WATER RESOURCES PLANNING AND MANAGEMENT IN ADVANCED ECONOMIES: THE CASE STUDY OF WESTERN SKÅNE, SWEDEN - A BACKGROUND REPORT

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PREFACE

This is a Working Paper intended to give background information on the Western Skåne case study of water resource planning and management which is being pursued jointly by IIASA and Lund University. The paper is primarily intended to be read by a non-Swedish public. We have, however, also included some discussion of the most important analytical and policy-oriented problems of the Skåne area, which means that some of the information is also of interest to a Swedish public.

The presentation in this paper is based on currently available published information on the economic and administrative structure and environmental conditions related to water planning in the region.

A preliminary version of the paper was distributed for review to planning agencies at the central and regional level of decision making. Our interpretation of their comments have been included in this final version.

We have abstained from including discussions about modeling and other methodological issues at this stage. Such methodological issues will be presented in separate papers.

It is also the intention to present a research plan based on this paper and other methodological research currently pursued at IIASA. The research plan is intended to cover a working period of approximately two years at IIASA and to be fitted into a four to five year research plan for the group working with these issues in Sweden.

CONTENTS

I. ECONOMIC DEVELOPMENT OF SOUTHERN SWEDEN IN A NATIONAL PERSPECTIVE

The Skåne area constitutes an important part of the Swedish economy. Its current role is indicated by Table 1.

Table 1: Selected Indicators on the Relative Importance of the Skåne Area in the Swedish Economy (Share of National Totals).

Source: Statistisk Årsbok, 1962 and 1976.

	Population	Total land	Agricultural land	Income	Density of population
1960	11.8%	2.7%	15.3%	11.7%	81*
1975	12.3%	2.7%	16.7%	12.1%	93*

*Inhabitants per square kilometer.

The country as a whole has a population density of 20 inhabitants per square kilometer, which shows that the Skåne region is relatively densely populated. This means that the environmental problems are important in the planning of land use in this area. Conflicts on the use of land and other natural resources are also serious in this area. The region has always performed productively in the city industries (transportation, communications, commerce, manufacturing) while at the same time having the most productive agricultural sector in the country. This has created serious conflicts on the use of land and water. The growth of population density associated with the high productivity of the area has gone hand-in-hand with an increasing relative importance of Skåne in national agriculture production and policies.

The employment structure as seen in a national comparative point of view is given in Table 2. It indicates that agriculture is a sector of specialization of the region, together with transportation and commerce. The table also shows that the region's share in manufacturing is almost proportional to its share in income. Table 1 again shows that the region has not changed its relative importance in the Swedish economy to any considerable extent during the fifteen year period, 1960-1975.

Table 2: Employment in Different Industries of the Skåne Area as Percentage Shares of National Totals, 1975.

Source: Statistical Yearbook of Sweden, 1977, Table 26, SCB.

Industries	Employment Shares, % of National Totals
Agriculture, Forestry, etc.	15.0
Transportation, Storage and Communication	13.3
Commerce, etc.	12.9
Manufacturing	12.2
Construction	12.1
Services, etc.	12.0
Mining	4.7

The structural stability of the Swedish regional economy should be demonstrated in a much longer time perspective. This can be done with three indicators of the economic structure of Sweden: population, income and manufacturing employment. For the description of the structural stability of the region economies of Sweden we will use a somewhat different delimitation of southern Sweden as indicated by Figure 1.

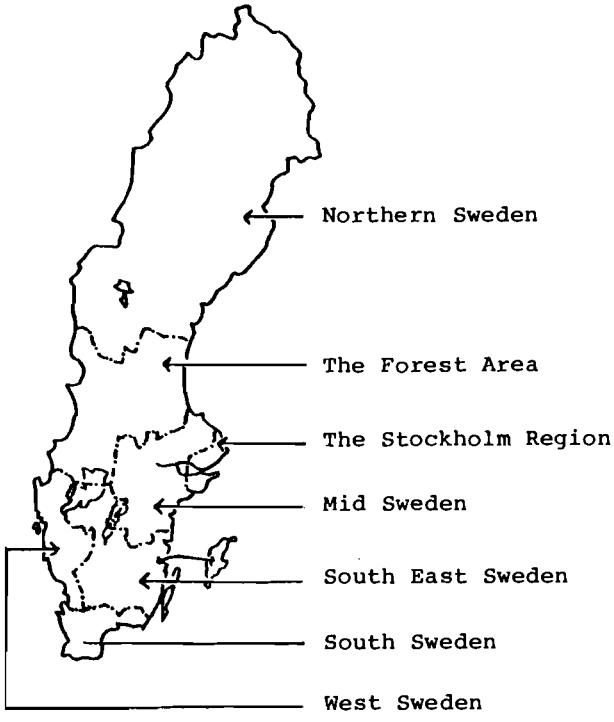


Figure 1. Regional Delimitation of Sweden

Table 3 gives the development of the population distribution for the regions over the period 1920 to 1975.

Table 3: The Swedish Population Distribution (Percentage Shares) Between Different Parts of the Country, 1920-1975.

Source: Folk- och bostadsräkningarna.

Geographical Area	1920	1930	1940	1950	1960	1970	1975
Stockholm Region	11	12	14	16	17	18	18
Mid-Sweden	17	17	16	17	17	17	17
South-East Sweden	16	15	14	14	13	13	13
South Sweden	15	15	15	14	14	14	14
West Sweden	15	15	15	15	16	16	16
Forest Area	13	13	13	12	12	11	11
North Sweden	13	13	13	13	12	11	11

The table shows that the share of the South of Sweden in the total population of the country has been remarkably stable over this extremely extended period. The Stockholm metropolitan region is in fact the only part of the country that has shown a strong shift in its share of the population, although this tendency has stabilized during the last recorded five year period. This picture of the stability of the population shares can be complemented with corresponding information about the regional allocation of income between the different parts of the country (Table 4).

Table 4: Recorded Income Shares for Different Geographical Areas of Sweden in the Period 1920-1975.

Source: Årsbok För Sveriges Kommuner.

Geographical Area	1920	1930	1940	1950	1960	1970	1975
Stockholm Region	26	29	24	25	25	25	23
Mid-Sweden	15	14	16	16	16	16	16
South-East Sweden	8	9	10	11	11	11	11
South Sweden	14	14	14	14	13	14	14
West Sweden	17	16	16	16	16	16	16
Forest Area	11	10	10	10	10	9	10
North Sweden	9	10	9	10	10	9	10

Taken together these two Tables show that the relative role of the South of Sweden in the Swedish economy is extremely stable in a long time perspective. The region has had fourteen to fifteen percent of the population during the whole period and approximately fourteen percent of the total income of the country.

There is also a strong tendency to convergence between the income shares and the population shares of the regions. The pattern of convergence also seems to be rather clear:

A. The network for railroad transportations was already established in its basic structure by the end of the nineteenth century and had already then established a general transportation and communication advantage for the different geographical areas of the country. The main road network which was built in the 1920's and 1930's followed the same pattern as well as the developing network for electricity distribution. This means that the communication and transportation advantage for the different regions established in the beginning of the century has been reinforced by the subsequent investments in other networks.

The investments in the private and public sectors in the nodes of this network tended to follow the relative accessibility differentials and thus created a capital, production and income structure which was established already by 1920.

B. The population distribution in 1920 was grossly at variance with the allocation of income between the regions. The response to this regional income inequality was heavy migration towards the Stockholm region and away from the northern and inland counties. In this whole migration process the South of Sweden remained undisturbed by this great economic change.

C. The general conclusion is thus that the South of Sweden, seen as a macro-object, is an extremely stable part of the Swedish economy. It is not to be expected that it will lose any of its relative importance in the future. It is rather the case that one could expect certain increases in its relative share of income, employment, population, and capital, especially if its position in the transportation networks would be strengthened by the building of a bridge or tunnel across the strait of Öresund.

The stability of the relative share of the Skåne region in the national totals does not imply that the structure of production and employment in the region is stable over time. The industrial structure is changing rather rapidly as can be seen in Table 5.

Table 5: Relative Changes in the Structure of Employment in the Industry of Skåne between 1960 and 1975.

Source: SOU 1978:20.

Sector	1960-1970		1970-1975	
Agriculture & Forestry	-31	percent of empl. 1960	-16	percent of empl. 1970
Manufacturing Industry	- 7	" " " "	- 1	" " " "
Construction	+26	" " " "	-13	" " " "
Trade, Restaurants, etc.	+18	" " " "	- 1	" " " "
Electricity, Gas & Water	+ 3	" " " "	+19	" " " "
Transportation	+12	" " " "	+ 9	" " " "
Service (Public & Private)	+42	" " " "	+17	" " " "
Financial Institutions	+93	" " " "	+18	" " " "
Total Change	+ 9	" " " "	+ 2	" " " "

The Table indicates that the rate of structural change is related to the general rate of growth. The contraction of the construction industry is a consequence of the decline in the growth rate of the Skåne economy in the 1970's. Industries and their sub-branches have very different requirements of land and water. Swedish studies of the use of land and water in different sectors have indicated that the demand for land and water differs between and within the different branches within industrial sectors. Many

studies from the US, Netherlands, Norway, and other developed countries have also shown that there are great differences in pollution output per unit of production between different sectors of the economy. It is thus necessary to make good predictions of the growth of production in the different industrial sectors of the Skåne economy in a long term perspective. We will thus need to develop a dynamic model of production to forecast the demands for water and land, and the consequence of growth for the accumulation of pollutants in lakes, rivers and the coastal area of the Strait of Öresund. These problems are dealt with at some length in sections below.

Skåne consists of two counties, Kristianstad County and Malmöhus County. There are great differences in population density and economic performance of the two counties. The northeastern Kristianstad County has an average density of population of 45 inhabitants per square kilometer, which means that the county has a density close to the densities recorded for most counties south of Stockholm. The southwestern Malmöhus County has a clearly metropolitan character with an average density of 150 inhabitants per square kilometer. The density of population of Malmöhus County has increased by 27 inhabitants per square kilometer during the past 25 years, while the population density of Kristianstad has increased by only 3 inhabitants per square kilometer in the same time period.

Really high population densities are located close to the western coast of Malmöhus County as indicated by Figure 2 which gives the population distribution in Skåne and Själland (Denmark). Each figure indicates the number of inhabitants in hundreds per square with a side of five kilometers. The population around Malmö city is 256,000. The metropolitan region around Malmö city which is planned by the Local Federation of South-West Skåne (SSK), is delineated and is overlapping the densely populated coastal strip. The Kävlinge River basin is located in the northern section of the SSK area and crosses the boundary of

Malmöhus County in an area of very low population density close to the eastern Baltic coast. It is thus clear that both from the point of view of water resource planning and with respect to the conflict on land use planning the analysis should be primarily concentrated on Malmöhus County and within that county to the metropolitan planning area of SSK.

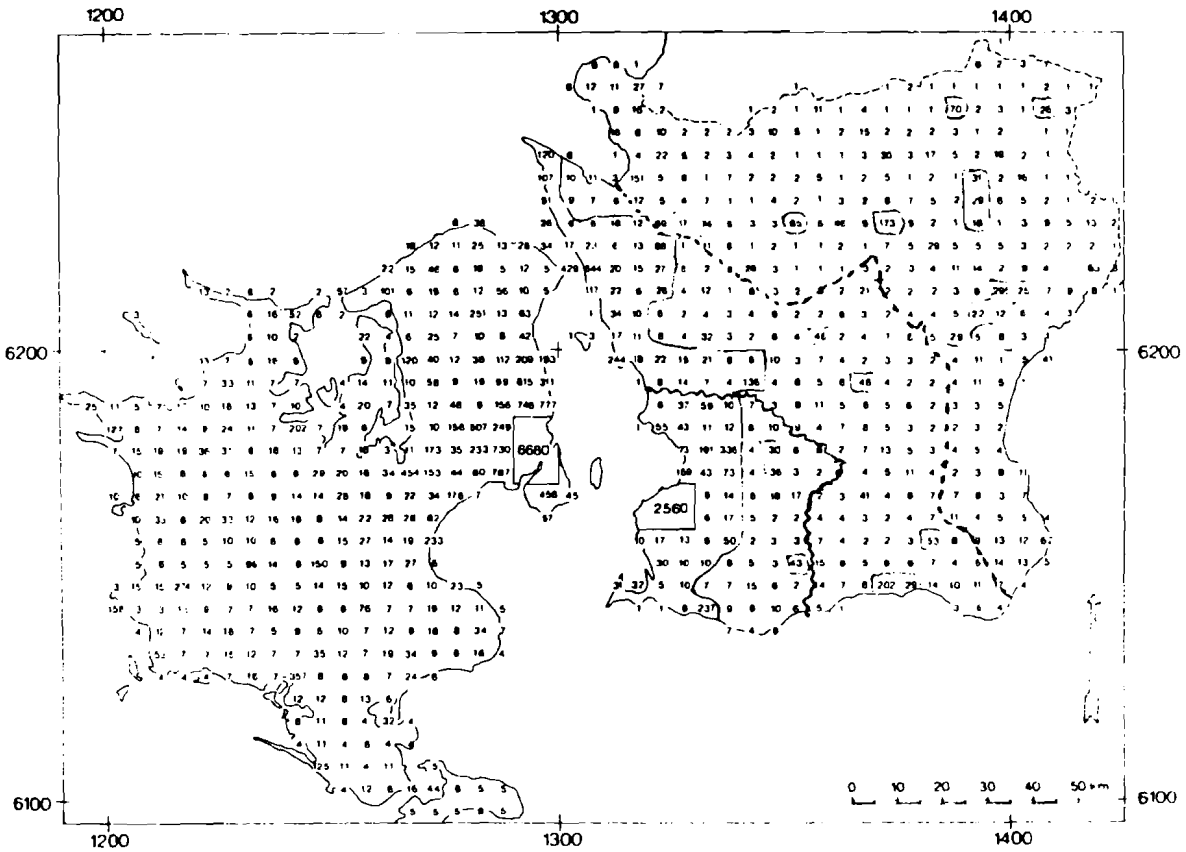


Figure 2: Population Distribution in Skåne and Själland, Denmark.

The Manufacturing and Agricultural Industry of Skåne and SSK Planning Region

Swedish manufacturing is specialized on machinery and other engineering products, paper, pulp and other forestry products and steel. Table 6 shows that Malmöhus County has a completely different industrial profile.

Table 6: Percentage Share of National Manufacturing Value Added Located to Malmöhus County.

		1968-1970	1973-1975
31.	Food and Beverages	21.4	20.8
35.	Chemicals, Rubber, etc.	18.6	18.3
36.	Nonmetallic Mineral Products	14.1	15.3
32.	Textiles, Apparel	9.2	8.7
34.	Paper, Pulp, Printing	9.0	8.0
38.	Fabricated Metal Products, Machinery, etc.	7.1	7.3
37.	Basic Metal Industries	3.2	2.9
33.	Wood and Wood Products	1.9	1.6
39.	Other Manufacturing	6.4	4.5
3.	Manufacturing	9.5	9.1

The Table shows that Malmöhus County's manufacturing is specialized in food and beverages, chemicals, rubber, etc. and nonmetallic mineral products (basically building products). The dominance of food and beverages is related to the large share of agricultural production located in Southern Sweden. A recent study of the productivity development in the metropolitan areas also shows that the Malmöhus County food and beverage industry has the highest productivity of all regions in the country. This statistic indicates that the Skåne study must be rather specific on questions relating to the growth of production, pollution and water demand from the food and agriculture complex, the chemical and rubber industry and the nonmetallic mineral product industry.

The food production industry is mainly specialized in sugar refining, chocolate, and meat and pork. A recent study of the profitability of these industries shows that more than 40 percent of the employed in these industries were in production units classified as "high profit units". The same study showed that almost all the production units running at a loss were located in the city of Malmö.

The chemical industry of the SSK planning region is facing serious productivity problems. More than 60 percent of the employed are working in units with extremely low or negative profits. This means that the chemical industry can undergo a sudden structural change in the region.

We have shown above that Malmöhus County is extremely important for Swedish agriculture in spite of its metropolitan character. This is due to the high productivity of the agricultural sector of Malmöhus County. An indication of the producticity of land is given in Table 7.

Table 7: Land Productivity of the Skåne Region 1976, (Crops per Hectare in Kilogrammes).

Region	Winter Wheat	Index	Spring Wheat	Index	Winter Rye	Index	Barley	Index	Oats	Index	Mixed Grains	Index	Ley	Index
Malmöhus	5460	118	3680	101	4170	119	4120	125	3820	137	3340	127	7870	141
Kristianstad	5140	111	3740	103	3050	87	3490	106	3040	109	2670	102	6880	123
Sweden	4630	100	3630	100	3490	100	3290	100	2780	100	2630	100	5580	100

Region	Table Potatoes	Index	Potatoes for Processing	Index	Sugar Beets	Index	Winter Rape	Index	Spring Rape	Index	Winter Turnip Rape	Index
Malmöhus	28180	126	26040	101	39210	100	2900	105	1460	102	2150	102
Kristianstad	26640	119	26270	102	41630	107	2910	105	1680	117	2030	97
Sweden	22370	100	25770	100	39060	100	2770	100	1430	100	2100	100

The structure of the agricultural sector is changing quite rapidly which creates significant changes in water demand.

The number of cows and horses has decreased rapidly. In 1961 there were 1.16 million cows; in 1971 there were 0.73 million and in 1980 there will be about 0.55 million cows. The number of pigs, on the other hand, has increased, especially in Malmöhus County, from 350,000 in 1961 to 440,000 in 1971. This has led to a 20% decrease of grazing land and a corresponding increase of land used for forage.

Vegetable production, which is very water demanding, has been strongly concentrated to Malmöhus County. In 1951, the county had 35% of the Swedish greenhouse acreage and in 1970, 44.5%. Of the open air vegetable producing land, Malmöhus County had 34.5% in 1951 and 42% in 1970.

The mean size of Swedish farms increased steadily from 12.5 hectares in 1951 to 20.1 hectares in 1971. Together with rapidly increasing labor costs this has led to a high degree of mechanization, for instance, investments in efficient irrigation equipment.

We can conclude that the South of Sweden and especially the metropolitan part of Malmöhus will face growing environmental problems due to the increase of the density of industrial, agricultural, and infrastructure capital on its land areas. It is also obvious that long term water planning for the Skåne region must be focused on problems of access to lakes, rivers, and the coast areas for industry, agriculture, households, and the public sector.

II. THE SWEDISH DECISION SYSTEM - AN OVERVIEW

This chapter is intended to give a short description of the Swedish decision system on three decision/advisory levels: the local level, the regional level and the national level and their interactions with special reference to Skåne. The formal system will be emphasized, but the reader should be aware that on each level there are divergences depending on tasks or on regional or local circumstances. For local research projects, e.g. in water resource planning, it is therefore necessary to examine both the formal decision system and the informal networks in the organizational structure.

Figure 3 roughly outlines some important tasks at the national, regional and local level.

