HEALTH RISK ASSESSMENT RELATED TO ATMOSPHERIC EMISSIONS AT AN INDUSTRIAL ZONE. CASE STUDY : AN INDUSTRIAL ZONE IN DUNKIRK, FRANCE

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OBJECTIVES

At the request of the SPPPI Nord-Pas-de-Calais, ARIA Technologies associated with LITWIN and CAREPS have accomplished a study of human health risks related to atmospheric emissions at the industrial zone of Dunkirk, FRANCE. The evaluation of health risks has previously been carried out for each industry separately, whereas in this study the total industrial emission in the zone was considered in order to calculate the global industrial pollution to which the surrounding population is exposed.

METHODOLOGY

The following pollutants have been included in the study: 1,3-butadiene, sulfur dioxide, nitrogen dioxide, benzene, toluene, xylene, arsenic, cadmium, chrome, mercury, manganese, nickel, lead, benzo(a)pyrene and dioxins/furans.
The methodology implemented for the assessment of industrial air quality impact and health risks are based on the INERIS (Institute National de l'Environnement industriel et des RISques) guidelines from 2003.

The assessment is carried out in four steps:

- Identification of dangers
- Analysis of dose-response relationship
- Calculation of exposure based on the implementation of a dispersion model that provides maps of the plant's long-term air quality impact on the surroundings
- Assessment of health risks
- The methodology is illustrated in the diagram below (figure 1).

The atmospheric dispersion of pollutants has been calculated with the gaussian model ARIA IMPACT developed by ARIA Technologies. The emissions from 25 different industrial sites within the study domain have been included. The collection of emission input data for 356 point and area sources has been carried out by LITWIN whereas the characterization of health risks has been made by CAREPS.

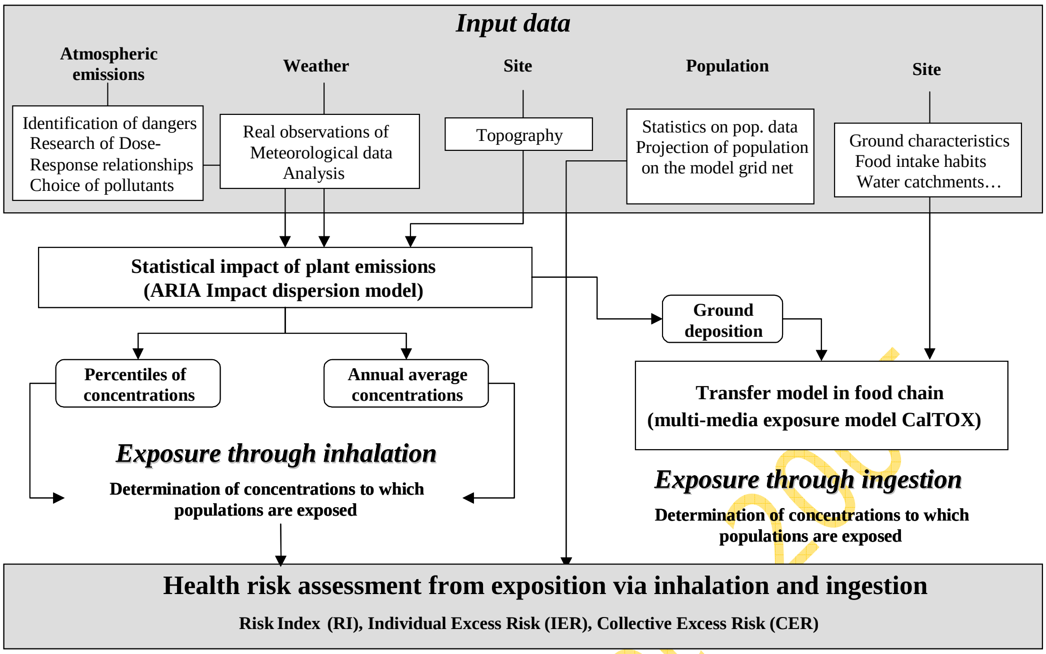
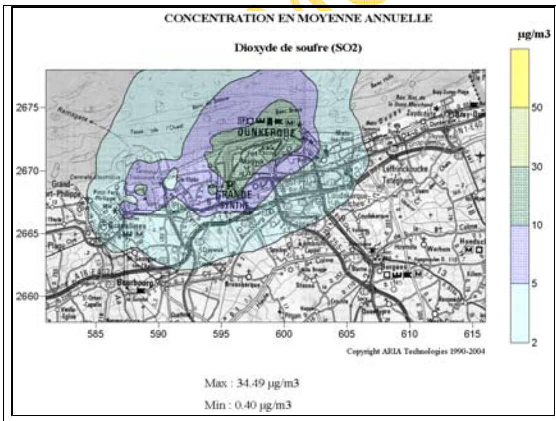


