Although difficult to quantify, and long obscured by occupational exposure, the health impact of environmental exposure to asbestos can no longer be denied. The French Institute for Public Health Surveillance (InVS) has conducted several risk assessment studies to help decision-makers manage those risks.

Asbestos is a natural fiber material that was very much used in the building, automotive, textile, and plastic industries, at least until it was officially banned on 1 January 1997. Several decrees and specific orders have been issued since this general ban to protect workers and the population from health risks associated with existing asbestos products, especially in buildings.

Given the very long period it takes for a cancer linked to asbestos exposure to be diagnosed, exposure to asbestos still remains the primary cause of occupational cancer cases.

It has been established since early 20th Century that occupational exposure results in pulmonary fibrosis or asbestosis. The role of asbestos in various diseases was established later: lung cancer and pleural cancer or mesothelioma, pleural plaques and pleural thickening. Other cancer sites are also suspected. Public health issues linked to environmental exposure are far more recent.

Unlike lung cancer, mesothelioma is a highly specific disease: there are no known risk factors other than exposure to asbestos, hence its use for assessing the health impact of exposure to asbestos. However, this impact is not limited to mesothelioma: 5 to 15% of human lung cancer cases in France are thought to be linked to asbestos.

Occupational exposure is associated to the vast majority of mesothelioma cases (see box above). No occupational factor could be identified in other cases. The resulting assumption is that those cases involved some other types of exposure to asbestos.

What is the overall impact of all these modes of exposure? This summary of the various studies conducted by the InVS attempts to answer that very question.

The National Mesothelioma Surveillance Program (PNSM)

Introduced by the InVS in 1998, the PNSM allowed for exhaustive record keeping of all suspicious primary pleural tumors, including mesothelioma cases noted in many French departments. Twenty-two departments are participating in this program in 2009, representing some 18 million people or 30% of the French population.

As of 1 December 2008, 1,947 cases had been recorded between 1998 and 2006. These cases, representing 1,538 men and 409 women, were “not excluded” by the systematic diagnostic certification process. Of these 1,947 cases, 1,127 (58%) underwent an occupational background review (894 men or 58% and 233 women or 57%).

Based on this review process, 811 men (91%) were deemed having been occupationally exposed to asbestos. As for women, 95 of them (41%) were exposed to asbestos according to their curriculum. Consequently, the diagnosed or suspected pleural mesothelioma could not be linked to occupational exposure in 83 men (9%) and 138 women (59%).

Based on the PNSM case-control study conducted between 1998 and 2002, the ratio of pleural mesothelioma caused by occupational exposure was 84% for men and 40% for women.

In May 2003, the Health Directorate asked the InVS to “assess the health effect of environmental exposure to asbestos from former industrial sites, asbestos processing facilities and natural outcrops”.

Internationally speaking, there are valid scientific arguments that seem to attest to the causal relationship between environmental exposure to asbestos and the risk of developing a pathology associated with that material. Risks have been assessed in several western countries, such as Quebec, Italy, Spain or Switzerland. It is believed that sources of environmental exposure to asbestos have been and are still responsible for ulterior environmental concentrations of asbestos fibers, a health risk for people living near these sources.
**What does environmental exposure refer to?**

Given the ubiquitous nature of asbestos, there are many types of exposure: occupational, para-occupational, domestic and environmental (see box page 2).

Environmental exposure is defined as exposure to asbestos fibers via outside or inside air pollution. In Metropolitan France, there are several possible sources of environmental exposure to asbestos:
- a geological site containing asbestos-bearing outcrops susceptible of releasing fibers through either wind erosion or human activities (building and public works, leisure time activity);
- a polluted area as the result of demolishing facilities containing asbestos or the proximity of mines or plants where asbestos was processed or used;
- from regular road traffic (brakes, clutches, erosion of road surfaces containing asbestos, etc.);
- degradation of buildings containing asbestos as a result of aging or human action; referred to as intramural exposure.