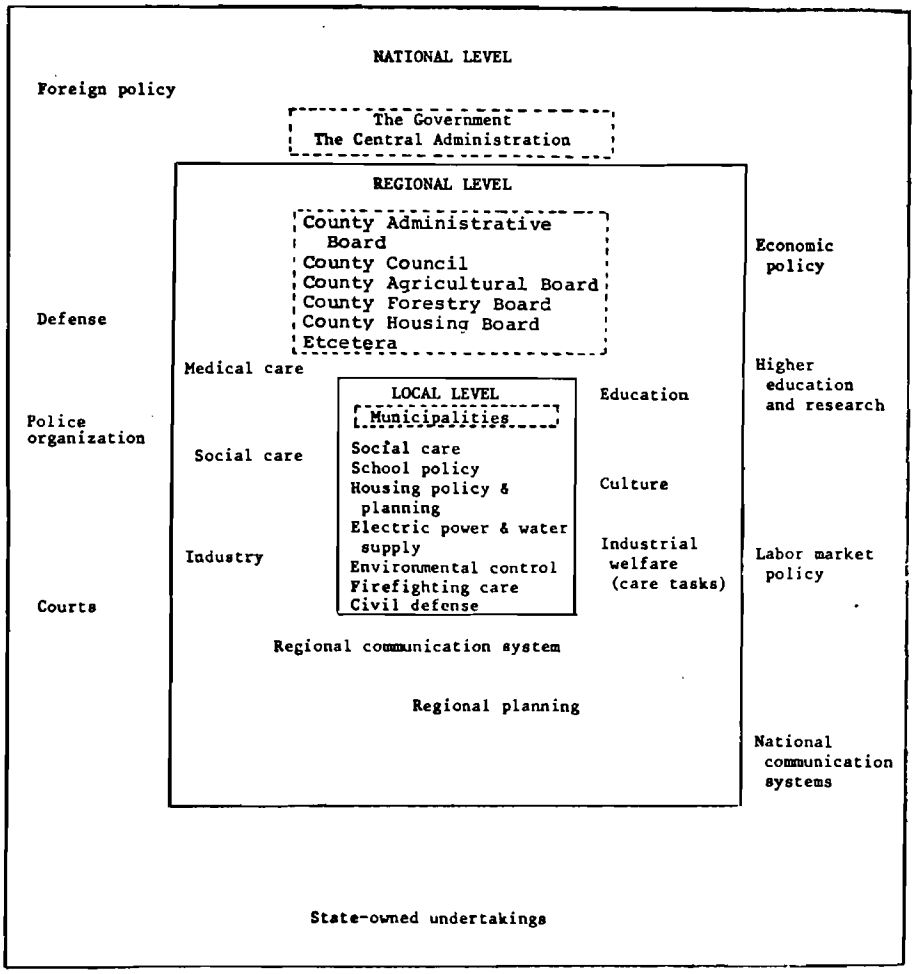


Figure 3. A Summary of Tasks at Different Levels of the Swedish Public Administration System.

Source: Gustafsson, A: Kommunal självstyrelse, Liber, Lund, 1977.

The Local Level:

Municipalities

Swedish democracy has a long tradition of local government. The first Municipal Administration Act dates back to 1862. Certain basic principles from that time are still to be found in the new Municipal Administration Act of 1 July 1977.

A guiding principle of the new Act is that the municipalities themselves can, to a large extent, determine their organizational forms. The Act makes possible collective municipal government or modified forms of majority government. The possibility of organizing opinion polls or their equivalent on certain municipal issues among the inhabitants is also new.

The municipality is the level closest to the individual's social reality. Thus, for example, town planning, school systems, social welfare, public health, etc., are municipal tasks. There has been a gradual shift in emphasis in the distribution of tasks shared between central government and municipalities in favor of municipalities. This is due to a gradual reduction in detailed governmental control of municipal activities.

At the time of the 1862 municipal reform, the country's division into municipalities followed the lines of the old church parishes. The municipalities then amounted in number to about 2,500. In the early 1950's, a new reform reduced this number to about 1,000. Another reform was carried out in the late 1960's and early 1970's. Today there are 277 municipalities, 33 of which are situated in Skåne (Figure 4).

One main reason for these 3 reforms in the municipal boundary and allocation system has been population movements which have progressively expanded the urban areas at the expense of an ever more sparsely populated countryside. By reducing the number of inhabitants in certain rural municipalities, this population movement diminished the base for municipal public services, at the same time as the demands placed on some of these services were growing. This made it difficult for the small municipalities to provide their citizens with an acceptable level of service.

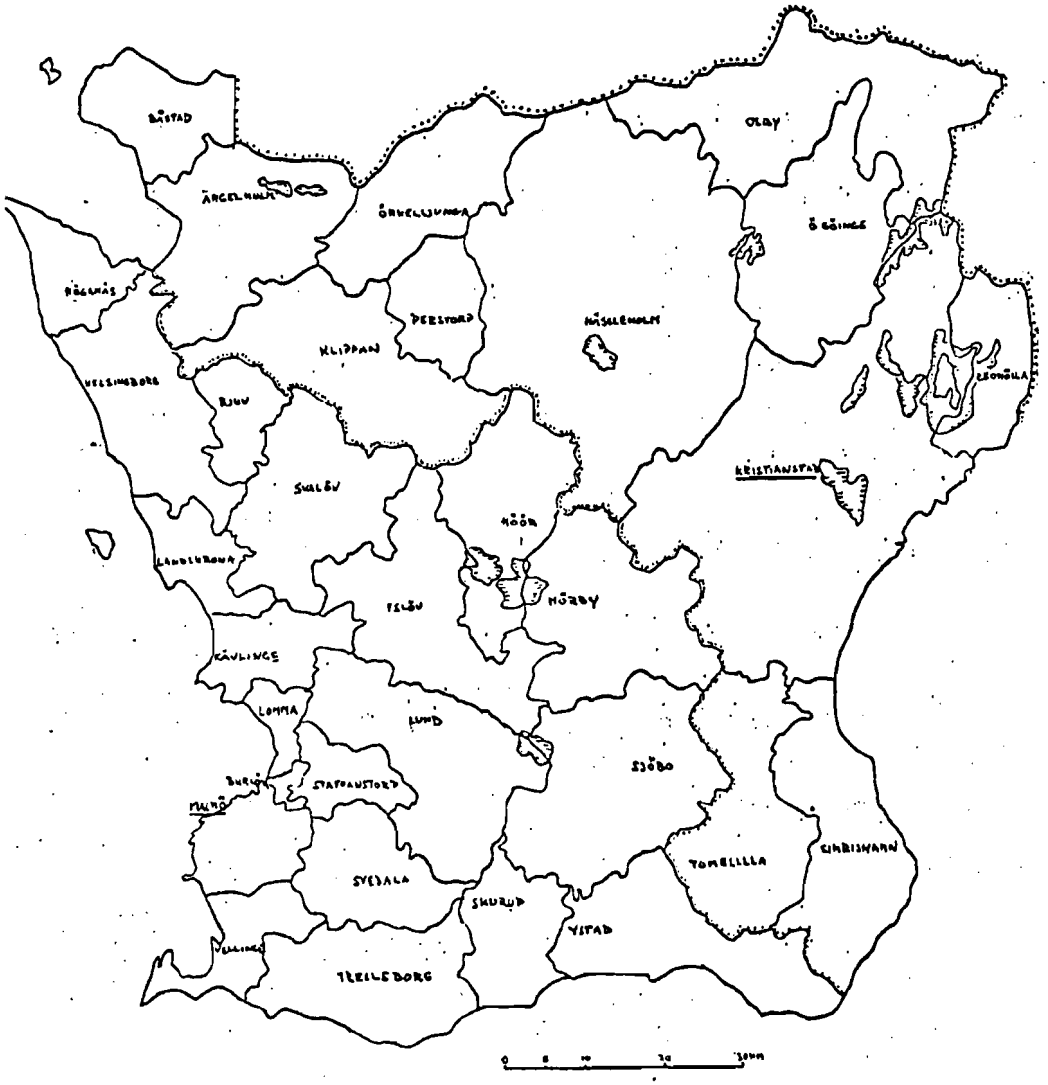


Figure 4: Municipalities in Skåne.

S K Å N E
County of Malmöhus
and
County of Kristianstad

Administrative boundaries:
1.1.1977

County boundary
Municipal boundary

Thus, in order to avoid nationalization of various administrative tasks and duties and to maintain municipal self-government, it became necessary to revise the whole municipal boundary system.

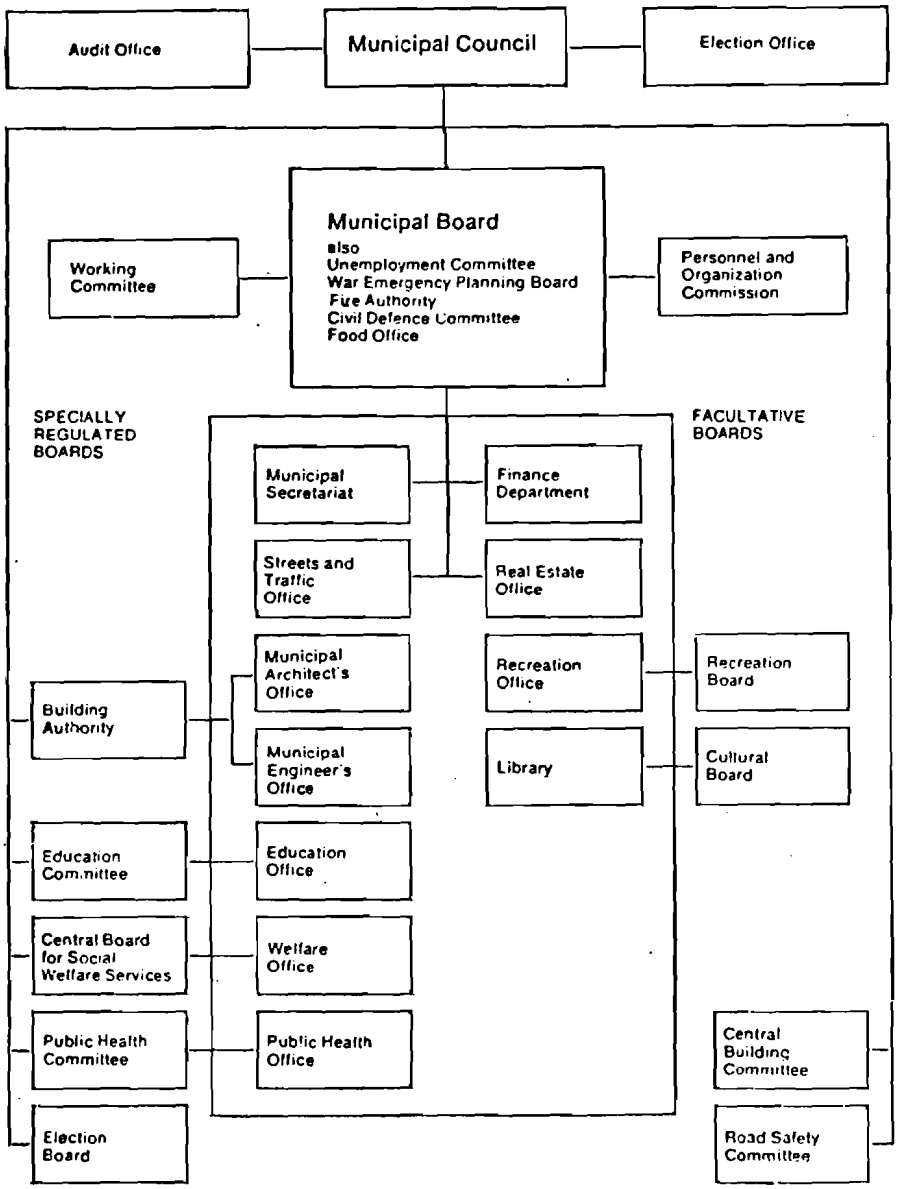
Section 4 of The Municipal Administration Act says that the municipality shall handle its own affairs, i.e., the municipality must not engage in activities which according to current law come under the jurisdiction of another administrative body.

Many of the municipality's activities are regulated by about 30 special laws and certain other forms of legislation. According to the Municipal Act and the special laws, there are great differences in organizational structures between municipalities of

different size (number of inhabitants). The compulsory committees, which are regulated in special laws, are the same in every municipality (education authority, board of works, board of health, electoral committee, board of social care, and board of town planning). All other committees in the organization of municipalities are voluntary and vary from about 4 to 25 with or without subdivisions. Compulsory committees in bigger municipalities also have subdivisions. Figure 5 shows the organizational structure for a municipality of middle range size (10,000-50,000 inhabitants).

Figure 5.

Plan of local administrative organization



A fundamental principle of municipal administration is that it is directed by elected representatives. Formerly, these representatives carried out most of a municipality's tasks. But as municipalities have grown in size and ever larger duties have been imposed upon them, more and more local officials and staff have had to be employed in an executive capacity. Another result of the increase in size of the municipalities has been a sharp drop in the number of representatives (Table 8).

Table 8a: Average Number of Representatives in Different Municipalities.

Degree of urbanization	Size I	Size II	Size III
A	104	153	222
B	101	148	
C	92		

Table 8b: Average Number of Administrative Officials in Different Municipalities.

Degree of urbanization	Size I	Size II	Size III
A	18	111	532
B	13	73	
C	8		

Table 8c: Ratio Representatives to Administrative Officials in Different Municipalities.

Degree of urbanization	Size I	Size II	Size III
A	5.8	1.4	0.4
B	7.8	2.0	
C	11.8		

Size I < 8,000 inhabitants
II 8,000 - 30,000 "
III > 30,000 "

Degree of Urbanization:

A - 90% or more living in urban areas (tätort)
B - 30-90% living in urban areas
C - < 30% living in urban areas

Source: Molin, B; Månsson, L. and Strömberg, L: Offentlig förvaltning. Stats-och Kommunalförvaltningens struktur ocn funktioner, Bonniers, 1975.

In total, some 700,000 persons are presently employed by municipalities, compared to an estimated 30,000 elected representatives.

Another conclusion from Tables 8a-c is that small municipalitites have to handle lots of tasks (including planning) directly integrated with the work of the municipal board. These conditions can have some advantages in the short run over narrow range local planning, but can also be a great problem in cooperation with other municipalities or administrative levels. In some cases the small municipalities become very dependent on bigger municipalities, other professional planning organizations, or other planning and decision levels, to enlarge their competence and capacity in planning for the future.

The size of the municipalities in Skåne is shown in Table 9.

Table 9. Number of Inhabitants in the Municipalities of Skåne.

Number of Inhabitants	Number of Municipalities
< 9.999	2
10.000 - 14.999	13
15.000 - 49.999	14
50.000 <	4
N	33

As far as the western part of Skåne is concerned, the water and land resources are situated in the smaller municipalities and are used by the population and industries in the urban areas. It is important to notice these circumstances because it is the municipality "owning" the resources which plans for the use of resources in its area.

Different Forms of Cooperation on the Local Level

The local federations are organizations for cooperation, based on public law, between municipalities in a certain region. These local federations are now less common. In 1976, there were only 21. In Skåne there are five such organizations (Figure 6). Two of them are organized as federations with their own offices and planning organizations for the area. Three of them are organized as cooperative committees, which mainly means a place for discussion and information exchange on common affairs.

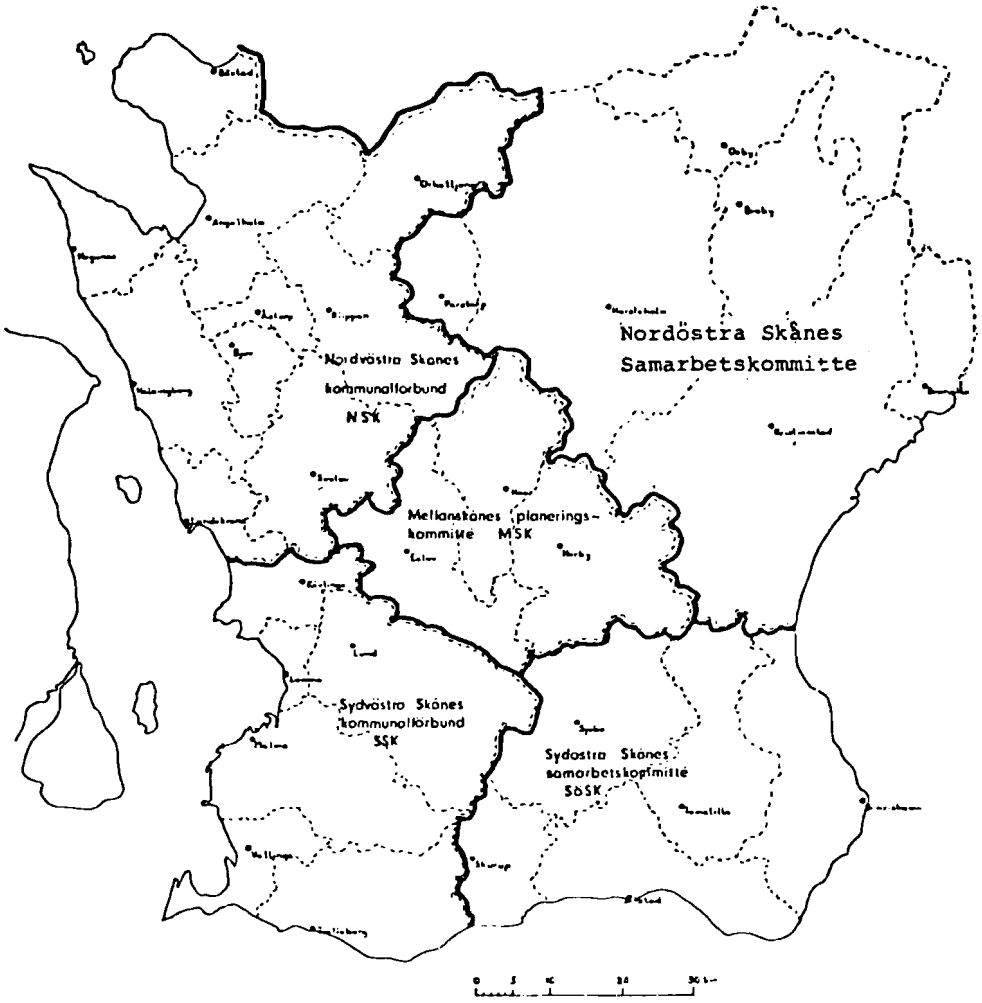


Figure 6: Local Federations in Skåne.

The local federation can be based on questions which are important for the municipalities. When a federation is established, the right to make decisions regarding these questions is handed over from the municipalities to the local federation, according to the Act (in reality it can be different, e.g., the Malmö region). But in the case of cooperative committees, the decision making authority usually stays within the municipalities. The Local Federation of Southwest Skåne (SSK), for example, deals mainly with planning in the area, e.g., housing policy, regional collective traffic problems, planning for regional roads, the location of senior high schools, technical service and land use in a regional perspective.

The municipality associations are voluntary organizations not regulated by law. These organizations, by their statutes, guard the common interests of their members, promote cooperation among them, and further the knowledge of municipal affairs. Of great importance to the municipalities is the aid in budget work and accounting which the Swedish Association of Local Authorities is able to offer. The association also has a school of Municipal Affairs. The school offers courses in several branches of municipal activities for council members and officers in municipal service.

Other Forms of Cooperation

There are, of course, possibilities for the municipalities to cooperate in other ways in sectors which are of high priority in the region. In Skåne, an expected future lack of water was the direct reason for the establishment of the AB Sydvatten, an enterprise presently owned by twelve municipalities in Western Skåne; it will guarantee the water supply to these municipalities in the future by importing water to the region from Lake Bolmen, north of Skåne.

Another area of sector cooperation among municipalities in Skåne concerns solid waste management. In the highly urbanized area of Malmö-Lund, this management is performed by SYSAV (Sydvästra Skånes avfallsaktiebolag), another regional enterprise.

A third sector of cooperation among certain municipalities in Southwestern Skåne concerns sewage treatment.

THE REGIONAL LEVEL

Among regional state organizations the County Administrative Boards play a leading role in coordinating regional activities. In addition to these boards, there are several regional organizations which have more specialized tasks, e.g., the County Agricultural Board, the County Forestry Board, the County Housing Board. There are also County Councils which deal with the whole of counties; these boards are comparable to municipalities in their organizational structure and tasks.

