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CLEAN AIR PLANS IN THE FEDERAL REPUBLIC OF GERMANY

"Clean Air Plans" are a core element of Air Quality Management Systems in several industrialized countries. In this article, the strategy of "Clean Air Plans" in the Federal Republic of Germany is described and the problems of its implementation are analyzed.

1. Introduction

In January 1985 air pollution levels in Essen and Duisburg, two towns in the heart of the heavy industrialized Ruhr Valley, rose to a dangerous level. For the first time in the history of air pollution control in Germany, a smog-alarm of the second and third degrees had to be released. Over a period of one week, in parts of the Ruhr Valley, the private use of automobiles was forbidden and factories had to reduce or even stop their production.

This happened ten years after one of the most ambitious environmental laws in German history - the "Law for the Prevention of Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration, and Similar Phenomena" came into force. The smog-period in january 1985 showed that there are still major unsolved problems in air pollution control in Germany despite considerable efforts in reducing the level of air pollution during the last 15 years. It also showed that the heavy industrialized urban agglomerations pose the biggest challenge to air pollution control. It is important to note that those areas with heavy pollution loads are not only a threat to the area it-

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self, but also to areas that are far away. In this paper I will focus on the air pollution control policy in the heavy industrialized areas.

In the last two decades, air pollution has become a subject of immediate concern to the industrialized countries. In the very beginning of air pollution control, the measures undertaken by industrial emitters and public administrations focussed on single cases of pollution. However, it became more and more evident that it is not sufficient to control air pollution by means of single isolated actions and that actions have to be integrated into a coordinated Air Quality Management System (AQMS).

The characteristic elements of an AQMS are:

- emissions standards,
- ambient air quality standards or objectives,
- the goal of preventing the degradation of air quality in regions with pollution levels in the harmless category,
- equipment standards and product standards, and
- the incorporation of air pollution aspects in town, regional and economic planning processes.

To implement an AQMS, huge amounts of information are needed. To collect the necessary data, to give a basis for action, and to outline the action in the heavy polluted areas, Clean Air Plans (CAPs) are set up.

In the Federal Republic of Germany, those areas for which CAPs have to be set up are described in the "Law for the Prevention or Harmful Effects on the Environment Caused by Air Pollution, Noise, Vibration, and Similar Phenomena" (of 15 March 1974, Bundesgesetzblatt Par I, pp. 721, 1193, as amended by the Law Amending the Law to Introduce the Penal Code, dated August 15, 1974) as follows: "(2) Areas with a heavy pollution load shall be areas in which air pollution occurs or is to be expected, which, owing to 1. its frequency and duration, 2. its high concentration, or 3. the danger inherent in combinations of different types of air pollution, may cause particularly harmful effects on the environment." (§ 44, 2). According to another official definition a heavily polluted area is an area of at least 48 square kilometres where the following conditions apply:

- the standard for one pollutant is exceeded or
- 90% of the limit value is reached for each of two pollutants or
- the sum of the proportions of actual pollution to related limit

value for 3 or 4 of the pollutants with the highest proportions exceeds the figure 2 or
- damage to the environment is already manifest or to be expected.

Table 1 shows the major heavy polluted areas in the Federal Republic of Germany and the kind of plans that have been set up for these areas. All in all we have today in Germany 27 regions that are declared heavy polluted areas. More than one fourth of the population live in these areas.

In the past and today, North-Rhine Westfalia is one of those states in the Federal Republic of Germany that has the most severe problems in air pollution. It is therefore not astonishing to know that in this state air pollution control started more than a hundred years ago. The strategy of CAPs has been mainly developed here. Starting at the end of the 1960s, CAPs for five regions in North-Rhine Westfalia have been set up.

In the first part of this paper (chapter 2) I will describe the theoretical and methodological approach of CAPs. In the second part (chapter 3) I will make some remarks on the performance of CAPs and give some explanations, why these instruments that are in use for more than ten years show often poor results in practice.

