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INDICES AS AN INSTRUMENT OF CLEAN AIR POLICY

This paper discusses some current approaches to indexing ambient air quality in the Federal Republic of Germany, as well as it examines the FRG's Smog Index and the Pollution Standards Index in the United States of America.

Introduction

Seen on a more general view--for example, from the standpoint of cybernetics--information is a prerequisite of goal-oriented action. A special instrument used for obtaining and publishing precise and easily understandable information are indices. Indexing means to shape and present data related to a certain unit (e.g., a standard) in the form of a dimensionless number. Of particular importance are combined indices by which complexity can be reduced, aggregating different indicators.

In the field of clean air policy, indices of ambient air quality are used, for example, in Japan, in the United States of America, and in the Federal Republic of Germany. Some possible functions of indexing ambient air pollution would be

- (1) warning the public, particularly members of so-called "risk groups" such as those who suffer from cardiac or respiratory ail-

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ments.

- (2) a technical steering function: measures to reduce the discharge of pollutants can be linked to certain index values.
- (3) providing administrators, experts, and the public with information about where the biggest problems are located and about the success, if any, of former environmental protection measures. Long-term development of air pollution can be better evaluated, and if indices of the same type are used the development of ambient air pollution in different areas can be compared.

1. The "Smog Index" in the Federal Republic of Germany

Following the North Rhine-Westfalian Smog Ordinance of 1964, the Board of Experts for Clean Air Policy of the West German Länder (Länderausschuß für Immissionsschutz) passed general guidelines in 1974 and again in 1978 for the Länder smog ordinances that followed. According to the October 1984 guideline, smog alarm must be given under the following circumstances:

- (1) when stagnant air conditions (resulting from a temperature inversion less than 700 meters above ground surface accompanied by wind velocity of less than 3 meters per second) persist for more than 24 hours;
- (2) when the concentrations of SO₂, NO₂, CO or a combination of SO₂ and fine dust exceeds the standards at two adjacent monitoring stations, or at half the monitoring stations in a smog warning district.

There are three phases of alert. In phase one, the general public, including managers of industrial sites, are asked to avoid discharges of air pollutants voluntarily. The general public and especially members of "risk groups" will be warned of possible hazardous effects to health from the high level of air pollution. This alert phase must be officially declared if

- (a) the sum of the concentration of SO₂ plus twice the concentration of fine dust exceeded 1.10 mg/m³ on the average over the last 24-hour period.
- (b) the concentrations of SO₂ exceeded 0.60 mg/m³, the concentration of NO_x exceeded 0.60 mg/m³, or the concentration of CO exceeded 30 mg/m³ within the previous 3-hour period. In phase two, automobile

use is restricted to specific times of the day, and the discharge of air pollutants from industrial sites must be reduced to 60 per cent of their normal amounts.

Alert phase two regulations go into effect if

- (a) the sum of the concentration of SO_2 plus twice the concentration of fine dust exceeded 1.40 mg/m^3 on the average over the last 24-hour period, or 1.10 mg/m^3 within a space of 72 hours;
- (b) the concentration of SO_2 exceeded 1.20 mg/m^3 , the concentration of NO_2 exceeded 1.00 mg/m^3 , or the concentration of CO exceeded 45 mg/m^3 within the last three hours.

In phase three automobile use is prohibited with the exception of public buses or emergency vehicles, for example. Facilities which discharge large quantities of air pollutants must suspend their activities, with certain obvious exceptions such as those producing heat for residences. The operation of exempted facilities must be reduced to the lowest possible amount of activity. Alert phase three regulations come into force whenever

- (a) the sum of the concentration of SO_2 plus twice the concentration of fine dust exceeded 1.70 mg/m_3 on the average over the last 24 hour period, or 1.40 mg/m_3 within a space of 72 hours;
- (b) the concentration of SO_2 exceeded 1.80 mg/m_3 , the concentration of NO_2 exceeded 1.40 mg/m^3 , or the concentration of CO exceeded 60 mg/m^3 within the last three hours.