Figure 1: Methodology

POLLUTANT DISPERSION

The maximal annual concentration calculated within the study domain are, for the majority of pollutants, below the French regulatory values for ambient air quality as well as the WHO recommendation. Only the maximal annual concentration of nitrogen oxides, manganese and benzene exceed the French limit value and/or the WHO recommendation.



A comparison of the model results of SO_2 concentrations with those measured at 9 stations belonging to OPAL'AIR (ambient air quality network in Nord-Pas-de-Calais), was carried out. Globally, the results obtained from this comparison were very satisfying with a ratio of 0.95 on an average for the year 2002. This result confirms the choice of different calculation parameters: the meteorological station used (Meteo-France station at Dunkirk), the parameterization of the dispersion model, the formula for calculating the effective stack height etc. Below, is a map showing the concentration of SO_2 obtained with the model.

HUMAN HEALTH RISKS

The potential health risks linked to the exposition of the different compounds are:

- Respiratory effects: 1,3-butadiene, cadmium, chrome, sulfur dioxide, nickel, nitrogen dioxide and xylene
- Effects on the nervous system: arsenic, manganese, mercury, lead, toluene and xylene
- Kidney damage: cadmium, mercury and lead
- Effects on the cardiovascular system: 1,3-butadiene, arsenic, benzene, nickel, lead and xylene
- Hepatic effects: xylene
- Skin symptoms: arsenic, chrome (III).
- Bone and digestive diseases: lead
- Cancer risk: 1,3-butadiene, arsenic, benzene, benzo(a)pyrene, cadmium, chrome, dioxin and nickel

The toxicological reference values applied are based on a synthesis of publications prepared by different organisms specialized in the domain as well as on criteria recommended by the French national institutes InVS and INERIS.

Among the pollutants presenting a health risk, only chrome impact on a zone with many inhabitants. However, the emissions of chrome accounted for in the dispersion model have been assimilated to chrome VI, which means that the calculated risk has been overestimated with a proportion that cannot be exactly determined.

The other compounds presenting carcinogenic effects are benzene and cadmium. The pollutants implying a non-negligible risk of organ damage are: dioxins and furans, cadmium and manganese. However, the impact of these compounds are related to industrial zones implying that the calculated risks only are theoretical and not connected to an exposure through food intake.

CONCLUSION

The meteorological conditions around the industrial zone of Dunkirk are relatively favorable for the dispersion of pollutants, allowing the industrial gas plumes to be transported with the strong southwesterly winds over the sea.

This study demonstrates the importance of evaluating health risks by taking into account **all** of the industries within the study area. Within the framework of this project the human health risk have been determined based on the industrial emissions in the region. An interesting extension would be to complete the study by integrating other emissions such as road traffic and harbor activities.

A more general conclusion : this study shows very clearly the need of making work together different professions as here with a general Engineering Company, a specialist of health and a specialist of atmospheric dispersion.

PS: The authors want to thank S3PI in Dunkirk for having initiated the work and authorized this publication.