The County Administrative Board

In Skåne there are two Administrative Boards, in Malmöhus County and Kristianstad County (see the map in Figure 4). The County Administrative Board has a long tradition as a "central government in the countryside", particularly in the past, when transportation was slow and inconvenient. By 1971, both the organization and the tasks of the County Administrative Boards had changed. In recent years stress has been placed on tasks which coordinate regional activities and organizations, information collection and distribution, and advising and controlling functions. As Figure 7 shows, the County Administrative Board acts as an intermediary link between the government, the Central Administration, and other organizations at the national level and local level, mainly the municipalities.

Organizationally, the County Administrative Board is divided into different sections. Of particular interest for water resource planning and management, are the regional planning section and the environmental protection section. The former coordinates different aspects of physical planning among the municipalities in the region.

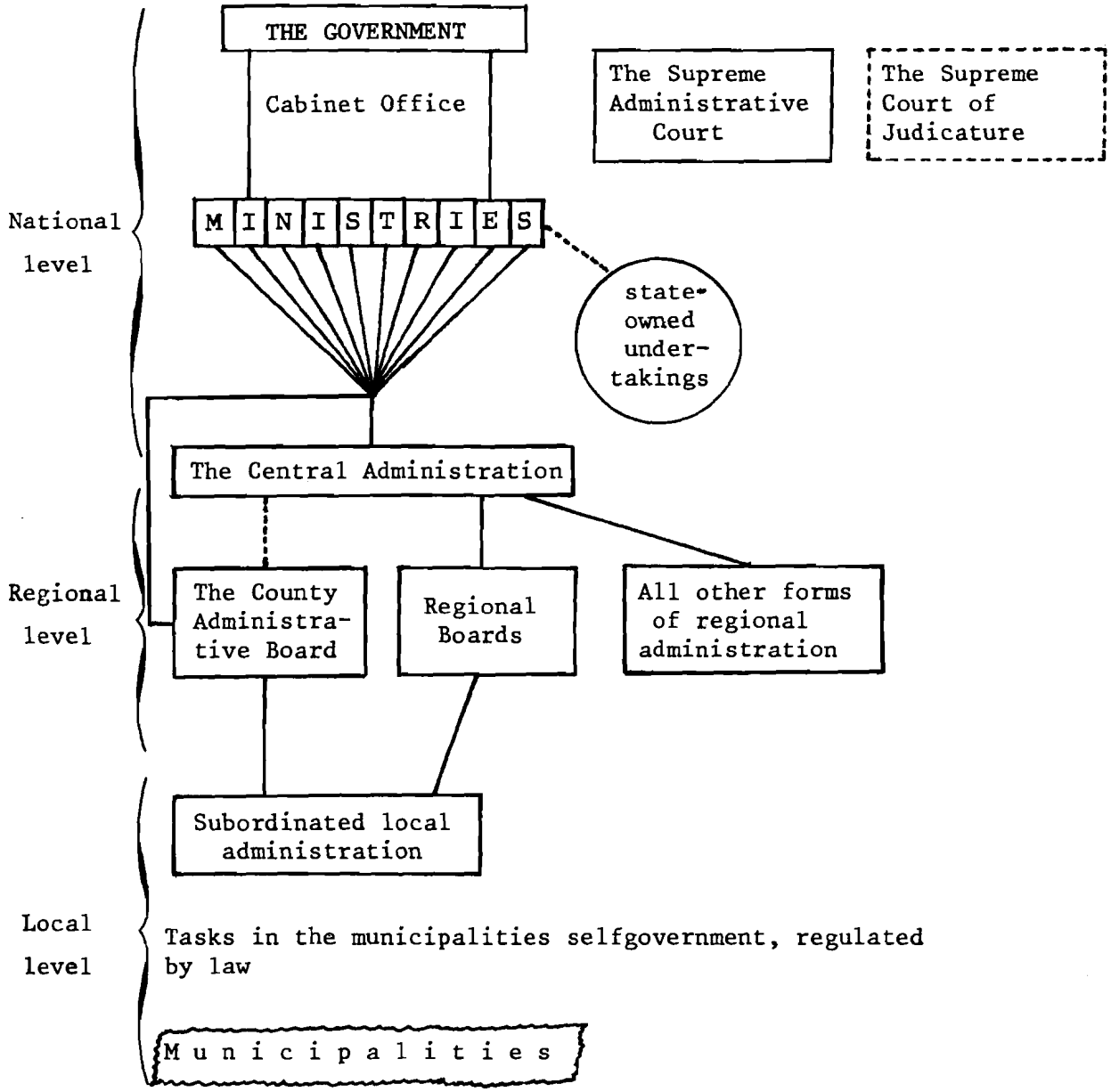


Figure 7 : The Organization of the Swedish State Administration.

Source: Molin, B., Månsson, L. and Strömberg, L.: Öffentlig förvaltning. Stats-och Kommunalförvaltningens struktur och funktioner, Bonniers, 1975.

The environmental protection section plays, among other things, a planning and controlling role in environmental protection, and a supervisory role in water and air pollution and sewage treatment in the region.

The County Council

A County Council comprises several primary municipalities, and its boundaries usually correspond to those of the county, e.g., in Skåne, Malmöhus County Council and Kristianstad County Council (see the map in Figure 4). By far, the largest task of a County Council is providing public health programs, medical care, and dental care. The role of a County Council in the educational sector is to provide schools for the mentally handicapped, training colleges for medical personnel, and secondary schools. Due to special circumstances in the Stockholm region, the Stockholm City Council is responsible not only for the planning of secondary education, but also for public transport, the overall planning of water supply and drainage, and regional planning.

Other County Boards of Interest to Water Resource Planning

The County Agricultural Board, which works under the National Board of Agriculture, bears the responsibility for programs fostering more efficient farming methods. To attain this goal, the boards plan systematically for agricultural land use, offer education and advice (e.g., in the use of irrigation equipment for different crops on different soil), and also provide financial support to the farmers.

The County Forestry Board has the same main tasks as the County Agricultural Board, but for the forestry sector.

THE NATIONAL LEVEL

We can only present a rough picture of the relations between different decision levels (Figure 7). Different aspects of water

resources and planning are dealt with today by the Ministry of Agriculture, Ministry of Housing and Physical Planning, Ministry of Industry, Ministry of Justice, Ministry of Transport and Communications, Ministry of Health and Social Affairs, and the Ministry of Local Government.

At the central level of administration, water related activities are dealt with by the National Environment Protection Board, the National Food Administration, the National Board of Planning and Construction, the National Board of Health and Welfare, the National Board of Agriculture, the National Board of Fisheries, etc. It is evident that the problems involving water resources and water related activities are the concern of many interest groups and administrative bodies. Some of the water resource planning activities are summarized in the concluding part of this chapter.

Information Distribution and Public Participation

The municipalities today do not have to distribute information, arrange exhibitions, or take into consideration the views of the public (individuals and pressure groups), except in the physical (land use) plan for housing, traffic, recreation, etc. However, Sweden has a long tradition of taking into consideration the views of the formally organized parts of the public (e.g., political parties, trade unions, sector unions) by sending submissions on all kinds of problems to many different organizations.

Let us summarize the interaction between the decision levels with reference to a newly decided working schedule for physical planning (Figure 8).

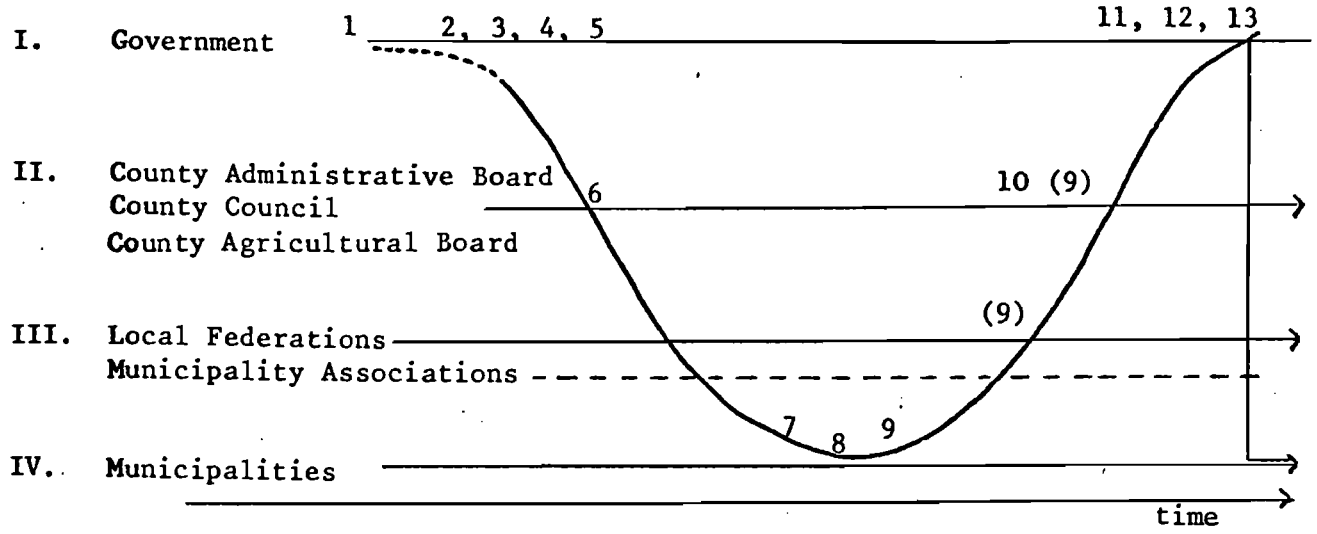


Figure 8: The Decision Process in the Swedish System. (The Figure refers mainly to the physical planning process).

The formal Swedish decision process:

1. Presentation of a proposal
2. The proposal is submitted to different organizations for consideration.
3. The new proposal is presented by government.
4. Decision in Parliament
5-6. The government and regional organizations write a memorandum with guidelines addressed to the municipalities.
7. Municipalities produce plans. In this work, they receive information and advice from county organizations and local federations or municipality associations.
8. The municipality presents a program for land use which must be displayed for a few months to make it possible for the public to become informed and to refer to the exhibition for consideration.
9. Decision on the plan in the municipal board, or in local federations and at the regional level if there are tasks concerning these levels.
10. The program is sent to the County Government Board for acceptance.

11. The government collects information and viewpoints on the program from the central administrative organizations.
12. Government's approval or rejection.
13. The program is carried out at the local level.

If the County Administrative Board and/or the Government does not accept the program (points 10-12), it will be sent back to the municipality with concrete recommendations for revision.

Water Resources Planning

In Sweden, there is so far, no formal water resource planning and management procedure. Each decision on water related activities has been made from case to case without much regard to the possible future demand-resource situation. Today, however, intensive activities are being initiated at all levels of society to arrive at some conclusion on how to solve the emerging conflicts in water use. At the national level, the Ministry of Housing and Physical Planning is working on a new proposal for Swedish National Physical Planning. The first proposal, released in 1971, contained almost nothing about water. There is however, a strong intention to make it a prerequisite that the new proposal should take into account water conditions and water problems.

The water questions within the National Physical Planning are dealt with by the Ministry of Agriculture, which traditionally has been responsible for water issues at the governmental level. The Ministry of Agriculture has thus commissioned the National Environmental Protection Board to investigate, on an aggregate level, the water resources and the water demands in Sweden. The investigation also includes a more thorough analysis of areas which may be subject to severe water use conflicts.

As there are numerous ways in which land use and water use are interrelated, there is an urgent need for investigations concerning the relations between administrative levels in terms

of power, competence and integration with other aspects of planning. Thus, the Ministry of Agriculture has appointed a separate Water Planning Committee with a mandate to investigate and propose an administrative procedure for water resources planning and management. It should also propose suitable levels for data collection responsibilities and water resource planning responsibilities.

The legal aspects of the water resource planning problems have also been updated in the form of a new water act proposal released last year by the Ministry of Justice. If the proposal is passed in its present form through Parliament, the new act will be valid beginning in 1982.

At the regional level water planning and management in Sweden is today mainly performed on a river basin level, e.g., in northern Sweden by river regulation companies and especially in southern Sweden by river management organizations. Their scope can differ from mere data collection and water pollution information to water use and conservation of basins. Recently, a draft of legislation on water associations for cooperation among different interests in a river (primarily municipalities, industries and drainage enterprises) has been taken up by the Swedish Parliament. These associations are voluntary and until today no such association has been founded. But there are older ones existing, for example, the Kävlinge River Basin Association.

The local water planning in the municipalities in Sweden today is mainly concerned with technical questions of water supply, sewage treatment and waste management and not at all with water resource management.

There are numerous conclusions to be drawn from this chapter. Some of the more water-related may be summarized as follows:

Sweden is in urgent need of water resource planning procedures and methods adaptable to:

a) far reaching local self government and administration;

b) integration with other forms of physical planning;

c) conflict solving in a situation with many independent actors;

d) regional water supply or pollution projects with many independent actors;

e) public participation in both planning and management.

III. POPULATION AND HOUSING

The counties of Skåne, Kristianstad and Malmöhus comprise a land area of some 11,000 km^2, whereof Kristianstad County accounts for 6,000 km^2 and Malmöhus County 5,000 km^2. At the end of 1976 the total population was 1.014 million, with 274,000 in Kristianstad County and 740,000 in Malmöhus County. The population density is thus very unevenly distributed between the counties, with Malmöhus having the highest density in the country (except for Stockholm) with 150 inhabitants per km^2 and Kristianstad only 45, which anyway is far above the country average of only 20 inhabitants per km^2.

Figure 9 shows the population in thousands at the beginning of each five year period for the two counties and for Skåne. The numbers in brackets show the percentage of population increases for the respective periods for the counties, Skåne, and for Sweden. The figure indicates that Skåne in the last 15 years has had a larger percentage population increase than the country as a whole. But it is also evident that there are extreme differences between the counties. This is especially true for the urbanization period of 1950-1970, with large migration to the urban centers of Malmö and Helsingborg. However from about 1968 this trend changed so that between 1971 and 1976 the percent increase was larger in Kristianstad County than in Malmöhus, although the absolute increase still was larger in the latter county (Figure 10). This indicates that the determining variable is domestic net migration, which for Kristianstad County is increasing and for Malmöhus rapidly decreasing and in the later years even negative.

Looking closer at Malmöhus County one can see that of the total increase during 1951-1966 of 93,000 inhabitants, Malmö municipality accounts for 60%, and Malmö, Lund and Hälsingborg together account for 92%. This was the time of intensive migration towards city centers (Figure 11). For the same period Figure 12a shows that the four coastal municipalities surrounding the larger cities remained constant, and Figure 12b shows a constant or even decreasing population in the inland municipalities in spite of

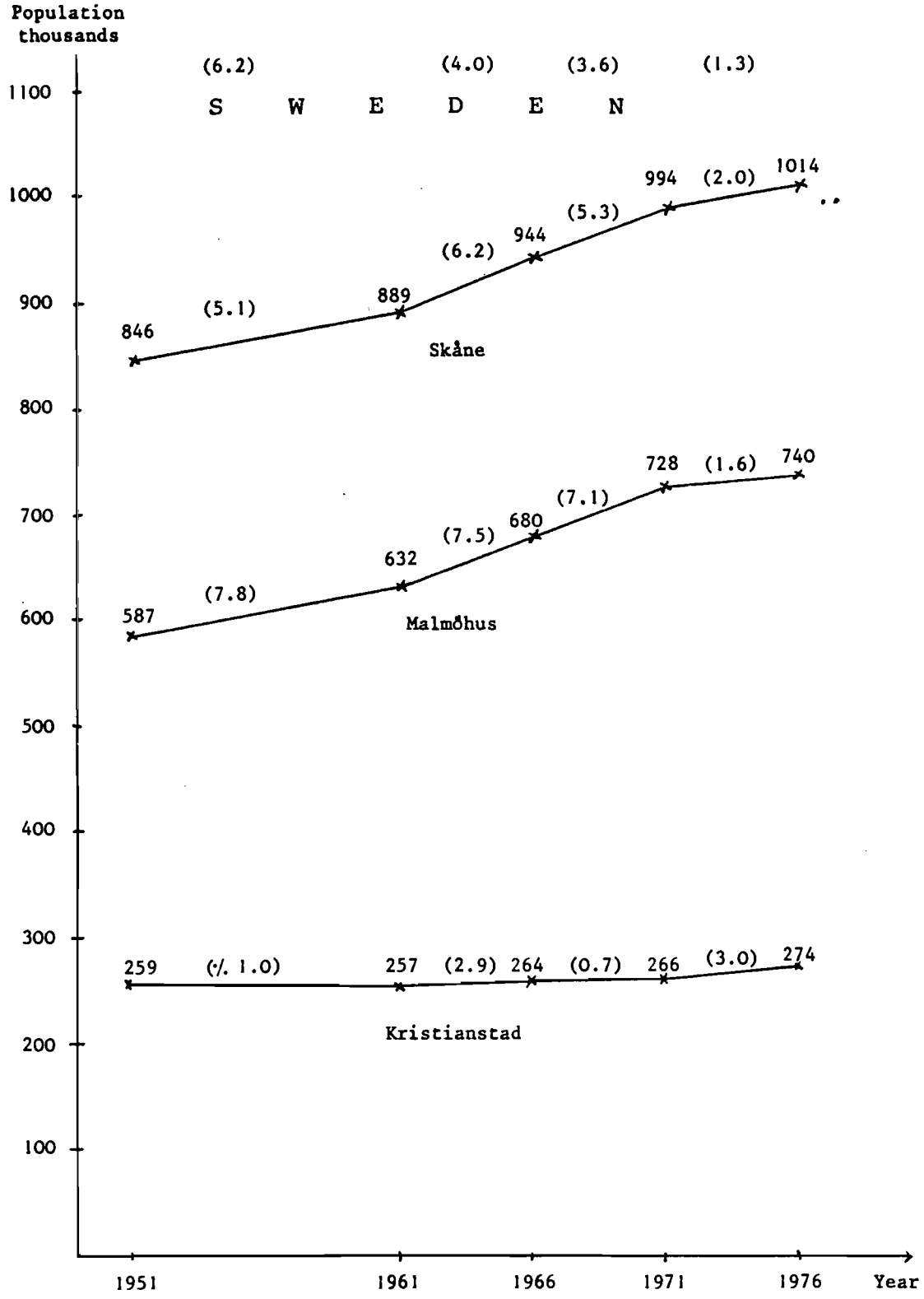
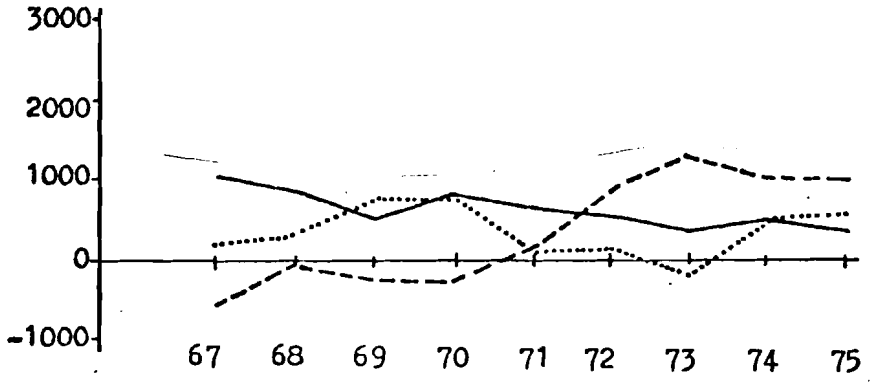


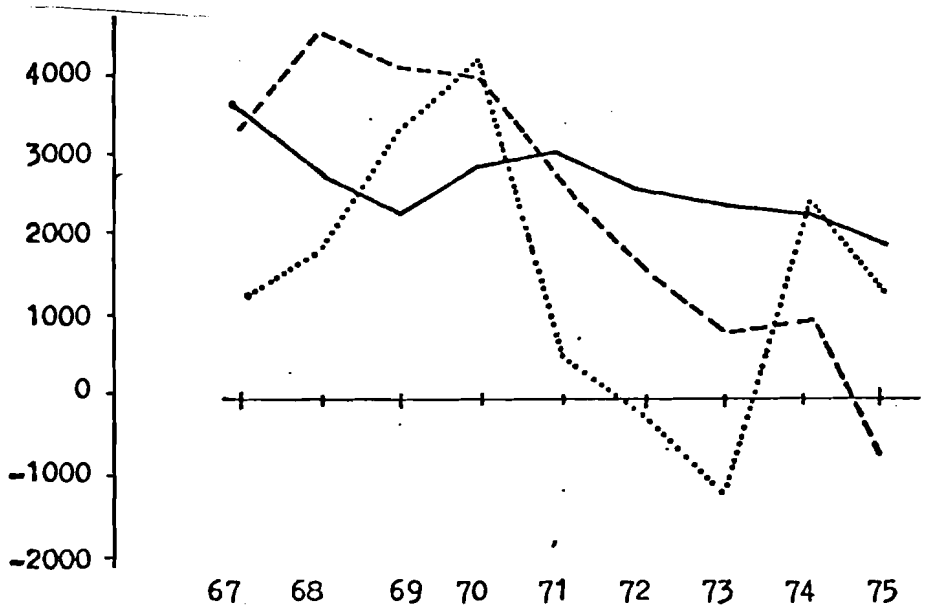
Figure 9: Population Changes 1951-1971 in Kristianstad and Malmöhus Counties and in Skåne. Percental Changes in brackets for the Same Regions and for Sweden.

