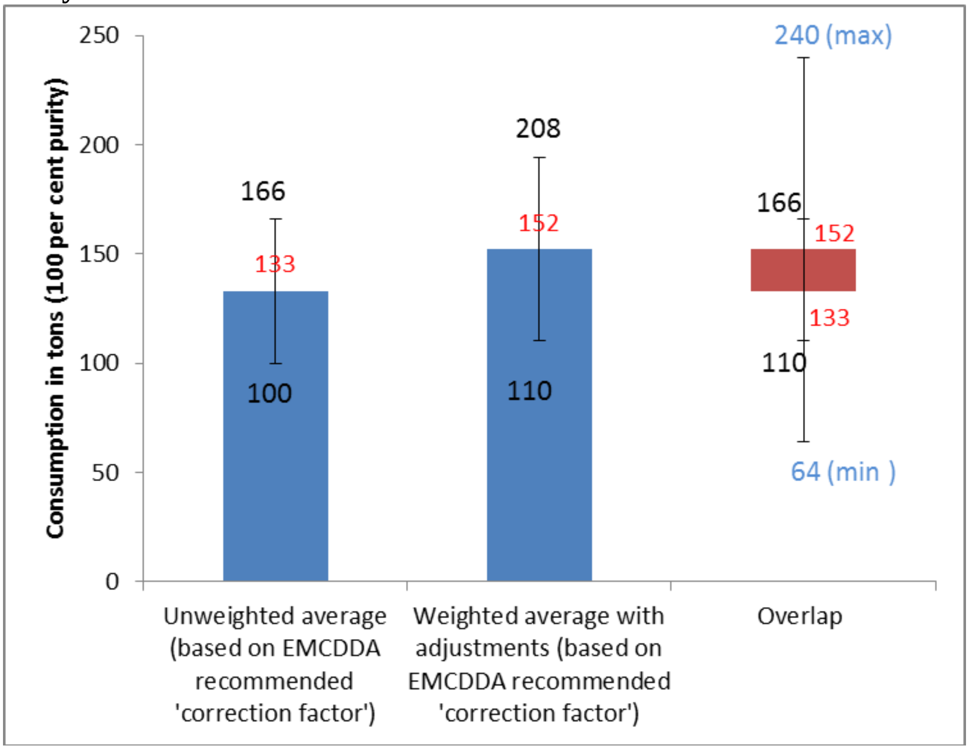
[10] Office for National Statistics, *Drug Misuse: Findings from the 2014/15 Crime Survey for England and Wales*, London 2016.

Europe and cocaine use is reported higher there) and taking into account that cocaine is still more of an urban than a rural phenomenon would reduce these estimates. At the same time, using the recommended 'correction factor' by EMCDDA would have to start the downward correction from the upper limit of 183 tons (range from 126 to 240 tons).
The most appropriate methods for these ex-post stratifications still need to be developed and required data inputs generated.

In other words, while waste-water analysis provides objective evidence and can certainly help to get a better understanding of overall consumption levels, it may still take more time, more modelling efforts and additional information (notably information on the actual differences between urban and rural cocaine use in the various European countries) to arrive at conclusive results.

What can be said with a high degree of certainty is that actual cocaine consumption in the EU, EFTA and non-EU Balkan countries falls most likely within a broad range of **64 to 208 tons (or 240 tons without any downward adjustment).** Based on limited information available so-far , as discussed above, consumption levels of between **133 tons** (based on unweighted averages of benzoylecgonine found in waste-water in European cities and the EMCDDA recommended 'correction factor') and **152 tons** (based on weighted averages of benzoylecgonine found in waste-water in European cities, adjusted for the dominance of West European cities and lower levels of use in rural areas and applying the EMCDDA recommended 'correction factor') i.e. rounded between **some 130 tons and some 150 tons** seem to show, for the time being, the highest level of plausibility. But this may change as better models and new information become available.

Best estimates of cocaine consumption in Europe in 2016 derived from waste-water analysis



Source: UNODC calculations based on SCORE, Sewage Analysis CORE Group Europe (SCORE) and EMCDDA, *Assessing illicit drugs in wastewater*, Lisbon 2016, pp. 37-39.

Estimates of the prevalence of injecting drug use, HIV and hepatitis (C and B virus) among people who inject drugs (PWID)

Criteria for selecting national estimates

Besides the official UNODC, UNAIDS and WHO data collection instruments, data sources considered also included: European Monitoring Centre for Drugs and Drug Addiction (EMCDDA) country reports and the EMCDDA Statistical Bulletin; and country level estimation studies including HIV seroprevalence and behavioural surveillance.

Factors considered in selecting national data:

- Quality of methodology (i.e., classified A – D according to the table below)
- For PWID, annual prevalence in preference to lifetime injecting
- Most recent data

The study with the strongest classification of methodology was used. Where there were multiple such studies, PWID data referring to annual prevalence was used, otherwise the most recent data was used. More recent, weaker study designs did not replace an estimate based on a superior methodology..

Table: Classification of methodology for people who inject drugs and those among them living with HIV

Data are categorized by methodology according to a slightly modified classification originally proposed in Mathers et. al. (2008) Lancet paper.[11]

Class	*Data on people who inject drugs*
A	Indirect prevalence estimation methods e.g., capture-recapture, network scale-up method, multiplier methods, etc
B1	Mapping/census and enumeration
B2	General population survey
C	Treatment and other national registers of drug users
D1	· Official government estimate with no methodology reported · Experts' judgment with known method of estimation (eg. an estimate obtained through a rapid assessment) · Modelling studies (e.g. Spectrum) · Delphi method or other consensus estimate
D2*	Estimate with methodology unknown

*Data graded D2 are excluded from the dataset

Class	*Data on the prevalence of people who inject drugs living with HIV*
A	Seroprevalence study
A1	Multi-site seroprevalence study with at least two sample types (e.g. treatment or outreach sample)
A2	Seroprevalence study from a single sample type
B	Registration or notification of cases of HIV infection (e.g. from treatment services)
C	Prevalence study using self-reported HIV
D1	· Official government estimate with no methodology reported · Modelling Studies (e.g. mode of transmission models)
D2*	Estimate with methodology unknown

*Data graded D2 are excluded from the dataset

[11] Mathers, B., L. Degenhardt, et al. (2008). Global epidemiology of injecting drug use and HIV among people who inject drugs: a systematic review. *The Lancet* 372(9651): 1733-1745

Calculation of regional and global estimates

Regional and global estimates were calculated for a specific reference year. Presently this is for 2015 (as for most of the data presented in the World Drug Report 2017).

People who inject drugs (PWID):

Best estimates: Country-level best estimates of the prevalence of PWID were weighted by the population aged 15-64 years (in the reference year) to obtain a sub-regional average prevalence (where there was insufficient data within a sub-region, a regional weighted-average prevalence was calculated). Countries from within the same sub-region without a prevalence estimate were given this sub-regional average. The sub-regional estimates of the numbers of PWID were summed to produce the regional and global estimated numbers, with the corresponding rate calculated using the relevant populations aged 15-64 years.[12]

Ranges in estimates: The range in the sub-regional estimates were calculated using the 10th and 90th percentiles of the known country-level prevalence estimates from within the same sub-region. For countries where the best estimate was also presented with a range then these lower and upper estimates were incorporated into the 10th and 90th percentiles, respectively. The range reflects the sub-regional variability in prevalence estimates that were then applied to the population aged 15-64 from countries from within the same sub-region for which no country-level prevalence were available. By summing the upper and lower estimates for the number of PWID, ranges in the regional and global estimates were calculated.

People who inject drugs living with HIV:

Best estimates: Country-level estimates of the prevalence of HIV among PWID were weighted by the number of PWID to obtain the sub-regional average. If the number of PWID was not known for a particular country with a prevalence estimate of HIV among PWID then the sub-regional average prevalence of PWID was used in the weighting. Countries within the same sub-region without an estimate of HIV among PWID were given the sub-regional average prevalence applied to number of PWID (known or sub-regional weighted average). The sub-regional numbers of PWID living with HIV were summed to obtain the regional and global estimates.

Range in numbers of PWID living with HIV: The range in the sub-regional estimates were calculated using the 10th and 90th percentiles of the known country-level prevalence estimates from within the same sub-region. For countries where the best estimate was also presented with a range then these lower and upper estimates were incorporated into the 10th and 90th percentiles, respectively. For each country a lower estimate of the number of PWID living with HIV was made using the lower estimate of the prevalence of HIV among PWID (either known or the sub-regional 10th percentile) and the lower estimate of the number of PWID (either known or sub-regional 10th percentile). The upper estimate was calculated in a similar manner using the upper estimate of the prevalence of HIV among PWID and the upper

[12] This is the same as the methodology used by Mathers et. al. for the UN Reference Group estimates published in 2008

estimate of the number of PWID. These numbers were summed to give regional and global lower and upper bounds to the number of PWID living with HIV.

Review of data and methodology for PWID and those among them living with HIV

In calculating the 2015 estimates, UNODC, UNAIDS, WHO and the World Bank joined forces and reached out to a broad group of experts from academia (including all former members of the Reference Group to the United Nations on HIV and Injecting Drug Use), regional, international and civil society organizations to ensure that a scientific approach to the methodology was used and to access the greatest number of data sets available worldwide on the subject. The new estimates reflect the results of the fourth joint UNODC/WHO/UNAIDS/World Bank data and methodology review.