As noted, there are many types of exposure, each associated to different concentrations: although a maximum concentration of 5 fibers per liter (F/l) has been set under Article R 1334-16 of the Public Health Code, concentrations of 6 to 1 000 F/l have been recorded near geological sites, of 1 to 13 F/l near industrial sites, and of 0.08 to 3.5 F/l in urban and rural areas, and of 0.06 to 25 F/l for passive exposure inside premises.

**INVS intervention in local situations**

The mission of the InVS, which is responsible for continued monitoring and surveillance of the population’s health, is one of surveillance, vigilance and health warning. Its mission is to actively detect potential risk factors that could affect the health of the entire French population, or part of it.

In the wake of the 2003 referral from the Ministry of Health, the Department of Environmental Health (DSE) and the Department of Occupational Health (DST), collected, analyzed and updated existing knowledge.

Firstly, the InVS had previously conducted (or was conducting) specific local studies on intra-mural and environmental exposure of the population to industrial and natural sites. It was in both cases in response to requests made by individuals or associations:
- a five-year study of mesothelioma cases amongst the staff of the Jussieu University campus: three research teachers and two engineers. The Jussieu Anti-Asbestos Committee signaled these five cases diagnosed in 2001 and 2002 to the InVS. Of these five persons, all born between 1934 and 1942, no current occupational, domestic or environmental exposure could be identified, except for the rare use by some of them of protection products containing asbestos. This was the first time that several cases of pleural mesothelioma in staff working in a flocked building (isolated with a fireproof layer containing asbestos and a binder) but who were not actively exposed to asbestos were described. The study underlined "the significant health impact of a contaminated workplace where people spend a considerable amount of time".
- a public health study near a former asbestos grinding plant: the Aulnay-sous-Bois (Seine-Saint-Denis) Comptoir des minéraux et matières premières (CCMP) (Mineral and raw Material Office). Complaints lodged after the mesothelioma-related death of people living near the plant incited the Île-de-France InVS regional branch and the Interregional Epidemiology Unit to conduct a public health study to address the concerns of the local population.

**Para-occupational and domestic exposure to asbestos**

Let us consider so-called domestic exposure to asbestos, which contributes or has contributed to overall population exposure:
- domestic exposure to objects containing asbestos: work clothes of an occupationally-exposed spouse, ironing board, insulation panels, toaster, heating appliances, etc.;
- handiwork such as replacing brake lining, building an asbestos-cement garden shed or replacing joints containing asbestos.

These types of domestic exposure fall under so-called paraoccupational exposure. They relate to individuals who are in contact with asbestos professionals, often from the same family, and that may be exposed to asbestos dust carried, for example, on work clothes.

Since this kind of exposure is usually excluded from typical environmental exposures, it will not be addressed herein.

**Figure 1**

Chrysotile or white asbestos cluster

Source: DSE-InVS.
The Corsican Case...

Initial French data pertaining to exposure to natural asbestos outcrops came from Corsica. Many asbestos-bearing outcrops can be found in areas of high fracturing density in the eastern part of that region. Several epidemiological studies have shown a risk of exposure to environmental asbestos in Corsica. For example, in Murato, a Nebbio village located close to one of the major serpentine outcrops in Northeastern Corsica, 41% of people over 50 who underwent radiography showed pleural plaques. Many cases of pleural mesothelioma were also diagnosed in local people who were never occupationally exposed to asbestos.

In 1996, the Corsica Prefet asked the National Public Health Network (renamed the InVS in 1999) to assess the health impact of environmental exposure to asbestos amongst the Corsican population.

In 2004, the Haute-Corse Health and Social Affairs Departmental Directorate (Ddass) conducted a study of atmospheric asbestos fiber concentrations, with the support of the Inhaled Particle Laboratory. The study showed that 133 communes were affected. Concentrations of 5 to 6 times the regulatory threshold of 5 fibers per liter of air, both indoors and outdoors, were recorded in some communes, such as Bastia, Bustanico and Murato. The asbestos fiber samples contained primarily tremolite, a type of fiber that has never been used for industrial purpose and which is consequently used as an environmental pollution marker.