2. Clean Air Plans in Theory

A Clean Air Plan consists of seven consecutive steps:

1. Examination and analysis of the geographical area and the land use
2. Emissions inventories
3. "Immissions inventories" (data on ambient air quality)
4. Examination of environmental degradation
5. Analysis of the connection between emissions, ambient air quality and environmental degradation
6. Emissions and ambient air quality forecasts
7. Plan to improve the air quality

Table 1: Clean-Air-Plan Regions and Regions under Investigation in the Federal Republic of Germany

State	Clean-Air-Plan Region (1) Region under Investig.(2)	Area in sq. km2	Inhabitants in 1000	Remarks	Year - Duration
Baden-Württb.	Mannheim-Karlsruhe (2)	1373	1200	Emissions inventory	w.y.
Bayern	Aschaffenburg (1)	736	n.i.	No Clean Air Plan	
	Augsburg (1)	228	n.i.	No Clean Air Plan	
	Burghausen (1)	65	n.i.	No Clean Air Plan	
	Erlgn.-Frth.-Nrbg.(1)	447	765	Emissions inventory	w.y.
	Ingolstadt et al. (1)	541	n.i.	No Clean Air Plan	
	München (1)	822	n.i.	No Clean Air Plan	
	Regensburg (1)	55	n.i.	No Clean Air Plan	
	Würzburg (1)	63	n.i.	No Clean Air Plan	
Berlin	Berlin (1)	480	1900	Clean Air Plan only for Sulfurdioxid	1981
Hamburg	Hamburg (2)	n.i.	1650	Preparatory work finished	1984
Hessen	Rhein-Main (1)	122	280	"Plan to improve the air quality" for 4 pollutants	1981
	Untermain (1)	466	n.i.	No Clean Air Plan	
	Wetzlar (1)	49	n.i.		1982
	Kassel(1)	148	50	No Clean Air Plan	
Niedersachsen	Braunschweig (2)	n.i.	n.i.	-	
	Hannover (2)	n.i.	n.i.	-	
	Oker/Harlingerode (2)	n.i.	n.i.	-	
	Nordenham (2)	n.i.	n.i.	-	
	Salzgitter (2)	n.i.	n.i.	-	
Nordrhein-Westfalen	Rheinschiene Süd I (1) (Köln)	649	1400	"Plan to improve the air quality" for 25 pollutants	1976 1977-81
	Rheinschiene Süd II(1) (Köln)	649	1330	" 11 pollutants	1983 1982-1986
	Ruhrgebiet West (1) (Duisburg - Oberhausen - Mülheim)	711	1260	" 18 pollutants	1977 1978-1982
	Ruhrgebiet Ost (1) (Dortmund)	712	1200	" 16 pollutants	1978 1979-1983
	Ruhrgebiet Mitte (1) (Essen-Bochum)	765	2000	" 12 pollutants	1980 1980-1984
	Rheinschiene Mitte (1) (Düsseldorf)	356	779	" 8 pollutants	1982 1982-1986
Rheinland-Pfalz	Ludwigshafen-Frankenthal (1)	116	212	"Plan to improve the air quality" for 16 pollutants	1980 1979-1984
	Mainz-Budenheim (1)	96	195	" 4 pollutants	
Saarland	Dillingen et al. (1)	303	368	Emissions inventories	1978
Schleswig-Holstein	Brunsbüttel (2)	n.i.	n.i.	-	

Remarks: n.i.: no data available; - : no activities or no information; w.y. : without year

Sources: Dritter Immissionsschutzbericht der Bundesregierung 1984, Meinl et al. 1980, author's calculations

2.1. Examination and analysis of the geographical area and the land use

A CAP starts with the examination and documentation of the characteristics of the geographical area and the land use patterns. These affect the later selection of the feasible control and enforcement strategies to a great extent.

The main items of this part of the CAP are geographical and topographical characteristics (i.e. the relief of the area), metereological and climatological data (i.e. wind speed and direction, air temperature, relative humidity), development and density of the population, industry, traffic, and their spatial distribution; the energy production and consumption patterns of the surroundig areas and their characteristics as far as they are important for the assessment area. All these data I mentioned should be collected and analysed for some 10 years to be able to develop long time series projections.

2.2. Emissions Inventories

The second step is to establish source and emissions inventories. Emissions invetories play a crucial role within the context of a Clean Air Plan. They are the basis for all the succeeding steps. Emissions inventories should give the type, quantity, spatial and time-related distribution, together with the emissions conditions for atmospheric pollutants. These datails should be recorded for large and small scale industrial plants, for domestic heating and for motor vehicles.