Data quality of estimates on injecting drug use and HIV among PWID

Interpretation of regional and global estimates

The global and regional estimates of the prevalence of injecting drug use and HIV among people who inject drugs presented for 2015 in the World Drug Report should be viewed as an update to those presented in previous editions of the World Drug Report which reflects the latest data available. This year new or updated information was identified on PWID from 36 countries and on HIV among PWID from 48 countries. There is no intention to imply that there has been an actual change in the prevalence of injecting drug use or HIV among PWID at the regional or global level. The new values represent an update based on the best estimates that can currently be made using the most recent and highest quality data available to UNODC, WHO, UNAIDS, and the World Bank.

Quality of national-level data on PWID

Of the 107 countries with information on the prevalence of PWID, 65 per cent were of high methodological quality (class A, as defined in the table above) and 76 per cent related to timely data from 2011 or more recently. One half (50 per cent) of the countries have information that is from recent, methodologically high quality surveys. With a low level of coverage of the population aged 15-64 compared to other regions there is limited information on PWID for countries in Africa. It is noticeable that there are relatively few recent, methodologically high quality data from the Americas. However, for the two sub-regions with the highest prevalence of PWID (Eastern and South-Eastern Europe, and Central Asia and Transcaucasia) there is a very high percentage data coverage of the populations aged 15-64 and a high proportion of the data are both recent and of high methodological quality.

Table: Population coverage, timeliness and methodological quality of information from the 107 countries with data on people who inject drugs

Region	*Subregion*	*Percent coverage of population aged 15-64*	*Number of countries reporting data / Total number*	*Of countries reporting data*		
				Percent with recent data (2010 or more recent)	*Percent with high methodological quality (class A)*	*Percent with recent and high methodological quality*
Africa		**49.5**	**15 / 55**	**93**	**53**	**53**
America		**86.2**	**14 / 50**	**71**	**29**	**14**
	North America	100.0	3 / 3	33	33	0
	Latin America and the Caribbean	73.1	11 / 47	82	27	18
Asia		**94.3**	**32 / 49**	**63**	**66**	**47**
	Central Asia and Transcaucasia	93.6	7 / 8	57	100	57
	East and South-East Asia	95.1	13 / 19	69	54	38
	South-West Asia	100.0	3 / 3	67	67	67
	Near and Middle East	13.3	3 / 13	33	0	0
	South Asia	100.0	6 / 6	67	83	67
Europe		**99.9**	**41 / 50**	**71**	**85**	**59**
	Eastern and South-Eastern Europe	100.0	13 / 13	92	92	85
	Western and Central Europe	99.9	28 / 37	61	82	46
Oceania		**74.3**	**2 / 25**	**100**	**100**	**100**
Global		**87.7**	**104 / 229**	**72**	**67**	**49**

Sources for original estimates on PWID: UNODC annual report questionnaire, progress reports of UNAIDS on the global AIDS response (various years), the former Reference Group to the United Nations on HIV and Injecting Drug Use, peer-reviewed journal articles and national government reports.

Quality of national-level data on HIV among PWID

Of the 117 countries with information on the prevalence of HIV among PWID, 70 per cent were of high methodological quality (class A, as defined in the table above) and 62 per cent related to timely data from 2013 or more recently. Considerably more than a third (42 per cent) of the countries have information that is from both recent and methodologically high quality surveys. The two sub-regions that have by far the highest prevalence of HIV among PWID (South-West Asia, and Eastern and South-Eastern Europe) have prevalence estimates from all countries and from recent methodologically high quality data sources from a good percentage of those countries.

Table: Data coverage of HIV prevalence estimates among the estimated numbers of people who inject drugs, timeliness and methodological quality of information from the 117 countries with data on HIV among people who inject drugs.

Region	*Subregion*	*Percent coverage of estimated number of people who inject drugs*	*Number of countries reporting data / Total number*	*Of countries reporting data*		
				Percent with recent data (2012 or more recent)	*Percent with high methodological quality (class A)*	*Percent with recent and high methodological quality*
Africa		**65.9**	**21 / 55**	**57**	**76**	**43**
America		**94.0**	**15 / 50**	**40**	**53**	**33**
	North America	100.0	3 / 3	33	100	33
	Latin America and the Caribbean	75.5	12 / 47	42	42	33
Asia		**96.3**	**38 / 49**	**63**	**74**	**47**
	Central Asia and Transcaucasia	93.6	7 / 8	86	100	86
	East and South-East Asia	96.4	14 / 19	86	64	57
	South-West Asia	100.0	3 / 3	67	100	67
	Near and Middle East	55.6	9 / 13	22	44	0
	South Asia	99.9	5 / 6	40	100	40
Europe		**99.9**	**41 / 50**	**71**	**54**	**32**
	Eastern and South-Eastern Europe	100.0	13 / 13	77	77	62
	Western and Central Europe	99.9	28 / 37	68	43	18
Oceania		**74.3**	**2 / 25**	**100**	**100**	**100**
Global		**95.1**	**117 / 229**	**62**	**65**	**40**

Sources for original estimates on HIV among PWID: UNODC annual report questionnaire, progress reports of UNAIDS on the global AIDS response (various years), the former Reference Group to the United Nations on HIV and Injecting Drug Use, peer-reviewed journal articles and national government reports.

Estimates of the number of drug-related deaths

Drug-related deaths include those directly or indirectly caused by the intake of illicit drugs, but may also include deaths where the use of illicit drugs was a contributory cause, including cases where drug use was involved in the circumstances of the deaths (for example, violence and traffic accidents). Member States report on drug-related deaths according to their own definitions and therefore care should be taken in making country comparisons.

The total number of drug-related deaths reported by Member States were used to determine a rate for the reporting year and this rate was used to produce an estimate of the number of drug-related deaths corresponding to the year 2015. The estimated number of drug-related deaths for 2015 were aggregated at the regional level. To account for non-responding countries, an upper and lower estimate of the number of deaths was made using the 10th and 90th percentiles of the mortality rates for countries that did report within the same region. Because of the lack of reported information on drug-related deaths in Africa, an alternative source was used.[13] The wide range in the estimates for Asia reflects the low level of reporting from countries in the region. The global estimate of the number of drug-related deaths is the sum of the regional estimates. The overall estimated number of deaths for a region was presented as a range to account for uncertainty, and also presented as a rate per 1 million population aged 15-64 to allow for some degree of comparison across regions.

3. Drug cultivation, production and manufacture

Data on cultivation of opium poppy and coca bush and production of opium and coca leaf for the main producing countries (Afghanistan, Myanmar and the Lao People's Democratic Republic, for opium; and Colombia, Peru and the Plurinational State of Bolivia for coca) are mainly derived from national monitoring systems supported by UNODC in the framework of the Global Illicit Crop Monitoring Programme (ICMP). The detailed country reports can be found on the UNODC website https://www.unodc.org/unodc/en/crop-monitoring/index.html

UNODC estimates for Afghanistan cover the period 1994-2016. UNDOC supported monitoring systems in most other countries started following UNGASS 1998, became operational over the 2000-2002 period and have reported data ever since. Opium cultivation and production estimates are available up to the year 2016.

The preliminary opium poppy cultivation data for 2015 have been revised as new information from missing countries became available and some country results were revised. The total area under opium poppy cultivation for the year 2015 thus increased marginally, from 281,100 hectares reported in the 2016 World Drug Report, to 281,500 hectares reported in the 2017 World Drug Report.

Preliminary data for 2016 – 304,800 hectares - have to be interpreted with caution as they are less robust than data published in previous years. No opium poppy surveys took place in 2016 in Myanmar, the second largest opium poppy producing country, and in the Lao PDR. Some indirect indicators (derived from a socio-economic survey conducted in Myanmar in 2016) suggest though that opium production in Myanmar, at least, may not have changed significantly in that year. For the opium growing season 2014/2015 UNODC, in cooperation with the Government of Mexico, revised slightly the the results of the opium cultivation monitoring system of Mexico (supported by UNODC) to reflect a necessary statistical adjustment. Work for the estimation of opium poppy cultivation in Mexico for the season 2015/2016 is still ongoing. Data published for Mexico up the to year 2014 have been based on estimates provided by the US State Department in its annual International Narcotics Control Strategy Report (INCSR) and are – for methodological reasons – not directly comparable with the new estimates from the new Mexican crop monitoring system.

Opium poppy cultivation in countries which do not conduct area surveys, was estimated with an indirect method (see below). The global opium poppy cultivation estimates for 2016 will be adjusted again in next year's World Drug Report once more data will have become available.

Coca cultivation estimates in the three main Andean coca producing countries were available – at the time of drafting the World Drug Report - up to the year 2015. Results for the year

[13] Degenhardt L, Hall W, Warner-Smith M, Lynskey M. Chapter 13: Illicit drug use. In: Ezzati M, Lopez A, Rodgers A, Murray CJL, eds. Comparative quantification of health risks: global and regional burden of disease attributable to selected major risk factors. Geneva, World Health Organization, 2003.

2016will be published on UNODC's website as soon as the new reports will have been released in the summer months of 2017.