Source: Årsbok för Sveriges Kommuner, SCB.

Kristianstad County



Malmöhus County



——— Net birth rate

------ Domestic net migration

..... Foreign net migration

Figure 10 : Demographic Changes, 1967-1975.

Source: Befolkningsutvecklingen i Skåne 1966-1975, Länsstyrelsen Malmö 1976.

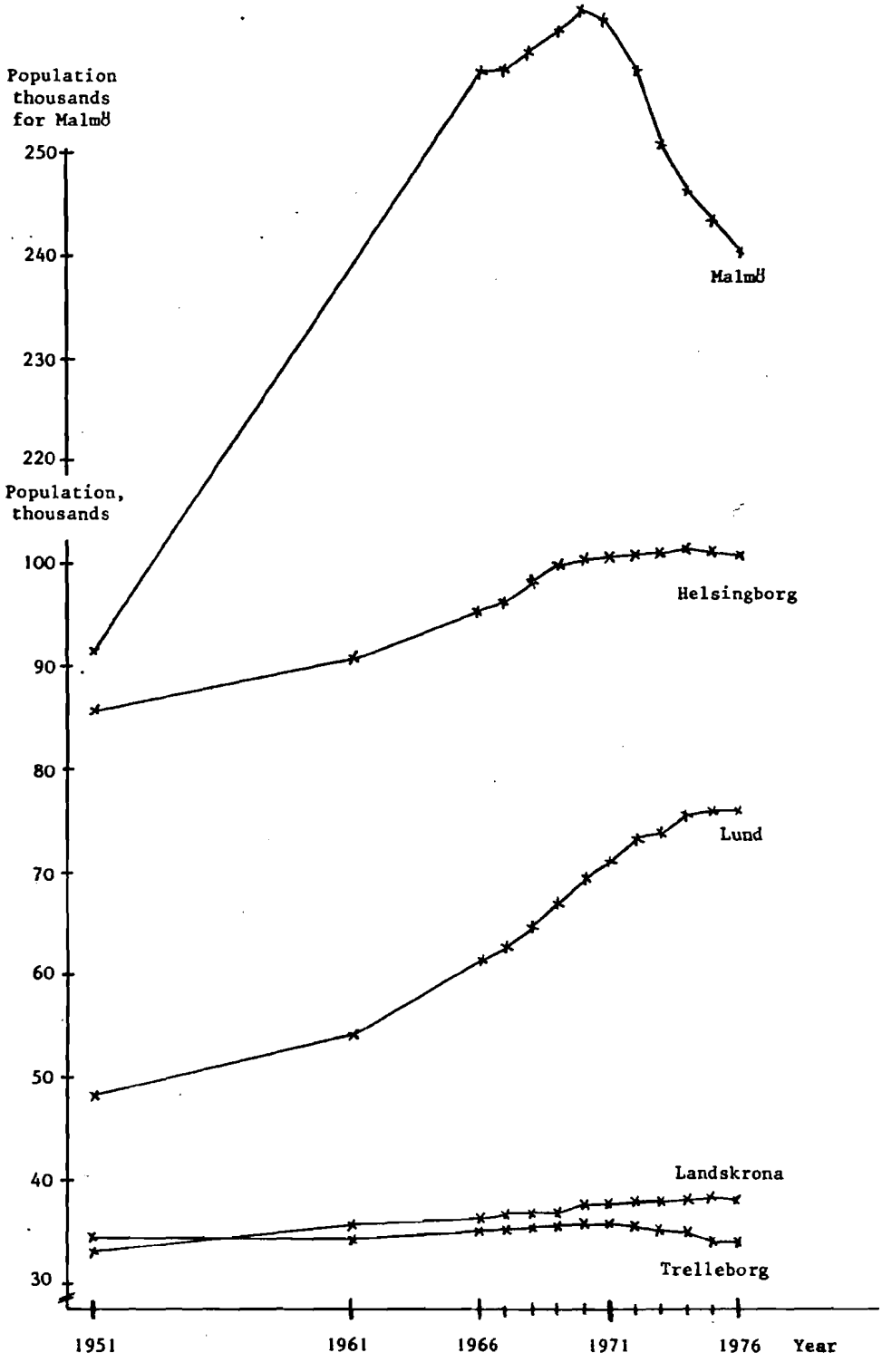
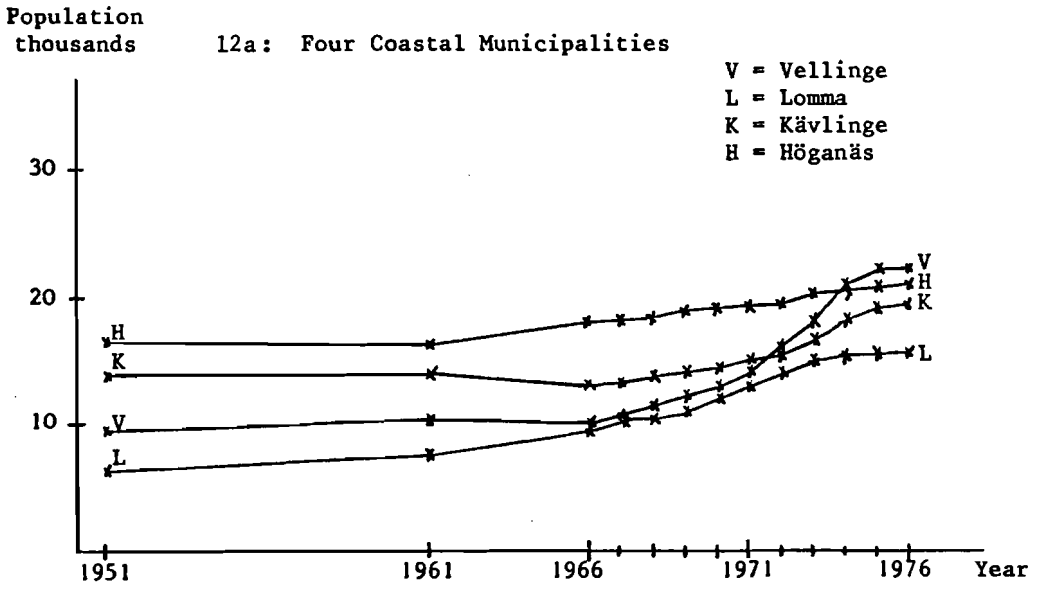


Figure 11: Population 1951-1976 in Five Large Urban Municipalities.

Sources: Årsbok för Sveriges Kommuner, SCB.
Befolkningsutvecklingen i Skåne 1966-1975,
Länsstyrelsen i Malmö 1976.



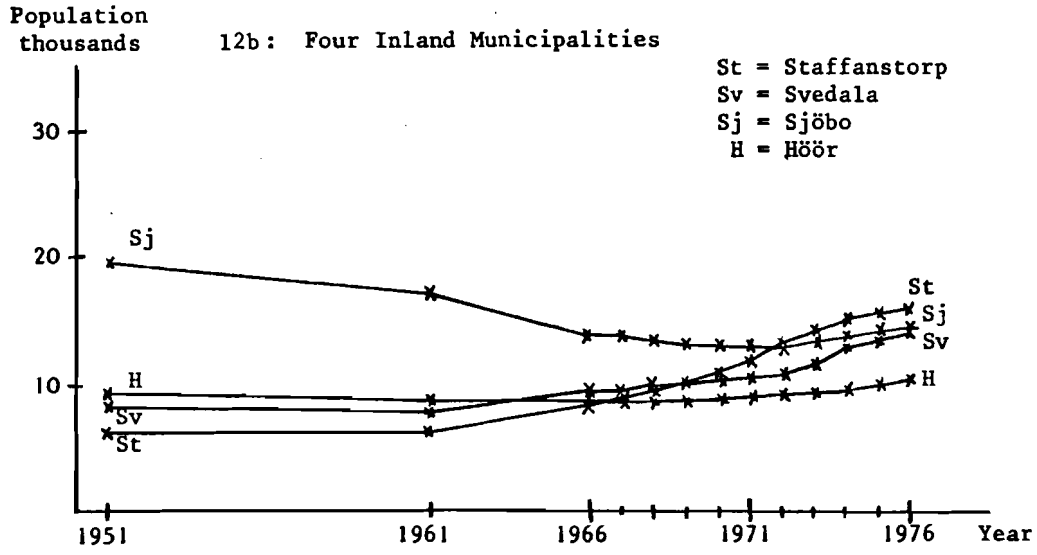


Figure 12a-12b: Population 1951-1976.

Sources: Årsbok för Sveriges Kommuner, SCB.
Befolkningsutvecklingen i Skåne, 1966-1975, Länsstyrelsen i Malmö 1976.

the large countrywide and especially countywide increase. Staffanstorp municipality is an exception, which probably depends on its close proximity to Malmö. Svedala is also showing this tendency.

Since 1968 the population trends have changed. From then up to 1972 the population increase in the cities has been slowing down considerably, in the case of Malmö, even turning negative. At the same time the neighboring coastal municipalities face a peak in their increases. The inland municipalities still remain fairly constant. Since 1972 the larger cities all face decreasing populations while the smaller coastal municipalities are approaching a steady state condition. However, the population of inland municipalities is now increasing at higher rates. This is also concluded from Figure 13 which shows the percent of changes during 1975 of the municipalities of Figures 11 and 12. The local migration pattern strongly supports the interpretation that the population changes indicate an urban sprawl phenomenon, i.e., people moving from city centers to areas within commuting distance. Table 10 shows that of net out-migration from Malmö, some 90% remained in Malmöhus County, and of the net in-migration to Sjöbo almost 100% came from somewhere else in the county. The fairly low percentage value for Lund is explained by its status as a university city and the very low value for Helsingborg is explained by its close proximity to Kristianstad County. Of the net migration of -304, 491 or 162% falls on Kristianstad County. At the same time the neighboring municipality of Åstorp in Kristianstad County received a net of 442 persons from Malmöhus County.

The migration patterns have largely influenced the housing construction. For the period prior to 1970, the predominant problem in the housing field was the shortage of dwellings in expanding municipalities, i.e. in the cities. The prime requirement was therefore to build more. In the mid-sixties, the Swedish Parliament passed a resolution stating that one million new dwellings should be constructed in the following ten years. This target for the whole country was reached and then followed by a decline in housing construction (Table 11).

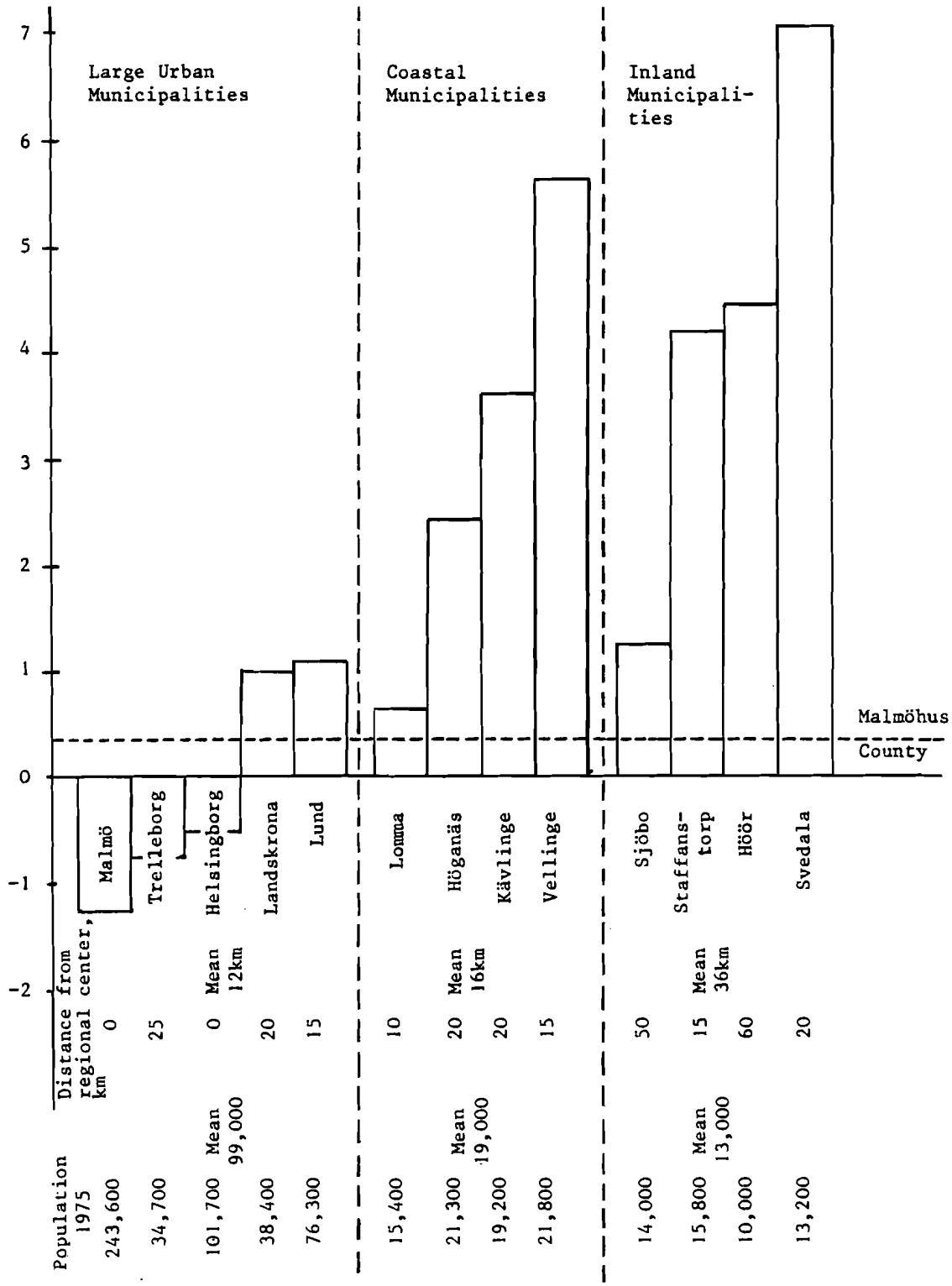


Figure 13: Percental Population Changes 1975 in Thirteen Municipalities.

Source: Befolkningsutvecklingen i Skåne 1966-1975, Länsstyrelsen i Malmö 1976.

Table 10: Net Migration, Total and Part Thereof Within Malmöhus County, 1976.

Source: Befolkningsförändringar del 1, 1976, SCB.

Municipality	Total Net Migration Persons	From origins or to destinations in Malmöhus County, %*
Malmö	- 2967	88
Lund	- 270	50
Landskrona	- 483	82
Helsingborg	- 304	36
Vellinge	+ 239	133
Höganäs	+ 109	87
Svedala	+ 256	93
Sjöbo	+ 381	97
Höör	+ 150	120

*Explanation: The Malmöhus County percental part may exceed 100 as the first column shows net migration to/from the municipality. For Höör the net in-migration is 150 persons, whereof net 180 persons moving from some origin in the county to Höör and net 30 persons moving from Höör to some county outside of Malmöhus.

Table 11: Trends in Construction of New Dwellings in Sweden.

Source: Fact Sheets on Sweden.

Year	Single and Two-Family Houses, Thousand Dwellings per Year	Multi-Family Houses, Thousand Dwellings per Year	Total	Number of New Dwellings per 1000 population
1951-55	12	38	50	7.0
1956-60	17	47	64	8.6
1961-65	24	59	83	10.8
1966-70	30	73	103	12.9
1971-75	41	53	94	11.5
1976	40	16	56	6.8
1977	41	14	55	6.6

Prior to 1970 when the migration was towards the cities, the number of new dwellings constructed each year was ever increasing with the largest part falling on multi-family houses. Since 1970 the number of new dwellings has rapidly declined, but only for multi-family houses. The number of new one-and-two-family houses is still increasing to meet the demand of the population migrating from the cities to the suburbs.

The problems to be faced by the physical planners may be summarized as follows:

a) *During the past ten year period, which coincides with the period of environmental debates, urban sprawl has been tremendous. This trend is likely to continue although there are signs that the sprawl might slow down.*

b) *The urban sprawl leads to increasing demands for land for dwellings and transport. The cost for water and sewage networks is likely to increase.*

c) *There will possibly be changes in the per capita demand for water due to the increase of private use. However, it is not clear in what direction. As will be described later, the per capita water use is on the average larger in multi-family houses which is said to be mainly due to collective metering. However, we still lack an analysis of the price-demand relationships in the water use sector.*

IV. RECREATION

There are two factors which seem to be especially important in determining recreational demand in Sweden. The first is the general increase in the standard of living, which makes it possible for a large proportion of the population to have access to cars and to buy weekend houses. The second is the reduced working time, from about 3,100 hours per year at the turn of the century to 1,700 hours per year today. The weekly working time is now 40 hours with intensive discussions about a 38 hour working week. The four day working week is probably not far ahead. Moreover, every worker is now entitled to at least five weeks yearly vacation to which should be added four weeks of public holidays.

This means that many people have access to relatively remote recreational sites and that the time spent in weekend houses is large.

The weekend house demand from families in Skåne has until now been concentrated to the counties of Kristianstad and especially to Malmöhus. From 1970 to 1975 the number of weekend houses increased by 18,000 in southern Sweden (approximately the area south of Lake Vättern). Malmöhus County accounted for one third of these. Of the present (1975) stock of 22,800 weekend houses in the county, most are concentrated in the coastal area and lake areas in central Skåne (Figure 14). However, the number of weekend houses along the coast has decreased since 1970. This decrease is due to essentially two factors. First, the area is already densely populated and secondly the trend of transforming weekend houses into permanent residences is very strong (Figure 15). Thus, in 1970, the weekend houses in coastal areas accounted for 60% and in 1975 for only 45% of the total stock in the county.