The data included in the emissions inventory should be continously updated for the industrial plants by means of annual, comprehensive statements to be drawn up by the operator. The current situation for small scale installations and domestic heating is recorded on the basis of numbers and included in the emissions inventory after application of emissions factors. The emissions sources are shown in a grid section of one square kilometer. The emissions from motor vehicles are based on the number of vehicles travelling, which is determined by means of count, and on the application of emissions factors which take into account speed and type of vehicle.

Inventories kept by chimney sweeps show the number, geographical location and type of fuel. A random sample is taken from the total number of installations. The heating habits of the dample must be determined through a survey. The result of this is then used to describe the heating habits of the total number.

It is also usual to use estimates to supplement information for motor vehicles. The scope of these estimates depends on how far it has been possible to count the number of vehicles on the roads over the whole region. With the application of transfer criteria, the factors give justifiable results if these criteria originate in the universe to be described and not in other differently structured areas.

The emissions inventories are characterized by the following four principles:

1. Universality: the systematics is uniform for all emitter categories and thus all plans are applicable to all air pollutants.

2. Flexibility: the systematics allows every desired resolution with respect to time and space.

3. Cause orientation: the systematics differentiates between the processes - within the plant or aggregate - being responsible for the emissions and the places of their transition into the atmosphere.

4. Emissions orientation: the systematics allows a largely qualitative description of the causes for emissions. Emissions are exclusively described by absolute mass flows and not as specific values such as emission factors.

The emissions inventories show for every part of the area under investigation the amount of emissions and are the basis for the transformation of emission data into data on ambient air quality for those pollutants that are not permanently measured.

The costs of emissions inventories are considerable. They depend on the size of the area and the amount of data to be collected. The city of Cologne estimated that an inventory for an area of 1.5 million people, including 1,000 substances emitted with more than 1 kg per year cost about 6 million DM. That was in the beginning of the seventies. Today the same efforts would probably take more than 8 million DM.

In North-Rhine Westfalia we find five heavy polluted areas for which CAPs have been set up. For the Cologne region there have been two inventories, the first in 1976 und the second in 1981. The annual running costs for the emission inventories in North-Rhine Westfalia alone are estimated at some 2 million DM per year. All these costs total to an amount of some 50 million DM in the last fifteen years.

One main problem in the process of setting up a CAP is the number of pollutants that should be included in the inventory. In heavy polluted areas we normally find a huge number of air pollutants. As mentioned above, in the Cologne region alone, where the first German emissions inventory has been set up, more than one thousand pollutants with an emission quantity of more than one kg per year has been found. Out of this number, 79 pollutants cover 97 percent of the total emissions. Out of this number, the following have been declared the most important:

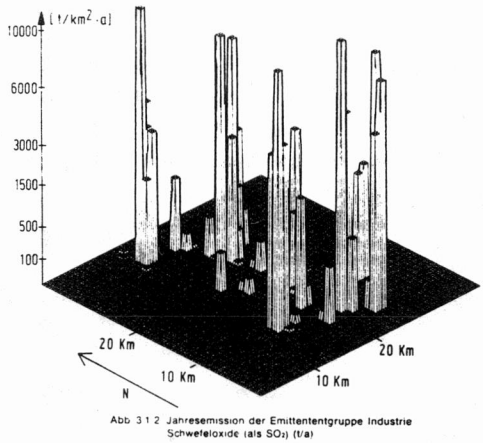
- particulate matter,
- suspended dust,
- lead,
- sulphur dioxide,
- nitrogen oxides,
- carbon monoxide,
- organic substances,
- chlorine and gaseous chlorine compounds,
- fluorine and gaseous fluorine compounds.

In addition to these pollutants, all other pollutants found in the assement area with more than one kg emissions a year should be included in the inventory.

Another problem of emissions inventories is the reliability of the collected data. In Germany, the main emitters have to submit a detailled 'emissions statement' every year. These data are the basis for the inventory of the emitter group industry. The data for the emitter groups small industry/domestic heating and traffic are mostly calculated.