Estimates of cannabis cultivation in 2009, 2010, 2011 and 2012 in Afghanistan, as well as cannabis cultivation in 2003, 2004 and 2005 in Morocco, were also produced by the UNODC-supported national monitoring systems and can be found on the UNODC website. Estimates for other countries were drawn from ARQ replies and various other sources, including reports from Governments, UNODC field offices and the United States Department of State's Bureau for International Narcotics and Law Enforcement Affairs.

A full technical description of the methods used by UNODC-supported national monitoring systems can be found in the respective national survey reports available at https://www.unodc.org/unodc/en/crop-monitoring/index.html

Net cultivation

Not all the fields on which illicit crops are planted are actually harvested and contribute to drug production. For Afghanistan, a system of monitoring opium poppy eradication is in place which provides all necessary information to calculate the net cultivation area. In Myanmar and the Lao People's Democratic Republic, only the area of opium poppy eradicated before the annual opium survey is taken into account for the estimation of the cultivation area. Not enough information is available to consider eradication carried out after the time of the annual opium survey.

A major difference between coca and other narcotic plants such as opium poppy and cannabis is that the coca bush is a perennial plant which can be harvested several times per year. This longevity of the coca plant should, in principle, make it easier to measure the area under coca cultivation. In reality, the area under coca cultivation is dynamic which makes it difficult to determine the exact amount of land under coca cultivation at any specific point in time or within a given year. There are several reasons why coca cultivation is so dynamic, including new plantation, abandonment, reactivation of previously abandoned fields, manual eradication and aerial spraying.[14]

The issue of different area concepts and data sources used to monitor illicit coca bush cultivation was repeatedly investigated by UNODC.[15] To improve the comparability of estimates between countries and years, since 2011 net coca cultivation area at 31 of December is presented not only for Colombia but also for Peru. For technical reasons, the initial area measurement of coca fields takes place on satellite images acquired at different dates of the year and sometimes having different technical specifications. For the Plurinational State of Bolivia, in contrast, most satellite images are taken close to the 31 of December in order to reduce potential errors linked to subsequent eradication. In any case, for the Bolivian and Peruvian estimate, these difference are considered to have a limited effect only, whereas the dynamic situation in Colombia requires more adjustments to maintain year-on-year comparability. For more details, please see the country specific reports.

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[14] Plant disease and pests are not considered here as their impact is likely to be captured in the coca leaf yield estimates.

[15] See World Drug Report 2011, p. 262.

Indirect estimation of illicit opium poppy cultivation

Eradication and plant seizure reports indicate that illicit opium poppy cultivation exists in many countries, which do not regularly conduct illicit crop surveys. Starting 2008 a new methodology was introduced to estimate the extent of this illicit cultivation with an indirect method based on two indicators available in UNODC's databases: eradicated poppy area and opium poppy (plant, capsule) seizures reported as units or weight.

Prioritization of data sources: Whenever possible, the eradicated poppy area was used as this indicator is conceptually closest. If this indicator was not available, poppy plant seizure data was used, which requires an additional conversion of the seized amount into area eradicated. It can be assumed that plant seizures are often a different way of recording eradication. e.g. in cases where area measurements are technically difficult or because the law requires all seized material to be weighed even if the seizure consist actually of eradicated plants on a field. Large-scale or long-distance illicit trade with opium poppy plants is unlikely as the plants are bulky, perishable and of low value.

Eradication factor: Evidence from countries which provide both illicit cultivation and eradication data indicates that illicit cultivation is typically a multiple of the area eradicated. This relationship, averaged over the last five years for which information is available, was used to calculate a factor which allowed to estimate illicit cultivation in countries from eradication figures. Since 2008, this factor is based on opium poppy cultivation and eradication data from Colombia, Lao People's Republic, Mexico, Myanmar, Pakistan and Thailand. Over the years, the average over these five countries ranged between 2.1 and 3.0 (eradicated area * factor = net cultivation area). (Afghanistan was not considered for the calculation of the factor as the objective was to estimate low to mid-levels of illicit cultivation. Afghanistan, representing two thirds or more of global illicit poppy cultivation, clearly fell outside this range).

Plant seizures: seizures of poppy plant material usually happen close to the source, i.e. in vicinity of the cultivation area. The available to UNODC does not allow to accurately and systematically differentiate between the various parts (capsules, bulbs, entire plants) of the plant seized as for plant seizures. Most (roots, stem, leaves, capsules) or only some parts (poppy straw, capsules only) of the plant may be seized. While this does not influence seizure data given in plant units, it plays a role when interpreting seizure data given as weight.

Plant seizure data in units represent plant numbers, which can be converted into area (ha) using an average number of opium poppy plants per hectare. Yield measurements from Afghanistan and Myanmar, where UNODC has conducted yield surveys over several years, indicate an average figure of about 190,000 plants per hectare. Dividing poppy plant seizure numbers by this factor results in estimate of the area on which the seized material was cultivated. This is equivalent to eradicated area, as the seized material was taken out of the production cycle. Eradicated area multiplied with the eradication factor described above yields then cultivation area.

Plant seizure data reported as weight: In order to convert the weight of seized poppy plants into area, a typical biomass per hectare of poppy was estimated based on the evaluation of various sources. The biomass yield in oven-dry equivalent including stem, leaves, capsule and seeds reported by a commercial licit opium poppy grower in Spain[16] was 2,800 kg/ha for rain-fed and 7,800 kg/ha for irrigated fields respectively. Information on the weight of roots was not available. Loewe[17] found biomass yields between 3,921 kg/ha to 5,438 kg/ha in trial cultivation under greenhouse conditions. Acock et al.[18] found oven-dry plant weights of about 37 grams including roots in trials under controlled conditions corresponding to a biomass yield of around 7,000 kg/ha with the assumed plant density of 190,000/ha. Among the available biomass measurements only the figures from Spain referred to poppy grown under field conditions. All other results fell into the range between the non-irrigated and irrigated biomass yields (2,800 – 7,800 kg/ha) reported. For purposes of this calculation the simple average of these two values was taken.

Two caveats have to be made: a) As the reporting format does not differentiate between capsules and plants or between the different growth stages of a poppy plant, it was assumed that the reported weight refers to whole, mature plants. This leads to a conservative estimate as many plant seizures are actually carried out on fields before the poppy plants reach maturity. b) The reference biomass measurements from scientific studies are expressed in oven-dried equivalents, whereas the reported weights could refer to fresh weight or air-dry weight; both of which are higher than the oven-dry equivalent weight equivalent. This would lead to an over-estimation of the illicit cultivation area. In the case of young plants, which are typically fresh but not yet fully grown, both errors could balance off, whereas in the case of mature or harvested plants, which tend to be drier, both errors would be smaller.

In order to avoid the fluctuations typically present in seizure and eradication data, the above calculations were based on plant seizures averaged over the most recent five-year period, rather than datapoints relative to the specific year. If no eradication or plant seizure was reported in that period, no value was calculated.

Yield[19] and production

To estimate potential production of opium, coca leaf and cannabis (herb and resin), the number of harvests per year and the total yield of primary plant material has to be established. The UNODC-supported national surveys take measurements in the field and conduct interviews with farmers, using results from both to produce the final data on yield.

Opium yield surveys are complex. Harvesting opium with the traditional lancing method can take up to two weeks as the opium latex that oozes out of the poppy capsule has to dry before harvesters can scrape it off and several lancings take place until the plant has dried. To avoid

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[16] Personal communication, 2010, from Alcaliber company.

[17] Personal communication, 2010, see also Loewe, A. (2010). Remote Sensing based Monitoring of Opium Cultivation in Afghanistan. Philosophische Fakultaet. Bonn, Rheinische Friedrich-Wilhelms-Universitaet**:** 106.

[18] Acock, M. C., R. C. Pausch, et al. (1997). “Growth and development of opium poppy (Papaver Somniferum L.) as a function of temperature.” Biotronics **26**: 47-57.

[19] Further information on the methodology of opium and coca leaf yield surveys conducted by UNODC can be found in United Nations (2001): *Guidelines for Yield Assessment of Opium Gum and Coca Leaf from Brief Field Visits*, New York (ST/NAR/33).

this lengthy process, yield surveyors measure the number of poppy capsules and their size in sample plots. Using a scientifically developed formula, the measured poppy capsule volume indicates how much opium gum each plant potentially yields. Thus, the per hectare opium yield can be estimated. Different formulas were developed for South-East and South-West Asia. In Afghanistan, yield surveys are carried out annually; in Myanmar regularly.