The capacity to develop new weekend house areas in Malmöhus County is very limited. As mentioned before. the coastal area is already fully developed. Moreover the Swedish planning authorities (national physical planning, municipality physical planning, environmental protection planning) have more or less agreed that

- expanding, densely populated areas;
- agricultural areas;

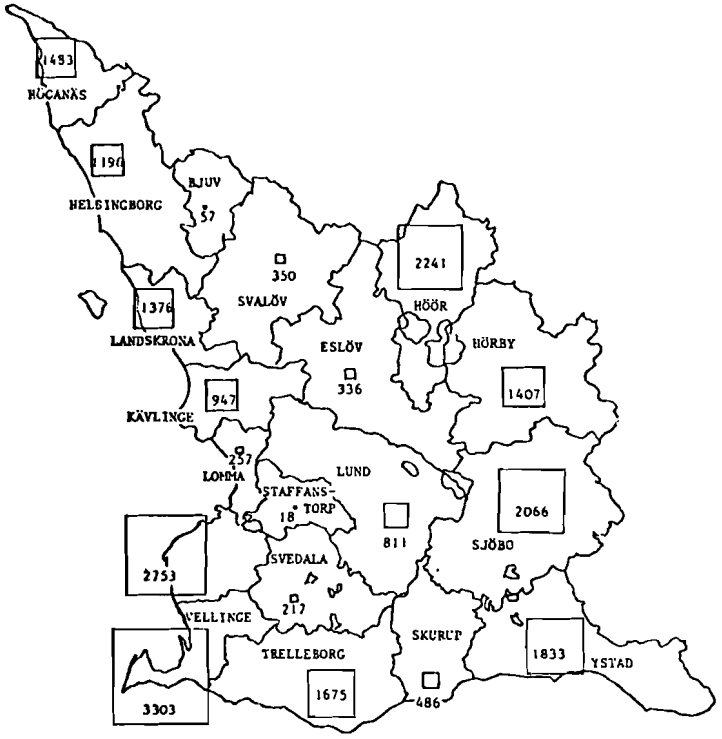


Figure 14: Number of Weekend Houses in Malmöhus County 1975.

Source: Fritidshusinventering i Malmöhus län 1976, Länsstyrelsen, Malmö, 1977.

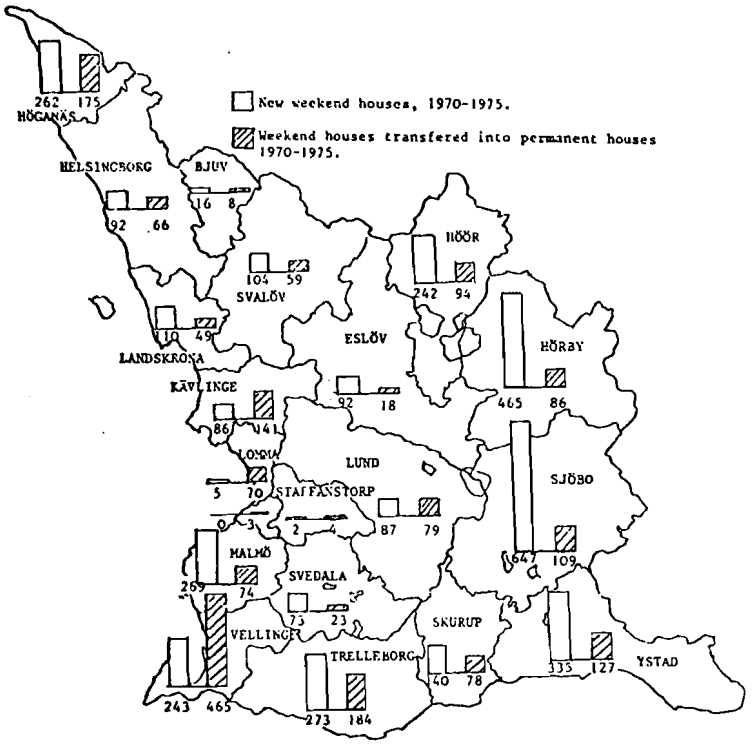


Figure 15: New Weekend Houses 1970-1975.
The allotment-garden cottages, concentrated to the city areas (Malmö c.a 2000, Landskrona and Helsingborg c.a 1500) are not included.

Source: Fritidshusinventering i Malmöhus län 1976, Länsstyrelsen, Malmo, 1977.

- areas with high productivity forestry;
- environmental protection;
- protection of cultural and historical sites;
- military areas;
- and areas for outdoor recreation

should in principle have priority before weekend house development. All these priority sectors are extensively established in Malmöhus. Therefore it is calculated that there is room for no more than 1,000 new weekend houses, even if parts of the high productivity forest areas are used for this development.

This very severe capacity constraint means that the weekend house development will extend towards the east and north. However, the capacity in the east (Kristianstad and Blekinge Counties) will also very soon be reached, especially if the demand from Malmö is to be met. The main direction, in a long time perspective, will therefore probably be towards the north where there is still some capacity left.

The quantitative and qualitative knowledge of demand for outdoor recreation in Sweden is relatively limited. However, different investigations have indicated that the types of outdoor recreation demanded in Sweden include activities that require access to continuous areas with relatively small demands for specific recreational structures. The types of recreation most demanded are walking, swimming, fishing, hunting, cycling, etc.

The outdoor recreation is based on the fundamental Swedish concept of "Right of Common Access (Allemansrätt)" which is not fully laid down in written law but is traditionally regarded as self-evident. The Right of Common Access means that everyone has the right to move freely in nature and the right of way over another's land provided no damage is inflicted on the property. A person is also entitled to pick berries, flowers, and mushrooms anywhere. The waters owned by others may be used for boat rides, swimming and fetching water. However the Right of Common Access does not apply to private grounds and gardens next to private dwellings nor to croplands and private parks.

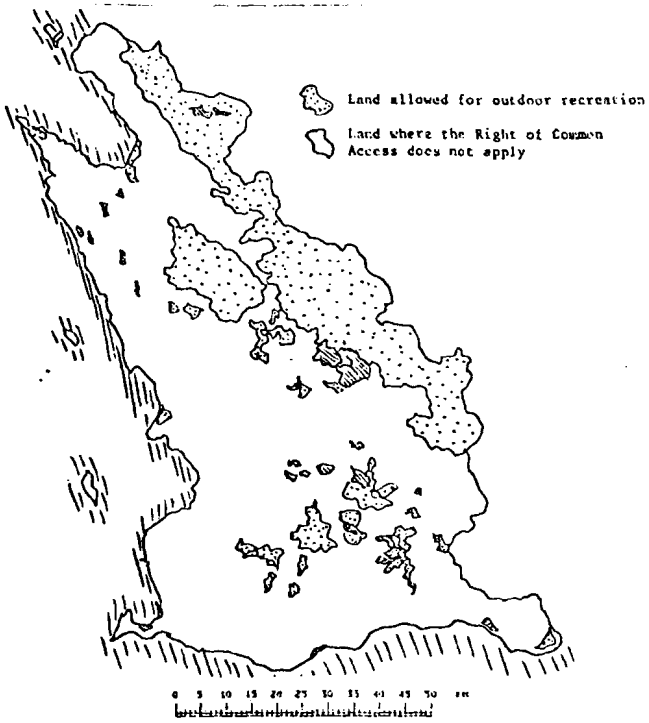


Figure 16: Vegetation and Land Use.

Source: Öresundsförbindelser: Planerings-och miljöfrågor, DsK 1978:6.

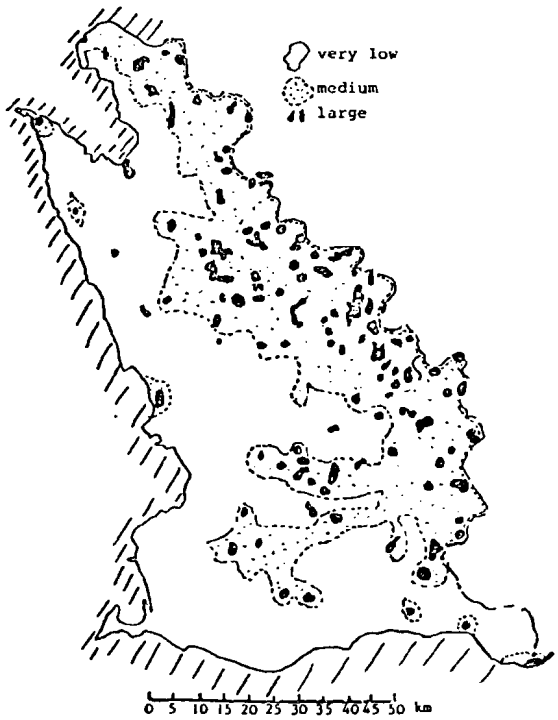


Figure 17: Capacity for Outdoor Recreation.

Source: Öresundsförbindelser: Planerings-och miljöfrågor, DsK 1978:6.

The exceptions to the Right of Common Access apply especially to Malmöhus County with its exreme agricultural areas and its heavily exploited coastal zones (Figure 16). Moreover the surface water resources are small and scarce in the area. Therefore the capacity for outdoor recreation is very limited and restricted essentially to areas north of Ringsjön (Figure 17). This figure shows areas with different capacities for outdoor recreation. Capacity is defined in terms of positive factors such as accessibility and site attributes and negative factors such as limited entering permits and ecological sensitivity.

As is the case with weekend houses the demand for outdoor recreation is more or less forced to turn towards the northern parts of Skåne and into Småland. A possible substitute, however, is to develop possibilities for outdoor recreation in the close vicinicy of private dwellings. This means that some land resources have to be set aside for more recreational structures such as more walking and cycling paths and more public parks.

There are essentially four conclusions to be drawn from this chapter.

1) *The increase of leisure time has caused a tremendous increase in the demand for and actual development of weekend houses. The expected demand for such houses is far above the possible capacity in Malmöhus County where investigations have shown a maximum capacity of 1,000 new houses. Unless the land use policy is changed, this means that the development of the weekend house sector is of minor importance for Malmöhus County.*

2) *The conversion of weekend houses to permanent use amounted to 2% per year during 1970-1975. This conversion will continue, thus contributing to the migration-urban sprawl and to the network costs. A particular problem is that the water and sewage standard in these areas does not correspond to that required in permanent housing areas.*

3) *An important regional planning issue is where to locate and how to arrange for outdoor recreation. One must take into consideration the importance of access to water in outdoor recreation areas.*

4) *Kristianstad County must be included in the analysis if recreational use of water and related land is to be properly studied.*

V. POLLUTION AND ENVIRONMENTAL PROTECTION

Most of the water extracted for various purposes returns to the natural water system as polluted wastewater. The rapidly increased water demand has meant that the wastewater in Swedish streams trebled between 1945 and 1970.

The first pollution problem to develop was oxygen depletion followed by eutrophication caused by rapid urbanization. This gross increase was combined with an aggregation of the population into relatively few densely populated areas, and the adjacent waters reached specific nutrient loads often exceeding the tolerance limits many times over.

The introduction of synthetic detergents in the 1950's accelerated the eutrophication and the situation became severe in many water-courses towards the end of the 1950's.

By the end of the 1960's the pollution from municipal areas had increased considerably due to the increase in urban population, a rise in the sanitary standard in dwellings and the use of detergents containing phosphates. In 1970 about 20 percent of the urban population were not connected to any sewage treatment system and some 25 percent were connected to plants with only sludge separation. Strong measures have since been taken for biological and chemical treatment (Figure 18).

The worst water pollution was due to industry, particularly the paper and pulp factories. Attention has been focused on pollutants such as oxidizable organic substances, nutrient salts, heavy metals (especially mercury), chlorinated hydrocarbons and other persistent substances.

Agriculture was a heavy polluter especially producing organic pollution from domestic animals, pressjuice from silos, and nutrient salts leached from farmland by the percolating water. The most serious aspect of this source is the time delay to be expected between fertilizer application and the appearance of nitrate in the groundwater. This time delay depends on factors like the depth of the groundwater table and the water balance of

the soil, and may frequently amount to tens of years. The rather intense development in agriculture during a series of years may thus have effects still hidden in the ground, even above the groundwater table, to be revealed in the future.

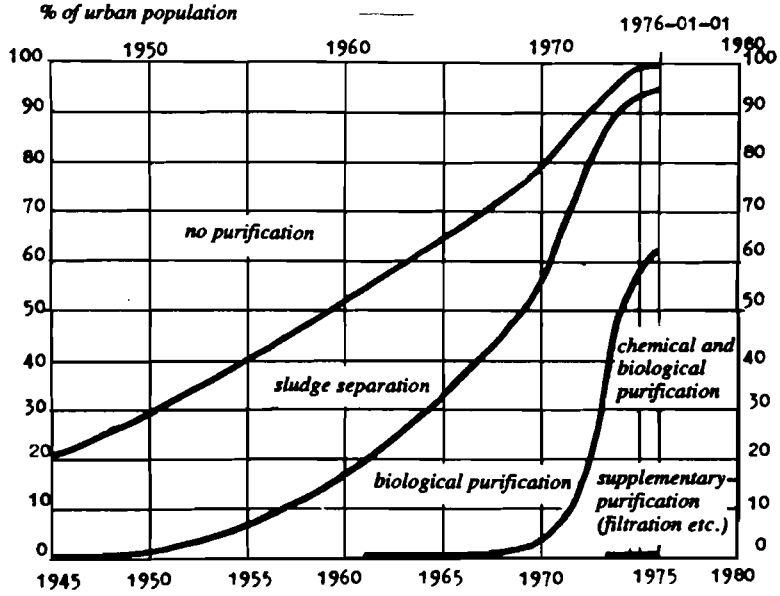


Figure 18: Treatment of Sewage from Swedish Urban Communities, 1945-1975.

Source: Ahlgren, N.: Water in Human Settlements, Ministry of Housing and Physical Planning, Stockholm, 1976.

In forestry, fertilizer use has been much less common than in agriculture and there has been very little cause for alarm.

The rate of pollution culminated around 1970. The pollution of coastal waters mainly emanated from the pulp and paper industry whereas inland waters were most polluted by municipal effluents.

An estimate of the amounts of pollutants from different sources is given in Table 12. To prevent further environmental deterioration, strict policy goals and action-oriented programs were established by the Swedish Government in the 1960's. The main incentives to follow these programs came from legislation and subsidies.

Table 12: Total Discharge of Main Pollutants in Sweden By the End of the 1960s.

Source: Water in Sweden, Ministry of Agriculture, 1977.

1. Tonnes/Yr	Oxygen Consuming Matters	Total Phosphorus	Total Nitrogen
To rivers	270,000	7,700	77,000
To coastal waters	400,000	5,200	16,000
Total Discharge	670,000	13,900	93,000
2. Relative amounts from Different Sources (per cent)			
Sewage	14%	58%	27%
Industry	86%	30%	8%
Leaching from forest and arable land		12%	65%
Total %	100%	100%	100%

Before the end of the 1960's some legislative incentives were at hand to combat water pollution: the Water Act, the Building Act and the Nature Conservation Act. But it was not until 1969 when the Environment Protection Act was passed that the legislation became a powerful tool. This act deals with water and air pollution, noise and vibrations, unwanted light and other

disturbances. The act stipulates that anyone who wishes to engage in hazardous activity must pick a site where the nuisances will be kept to a minimum.

The Environmental Protection Act stipulates prior assessment not only of new industrial enterprises, which already was possible under the earlier acts, but also of existing ones contemplating a change of production, of processing equipment or of any other factor of environmental importance. Prior assessment now also applies to new municipal sewage outfalls serving more than 200 persons, and to existing municipal sewage plants serving more than 1000 persons.

Just how much should be done to protect the environment is to be judged with reference to what is technically feasible and economically reasonable. The starting point is always the best available technology. Technological advances are thus supposed to rebound to the benefit of environmental protection.

Permits for activities which may have detrimental effects on the environment are granted by a special governmental authority, the National Franchise Board for Environmental Protection. This Board is very much structured like a court of law. It is to be noted that before 1969 water pollution cases were tried basically according to the Water Act by the six District Water Courts, but are now tried according to the Environmental Protection Act by the central National Franchise Board for Environment Protection. It is also to be noted that the National Environmental Protection Board is the central administrative agency in the ecological sphere. It is this agency which is called upon to implement the decisions of Parliament and Cabinet, to monitor trends and to propose changes as needed. This administrative agency even has some adjudicating authority under the Environmental Protection Act.

To reduce the pollution from municipal sources, a decision was made in 1968, which made it possible for municipalities to get State Grants for building or improving sewage works. The grants covered 30 to 50% of the costs--the more efficient the

treatment, the higher the percentage (Table 13). To provide more jobs, the grants were raised by 25% of the costs, during parts of the period 1971-1974.

Table 13: Relations Between Treatment Efficiency and Granted Percentage of Total Cost.

Source: Water in Sweden, Ministry of Agriculture, 1977.

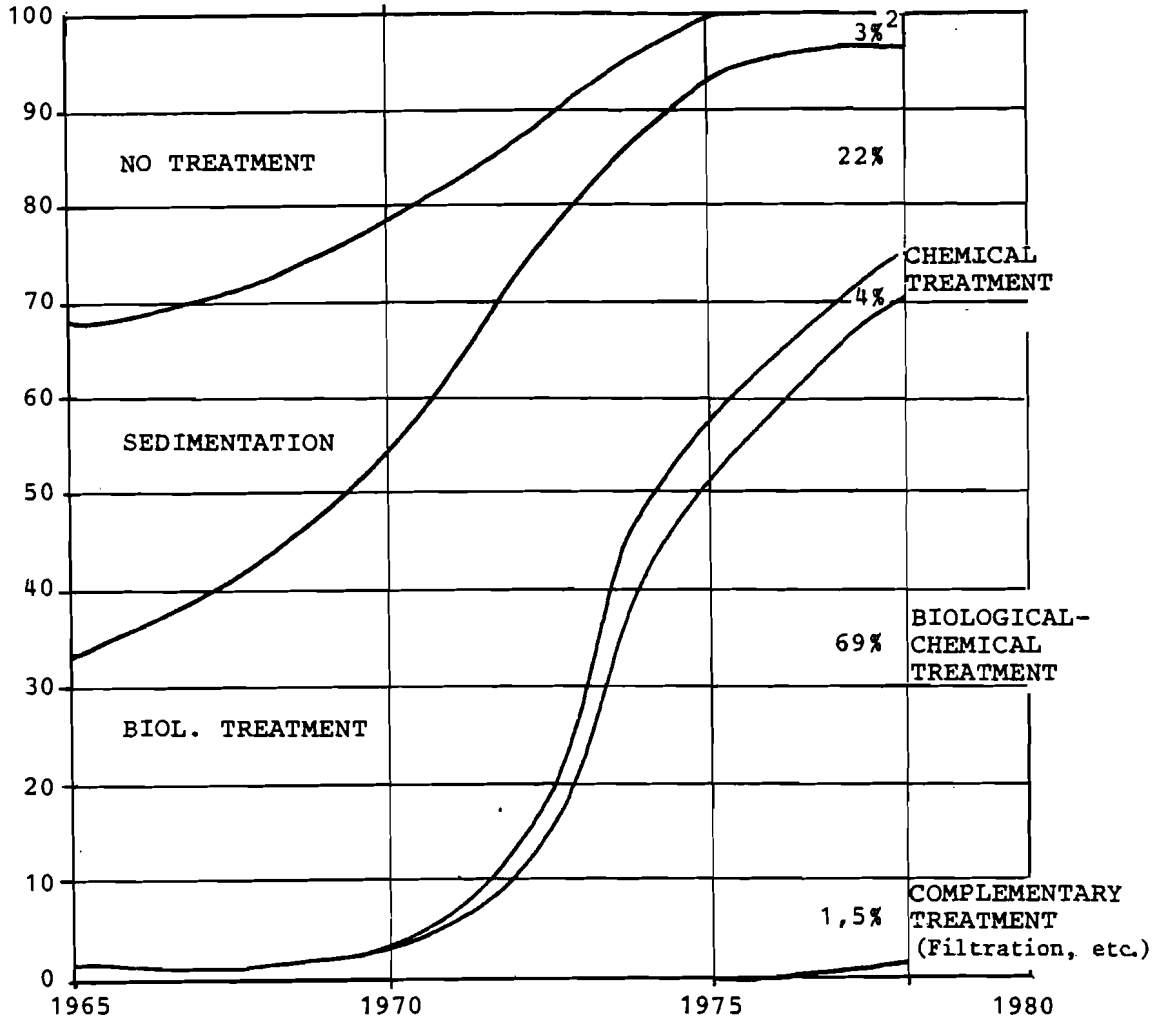
BOD Reduction per cent	Phosphorus Reduction per cent		
	< 50	50-89	≥ 90
	Percentage of costs granted:		
60-74	30	35	40
75-89	30	35	45
90-	35	40	50

During the six year period 1968/69 to 1973/74, 2.4 billion Swedish crowns (of which nearly 1 billion were grants) were invested in municipal sewage treatment plants. This corresponds to 4.5% of the total municipal investment during the same period. The investments during the period 1975-1980 are projected to be 1.6 to 1.7 billion Swedish crowns, which corresponds to 3% of the projected municipal investments during this period.