A health risk assessment was conducted, in collaboration with the InVS, to assess the lethal risks of lung cancer and pleural cancer. The risks were measured based on average exposure values derived from indoor and outdoor concentrations found in the communes of Bastia, Bustanico and Murato. The study showed that the lifelong risk of lung cancer did not differ significantly from that for a population never exposed to environmental asbestos, yet exposed to the effects of tobacco consumption.

On the other hand, where mesothelioma is concerned, individual risk values far exceeded those associated to non-exposure.

In this context, Corsica was integrated into the PNSM in 2006, given the necessity of monitoring the health of local populations.
...and the New Caledonian case

In 1991, Unit 88 (currently Unit 687) of the Institut national de la santé et de la recherche médicale (Inserm – National Health and Medical Research Institute) signaled a high incidence of pleural mesothelioma in New Caledonia. Case characteristics readily suggested environmental exposure to asbestos: equal incidence for both genders, young cases (some in the less than 40 age group) indicating exposure from young age, excess cases of mesothelioma limited to Melanesian natives and to some primarily rural areas.

A new study was conducted in 1993 to identify the risk factors responsible for these excess cases of mesothelioma, based on the fundamental assumption of asbestos fibers being present in the natural environment. The practice of covering interior and exterior house walls with a compound made from a weak rock found near the houses was identified early in the data collection process. Analysis of some samples of that compound, locally referred to as "pö" in several dialects, and of the rock used for its production, showed that it was made almost exclusively of tremolite, a type of asbestos of the amphibole group.

A mission, coordinated by the National Public Health Network, visited the area in March 1994. Several air samples showed very high concentrations of tremolite fibers, sometimes accompanied by chrysotile, during the making of pö, in tracks and inside housing, with indoor concentrations sometime reaching 78,000 F/l when sweeping. Recommendations and proposals regarding potential action were made to Territorial authorities in June 1994, based on collected data. These revolved around informing the population, measures of risk reduction, including the identification and decontamination of the risk environment, launching a metrology campaign in order to establish exposure characteristics, identifying tremolite areas, and quantifying the relationship between exposure to tremolite and the risk of respiratory cancer based on the exposure source.

Findings of the case-control study indicated in 1997 a strong link between using pö and the risk of mesothelioma. Using pö also increases significantly the risk of lung cancer in women.

Two inventories of housing at risk (covered with pö) were done, respectively in 1997 and in 2000. In 2001, at the request of the Government of New Caledonia, a joint mission uniting the InVS and the Scientific and Technological Building Center, issued technical proposals for risk reduction in housing (demolishing houses), as well as recommendations regarding health monitoring of affected populations. A demolition campaign of houses covered with pö was conducted between early 2003 and 2005. A second joint assessment was conducted in January 2003, by the National Research and Security Institute and the Professional Public Works and Building Prevention Agency. This study helped to finalize and validate the method for demolishing buildings covered with pö.

How to measure the impact of nation-wide environmental exposure?

These four studies of local situations helped confirm the impact of environmental exposure in specific conditions. They did not however allow any assessment of the situation nation-wide. One of the main difficulty is to distinguish environmental exposure from other exposures. Indeed, cases of straightforward environmental exposure appear to be extremely rare. The majority of cases involve multiple exposure types.

To address the Ministry’s referral, it was necessary to conduct much more global studies, after due analysis of the international literature and the French situation. Following the conduct of two small scale trials to confirm feasibility, two nation-wide studies on environmental exposure of population living near natural outcrops or former industrial asbestos plants and processing sites were conducted:

- a case-control study of the risk of developing mesothelioma, used as marker of asbestos exposure. The objective of the study was to compare the risk of mesothelioma based on the population’s past environmental exposure;
- a study to assess the current exposure of populations living near natural sites or former sites where asbestos was used or processed. The objective was to assess environmental exposure using several complementary methods.