For coca bush, the number of harvests varies, as does the yield per harvest. In the Plurinational State of Bolivia and Peru, UNODC supports monitoring systems that conduct coca leaf yield surveys in several regions, by harvesting sample plots of coca fields over the course of a year, at points in time indicated by the coca farmer. In these two countries, yield surveys are carried out only occasionally, due to the difficult security situation in many coca regions and because of funding constraints. In Colombia, coca leaf yield estimates are updated yearly through a rotational monitoring system introduced in 2005 that ensures that every yield region is revisited about every three years. However, as the security situation does not allow for surveyors to return to the sample fields, only one harvest is measured, and the others are estimated based on information from the farmer. In 2013 for the first time the concept of productive area was applied to calculate the coca leaf yields in Colombia, taking into account the dynamics of the fields due to spraying and eradication for which some fields are only partly productive during the year. This new way of calculating was retroactively applied to the results of 2005-2012, giving slightly different results than published before [20]. In Peru and Bolivia the additional production of partly productive areas are not considered for the coca leaf yield estimates.[21]

Conversion factors

The primary plant material harvested - opium in the form of gum or latex from opium poppy, coca leaves from coca bush, and the cannabis plant - undergo a sequence of extraction and transformation processes, some of which are done by farmers onsite, others by traffickers in clandestine laboratories. Some of these processes involve precursor chemicals and may be done by different people in different places under a variety of conditions, which are not always known. In the case of opium gum, for example, traffickers extract the morphine contained in the gum in one process, transform the morphine into heroin base in a second process, and finally produce heroin hydrochloride. In the case of cocaine, coca paste is produced from either sun-dried (in the Plurinational State of Bolivia and Peru) or fresh coca leaves (in Colombia), which is later transformed into cocaine base, from where cocaine hydrochloride is produced.

The results of each step, for example from coca leaf to coca paste, can be estimated with a conversion factor. Such conversion factors are based on interviews with the people involved in the process, such as farmers in Colombia, who report how much coca leaf they need to produce 1 kg of coca paste or cocaine base. Tests have also been conducted where so-called ‘cooks’ or ‘chemists’ demonstrate how they do the processing under local conditions. A number of studies conducted by enforcement agencies in the main drug-producing countries have provided the orders of magnitude for the transformation from the raw material to the

[20] More information on the results of the methodology used can be found in the report on coca cultivation in Colombia for 2013 (UNODC/ Government of Colombia, June 2014) available on the internet at http://www.unodc.org/unodc/en/crop-monitoring/index.html.

[21] In 2013 a correction factor was applied for the time that fields in Peru were productive during the year, however this approach was abolished as of 2014 due to incomplete eradication data. More information about the 2013 calculation to be found at page 73 of the Peru coca cultivation survey report for 2013 available on the internet at http://www.unodc.org/unodc/en/crop-monitoring/index.html.

end product. This information is usually based on just a few case studies, however, which are not necessarily representative of the entire production process. Farmer interviews are not always possible due to the sensitivity of the topic, especially if the processing is done by specialists and not by the farmers themselves. Establishing conversion ratios is complicated by the fact that traffickers may not know the quality of the raw material and chemicals they use, which may vary considerably; they may have to use a range of chemicals for the same purpose depending, on their availability and costs; and the conditions under which the processing takes place (temperature, humidity, et cetera) differ.

It is important to take into account the fact that the margins of error of these conversion ratios – used to calculate the potential cocaine production from coca leaf or the heroin production from opium - are not known. To be precise, these calculations would require detailed information on the morphine content of opium or the cocaine content of the coca leaf, as well as detailed information on the efficiency of clandestine laboratories. Such information is limited. This also applies to the question of the psychoactive content of the narcotic plants.

UNODC, in cooperation with Member States, continues to review coca leaf to cocaine conversion ratios as well as coca leaf yields and net productive area estimates.[22] More research is needed to establish comparable data for all components of the cocaine production estimate.

Many cannabis farmers in Afghanistan and Morocco conduct the first processing steps themselves, either by removing the upper leaves and flowers of the plant to produce cannabis herb or by threshing and sieving the plant material to extract the cannabis resin. The herb and resin yield per hectare can be obtained by multiplying the plant material yield with an extraction factor. The complex area of cannabis resin yield in Afghanistan was investigated in 2009, 2010, 2011 and 2012. The yield study included observation of the actual production of resin, which is a process of threshing and sieving the dried cannabis plants. In Morocco, this factor was established by using information from farmers on the methods used and on results from scientific laboratories. Information on the yield was obtained from interviews with cannabis farmers.[23] Given the high level of uncertainty and the continuing lack of information for the large majority of cannabis-cultivating countries, the estimates of global cannabis herb and resin production have not been calculated.

Potential production

'Potential' heroin or cocaine production refers to total production of heroin or cocaine if all the cultivated opium or coca leaf, less the opium and coca leaf consumed as such, were transformed into the end products in the respective producer country in the same year. It should be noted though that a product such as opium can be stored for extended periods of time and be converted into intermediate or final products long after the harvest year. Thus 'actual' heroin manufacture, making use of accumulated stocks of opium from previous years, can deviate significantly from 'potential' heroin manufacture out of the opium produced in a specific year. Direct consumption of opium or the coca leaf, in contrast, is being taken into account. For example, consumption of coca leaf considered licit in the Plurinational State of Bolivia and Peru is deducted from the amounts of coca available for the transformation into cocaine. Other factors, such as the actual amount of illicit coca paste or

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[22] More detailed information on the ongoing review of conversion factors was presented in the 2010 *World Drug Report*, p.251 ff.
[23] For greater detail on studies with cannabis farmers, see: UNODC, *Enquête sur le cannabis au Maroc 2005*, Vienna, 2007.

opium consumption and storage, are difficult to estimate and were not taken into account. Similarly, opium consumed in Afghanistan and neighbouring countries is deducted from the amounts of opium available for heroin production. In contrast, opium stocked or opium used from stocks accumulated over previous years is not considered in the calculation of 'potential' heroin manufacture.

For **cocaine**, potential production of 100% pure cocaine is estimated. In reality, clandestine laboratories do not produce 100% pure cocaine but cocaine of lower purity which is often referred to as 'export quality'.

For **heroin**, two conversion ratios are used. Apart from Afghanistan, not enough information is available to estimate the production of heroin of 100% purity. Instead, potential production of export quality heroin is estimated, whose exact purity is not known and may vary. For Afghanistan, the calculations are more detailed, here the share of all opium converted to heroin is estimated and a specific conversion ratio is applied, which uses an estimated purity for heroin of export quality.

Although it is based on current knowledge on the alkaloid content of narcotic plants and the efficiency of clandestine laboratories, it should be noted that 'potential production' is a hypothetical concept and is not an estimate of actual heroin or cocaine production at the country or global level. The concept of potential production is also different from the theoretical maximum amount of drug that could be produced if all alkaloids were extracted from opium and coca leaf. The difference between the theoretical maximum and the potential production is expressed by the so-called laboratory efficiency, which describes which proportion of alkaloids present in plant material clandestine laboratories are actually able to extract.

Colombia

In 2013, for the first time, and again in 2014 and 2015 the yearly productive areas were estimated, instead of using the average area under coca cultivation of the reporting year and the previous year (the approach used in previous reports). In addition a different conversion factor for estimating cocaine base was applied. Both the adjustment of the productive area estimate and the estimation of the conversion factor for cocaine base were retroactively applied to the results of 2009-2012, and in this year's World Drug Report also for the period 2005-2008 giving slightly different results than published before.[24]

Peru

Potential cocaine production in Peru is estimated from potential coca leaf production and after deducting the amount of coca leaf estimated to be used for traditional purposes according to Government sources (9,000 mt of sun-dry coca leaf).

[24] More information on the results of the two approaches and the methodology used can be found in annex 3 of the report on coca cultivation in Colombia for 2013 (UNODC/ Government of Colombia, June 2014) available on the internet at http://www.unodc.org/unodc/en/crop-monitoring/index.html and in UNODC and Gobierno de Colombia, *Colombia, Monitoreo de territorios afectados por cultivos ilícitos 2015*, July 2016, available on the internet at: https://www.unodc.org/documents/crop-monitoring/Colombia/Monitoreo_Cultivos_ilicitos_2015.pdf .

The Plurinational State of Bolivia

Potential cocaine production in the Plurinational State of Bolivia is estimated from potential coca leaf production after deducting the amount of coca leaf produced on 12,000 ha in the Yungas of La Paz where coca cultivation is authorized under national law.