As a result of the environmental program, sewage treatment plants are proliferating. There are now around 2100 municipal sewage treatment plants in Sweden serving some 7.2 million people. In urban areas there are around 1350 municipal plants serving some 6.8 million people. Of these plants 607 are designed for biochemical treatment serving 4.7 million people (Figure 19).

Of more recent origin is the adoption of a fourth treatment step based on sand filtering or activated carbon. This is the

PERCENT OF THE POPULATION IN URBAN AREAS (LOCALITIES)[1]
1978-01-01



TYPE OF SEWAGE TREATMENT	NUMBER OF TREATMENT PLANTS	NUMBER OF PERSONS SERVED
NO TREATMENT	——	8 000 ——
SEDIMENTATION	190 (- 26)	202 000 (- 37 000)
BILOGOGICAL TREATMENT	417 (- 44)	1508 000 (-273 000)
CHEMICAL TREATMENT	138 (+ 10)	302 000 (+ 10 000)
BILO.CHEMICAL TREATMENT	607 (+ 31)	4727 000 (+226 000)
COMPLEMENTARY TREATMENT	16 (+ 9)	100 000 (+ 79 000)
	1368 (- 20)	6840 000

The figures in brackets refer to changes since 1 January 1977.

Figure 19: Sewage Treatment in Sweden 1965-1978.

Source: National Environment Protection Board, Solna, Sweden, 1978.

[1] Population clusters with at least 200 inhabitants are called localities if the distance between buildings as a rule does not exceed 200 meters. Localities account for approximately 83% of the total population.

[2] Half of which are without connection to municipal sewer system.

kind of technological advance that now lends itself to particularly sensitive water areas. The favorable effects of the environmental program on the municipal releases of oxygen consuming matter and nutrient solids are indicated in Figure 20.

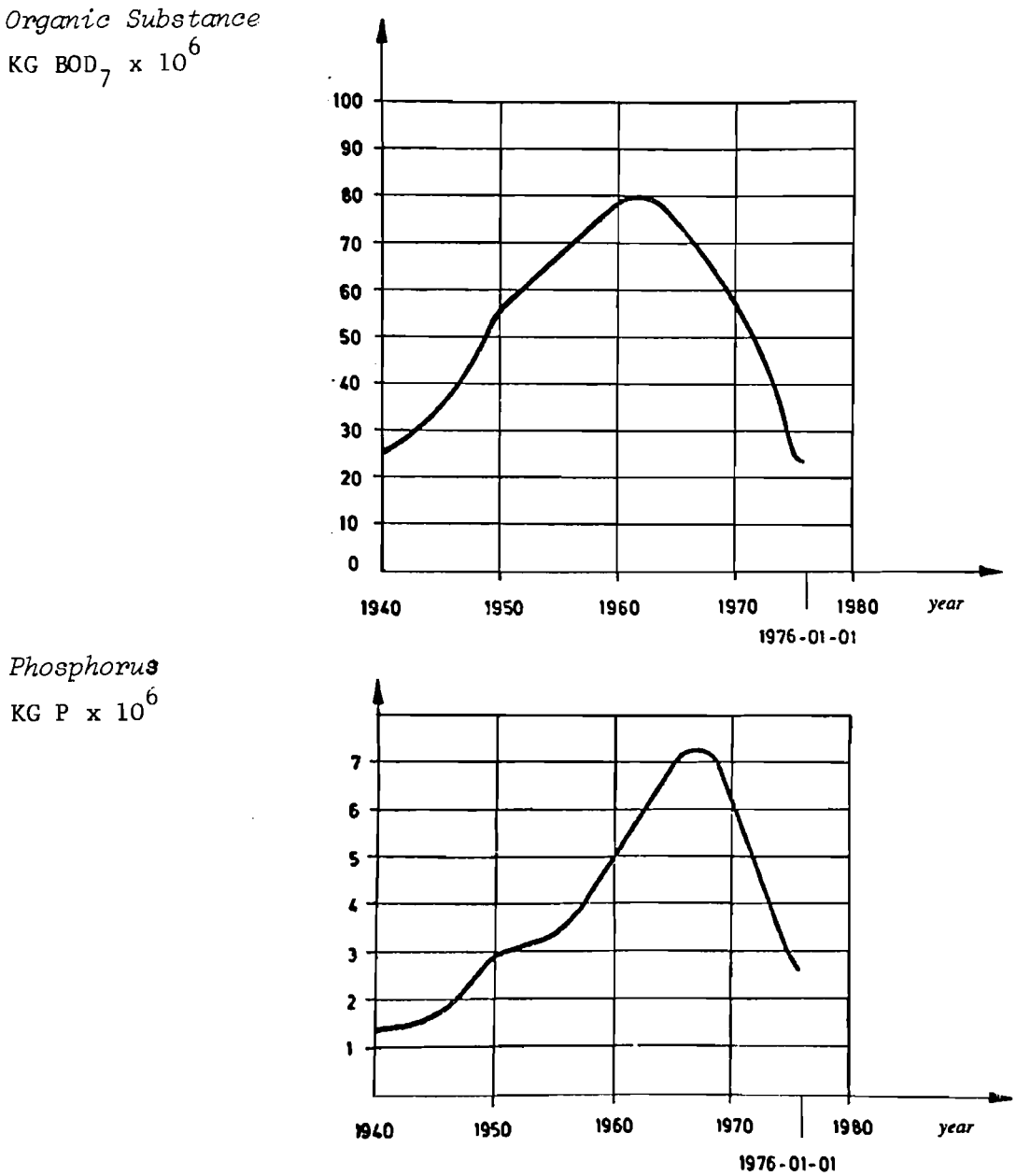


Figure 20: Estimated Discharges of Organic Substances (BOD_7) and Phorous from Urban Communities (domestic waste water) in Sweden.

Source: Aulgren N: Water in Human Settlements, Ministry of Housing and Physical Planning, 1976.

Now urban storm water management is becoming a large municipal environmental problem (Tables 14 and 15). During the past 25 years the main effort has been devoted to changing combined sewers into separate ones. Table 16 shows the length of the conduits in kilometers for urban areas with more than 5000 inhabitants and the year when they were completed. The cost of rebuilding all combined sewers into separate ones has been estimated at 10 to 15 billion Swedish crowns. This high cost has led to a discussion of modifying the storm water management policy. Local infiltration and the use of retention basins seem to be useful methods of handling the storm water and avoiding overflows or large disturbances in the treatment plants. Compared to rebuilding sewer systems these methods are usually cheaper. Presently instructions for management of storm water are in preparation.

Although very encouraging progress has been recorded on the municipal water conservation front the same cannot be said on the industrial side, which discharges the largest amount of effluents (80% of total effluents). The situation has improved since the mid-60's, however. Industries are pouring less waste into natural waters, although industrial production has risen sharply. For instance the pulp and paper mills have reduced the discharge of oxygen consuming matter by some 30% in spite of a production increase of about 30% (Figure 21). The iron and steel mills each year now emit 1,000 tonnes less oil and 8,000 tonnes less metal into the water. The considerable reduction of industrial water pollution is due to the same two factors described above: the environmental legislation and the state subsidies. The investments for environmental protection within industry were estimated to be 2.1 to 2.2 billion Swedish crowns for the five year period 1969/70 to 1973/74 which corresponds to about 5% of total industrial investment or 1.1% of the value added during the same period.

Table 14: Pollution Load Due to Urbanization (tons per annum).

Source: Carlsson, L. and Falk, J.: Urban Hydrology in Sweden - An Inventory of the Problems and Their Costs, Department of Water Resources Engineering, Lund Institute of Technology, Report No. 3017, 1978.

Pollutant	Waste water	Combined overflows	Storm water discharge	Total
SS	25 000	7 500	68 000	100 500
BOD_7	33 000	2 000	7 000	42 000
P	3 000	80	50	3 130
N	17 000	300	700	18 000
Zn	170	10	80	260

Table 15: Annual Discharge (in tonnes) of Pollutants in Three Urban Areas in the Stockholm Region.

Source: Water in Sweden, Ministry of Agriculture, Stockholm, 1977.

Pollutant	Annual discharge (tonnes)		
	area 1 35 p/km²	area 2 10,000 p/km²	area 3 traffic area
Solid substances	47	93	200
Suspended solids	17	62	120
BOD_7	1.4	4.3	10
Oil	10	240	3,600
Total phosphorus	4	16	20
Total nitrogen	140	350	510

Table 16: Length of the Conduits (km) at Different Times in Urban Areas with More Than 5000 Inhabitants.

Source: Carlsson, L. and Falk, J.: Urban Hydrology in Sweden- An Inventory of the Problems and Their Costs, Department of Water Resources Engineering, Lund Institute of Technology, Report No. 3017, 1978.

Type of conduit	Year of completion			Total
	-1950	1950-1965	1965-	
Waste water sewers	2 100	4 700	7 800	14 600
Combined sewers	5 200	2 100	500	7 800
Storm water sewers	500	4 700	6 800	12 000
Total	7 800	11 500	15 100	34 400

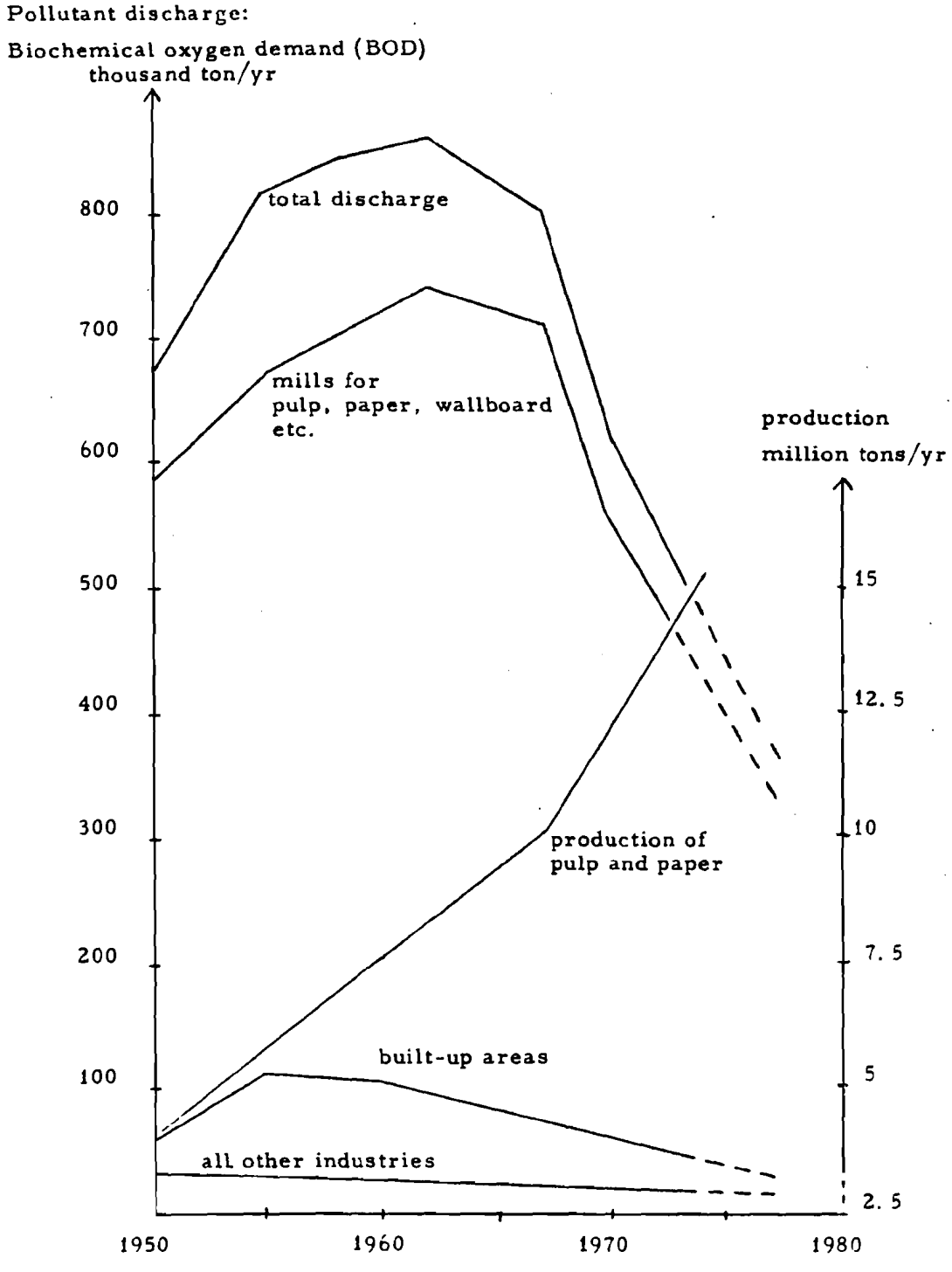


Figure 21: Development of Industrial Production and of Total Discharge of Organic Pollutants 1950-1975.

Source: Hanson, A., Swedish Policy for Water Quality Protection, Report for UN Water Conference, 1977.

During the six year period of 1969-1974 some 800 million crowns were granted to industry for improvement of the environment. About two thirds of this amount have been used for reducing water pollution (Table 17).

The food industry is mainly located in the large cities or in the farmland areas. Thus, Skåne has 25% of the amount of plants of this sector. The waste water from the food industry contains large amounts of oxygen-consuming matter and suspended solids. The total amount of waste water is estimated at 33 million m^3/year. The quality of the waste water from the dairy industry normally contains 1000 to 2000 mg BOD_7/l and from the fermenting industry about 10,000 mg BOD_7/l. The plants of the food industry are with a few exceptions (sugar mills and the starch industry) connected to municipal treatment plants. However, most of the contaminants are easily biodegradable and fit well into the process of municipal treatment plants.

The chemical industry in Sweden is relatively small. The industry is mainly located in a few areas in the southern part of Sweden (Figure 22). Production of phosphorous acid (the wet method) is concentrated in two factories, one in Helsingborg and one in Landskrona. Large amounts of wastes containing gypsum, fluorides, phosphorous and some mercury are discharged into the Sound. The amount of waste is now being reduced, partly by sludge deposition in artificial lagoons.

The fertilizer industry discharges phosphorous, nitrogen, fluoride and heavy metals. The nitrogen discharges have thus far caused the greatest problems. For one inland factory the discharges were 7,500 kg N/day but it has now been decreased to 1,400 kg N/day.

The organic-chemical industry has expanded significantly in the heavy organic compound and medical sectors. The greatest chemical problem is that of phenol-discharges. The problem is attacked in two ways, through modified production planning and the use of sophisticates waste water treatment (resulting in more than 99% reduction of phenols).

The discharges from the medical industry are varying from

Table 17: State Contributions to Environment Protection During the Seven Fiscal Years 1968/69 - 1974/75 (Million Kronor).

Source: Environment Protection - A Growing Public Task, Ministry of Agriculture and National Environment Protection Board, 1976.

PROTECTION OF THE ENVIRONMENT COSTS MONEY

Municipal sewage works are normally granted a State subsidy which covers 30–50 % of the building costs.

Since 1969, industries may receive State subsidies for measures that protect the environment. The subsidies cover 25 % of the building costs. Nowadays, subsidies may also be granted for building full-scale plants to test measures for reducing pollution. Since 1972, plants for handling chemical and other dangerous waste may be garanted 50 % of the building costs.

In order to stimulate economic development, the State allocated larger subsidies during the fiscal years 1971/72, 72/73 and 73/74. The subsidies went to municipalities as well as industries, and covered up to 75 % of the cost of equipment and processes to protect the environment.

During the years 1969–74, the State granted a total of about 800 million kronor (mkr) to industry in order to protect the environment. In the seven years 1968–74, about 1,050 mkr was granted to municipal sewage works.

State contributions to environment protection during the seven fiscal years 1968/69 – 1974/75 (million kronor)

	68/69	71/72	72/73	73/74	74/75
Research on environment protection (except universities & other institutes of advanced studies)	15,0	22,0	28,0	30,5	35,0
National Environment Protection Board	6,1	13,4	21,2	26,0	26,0
National Franchise Board for Environment Protection	–	1,1	1,4	1,6	1,7
Information on environment protection	0,6	2,2	2,2	2,2	2,0
Establishing & administering reserves for nature conservancy	9,3	18,7	21,1	22,4	23,6
Collective research on water protection & air protection	0,6	1,2	1,2	2,0	2,5
Municipal sewage works: subsidies	40,0	130,0	130,0	130,0	130,0
Investigations into water protection, restoration of lakes, etc.	4,0	4,0	4,0	4,0	4,0
Industry: subsidies for measures to protect water and air	–	50,0	50,0	50,0	50,0
Emergency measures for combating oil spills at sea	–	5,5	5,5	5,0	5,5
County Administration units for nature conservancy	9,7	30,6[3]	35,3	36,2	37,9
Swedish Forest Service, promoting nature conservency & outdoor life	0,5	0,6	0,6	1,0	1,0
Game Management	4,8	5,7	7,4	7,5	8,0
National Labour Market Board: relief work in nature conservancy (clearing shrubs, restoring scenic landscapes etc.)	10,0[1]	77,9	76,6	50,0[1]	50,0[1]
State advisory services for local planning authorities	16,0	11,1[3]	21,3[4]	16,7	17,5
Sports subsidies for building sports facilities	7,6	22,0	23,6	24,2	24,4
Subsidies to organizations	30,4	45,4	50,9	57,3	65,6
National Labour Market Board: relief work to promote sports & outdoor life	5,2	75,5	44,5	50,0[1]	50,0[1]
Products Control Board	0,4	1,4	1,4	–	–
Total	**160,2**	**518,3[5]**	**521,2[5]**	**516,6**	**534,7**

1) Estimated amount.
3) From July Ist, 1971, the County Architects Offices were incorporated into the the County Administrations.
4) Including temporary increase in subsidies to comprehensive planning.
5) In addition to the items in the table, there were special subsidies to stimulate employment. Industries and municipalities received special subsidies during 1971/72, 72/73 and 73/74. Municipal sewage works received about 365 mkr in 71/72, about 100 mkr in 72/73 and 100 mkr in 73/74. Industries received about 400 mkr in 71/72, about 100 mkr in 72/73 and 70 mkr in 73/74.