Figure 1 shows an example for an emission inventory from the Cologne CAP.

Figure 1: Annual Sulphur Dioxide Emissions for the Emitter Group Industry in tons for 1975.



2.3. "Immissions-" or Ambient Air Quality Inventory

The "Immissions -" or Ambient Air Quality Inventory gives an overview of the existing ambient air quality in the assessment area. Dependent on the situation in the region, a dense network of sampling stations is needed. While the more important air pollutants are permanently measured, others are covered by "immissions-simulations".

In North-Rhine Westfalia, two measuring and sampling systems can be distinguished. The more important network consists of some 30 stations at key locations in the state for continous measuring, the so-called TEMES system. The second network consists of numerous sampling stations that collect the downfall of the measured pollutants for a certain period of time. The data from these sampling stations are gathered only periodically. The stations are integrated into a grid section network of one square kilometer.
There are no detailed figures on the costs of these networks because they are in contrary to the emissions inventories not only set up for the CAPs.

The number of the pollutants that are included in the immissions inventory is much smaller than the number of pollutants in the emissions inventory. Under investigation in **all** CAPs are the following air pollutants:

- particulate matter,
- sulphur dioxide,
- nitrogen oxides,
- carbon monoxide, and
- organic substances.

In addition to these pollutants the states are obligate to measure those pollutants which may cause harmful effects on the particular region.

Figure 2 shows an example for an ambient air quality inventory, again from the Cologne region:

Figure 2: Immissions for Sulphur Dioxide (arithmetic mean) for the Cologne region in 1975.

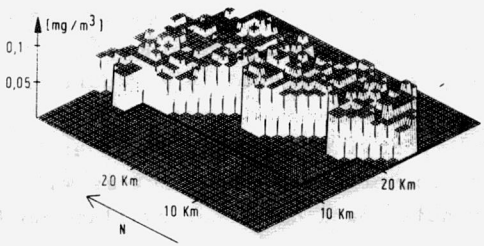


Abb. 3.2/1: Immissionsbelastung Schwefeldioxid
Arithm. Mittelwert für die jeweilige Einheitsfläche von 1 km² Größe

2.4. Examination of environmental degradation

Step No. 4 of a CAP is the examination of environmental degradation (or: impact assessment, impact inventory, "forecasting of environmental damage"). The examination of environmental degration is a potential instrument for integrated planning. However, it has inherent

difficulties due to a lack of baseline data and appropriate methodologies. Interests are conflicting and short-term and long-term considerations sometimes are divergent. The usefulness of modelling is important. Care must be taken in using elaborate techniques when they depend on individual subjective assumptions.

Within the CAPs, there are three different parts of such an examination:

- effects of air pollution on human beings,
- effects on animals and plants and
- effects on buildings and other materials.

One example for the examinations of the effects of air pollution on human beings are so called "panel studies", which concentrate on specific groups of the population.

The research on the effects of air pollution on animals and plants has grown considerably during the last five years. The main reason for this growth is the "Waldsterben", which has been discovered by the public only a few years ago.

The research on the effects of air pollution on materials has also grown during the last 10 years. This development was mainly due to the finding that some major historical buildings in Germany, like the Cologne Cathedral are severely affected by air pollution.

The costs for the "impact inventory" is considerable because the necessary field work is very expensive. But as with the immissions-inventories, no financial data have been availabe so far.

2.5. Analysis of the connection between emissions, ambient air quality and environmental degradation

The fifth step in establishing a CAP is the analysis of the connection between emissions, ambient air quality and environmental degradation. Here the emissions and immissions invetory and the examination of the effects are compared. In this part of the CAP, the authorities try to relate the emissions from specific sources with the ambient air quality found in the same region and the environmental damage identified there. Due to numerous unsolved methodological prob-

lems, the analysis of the relation between emissions, ambient air quality, and environmental degradation is one of the 'weaker' parts of the CAP.

2.6. Emissions and ambient air quality forecasts

With the analysis of the relation between emissions, ambient air quality and environmental degradation (step no 5), the collection of 'hard' data for a CAP is finished. CAPs, however, have a duration of several years. To get some information on how the environmental situation will look like at the end of that period, forecasts are needed.