"Old" versus "new" conversion ratios for cocaine

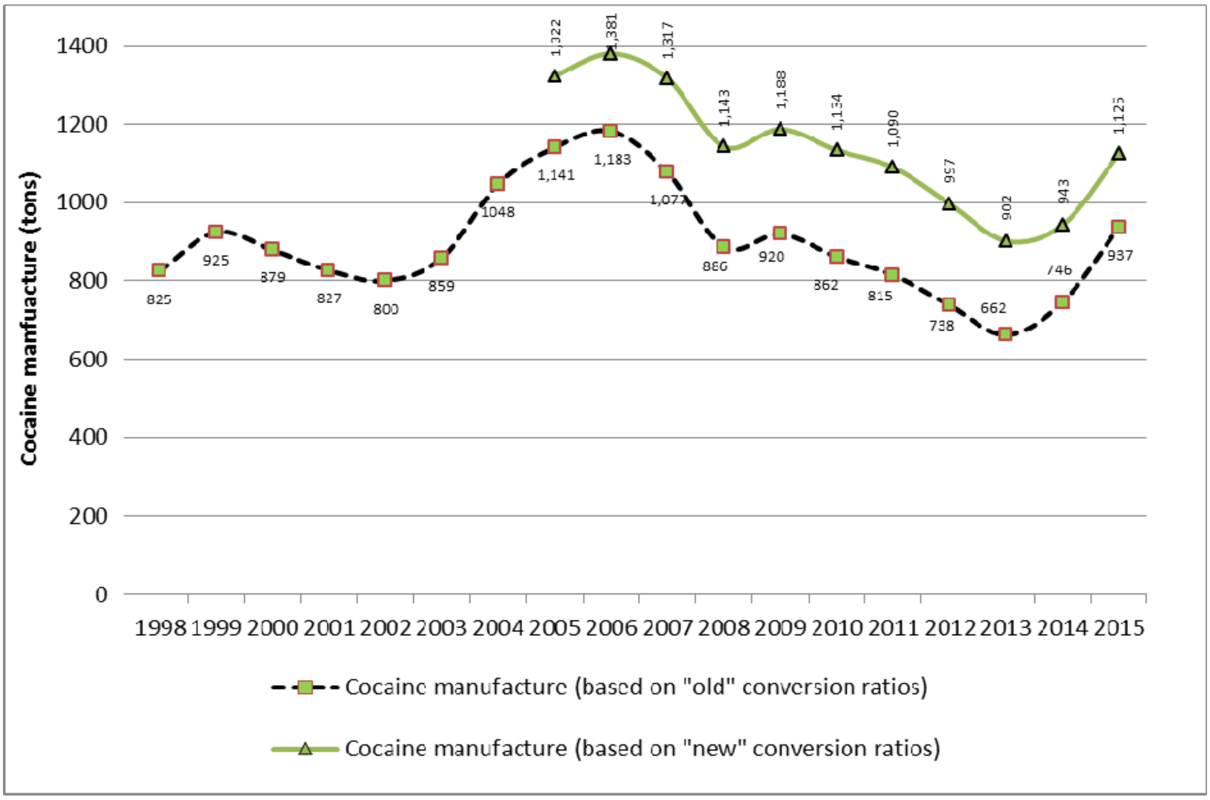
In order to estimate cocaine production from the area under coca cultivation, the coca leaf yield per region is estimated based on yield studies as well as – based on experiments in the field - the coca-leaf to coca-paste conversion, the coca-paste to cocaine base conversion and the cocaine-base to cocaine hydrochloride conversion. The results are then adjusted to show an overall conversion ratio from coca leaf to (a potential) 100 per cent pure cocaine hydrochloride.

In this report the 'old' conversion ratios from coca leaf to cocaine hydrochloride are based on studies conducted by the United States Drug Enforcement Administration (DEA) in the Andean region in the 1990s. The ratios for Colombia – in close cooperation with the Colombian authorities - were updated in 2004 and are part of the 'old' conversion ratio series.

In subsequent years the DEA undertook new studies in Peru (2005) and in the Plurinational State of Bolivia (2007-2008), following indications that the laboratory efficiency in these countries may have improved. The 'new' conversion rates used in this report – for the years 2005-2015 – however, have not been reconfirmed so far in national studies as funds for such studies have not been forthcoming. For this reason, cocaine production data are not shown separately for Peru and the Plurinational State of Bolivia; only the global total based on the 'new' conversion ratio is shown. The calculations of cocaine production based on the "new" conversion ratios refer to the "new" coca leaf to cocaine hydrochloride transformation ratios found by the DEA for Colombia, Peru and the Plurinational State of Bolivia and the updated ratios for Colombia. It should be noted that the 'new' conversion ratios are still temporary; they will be updated as soon as new data, jointly established between the respective Member States and UNODC will become available. (For more details, see World Drug Report 2010 (United Nations publication, Sales No. E.10.XI.13, pp. 251 and 252).)

As a result of some ex-post adjustments done in Colombia (see above), global cocaine manufacture estimates also have slightly changed for the years 2005-2008 as compared to data published in previous World Drug Reports.

Global cocaine manufacture in tons, 1998-2015



Source: UNODC, Coca cultivation surveys in the Andean countries, 2015 and previous years.

4. Drug trafficking

Seizures

The analysis presented in this report is mainly derived from the ARQ responses from Member States up to the 2015 reporting year. Including information from other sources, UNODC was able to obtain seizure data from 128 countries and territories for 2015. Over the 2010-2015 period seizures from in total 168 countries and territories were obtained. Seizures are thus the most comprehensive indicator of the drug situation and its evolution at the global level. Although seizures may not always reflect trafficking trends correctly at the national level, they tend to show reasonable representations of trends at the regional and global levels.

Seizures are reported in volume terms as well as in terms of the number of seizure cases. The analysis of seizure cases enables a direct comparison of data across drug categories. Reporting of seizure cases is, however, less comprehensive. A total of 61 countries and territories reported seizure cases to UNODC in 2015, or 100 countries and territories over the 2010-2015 period.

Countries reporting seizures of drug in volume terms may report seizures using a variety of units, primarily by weight (kg) but also in litres, tablets, doses, blotters, capsules, ampoules, et cetera. When reporting about individual countries in individual years, UNODC endeavours to be as faithful as possible to the reports received, but often it is necessary to aggregate data of different types for the purposes of comparison. For the aggregation, conversion factors are used to convert the quantities into ‘kilogram equivalents’ (or ‘ton equivalents’). UNODC continues to record and report the disaggregated raw data, which are available in the seizure listings published at: http://www.unodc.org/unodc/en/data-and-analysis/WDR.html In these tables, seizure quantities are reproduced as reported. In the rest of the Report, seizure data are often aggregated and transformed into this unique unit of measurement. Moreover, at some points in the analysis, purity adjustments are made where relevant and where the availability of data allows.

The conversion factors affect seizure totals of amphetamine-type stimulants (ATS) in particular, as a significant share of seizures of these drug types is reported in terms of the number of tablets. Apart from seizures of ATS tablets, drug seizures are mainly reported to UNODC by weight, and sometimes by volume. This includes seizures of ATS which are not seized in tablet form (for example, ATS in powder, crystalline or liquid form) as well as seizures of other drug types, such as heroin and cocaine. Moreover, ATS seizures made in tablet form are also sometimes reported by weight, and in some cases, the reported total aggregated weight possibly includes ATS seized in different forms. Reports of seizures by weight usually refer to the bulk weight of seizures, including adulterants and diluents, rather than the amount of controlled substance only. Moreover, given the availability of data, accurate purity adjustments for bulk seizure totals in individual countries are feasible in only a minority of cases, as they would require information on purity on a case by case basis or statistically calibrated data, such as a weighted average or a distribution. The bulk weight of tablets is easier to obtain and less variable.

To ensure the comparability of seizure totals across different years and countries, UNODC uses conversion factors for ATS tablets intended to reflect the bulk weight of the tablets rather than the amount of controlled substance. The factors used in this edition of the *World Drug Report* are based on available forensic studies and range between 90 mg and 300 mg, depending on the region and the drug type, and also apply to other units which are presumed to represent a single consumption unit (dose). The table below lists the factors used for ATS, by type and region. The conversion factors remain subject to revision as the information available to UNODC improves.

Weight of tablets in milligrams

	Ecstasy (MDMA or analogue)	Amphetamine	Methamphetamine	Prescription stimulants	Other stimulants	Non-specified amphetamines
Africa	271	250	250	250	250	250
Asia (excluding Near and Middle East/ South-West Asia)	300	250	90	250	250	250
Europe	271	253	225	250	250	250
Central and South America and Caribbean	271	250	250	250	250	250
Near and Middle East/ South-West Asia	237	170	250	250	250	250
North America	250	250	250	250	250	250
Oceania	276	250	250	250	250	250

For the other drug types, the weight of a ‘typical consumption unit’ was assumed to be: for cannabis herb, 500 mg; for cannabis resin, 135 mg; cocaine and morphine, 100 mg; heroin, 30 mg; LSD, 0.05 mg (50 micrograms); and opium, 300 mg. For opiate seizures (unless specified differently in the text), it was assumed that 10 kg of opium were equivalent to 1 kg of morphine or heroin. Though these transformation ratios can be disputed, they provide a means of combining the different seizure reports into one comprehensive measure. The transformation ratios have been derived from those normally used by law enforcement agencies, in the scientific literature and by the International Narcotics Control Board, and were established in consultation with UNODC's Laboratory and Scientific Section. As in previous editions of the World Drug Report, seizures quantified by volume (litres) are aggregated using a conversion ratio of 1 kilogram per litre, which applies to all drug types. Cannabis plants are assumed to have an average weight of 100 grams.

Trafficking routes and volumes

Information of trafficking routes was mainly obtained from analyses of reports by Member States in the annual report questionnaire and in individual drug seizures reported to UNODC, as well as analyses of trafficking routes reported by Member States.

Individual drug seizures would be the ideal data source for any in-depth analysis of drug flows. Unfortunately, reporting of individual drug seizure cases is very uneven. A total of just 27 countries reported individual drug seizures to UNODC in 2015 (99 over the 2010-2015 period). For most drug categories, reported individual drug seizures only account for a small proportion of global seizures (as reported to UNODC in the annual report questionnaire).

Drug price and purity data

Price and purity data, if properly collected and reported, can be powerful indicators of market trends. Trends in supply can change over a shorter period of time when compared with changes in demand and shifts in prices and purities are relatively good indicators for increases or declines of market supply. Research has shown that short-term changes in the consumer markets are first reflected in purity changes while prices tend to be rather stable over longer periods of time. UNODC collects its price data from the ARQ, and supplements this data with other sources such as DAINAP, EMCDDA and Government reports. Prices are collected at farm-gate level, wholesale level ('kilogram prices') and at retail level ('gram prices'). Countries are asked to provide minimum, maximum and typical prices and purities. When countries do not provide typical prices/purities, for the purposes of certain estimates, the mid-point of these estimates is calculated as a proxy for the 'typical' prices/purities (unless scientific studies are available which provide better estimates). What is generally not known is how data were collected and how reliable it is. Although improvements have been made in some countries over the years, a number of law enforcement bodies have not yet established a regular system for collecting purity and price data.