A Chlor - alkali
B Sulphuric acid
C Phosphoric acid
D Ammonia
E Fertilizers
F Chlorate
G Petrochemical
H Refineries
K Formaldehyde
L Explosives
M Medical
N Heavy chemical

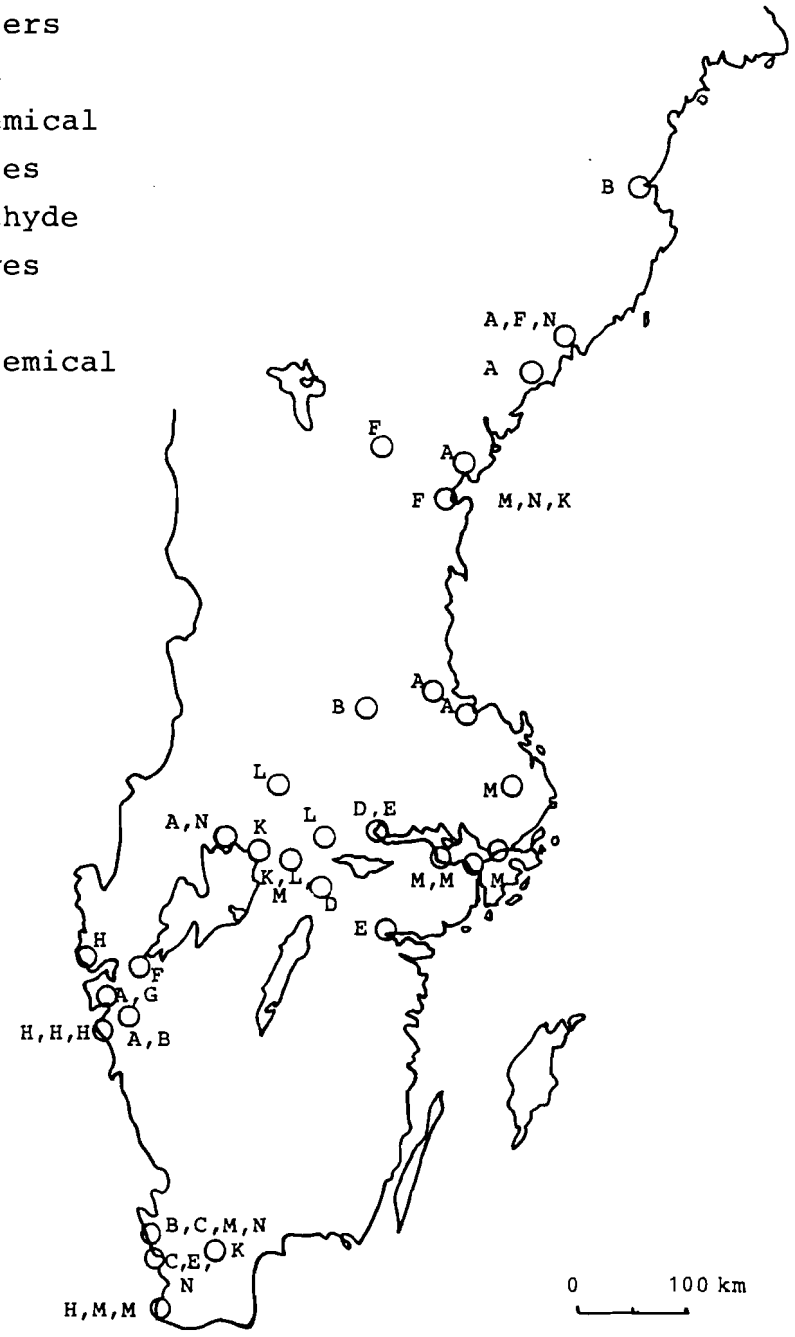


Figure 22: Chemical Industry in Sweden.

plant to plant. Several plants have had to install bio-test facilities to give early warnings.

Today's more efficient sewage treatment plants do a good job of protecting water resources but in the process create a huge sludge disposal problem. Each year municipal sewage plants produce 7 million cubic meters of thickened sludge and in a few years they are expected to produce 10 million cubic meters/year. At present the greater part of it is deposited in refuse dumps or used as a soil conditioner on farms. Experiments concerning alternative sludge handling systems are under way.

The airborne pollution has more and more become a matter of concern. Especially the emissions of sulphuric oxides have led to significant acidification of the oligotrophic lakes in southern and western Sweden. Countermeasures have been taken in terms of prescriptions about the maximum permissible content of sulphur in burning oil as well as compulsory smoke-discharge treatment. However, as a large portion of the airborne pollution is believed to come from places outside Sweden, the program has not had the desired effect.

It has become quite evident that there are close links between air, water, and land pollution. Thus, these aspects have to be subject to an integrated consideration. Fortunately, the Environmental Protection Agency is the responsible body for all these "elements".

The solid waste is taking on growing dimensions today. Today every Swede produces 300 kg of household waste per year and the figure is expected to reach 400 kg/year in 15 years.

Chemical wastes pose a special difficulty. Part of them end up in private or municipal refuse dumps, making it hard to bring this type of waste under proper control. One way of setting the waste problem to rights is to increase the recovery rate. Now some encouraging recovery experiments are being made in factories and municipalities. In a few years the local authorities will have wielded a complete monopoly over the collection and disposal of newsprint. Every household will then be required to separate old newspapers and magazines from other household waste.

Agriculture causes troublesome water pollution especially in Skåne where farming is intensive and the rivers small. The problems are growing due to increased sizes of animal production units and to increased use of fertilizer. (The use of nitrogen compounds doubles every ten years). Since 1957 it has been possible to limit the liquid from silos or liquid manure from cow-sheds, piggeries etc. but such discharges still occur. Government grants (25%) for requisite storage installations have been available since 1972. The establishment of new farms for breeding more than 1000 pigs or more than 10,000 fowl require a permit according to the environment Protection Act. The granting of this permit is conditional upon certain precautions being taken, e.g. that adequate areas are available for spreading manure.

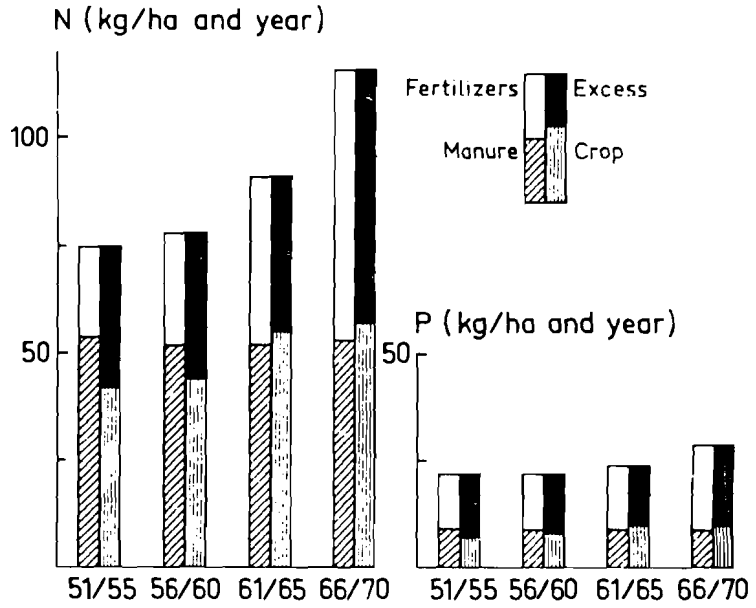


Figure 23: Use of Nitrogen and Phosphorus By Crops in Sweden (5 year averages).

Source: Water in Sweden, Ministry of Agriculture, Stockholm, 1977.

There are some important conclusions to be drawn from this chapter:

First, the "environmental era" has put a very strong emphasis on water pollution problems. The National Environment Protection Board, established in 1967, plays a very central role. So far the board has been concerned with point pollution which has been rather successfully combatted. Now the diffuse pollution is more severe and remains to be tackled.

The point pollution has been combatted through constraints on output discharge and through subsidies. Indirectly this has become a price incentive for the industries to reduce waste discharge which in turn has had a major influence on water use. What will be the incentives for reduction of diffuse pollution from agriculture and forestry in the future? The discharge is very difficult to control. It might be necessary to turn the controlling mechanism towards the input, i.e., mainly fertilizers and water, which probably would influence the production methods and water demand extensively.

VI. WATER DEMAND STUDIES

Manufacturing Water Demand

In Sweden, 80% of the total water demand stems from the manufacturing industry. Thus, the future water demand is heavily dependent upon the structural and technological development of the Swedish industry. Figure 24 shows how quickly the demand may change.

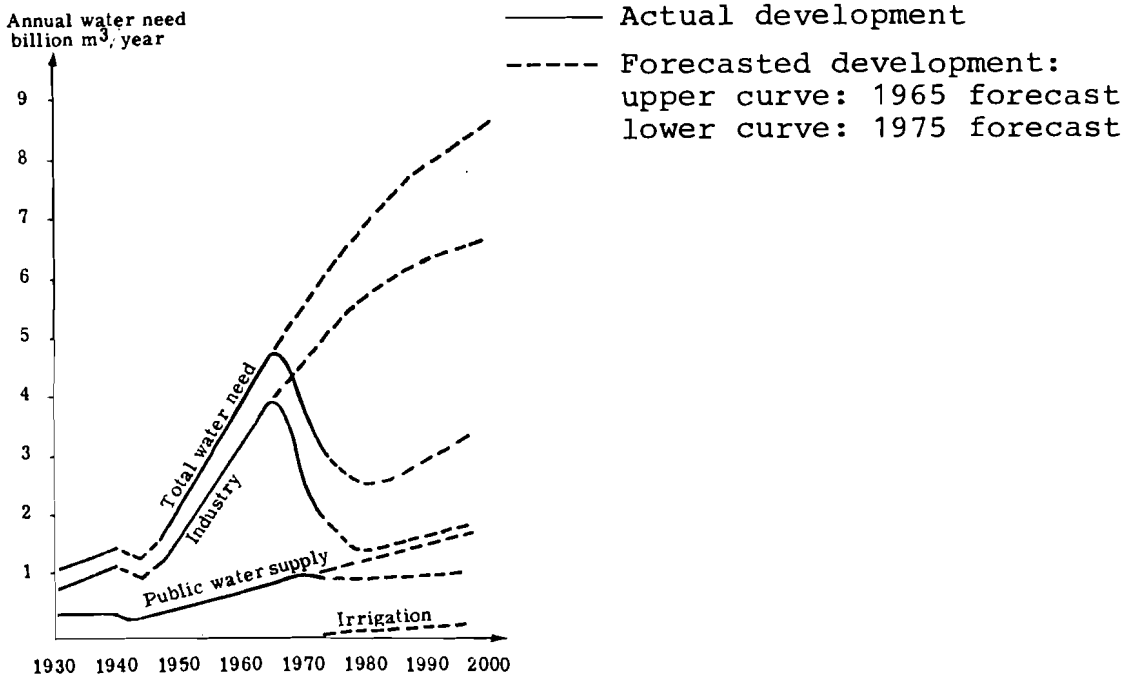


Figure 24: Development of Water Need in Sweden.

Source: Water in Sweden, Ministry of Agriculture, Stockholm, 1977.

In the above case, the change was, as indicated earlier, mainly a reaction by manufacturing and industry to higher water pollution standards and increased costs for waste water treatment. Also, increasing scarceness (and prices) of resources other than water, for instance energy, makes recirculation techniques more profitable.

About 8% of the manufacturing industrial water demand is met from municipal water supplies which corresponds to about 20% of

total municipal water supply. The figure of 20% or 70 litres/person and day holds quite well for the national (Figure 25) and the county level but for the design of individual water supplies a thorough analysis of the industrial structure is needed. This fact is easily seen from Table 18. A complicating factor in the design of municipal water supplies is that several industrial plants react to skyrocketing prices (Figure 26) of municipal water by trying to develop their own water supplies. This tendency is quite pronounced in Skåne, which is fairly rich in quite easily exploitable groundwater.

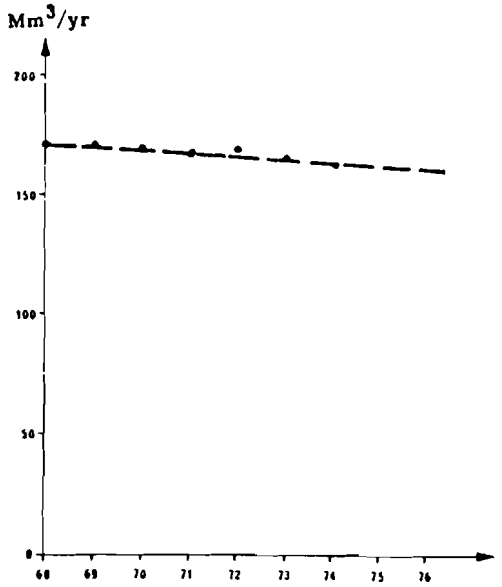


Figure 25: Water Use in Industries Connected to Municipal Waterworks During the Period 1968-1974. (170Mm^3/yr ≈ 70l/p.d).

Source: Vattenprognos 1975-2000, VAV P30, 1975.

As the Swedish industry is more than 90% self supplied with water, it is very difficult to estimate the water demand of various branches of industry. However, some attempts have been made to make such estimates. Table 19 shows four of these estimates.

Besides its 1964 estimates, the National Road Board published in 1965 the industrial water use forecast as in Figure 24. At the same time the official report on water supplies in Southwestern Sweden (SOU 1965:8) concluded that it was not possible to estimate

Table 18. Water Use 1974.

Source: VAV Statistics.

Name of installation	No. of persons supplied	Mean water use per day			
		Total	Per person		
			incl. of industry	excl. of industry	difference
		1000m^3	l/p.d	l/p.d	l/p.d
KRISTIANSTAD COUNTY	192855	65,5	340	285	55
Östra Göinge	10200	3,2	317	255	
Tomelilla	7000	3,3	474	279	
Bromölla	10200	2,1	207	189	
Osby	9500	2,3	242	213	
Perstorp	6300	1,5	233	202	
Klippan	12330	3,4	274	235	
Åstorp	9990	3,1	316	242	
Båstad	4000	2,8	704	663	
Kristianstad	51300	19,1	372	341	
Simrishamn	12000	6,5	542	379	
Ängelholm	23000	6,2	271	220	
Hässleholm	37035	11,9	322	273	
MALMÖHUS COUNTY	627845	224,3	357	272	85
Svalöv	7280	2,3	322	253	
Bara	5000	0,7	147	147	
Burlöv	13660	4,3	315	253	
Vellinge	16000	3,7	232	230	
Bjuv	12800	10,2	805	311	
Kävlinge	15565	5,1	327	250	
Svedala	5730	1,6	272	237	
Skurup	9960	2,8	285	270	
Sjöbo	7100	1,9	271	242	
Hörby	5500	1,8	320	-	
Höör	6800	1,6	234	218	
Malmö	238000	81,2	341	282	
Lund	71000	24,6	346	314	
Landskrona	32000	12,5	392	277	
Helsingborg	95900	42,7	445	264	
Höganäs	17140	4,5	263	250	
Eslöv	19410	7,7	396	237	
Ystad	20000	7,7	384	307	
Trelleborg	29000	9,1	313	247	
HALLANDS COUNTY	133542	46,2	346	247	99
GÖTEBORGS & BOHUS COUNTY	607807	234,9	386	326	60
ÄLVSBORGS COUNTY	305855	97,0	317	263	54

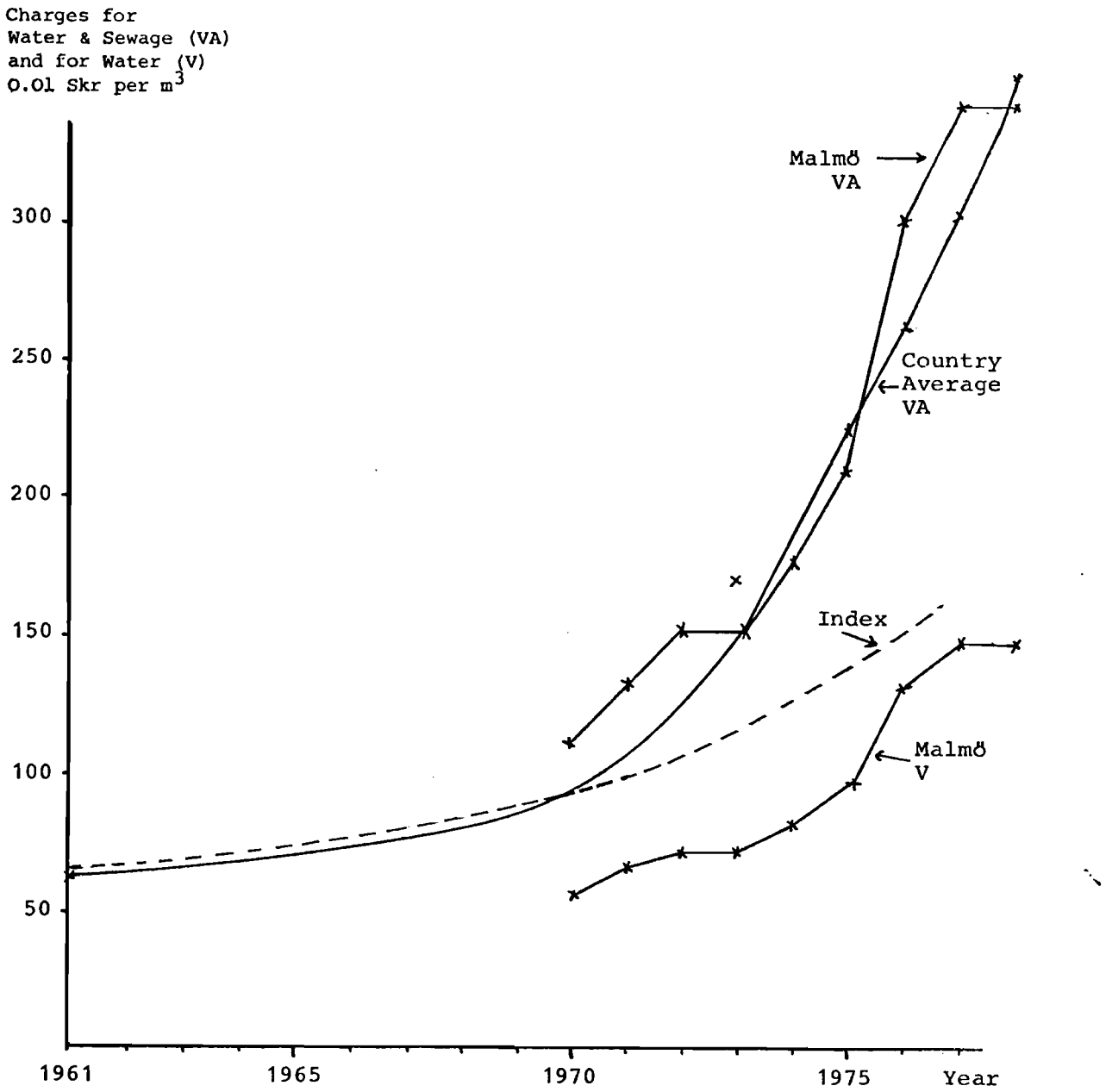


Figure 26: Charges for Water and Sewage in Malmö and Country Average and General Consumer Price Index (1971 = 100).

Source: VA-taxor, VAV Series TX, Statistisk Årsbok, SCB.

Table 19. Annual Water Use In Self Supplied Swedish Industry According To Different Estimates.

Branch of Industry	Source: [1]	[2]	[3,4]	[3]
	Year: 1964	1971	1975	1977
	Industrial Water Use, $mm^3/yr.$			
Pulp and Paper	2,700	2,260	1,400	1,150
Mining and Metal	600	470	~500	x
Food Production	50	180	~100	x
Other Branches	100	60		x
Total	3,450	2,910	2,000	~1,500

x = very rough estimates

Sources: [1] The Question of Pure Water in Sweden, The National Road Board Publications, 1964.

[2] Hilmer, A., and B. Andersson: Renvattenproblematiken, Dept. of Water Resources Engineering, Lund Inst. of Technology, Bull Series VA No. 1, 1973.

[3] Hansson,A: Present and Future Water Use by Public, Industrial, and Agricultural Users, Report to the ECE Seminar on Long Term Planning of Water Management, Bulgaria 1976.