The Ruhr Region of North Rhine-Westfalia experienced all three alert phases in January 1985. Alert phase one was reached repeatedly in several Länder of the FRG during the winter of 1984-85. Altogether, including cases of smog alarm as defined by the 1974 Smog Ordinance Guidelines, there have been 18 days in which smog alarm was recorded in the FRG, and on some of these days, a smog alarm situation occurred in several Länder at once.

The three phases of alert according to the Smog Ordinance in the FRG (and ordinances in other countries) can be understood as indices of ambient air pollution. Different absolute concentrations of air pollutants are combined, related to standards, and then expressed under a simple label which everyone can readily understand and use.

The Smog Ordinance regulations are important indicators only in the cases of very high concentrations of pollutants; they are not a suitable instrument for obtaining current information on ambient air pol-

lution. In order to gain information on current ambient air pollution, a number of suggestions have been made and several practical approaches outlined or taken. One of these is the Pollutant Standards Index (PSI) developed in the United States.

2. The Pollutant Standards Index in the United States of America

Until the mid-1970s, many different indices were used to inform people in the United States and Canada about the given ambient air quality in their vicinity. In 1975, 33 US cities and five states had special indices of ambient air quality. This large number and variety of indices made the public feel more unsteady rather than well-informed. In view of that situation, the Council on Environmental Quality (CEQ) formed a working group charged with the responsibility for designing a uniform index of ambient air quality. In 1978, the working group proposed the Pollutant Standards Index (PSI) which has since become the standard generally applied throughout the United States. This index

- is health oriented,
- comprises the pollutants CO, O₃, NO₂, and TSP,
- is calculated according to a linear method including non-constant coefficients,
- does not include synergistic effects, e.g., between SO₂ and TSP; however, the PSI values are determined by particular pollutants (selected from a set of five criteria pollutants) having the highest concentration relative to their primary air quality standard,
- is divided into five levels ranging from "good" (0 to 49% of the standard), over "moderate" (50 to 99), "unhealthful" (100 to 199), and "very unhealthful" (200 to 299), to "hazardous" (300 and more). If air quality equals the primary standard for a given pollutant, the index has a value of 100; if it is twice the standard, the index has a value of 200, and so on (see table 1).

Under the President Reagan's administration, the definition of the alert phases has been changed. Since 1982, the label "unhealthful" marks index values between 200 and 299, and "very unhealthful" marks index values between 300 and 399.

The pollutant Standards Index has been used not only as the basis for short-term alert warning in urban areas, it is also been used as the

basis for longer term evaluation of ambient air pollution.

3. Approaches to Indexing Current Ambient Air Pollution in the Federal Republic of Germany

Meinl (1976), Münch & Wycisk (1984), and Prittwitz & Haushalter (1985) have all offered suggestions for indexing current ambient air quality in the FRG. These approaches are similar in several respects.

- (a) An easily understandable, uniform index on ambient air quality, comprising the main pollutants measured in the FRG (SO₂, NO₂, CO, partly TSP, and O₃ as well) has been proposed with the suggestion that the SO₂-TSP combination be included.
- (b) Degree of health hazard should be labelled similarly to those in the American PSI, e.g., "unhealthful", "Very unhealthful", "hazardous", etc.

(c) Measured concentrations of air pollutants should be evaluated according to standards set by the Association of German Engineers, "Verein Deutscher Ingenieure" (VDI):

- SO₂ = 1.0 mg for a half-hour period or 0.3 mg for a 24-hour period,
- TSP = 0.2 mg for a 24-hour period,
- NO₂ = 0.2 mg for a half-hour period or 0.1 mg for a 24-hour period,
- CO = 50 mg for a half-hour period or 10 mg for a 24-hour period,

combined with the standards indicated by the World Health Organization:

- SO₂ = 0.1 to 0.15 mg for a 24-hour period,
- TSP = 0.1 to 0.15 mg for a 24-hour period.