Step No. 6 in a CAP are the emissions and ambient air quality forecasts. These forecasts are needed, among other things, to find, if it would be possible to build new factories in the region of the Clean Air Plan without exeeding the fixed ambient air quality standards. These forecasts serve also as in important information base in particular for town and city planners and for other all planning agencies within the public administration. These forecasts also can be the foundation for new laws, if the forecasts show that the environmental situation will deteriorate in the next years.

2.7. Plan to improve the air quality

The last step of a CAP is the plan to improve the air quality, with a more challenging title: strategy plan. This should be the centerpiece of the whole clean air plan. The strategy plan is based on the other parts of the clean air act and this plan should show the direction of the air pollution control in the assement area. The strategy must not be established only on the basis of the present situation. Future emissions must be projected and the realistic development of industrialization, population and traffic pattern as well as future land use must be taken into consideration.

To be effective, a strategy plan must contain legally enforceable measures to improve ambient air quality with schedules and time tables for compliance with the plan's objectives.

In heavily polluted areas a new source should only be constructed if

emissions from existing sources are reduced by an equivalent amount.

3. "Clean Air Plans" in practise

In chapter 2 it has been shown that the theoretical approach and methodological bases of the Clean Air Plans that have been developed some 10 years ago in North-Rhine Westfalia are one of the most advanced and sophisticated strategies in air pollution control. "Clean Air Plans" have a sound theoretical and methodological base. In this chapter I will give a small overview of the problems that occurr in the implemention of Clean Air Plans (CAPs). In this regard there are, in my opinion, two main problem areas that have to be distinguished.

The first problem area that has to be mentioned here is the legal status of CAPs in the German air pollution control policies. In contrast to other instruments, CAPs are not enforceable; they do not have the status of a law or a legally enforceable administrative regulation. This has two consequences. The first consequence is that the states can not be forced to set up CAPs for heavy polluted regions as defined by the law. **Table 1** shows that for a considerable number of heavy polluted areas no CAPs have been set up. The second consequence is that even if and when it is proven by a CAP that the environmental situation is deteroriating in a region it is not possible to take administrative actions on the basis of a CAP. That means that the "Plan to improve the Air Quality" is not legally binding.

The second main weakness of the CAPs is the way they are set up. It is evident that a CAP is only as good as its database. In several regards the database of the CAPs is not sufficient. First, concerning the most important emitter group - the industry, the environmental administration takes the information given by these emitters without checking them. In several cases it was proven that these information have not been complete or are even wrong. Second, the database of the CAPs in most cases is to old. The data base of the CAP for the Cologne Region, for example, goes back to 1974. The CAP was published in 1977. The duration time ended in 1981. Between 1974 and 1981 the economic, and therefore, also the environmental situation changed consideraly. For me it seems not possible to make decisions on a database that is more than five years old.

It is therefore not astonishing to learn that the environmental reality in North-Rhine Westfalia and in other heavy polluted areas in the FRG looks quite different than the theoretical description. The levels of ambient air quality for the most widely spread pollutants did not fall considerably in the last 15 years. The same is true for the amount of emissions. During the same time tremendous damages by air pollution have been found (for example, the fast growth of the "Waldsterben" since 1980). And also the smog situation in some heavy polluted areas in the beginning of 1985 show that not all objectives of the CAPs have been reached.

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PROGRAMY "CZYSTE POWIETRZE" W REPUBLICE FEDERALNEJ NIEMIEC

Programy "Czyste powietrze" są zasadniczym elementem systemów poprawy jakości powietrza atmosferycznego w wielu uprzemysłowionych krajach. Opisano programy "Czyste powietrze" w RFN i przeanalizowano problemy związane z ich wprowadzeniem w życie.

ПРОГРАММЫ "ЧИСТЫЙ ВОЗДУХ" В ФЕДЕРАТИВНОЙ РЕСПУБЛИКЕ ГЕРМАНИИ

Программы "Чистый воздух" являются элементом систем улучшения качества атмосферного воздуха во многих индустриальных странах. Описаны планы "Чистый воздух" в ФРГ и проанализированы проблемы, связанные с их осуществлением.