Prices are collected in local currency or in the currency in which the transactions take place and are then converted by UNODC into US dollars for the purposes of comparability among countries. The conversion into US dollars is based on official UN rates of exchange for the year. If comparisons of prices, expressed in US dollars are made over different years it should be noted that changes in such prices may be also influenced by changes in the exchange rates and may not necessarily reflect changes in the local markets.

Calculation of interception rates

In the subchapters on the opiate market and the cocaine market interceptions rates were calculated. The interception rate is the ratio of seizures divided by production and can be used as an indicator for the efficiency of law enforcement.

For the calculation of the **opiate interception rates** seizure data of opium, morphine and heroin were transformed into opium equivalents. Typically, a ratio of 10 kilogram of opium for 1 kilogram of morphine or heroin is used. In order to show results as a range, calculations were based a conversion ratio of 7:1 (as the lower range of the interception rate) and a conversion of 11.6 : 1 (as the upper limit of the interception rate). The lower limit represents the conversion ratios used in the Afghan opium surveys in previous years and the upper limit represents the conversion ratios used in the Afghan opium surveys in recent years. The average opiate seizures over the 1980-1989 period, the 1990-1997 period , the 1998-2008 period and the 2009-2015 period, expressed in opium equivalents were then compared to the average global opium production estimates over the same periods. Available data – theoretically - would have also allowed to calculate the interception rate for each year; such a calculation, however, would have been – most likely – misleading as not all of the opium produced in a year is actually sold; some of it is stocked and, in other years, heroin is produced out of stocks accumulated over previous years. While changes in stocks are important for individual years, stocks do not change too much once an average of several years is considered. The calculation of the interception rate over a number of years is thus far more meaningful than the calculation of an interception rate for any specific year.

For the calculation of the **cocaine interception rates** other adjustment were required. Seizures of cocaine were defined as seizures of cocaine hydrochloride, crack-cocaine, "coca paste/cocaine base", "cocaine base, paste and salts" and non-specified cocaine. Not included were seizures of coca leaf, seizures of the coca bush and seizures of 'other coca/cocaine type'. For the period 2009-2015 66 per cent of the reported cocaine seizures were in the form of cocaine hydrochlodride, 13 per cent were reported as "cocaine base, paste and salts", 11 per cent were reported as "coca paste/cocaine base", 10 per cent as non-specific cocaine and 0.3 per cent as crack-cocaine.

Cocaine production estimates are shown in equivalents of 100 per cent pure cocaine. Thus, all cocaine seizures also needed to be transformed into 100 per cent pure cocaine equivalents. The problem here is that purity data are not systematically reported by all member states. The approach used here was to base all conversions on the purities as reported in a specific year. An unweighted average of the reported wholesale purities was calculated for each year and the reported seizures of each year were adjusted with the an unweighted purity ratio for the specific year. The calculation of the interception rates for cocaine was then based on the averages of the purity adjusted seizures over the periods 1980-89, 1990-97, 1998-2008 and 2009-2015 and the cocaine production estimates over the same periods.

For the calculation of the average cocaine production estimates, the coca-leaf to cocaine conversions based on the 'old' conversion ratios were used for the years 1980-2006 while the 'old' and the 'new' conversion ratios were used for the years 2007-2015 (in line with the calculations done in last year's World Drug Report). For the upper range for the calculation over the period 2009-2015 purity adjusted seizures were divided by cocaine production based on the old conversion ratios while the lower limit was based on purity adjusted seizures divided by cocaine production estimates based on the "new" cocaine conversion ratios.

In contrast to opium, which can be easily stocked over several years, coca leaf tends to be processed rather quickly into cocaine in order to avoid that the cocaine alkaloid of the coca leaf degrades – if the coca leaves are not properly dried and kept dry and cool. Wet coca leaves lose their cocaine by biochemical degradation.[25] The leaves will ferment (rot) very quickly if they are not dried immediately, especially if they get rain-soaked during the drying process.[26] Moreover, storing coca leaves over a long period is not very practical as they are rather bulky. While dried opium often has a morphine content of more than 10 per cent (more than 12 per cent in Afghanistan in recent years)[27], the cocaine extracted from the dried coca leaf is 0.3 per cent or less[28]. Against this background the built-up of large stocks of coca leaf tends to be the exception rather than the rule. Thus, the calculation of annual interception rates for cocaine seems to be meaningful - in contrast to opiates where the amount of opium actually used for the manufacture of morphine and heroin in a specific year may be quite different from the amount of opium produced in that year. This has been done for cocaine for the years 2010-2015. The intervals shown were based on the 95 percent confidence interval around the calculated average wholesale purities calculated for each year. Multiplying the seizures with the lower wholesale purity and dividing them by cocaine production gave the estimate for the lower range of the interception rates; multiplying the seizures with the higher wholesale purity and dividing them by cocaine production gave the estimate for the higher interception rates. Only cocaine production estimates based on the 'new' conversion rates were used for the calculation of the annual cocaine interception rates over the 2010-2015 period.

5. *Special topics*

Calculation of illicit drug retail sales in constant currency units in the United States and in 21 European Union countries

Information on illicit drug retail sales in the United States was taken from two publications prepared under the auspices of the Office of National Drug Control Policy (ONDCP). The first ("What America's Users Spend on Illegal Drugs 1988-2000") was prepared by Abt Associates for ONDCP and expressed the results in constant 2000 US-dollars; the second ("What America's Users Spend on Illegal Drugs: 2000-2010") was prepared by the RAND Corporation for ONDCP and showed results in constant 2010 US dollars. In order to show comparable data the results of the first publication were converted from constant 2000 dollars into constant 2010 US dollars, using the Historical US consumer price index for All Urban Consumers (CPI), published by the US Bureau of Labor Statistics.[29]

For the calculation of the proportion of drug-related expenditure in gross domestic product the GDP figures provided by the World Bank for the United States were used. In order to calculate the proportion the drug retail sales of specific years expressed in constant 2000 US

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[25] United Nations International Drug Control Programme, *Guidelines for Yield Assessment of Opium Gum and Coca leaf – from Brief Field Visits*, New York 2001.

[26] Casale JF, Klein RFS, *Forensic Science Review* 5, 95-107 (1993).

[27] UNODC and Islamic Republic of Afghanistan Ministry of Counter Narcotics, *Afghanistan Opium Survey 2015*, December 2015, p. 60.

[28] Operation Breakthrough, conducted by the United States in Peru in 2003 and 2004 revealed that 375 kg of sun-dried coca leaf are necessary to produce one kilogramme of cocaine hydrochloride of 100 per cent purity, equivalent to a proportion of 0.27 per cent; for the Plurinational State of Bolivia Operation Breakthrough revealed that 370 kg of sun-dried leaf in Chapare (equivalent to a rate of 0.27 per cent) and 315 kg of leaf in the Yungas of La Paz (equivalent to a rate of 0.32 per cent) were required to produce one 1 kilogram of pure cocaine. (UNODC, *Coca Cultivation in the Andean Region – A survey of Bolivia, Colombia and Peru*, June 2008, p. 41 and p. 128).

[29]Bureau of Labor Statistics (Malik Crawford, Jonathan Chnurch, Bradley Akin), *CPI Detailed Report, Data for April 2017*, p. 75.

dollars were divided by the GDP figures of the same year expressed in constant 2000 US dollars; similarly for the calculation of drug-related expenditures reported in constant 2010 US dollars, the retail sales figures for the specific years were divided by the GDP, expressed in constant 2010 US dollars.

Calculation of illicit drug retail sales in constant currency units in the United States, 1988-2010

Source:	Currency	1988	1990	1995	2000	2005	2010
ONDCP, *What America's Users Spend on Illegal Drugs 1988-2000*, December 2001	Constant billion 2000 US dollar equivalents (as reported)	154	115	75			
	Transformed into constant billion 2010 US dollar equivalents (based on US CPI)	195	146	95			
ONDCP, *What America's Users Spend on Illegal Drugs*, 2000-2010, February 2014	Billion 2010 dollar equivalents (as reported)				108	119	109
	Constant billion 2010 dollar equivalents	195	146	95	108	119	109
	Expressed as a proportion of GDP	2.22%	1.57%	0.90%	0.85%	0.83%	0.73%

Countries of the European Union are supposed to provide estimates of the extent of the illicit drug sector to Eurostate as part of the calculations of the GDP. A total of 21 European countries (out of a total of 28 EU states) provided Eurostat repeatedly with such estimates. Drug retail sale data reported by the 21 European Union countries can be found on-line on Eurostat under the category of final consumption expenditure of household by consumption purpose (COICOP 3 digit[30], code: CP023 Narcotics; [nama_10_co3_p3]). Totals for the 21 European Union states were calculated. Under unit of measure data are reported in "current prices" as well as in constant prices ("chain linked volumes (2010"). Drug sales expressed as a proportion of GDP were calculated by dividing the final consumption expenditure of household of narcotics by current GDP figures for the respective years.

