

## Cumulative Impact

The terms “cumulative” and “cumulative effects” are becoming more widely used in environmental impact assessment. The popularity of the concept is understandable as our culture comes to recognize that solitary insults to the environment considered in isolation cannot capture the full effect of the problems now before us. But what exactly do we mean by the term “cumulative”?

“Cumulative” means growing by successive additions. This could mean additions over time, additional pollutants, additional sources of pollution, or additional routes of impact. The term could also be used to describe an individual’s integrated exposure to pollutants as he or she engages in daily activities and moves through successive microenvironments. This daily activity scenario incorporates all of the above accumulations as well as an integration over the space defined by the individual’s movements. In popular and even in technical usage, cumulative has been applied to each of these alone, to all of them together, and to combinations. Often the meaning is clear from the context, but this is not always the case.

U.S. Environmental Protection Agency (EPA) documents (1,2) define the term “aggregate risk” as the risk from all routes of exposure to a single substance, and the term “cumulative risk” as the risk from all routes of exposure to a group of substances. They are silent on the issue of multiple sources (1,2). The EPA also developed a “Cumulative Exposure Project” that incorporated multiple pollutants, multiple sources, and multiple pathways, but did not directly address time (3–5). However, the EPA has recently backed away from this project and apparently will no longer carry forward the facets involving exposure through media other than inhalation of ambient air.

In Minnesota, the Environmental Quality Board has developed state rules for

conducting environmental review (6). These rules address the issue of cumulative impacts. Specifically, they discuss multiple sources but are silent on the issue of multiple pollutants and multiple pathways. They allude to the issue of time. The courts in Minnesota have recently held that an environmental review should account for the possibility of combined impacts from multiple sources (7). The rulings have been less direct in addressing multiple pollutants, and they have not explicitly considered multiple media and multiple routes of exposure.

The Minnesota Rules, Part 4410.200, Subpart 11, on cumulative impact (6) state the following:

“Cumulative impact” means the impact on the environment that results from incremental effects of the project in addition to other past, present, and reasonably foreseeable future projects regardless of what person undertakes the other projects. Cumulative impacts can result from individually minor but collectively significant projects taking place over a period of time.

To effectively address the “cumulative” issue, we need to define the terms of the discussion so that we may communicate clearly. Environmental impacts may manifest themselves in a cumulative manner in the following ways:

- Incremental impact of a single source, pollutant, and pathway
- Combined impact of multiple sources of a single pollutant via one pathway
- Combined impact of multiple pollutants from a single source via one pathway
- Combined impact via multiple pathways of a single pollutant from a single source
- Combined impact of multiple pollutants from multiple sources via a single pathway
- Combined impact of multiple sources via multiple pathways of a single pollutant
- Combined impact of multiple pollutants via multiple pathways from a single source
- Combined impact of multiple pollutants from multiple sources via multiple pathways.

These are some of the categories of most immediate importance in my area of expertise, although this list does not include time. Other categories that might be included are invasions by alien species, physical disruptions by human development, climate change, and additions or subtractions of nutrients.

The combined impacts of multiple insults can take on one of three magnitudes: additive, more than additive (synergistic), or less than additive (negative synergy). I hope that my comments prove useful in furthering this discussion.

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