CANCER RISKS AND RISK VALUES IN CONTEXT

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1. Risk is a statistical possibility, a chance. It is not harm; it is not injury. The definition of risk in the Oxford English Dictionary is: *"(Exposure to) the possibility of loss, injury, or other adverse or unwelcome circumstance; a chance or situation involving such a possibility."*

2. Some risk calculations are based on exact statistical data. For example, based on reliable databases on accidents, we know the death or injury risks associated with driving a car, flying on an airplane, or riding a bicycle.[1]

3. Other risks, for example cancer risks due to air pollution, are not based on actual statistics on cancer occurrences. Rather, these types of risks have been calculated with animal experiments and then translated to humans through hypothetical correlations. This second group of risks are very uncertain and calculated to be conservative. There are many statements in the literature that help us understand what cancer risk calculations are and how these numbers should be interpreted.

4. For example, in the first chapter of the MATES III report, prepared by the South Coast Air Quality Management District ("SCAQMD"),[2] it is discussed how risk assessment calculations should be interpreted and explained (MATES III,

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[1] E.g., https://journalistsresource.org/studies/environment/transportation/comparing-fatality-risks-united-states-transportation-across-modes-time/ and https://www.transportation.gov/mission/health/road-traffic-fatalities-exposure-rate

[2] http://www.aqmd.gov/

p. 1-3 and 1-4).[3] The first point deals with the comparison between environmental risks and other risks. It states:

> *It may be useful to compare risks estimated from assessments of environmental exposures to the overall rates of health effects in the general population. For example, it is often estimated that the incidence of cancer over a lifetime in the U.S. population is about 1 in 4, to 1 in 3. This translates into a risk of about 300,000 in a million. It has been also estimated that the bulk of cancers from known risk factors are associated with lifestyle factors such as tobacco use, diet, and being overweight. One such study, the Harvard Report on Cancer Prevention,[4] estimated that of cancers associated with known risk factors, about 30% were related to tobacco, about 30% were related to diet and obesity, and about 2% were associated with environmental pollution related exposures.*

5. Of course, these are average values and can vary in different locations. But it is important to underline that the cancer risk caused by air pollution in a population represents a "signal" that is typically one or even two orders of magnitude lower than other "signals" due to lifestyle factors. From a purely mathematical point of view, the challenge is enormous. One needs to extract from the available data a "signal" (the risk component due to air pollution) that is buried and hidden under

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[3] http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iii/mates-iii-final-report-(september-2008)/chapter-1-introduction-and-chapter-2-air-toxics-monitoring-and-analysis.pdf?sfvrsn=10

[4] Harvard Report on Cancer Prevention Volume 1: Causes of Human Cancer, Causes & Control, Volume 7 Supplement November 1996.

other much stronger signals (lifestyle factors). This extraction is difficult, complex, and strongly affected by errors, uncertainties, and individualized considerations. The results are often affected by oversimplification and can cause unjustified alarmism.

6. The uncertainties associated with these risk calculations are well explained in the section, *"Source of Uncertainty"* (MATES III, p. 1-4):

> *The estimates of health risks are based on the state of current knowledge, and the process has undergone extensive scientific and public review. However, there is uncertainty associated with the processes of risk assessment. This uncertainty stems from the lack of data in many areas necessitating the use of assumptions. The assumptions are consistent with current scientific knowledge, but are often designed to be conservative and on the side of health protection in order to avoid underestimation of public health risks.*
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> *As noted in the OEHHA guidelines, sources of uncertainty, which may either overestimate or underestimate risk, include: (1) extrapolation of toxicity data in animals to humans, (2) uncertainty in the estimation of emissions, (3) uncertainty in the air dispersion models, and (4) uncertainty in the exposure estimates. Uncertainty may be defined as what is not known and may be reduced with further scientific studies. In addition to uncertainty, there is a natural range or variability in the human population in such properties as height, weight, and susceptibility to chemical toxicants.*

7. We can add to the list above, the errors often made in assuming exposure times when, for example, for risk assessment calculations, it is often assumed that a person is exposed uninterruptedly for 70 years.

8. The conclusion is extremely important (MATES III, p. 1-4):

> *Thus, the risk estimates should not be interpreted as actual rates of disease in the exposed population, but rather as estimates of potential risk, based on current knowledge and a number of assumptions. However, a consistent approach to risk assessment is useful to compare different sources and different substances to prioritize public health concerns.*

9. In other words, when one publishes risk assessment results, it is necessary to clarify that these estimates are very uncertain and conservative, and to underline that these estimates should be used for relative instead of absolute evaluations.

10. Furthermore, the EPA has stated:[5]

> *It should be emphasized that the linearized multistage procedure leads to a plausible upper limit to the risk that is consistent with some proposed mechanisms of carcinogenesis. Such an estimate, however, does not necessarily give a realistic prediction of the risk. The true value of the risk is unknown, and may be as low as zero.*

[5] US EPA (1986), "Guidelines for carcinogen risk assessment," Fed Reg 51(185):33992-34003, September 24, pg. 13. (http://cfpub.epa.gov/ncea/raf/car2sab/guidelines_1986.pdf).