30 http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nama_10_co3_p3&lang=en

Calculation of illicit drug retail sales in 21 Member States of the European Union[a], 1995-2015

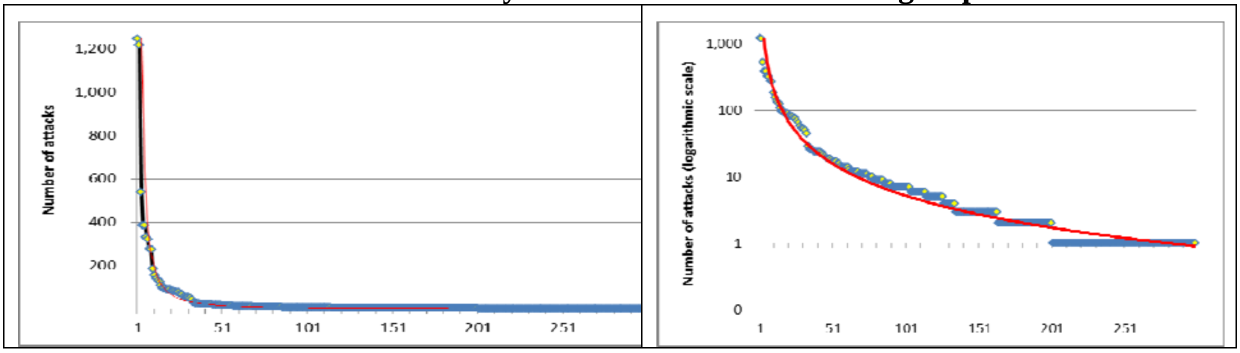
Source:	Currency	1995	2000	2005	2010	2015
Eurostat: Final consumption expenditure of household by consumption purposes (COICOP 3 digit), Classification of individual consumption purposes: Narcotics	Retail drug sales in current billion Euros	17.1	20.3	19.1	19.2	21.2
	Retail drug sales in constant billion 2010 Euros	13.1	15.3	19.2	19.2	18.0
	Drugs sales in current GDP expressed as a proportion of current GDP	0.62%	0.49%	0.37%	0.34%	0.32%

[a]Austria, Belgium, Bulgaria, Czechia, Denmark, Estonia, Ireland, Greece, Spain, Cyprus, Latvia, Lithuania, Luxembourg, Hungary , Portugal, Romania, Slovenia, Slovakia, Finland, Sweden, United Kingdom

Distribution of attacks and persons killed by terrorist and other non-state armed groups

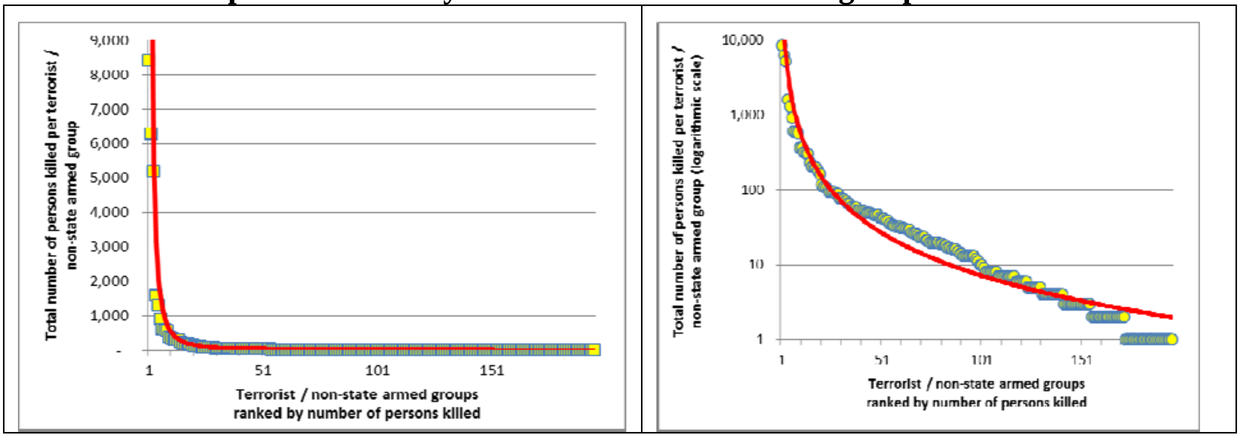
As mentioned in the World Drug Report, available data from the global terrorism database (START) suggested that terrorism is characterized by a highly skewed distribution with a few groups accounting for the bulk of terrorist attacks and persons killed. Available data show that these characteristics of terrorism are repeated each year, irrespective of changes in the respective totals.

Distribution of number of attacks by terrorist / non-state armed groups in 2015



Source: Global Terrorism Database.

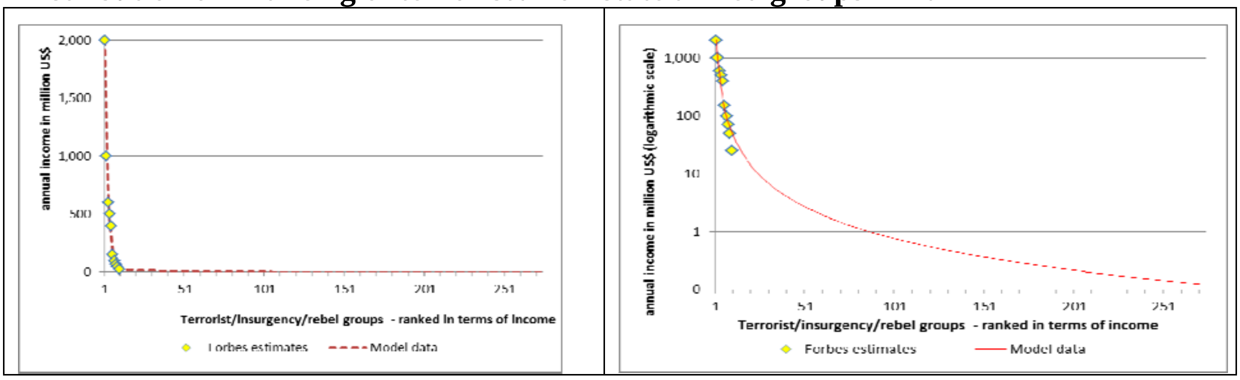
Distribution of persons killed by terrorist / non-state armed groups in 2015



Source: Global Terrorism Database.

A similarly skewed distribution is also seen from data on the financing of terrorist/non-state armed groups, as reported by Forbes International, based on information gathered from various intelligence organisations on the (allegedly) 10 'richest' terrorist / non-state armed organisations operating in 2014. Together they were estimated to have had an annual "income" of some US$ 4.9 billion, ranging from some $25 million to $2 billion. (Assuming a similar distribution as for the number of attacks and persons killed also for the financing of terrorist / non-state armed groups the total "income" of terrorist/non-state armed groups could have amounted to US$5.4-6.2 billion in 2014, depending on the models used.)

Distribution of financing of terrorist / non-state armed groups in 2014



Source: Forbes International, *10 Richest Terrorist Organizations in the World*, 12 December 2014 (also quoted in Institute for Economics & Peace, *Global Terrorism Index 2016*, pp. 52-57).

Explanation for calculating the amount of opium poppy cultivation by insurgency group in Afghanistan

The original map locating the insurgency groups was produced by the Institute for Study of War (Afghanistan partial threat assessment – November 2016, published online: http://understandingwar.org/backgrounder/afghanistan-partial-threat-assessment-november-22-2016).

The map shows Taliban and ISIS control zones as well as Taliban and ISIS high level and low level support zones in Afghanistan. The units (polygons) with different insurgency classes were digitized and given geographic coordinates using ArcGIS software, assisted by other geographic layers to improve the geographical accurate positioning[31]. The opium cultivation estimates are the results of the annual opium survey jointly conducted with the Government of Afghanistan (Ministry of Counter Narcotics) and UNODC. In order to assign the opium cultivation levels to the different groups in each district, an overlay was made of the insurgency group layer with a layer that shows the areas that are potentially used for agriculture in 2016[32]. The amount of opium poppy cultivation per district is attributed to each insurgency polygon with the same proportion as the proportion of agricultural areas covered by each insurgency polygon in that district.