(c) Information on the index values should be made available to the public daily through an automated (recorded message) telephone service. The general weather service should also inform citizens about the ambient air quality, particularly under stagnant weather conditions.

According to the proposal of Prittwitz & Haushalter (1985), the actual indexing of ambient air pollution would provide a sound basis for systematic forecasting of air pollution levels during each coming 24-hour period. Achieving this aim requires first a rough estimation of emissions (which ones and how many) and, second, information on the distribution of these pollutants in the atmosphere.

Table 1: Definition of Pollutant Standards Index (PSI) Values

| PSI Index Value | Pollutant level | | | | | | Health Effect | General Health Effects | Cautionary Statements |
|-----------------|-------------------|-------------------|---------------------------|-------------------|-------------------------|--------------------------|-----------------------|---|---|
| | Air Quality Level | TSP (24-hour) | SO ₂ (24-hour) | CO (8-hour) | O ₃ (1-hour) | NO ₂ (1-hour) | | | |
| | | mg/m ³ | mg/M ³ | mg/m ³ | mg/m ³ | mg/m ³ | | | |
| 500 | Signific. Harm | 1000 | 2620 | 57.5 | 1200 | 3750 | | | |
| 400 | Emergency | 875 | 2100 | 46.0 | 1000 | 3000 | | Premature death of ill and elderly. Healthy people will experience adverse symptoms that affect their normal activity. | All persons should remain indoors, keeping windows and doors closed. All persons should minimize physical exertion and avoid |
| 300 | Warning | 625 | 1600 | 34.0 | 800 | 2260 | hazardous | Premature onset of certain diseases in addition to significant aggravation of symptoms and decreased exercise tolerance in healthy persons. | Elderly persons with existing diseases should stay indoors and avoid physical exertion. General population should avoid outdoor activity. |
| 200 | Alert | 375 | 800 | 17.0 | 400 ^c | 1130 | Very unhealthful | Significant aggravation of symptoms and decreased exercise tolerance in persons with heart or lung disease, with widespread symptoms in the healthy population. | Elderly persons with existing heart or lung disease should stay indoors and reduce physical activity. |
| 100 | NAAQS | 260 | 365 | 10.0 | 240 | | Unhealthful | Mild aggravation of symptoms in susceptible persons, with irritation symptoms in the healthy population. | Persons with existing heart or respiratory ailments should reduce physical exertion and outdoor activity. |
| 50 | 50 % of NAAQS | 75 ^b | 80 ^b | 5.0 | 120 | | Moderate ^a | | |
| 0 | | 0 | 0 | 0 | 0 | | Good ^a | | |

a No Index values reported at concentration levels below those specified by "Alert Level" criteria.

b Annual primary NAAQS.

c 400 g/m³ was used instead of the O₃ Alert Level of 200 g/m³

The technical and economic prerequisites for the realization of such proposals do indeed exist. The first practical steps in this direction have already been taken in North Rhine-Westfalia and in West Berlin where current information on the concentration of individual pollutants in the air is available to the public. The development and application of forecasting systems throughout the FRG have nevertheless yet to be achieved.

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WSKAŹNIKI JAKO INSTRUMENT PROGRAMU "CZYSTE POWIETRZE"

Przedyskutowano próby indeksowania jakości powietrza atmosferycznego w RFN. Omówiono wskaźnik zadymienia obowiązujący w RFN i wskaźnik dopuszczalnych zanieczyszczeń obowiązujący w USA.

ПОКАЗАТЕЛИ КАК ИНСТРУМЕНТ ПРОГРАММЫ "ЧИСТЫЙ ВОЗДУХ"

Описаны попытки индексирования качества атмосферного воздуха в ФРГ. Обсужден показатель задымленности, действующий в ФРГ и показатель допустимых загрязнений, действующий в США.