“These two studies rely on different management approaches: on one hand, the current consequences of past exposure are being measured. The objective is to limit the health impact by detecting as quickly as possible potential affected individuals. On the other hand, the objective is to foresee the future consequences of current exposure, which must be limited to the minimum to reduce the risk of future asbestos-related pathologies.” – Côme Daniau, Department of Environmental Health, InVS.
**Case-control study in the general population**

Given the low number of mesothelioma cases not linked to occupational exposure, available French data proved insufficient to detect the risk of mesothelioma associated to environmental exposure. The study relied on two databases: the PNSM database for case inventory and the list of plants where asbestos was either used or processed. A Geographic Information System (GIS) was used to assess exposure, based on the case-specific residential background.

New methods were used for this study, which translated into a better assessment of environmental exposure of subjects to asbestos. The study highlighted the difficulty of obtaining specific data for assessing environmental exposure. Recommendations were issued as to which relevant data should be used to better define this type of exposure, such as the length of industrial activity, the kind of fiber used, the industrial process or the volume of asbestos produced.

Although the risk could not be determined, a recommendation was issued to act without delay based on international scientific data, including by making doctors who serve populations living near former industrial sites aware of these issues.

**Using GIS in the field of environmental health**

A GIS is a computer software used to process databases containing geographically positioned data. It allows for territorial representation of data (georeferenced data), mapping and cross-referencing of collected data. Beyond its limited use as a mapping tool of georeferenced data, it can also be used to study the spatial distribution of health events in relation to a potential hazardous site (incinerator, polluting plant, etc.), by cross-referencing environmental data (atmospheric pollution data, road network, land use, etc.) and health-related data (cancer cases, mortality figures, etc.). A GIS can be used to characterize various exposure variables by combining spatial and time-related data on environmental factors and health risks: the distance measured between a case and the suspected source of pollution, the length of time over which a polluting plant was active, etc.

Where the case-control study is concerned, the GIS was used to establish an exposure score for each personal and professional subject address. This score takes into account the degree of exposure to the various selected industrial sites, in a relevant manner, exposure duration and the distance between sites and subjects. A “space-time budget” is thus assigned to each subject for a better assessment of individual environmental exposure to asbestos.

**Study of exposure to natural asbestos outcrops**

The study resulted in the identification of 13 asbestos-bearing outcrops in continental France. Although not exhaustive, this inventory gives a good idea of the extent of local natural asbestos. As these sites are located in rural or mountainous areas, the number of people living near natural asbestos outcrops is low. Thus, where the three riskiest sites all located in the mountains are concerned, they can only be visited infrequently: low surrounding population density, difficult access, and covered with snow for most of the year.

Combining both qualitative and quantitative measurements of atmospheric fiber concentrations, the study showed that risks associated to environmental exposure of populations to asbestos contained in natural outcrops are determined by being in their proximity. In other words, it is not the asbestos-bearing site itself that poses a risk but the kind of activity held around it: “Anthropogenic mechanical disturbances may play a crucial role in the concentrations of fibers released from an asbestos-rich soil.”

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**A risk not easily quantified but that still yields risk reduction measures**

It remains difficult to quantify the risk associated with environmental exposure of the French population to asbestos, which is quite certainly lower than that of occupational exposure. Completed studies provide solid arguments for reducing people’s exposure, as a way of managing the risk presented by environmental asbestos, including by limiting access to asbestos-bearing outcrop sites.
Studies conducted by the InVS

National surveillance:
PNSM


National Studies:
Neighboring populatins of old industrial sites and asbestos-bearing outcrops


Local Studies:
Usine de broyage – Aulnay-sous-Bois

Jussieu (Occupational exposure)

Corsica

New Caledonia
Quenel P, Cochet C. Trémolites et cancers respiratoires en Nouvelle-Calédonie : recommandations concernant les mesures de réduction des risques et le suivi sanitaire. Saint-Maurice (Fra) : Institut de veille sanitaire, 2001


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This summary was coordinated by the Editorial Support Unit (Ceve, InVS) with the support of Côme Daniau (DSE, InVS), Stéphanie Vandentorren (DSE, InVS), Anabelle Gilg Soit Ilg (DST, InVS), and Marcel Goldberg (DST, InVS). Written in collaboration with Emmanuel Grenier (Scientific Editor). Translation in English by Alpha Omega Translations.

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