	Poppy cultivation 2016	Poppy in Taliban Control Zone	Poppy in High Confidence Taliban Support Zone	Poppy in Low Confidence Taliban Support Zone	Poppy in the 3 Taliban's zone	Poppy in High Confidence ISIS Support Zone	Poppy in Low Confidence ISIS Support Zone	Poppy in other areas
Area (ha)	201,294	52,642	116,135	2,490	171,267	2,229	623	43,400
Proportion (%)	100%	26%	58%	1%	85%	1.1%	0.3%	13%

Estimation of area under coca cultivation in the Alto Huallaga region of Peru

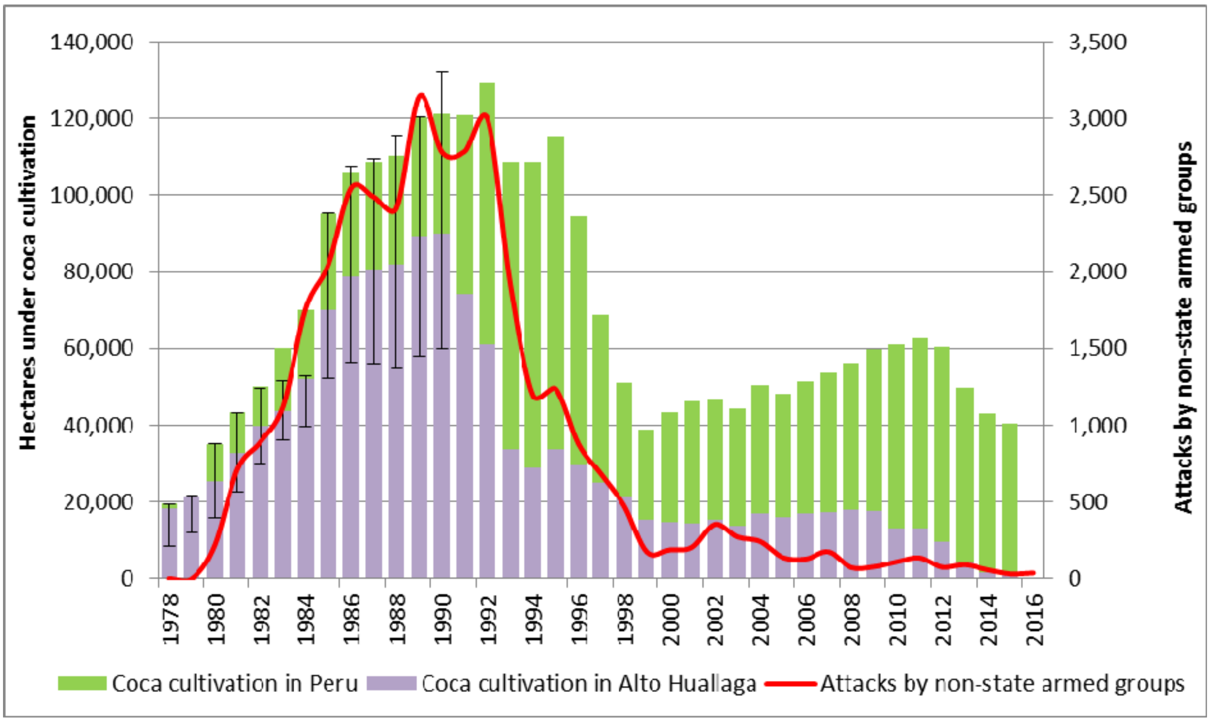
Ever since year 2000 UNODC has been involved – in close cooperation with the Government of Peru – in monitoring by remote sensing techniques the area under coca cultivation in the various parts of the country, including the Alto Huallaga region which used to be the country's main coca producing region. Such data are highly reliable.

In contrast, data for the area under coca cultivation prior to the year 2000 are less readily available. Estimates do exist for Peru as a whole, reported by the Comisión Nacional para el Desarrollo y Vida sin Drogas (DEVIDA), mostly based on US remote sensing estimates. But estimates for individual regions are more difficult to find for the periods prior to 2000. Most references in the literature though speak of the Alto Huallaga region as the main epicentre of coca leaf production of Peru prior to the year 2000. Some authors provided estimates suggesting a proportion of the total area under coca cultivation in the Alto Huallaga region of around three quarters of the total in the 1980s. Moreover, some time series data for the Alto Huallaga region can be found in the literature. However, they contradict each other when it comes to the measurement of the extent of the area under coca leaf production. For some years some of the estimates for the Alto Huallaga region even exceed the national totals reported by DEVIDA. Nonetheless, all of these estimates show a similar trend: a strong rise from the late 1970s to 1990 (or the early 1990s), followed by a strong decline in the 1990s and a further decline in recent years.

[31] The original geographic files were not available and therefore had to be re-digitized. Some obvious errors in the occupation map have been adjusted following the agricultural mask.

[32] The potential agricultural areas were mapped with the aid of medium resolution satellite images (Landsat) and historical very high resolution images taken for the opium poppy survey.

Peru: Attacks of non-state armed groups and hectares under coca cultivation, 1978-2016



Sources: UNODC and Comisión Nacional para el Desarrollo y Vida sin Drogas (DEVIDA), *Perú Monitorea de Cultivos de Coca 2015* (July 2016 and previous years); DEVIDA, *Información sobre Drogas Estadística en el Perú, Lima* (July 2006)*;* Policía Nacional del Perú, *Anuario Estadístico 2015* (2015 and previous years); Policía Nacional del Perú, Direccíon Contra el Terrorismo, *Anuario Estadístico 2009*; Hernán Manrique López, “Las bases históricas del milagro de San Martin: control territorial y estrategias estatales contra el narcotráfico y subversión (198-1995)”, Politai: *Revista de Ciencia Política,* vol. 6, No. 11 (2015), pp. 33-51; Juan Briceño and Javier Martínez, "El ciclo operativo del tráfico ilícito de la coca y sus derivados: implicancias en la liquidez del sistema financiero", en F. León, y R. Castro de Mata, eds., *Pasta básica de cocaína* (Lima, 1989), pp. 263-264; Ibán De Rementería, "Evolution of Coca Leaf Production in Peru and its Macroeconomic Role between 1978 y 1990", Peru Report, April 1991, p. 43.

A summary of some of the estimates showing a time series for the period 1978-1990 is shown below:

Estimates of the area under coca cultivation in Alto Huallaga, Peru and in Peru as a whole, reported in the literature, 1975-1990

	Briceño and Martínez	De Rementería	Estimates based on Ministerio de Agricultura (1960-84), NNCC (1985-89) and APODESA-INADE 1991	DEVIDA (MININTER-ONUDD; Observatorio Peruana de Drogas)
	Alto Huallaga			Peru
1975			6,544*	18,762*
1978		18,230		19,500
1979		21,582		21,582
1980	15,750	35,020	33,720*	35,020
1981	22,500	43,202		43,202
1982	30,000	49,603		50,000
1983	36,000	51,631		60,000
1984	52,000	52,724		70,000
1985	70,000	95,200	40,100	95,200
1986	97.500	107.500	60,100	106,000
1987	120,000	109,500	80,100	108,800
1988		115,630	80,100	110,400
1989		120,415	80.200	120,400
1990		132,457	80,200	121,300

*data based on Ministerio de Agricultura

Sources: Observatorio Peruano de Drogas "Informacion Estadistica sobre Drogas en el Peru 2006" - DEVIDA - MINNTER_ONUDD y CVR, Elaborado por el Observatorio Peruana de Drogas, 2017; Juan Briceño and Javier Martínez, "El ciclo operativo del tráfico ilícito de la coca y sus derivados: implicancias en la liquidez del sistema financiero", en F. León, y R. Castro de Mata, eds., *Pasta básica de cocaína* (Lima, 1989), pp. 263-264; Ibán De Rementería, "Evolution of Coca Leaf Production in Peru and its Macroeconomic Role between 1978 y 1990", Peru Report, April 1991, p. 43; projections based on APODESA-INADE (1991), Ministerio de Agricultura (1960-84), NNCC (1985-89).

All of these data served UNODC to arrive at tentative estimates of the likely evolvement of the area under coca leaf production in the Alto Huallaga region over the period 1978-1990.

The estimate of 90,000 hectares under cultivation in the Alto Huallaga región for the year 1990 came from Hernán Marique López in his paper on "Las bases históricas del «milagro de San Martín»: control territorial y estrategias estatales contra el narcotráfico y subversión (1980-1995)". He also provided detailed estimates of the area under coca cultivation in Alto Huallaga region over the 1992-1998 period based SIMDEV data, i.e. data from the Sistema de Información y Monitoreo de DEVIDA.

Estimates of the area under coca cultivation in Alto Huallaga, Peru, reported in the literature, and for Peru as a whole by DEVIDA, 1992-1998

Area	Source	1992	1993	1994	1995	1996	1997	1998
Alto Huallaga	SIMDEV (DEVIDA)	61,000	33,600	28,900	33,700	29,400	25,000	21,000
Peru	DEVIDA (MININTER-ONUDD; Observatorio Peruana de Drogas)	129,100	108,800	108,600	115,300	94,400	68,800	51,000

Sources: SIMDEV, quoted in Politai: *Revista de Ciencia Política*, vol. 6, No. 11 (2015), pp. 33-51 and DEVIDA (Observatorio Peruano de Drogas "Informacion Estadistica sobre Drogas en el Peru 2006" - DEVIDA - MINNTER_ONUDD y CVR, Elaborado por el Observatorio Peruana de Drogas, 2017.).

All data after 2000 are based on the joint monitoring of the area under coca cultivation by UNODC and the Government of Peru, making use of remote sensing technology. All of these data, as mentioned earlier, can be considered to be highly reliable.

Coca cultivation in Peru in hectares: 2000-2015

Year	Peru	Alto Huallaga
2000	43,400	n.a.
2001	46,200	14,481
2002	46,700	15,286
2003	44,200	13,646
2004	50,300	16,900
2005	48,200	16,039
2006	51,400	17,080
2007	53,700	17,217
2008	56,100	17,848
2009	59,900	17,497
2010	61,200	13,025
2011	62,500	13,121
2012	60,400	9,509
2013	49,800	4,302
2014	42,900	1,555
2015	40,300	1,099

Source: UNODC and Government of Peru, Peru Coca Survey 2015 and previous years.