[4] Industrivattenförbrukningen 1975-2000, VAV P40, 1978.

future local industrial use. Instead a general assessment was carried out in collaboration with the Federation of Swedish Industries. The assessment resulted in a doubling of the water use from 1960 to 1980 and a trebling from 1960 to 2000.

The 1977 estimate was actually a forecast based on previously decided modifications of existing plants and new processing techniques to reduce waste discharges.

Although the estimates are very rough and based on various, not always comparable, assumptions the general trend is towards reduced water demand. It is also clear that the pulp and paper industry consumes the most water and that the mining and metal industry is second. It should be noted that in Sweden it is exactly these two branches that have the gloomiest prospects in a long term perspective.

The pulp and paper industry is one of the branches where the decrease of water demand has been most significant (Figure 27). Though the production has more than doubled since 1960 the water demand has been reduced to about one third of the 1960 water demand. Apart from the increasing environmental concern this is partly due to energy conservation needs and partly due to a boom in the early 70's. However, the water demand is not uniform within the entire branch but varies significantly between products (Table 20).

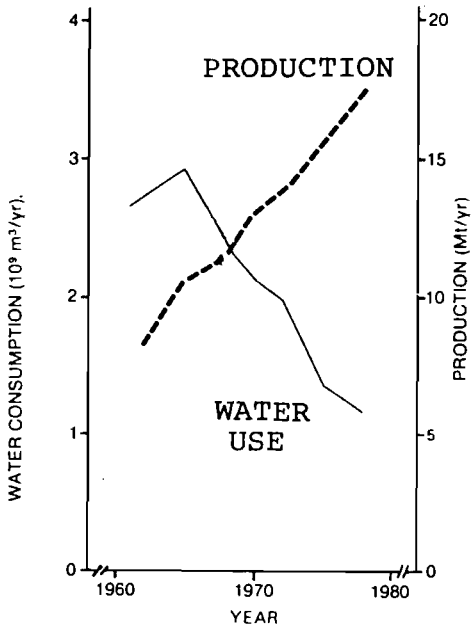


Figure 27: Production and Water Use From the Pulp and Paper Industry Since 1960.

Source: Falkenmark, M.: Reduced Water Demand - Result of Swedish Anti-Pollution Program, Ambio Vol. 6, No. 1, 1977.

Table 20: Water Use by Wood Processing Industry for Different Types of Pulp.

Source: Hansson, A.: Present and Future Water Use - Planning of Industrial and Agricultural Users, ECE Seminar on Long Term Planning of Water Management, Bulgaria, 1976.

Products	Water use* m^3 per ton
Viscose pulp	600
Sulphite pulp, unbleached	230
Sulphite pulp, bleached	450
Kraft pulp, unbleached	210
Kraft pulp, bleached	225
Semi-chemical pulp	50
Mechanical pulp	20
Fibre building board	60
Paper	100

*Total intake of water by the mill. Including spills, cooling, water, etc.

The changes of the specific water demand of the mining and metal industry have been less significant, but forecasts indicate that there may be some significant reductions during the next few years (Figure 28).

Water use varies not only with products, but also with the age of the individual plants or installations. However, information about the age distribution of plants is not easily available. Special studies have been undertaken for the pulp and

paper industry. From these it is quite clear that age or technical sophistication is a significant parameter (Figure 29).

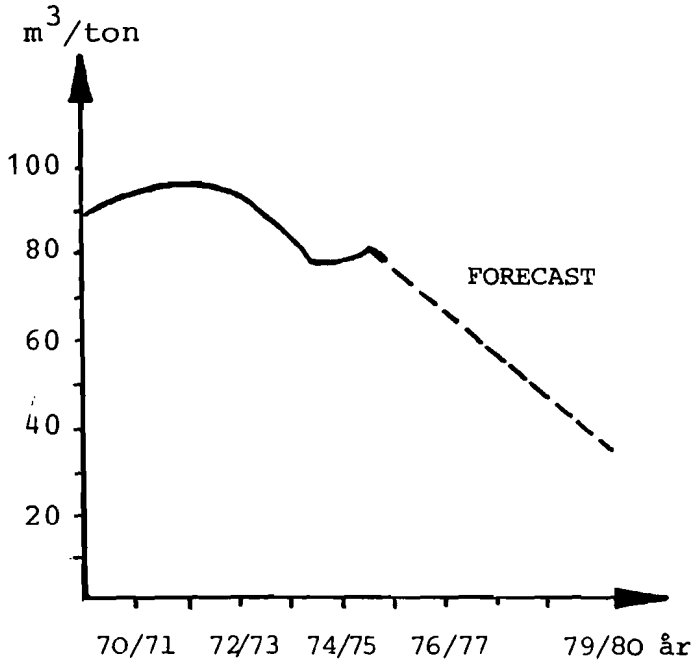


Figure 28: Specific Water Use in the Mining and Metal Industry.
Source: Vattenvård i Sverige, SNV PM 841, 1977.

The statistical background concerning industry connected to municipal water supplies is much better as most deliveries have been metered for a series of years. However, there are large uncertainties concerning the future industrial demands from municipal supplies. This is because plants may turn to other water sources, the technological development is unknown and further it is hard to find the relevant parameter with which to correlate the water demand.

The Swedish Water and Wastewater association has made a forecast of the industrial demand on municipal supplies for the period 1975 to 2000. This study concerns the spontaneous evolution, i.e.

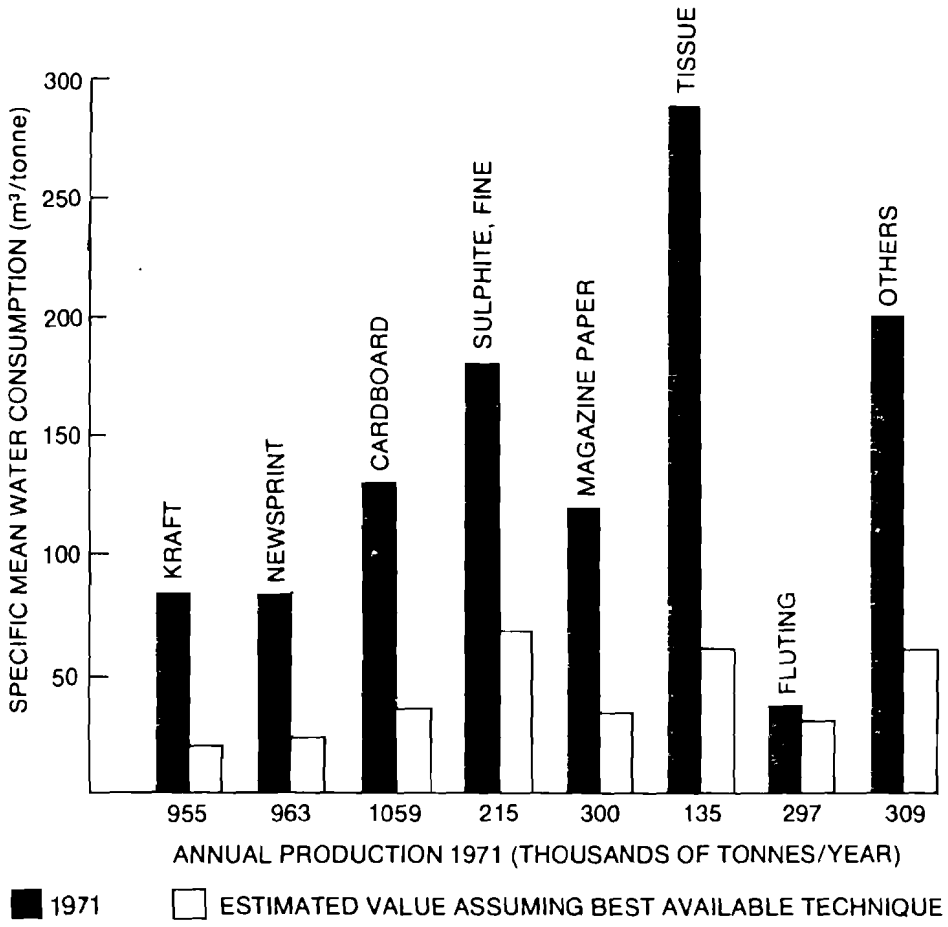


Figure 29: Mean Water Consumption in Swedish Paper Mills.

Source: Falkenmark, M.: Reduced Water Demand - Result of Swedish Anti-Pollution Program, Ambio, Vol. 6, No. 1, 1977.

it is assumed that no regulating mechanisms are applied by authorities. The estimated water use per unit of production is given in Table 21.

The most expansive industry since 1960 has been the chemical industry (Figure 30). This situation will probably remain for the foreseeable future. The structure of the drinking-water using industry in 1975 is presented in Table 22 together with the 1975 water use and water use efficiency.

It is to be concluded from this section that manufacturing industrial water use is not very well documented. It is however evident that the demand is sensitive to changes in input costs. A more thorough analysis of this sensitivity is yet to be done.

Table 21: Water Use Per Unit of Production.

Source: Industrivattenförbrukning 1975-2000, VAV P40, 1978.

Kind of Industry	Water Use / Unit of Production
Dairy	2-3m^3/ton incoming milk
Dairy new (milk for drinking)	1 m^3/ton incoming milk
Dairy without cheese making	4-15 m^3/ton incoming milk
Slaughterhouse	1-29 m^3/animal
" new	5-10 m^3/ton slaughtered
" with ennobling	21 m^3/ton product
" new "	10-12 m^3/ton product
Fruit and vegetables	11.2 m^3/ton
Vegetable preservation	20-25 m^3/ton raw material
Preservation	7-20 m^3/ton product
Chocolate	8-20 m^3/ton product
Breweries	4-60 m^3/m^3 of beer
" mixed production	6 m^3/m^3 product
Textile	110-170 m^3/ton product
	150 m^3/ton fibre
	0.12 m^3/m^2 fabric
Tannery	0.008 - 2.6 m^3/m^2 of leather
Laundry	10-60 m^3/ton wash
Galvanic	1-2.5 m^3/ton product
Automobile	14 m^3/car

Table 22: Value Added and Water Consumption in Various Branches of Swedish Industry Using Municipal Water Supply.

Source: Industrivattenförbrukning 1975-2000, VAV P40, 1978.

	Branch of Industry	Value Added 1975 10^9 SKr	Water Use 1975 $10^6 m^3$	Water Use 1975 %	Water Use per Value Added 1975 m^3 per 10^3 SKr	Water Use per Value Added 1975 Rank
Food and Beverage	Dairy Industry	1.2	4.0	2.5	3.3	7
	Bakery Industry	1.1	2.7	1.7	2.5	8
	Beverage Industry	0.9	3.0	1.9	3.3	7
	Sugar Industry	0.3	0.4	0.3	1.3	9
	Tobacco Industry	0.3	0.1	0.1	0.3	10
	Milling Industry	0.3	0.7	0.4	2.3	8
	Slaughter and Meat Industry	2.1	9.0	5.6	4.3	6
	Fruit and Vegetables Industry	0.7	6.7	4.2	9.6	1
	Fish and Fish Preservation Industry	0.2	0.9	0.6	4.5	6
	Oils and Fats Industry	0.3	1.6	1.0	5.3	5
	Chocolate and Sweet Industry	0.4	1.7	1.1	4.3	6
	Foodstuffs Industry	0.3	0.1	0.1	0.3	10
	Other Food Industry	0.5	1.6	1.0	3.2	7
	Yarn and Weaving Mills Industry	0.8	7.4	4.6	9.3	2
	Other Textile Industry	1.0	0.6	0.4	0.6	10
	Clothing Industry	1.3	1.0	0.6	0.8	10
	Leather and Shoe Industry	0.4	0.3	0.2	0.8	10
	Timber Industry	6.4	3.1	1.9	0.5	10
	Paper and Pulp Industry	8.7	2.4	1.5	0.3	10
	Mining Industry	2.3	3.0	1.9	1.3	9
	Metal Industry	6.0	22.0	13.8	3.7	7
	Manufacturing Industry	7.7	8.7	5.4	1.1	9
	Machine Industry	11.5	13.3	8.3	1.2	9
	Electrical Industry	7.4	14.6	9.1	2.0	8
	Transportation Industry	8.1	10.4	6.5	1.3	9
	Shipyards Industry	3.3	5.6	3.5	1.7	9
	Graphical Industry	4.4	6.4	4.0	1.5	9
Chemical	Chemical Industry	1.3	7.0	4.4	5.4	4
	Rubber and Plastics Industry	2.1	2.6	1.6	1.2	9
	Drug Industry	0.8	1.6	1.0	2.0	8
	Refinery Industry	0.3	2.5	1.5	8.3	3
	Other Chemical Industry	2.4	3.4	2.1	1.4	9
	Nonmetallic Mineral Products	2.3	6.0	3.8	2.6	8
	Other Industry	2.6	5.5	3.4	2.1	8
	Total	89.7	160.0	100.0	1.8	

For the Skåne region most of the industrial branches are such that they more or less naturally connect to municipal supply. We can also see (Figure 30) that the chemical, fabricated metal products, and food industries are facing increased production. These branches account for about 50% of the municipal water use and are at the same time extensively located in the Skåne region. Therefore, these branches have to be specifically taken into account in an economic analysis of the region.

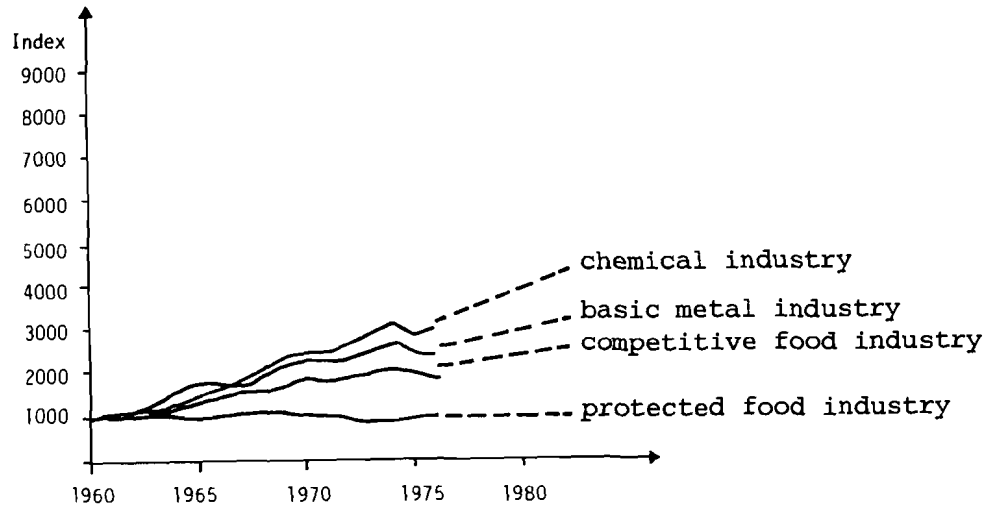


Figure 30: Development of Production Volume in Some Important Branches.

Source: Industrivattenförbrukning 1975-2000, VAV, P40, 1978.

Agricultural Water Demand

Irrigation is a recent phenomenon in Sweden as can be seen from Figure 24. It was only around 1970 that irrigation facilities began to be used more extensively, at first almost exclusively in Skåne and especially in Kristianstad County. It is to be noted that practically all irrigation in Sweden is sprinkler irrigation, a system implemented in later years through irrigation machines (cascades). Table 23 indicates the rapid increase in irrigation during the last years.

Table 23: Number of Irrigated Machines and Irrigation Capacity (hectares) in Sweden.

Source: Johansson, W. and Klingspor, P.: Bevattningen inom Lantbruket, Dept. of Soil Sciences, University of Agriculture, Uppsala 1977.

Year	Irrigation Capacity (hectares)	Irrigation Machines (Cascades) number
1960	20,000	0
1965	30,000	0
1970	55,000	0
1975	100,000	600
1976	125,000	1,600

There are essentially three reasons for the explosive expansion of irrigation potential during the 70's. The first is the six year series of dry summers 1970-75. The second is the realized importance of irrigation as a means to reach high productivity and good quality of the products. And the third is the availability of the relatively cheap and easily handled irrigation machines.

As part of the National Environment Protection Board investigation on water resources and demands, the Department of Soil Sciences, Agriculture University in Uppsala, made a study on irrigation demand in 1976 (Johansson, W. and Klingspor, P.: Bevattning inom lantbruket, Institutionen för markvetenskap, Sveriges Lantbruksuniversitet, 1977). This section is entirely based on the Uppsala study.

Table 24 shows the number of hectares that would have been irrigated during 1976 if this year had been a dry year (year 25 in a 30-year series ordered according to decreasing amount precipitaiton). The estimates are based on recorded irrigation in 1976, on estimates of dry year needs and on existing irrigation capacity.

The high proportion of agricultural land in Skåne compared to the rest of the country is even more pronounced in terms of

Table 24: Irrigated Area in 1976 (if dry year).

Crop	Malmöhus		Kristianstad		Rest of the country		Whole country
	hectares	%	hectares	%	hectares	%	hectares (100%)
Winter crops	125	3.1	625	15.1	3270	81.4	4020
Spring crops	475	2.2	1640	7.7	19195	90.1	21310
Oil plants	265	4.8	175	3.2	5090	92.0	5530
Hay	655	3.6	2580	14.2	14895	82.2	18130
Pasture	435	4.0	890	8.1	9665	87.9	10990
Potatoes	1785	11.5	4695	30.2	9090	58.3	15570
Sugar beets	1455	30.2	1855	38.5	1510	31.3	4820
Garden products	2410	32.4	1685	22.6	3345	45.0	7440
Other crops	160	6.0	510	19.1	2000	74.9	2670
Cultivated pasture	25	2.0	115	9.1	1120	88.9	1260
T O T A L	7790	8.5	14770	16.1	69180	75.4	91740
% of country agricultural land		10.4		6.3		83.3	100
% of country land		1.2		1.5		97.3	100

irrigated areas (Skåne has 3% of total land, 15% of agricultural land and 25% of irrigated land). The most important crops are potatoes, sugar beets and gardening. This fact is even more interesting from the irrigation point of view. Table 25 shows the total agricultural area and part thereof irrigated in 1976 as well as the irrigation forecast for the year 2000. These crops are potentially the ones considered worth irrigating.

The amounts of water used for irrigation in 1976 are given in Table 26. More than 30% of the irrigated water is used in the Skåne area. It is also to be noted that irrigation takes place essentially during the three months of June to August, although in Skåne the amount is more evenly spread out over the five month period of May to September than in the rest of the country.

Table 25: Crop Areas Worth Irrigating in Sweden During Dry Years, Now and in the Future.

Crop	Total crop area 1976, 1000 hectares	Irrigated area in 1976 if dry year, %	Irrigated area in a future dry year, %
Grain	1680	1.5	5
Oil plants	150	3.5	15
Hay	700	2.5	10
Pasture	210	5.0	15
Potatoes	50	34.0	70
Sugar beets	55	9.0	40
Garden products	15	53.5	70
Other crops	60	4.5	15
Cultivated pasture	150	1.0	5
Fallow	80		
T O T A L	3150	2.9	10

As surface water resources are scarce in Skåne (small rivers and few lakes) it is evident that a fairly large proportion of the water used for irrigation must be groundwater. It is also likely that this area should have some difficulty in providing irrigation water. This is to some extent supported by the fact that of the irrigation water sources in Sweden reported as not having sufficient quantities of water, 40% are situated in Skåne.

Table 27 is an attempt to summarize the importance of agriculture and irrigation in Skåne as well as the potential for water use conflicts in the area.

The present high proportion of agriculture and irrigation in Skåne is based on the following hypotheses, most of which, if they are true, do not lend themselves to quick changes. This means that agriculture and irrigation will continue to be very important sectors in the area.

1) The climate and soil conditions make agriculture favorable. The growing season is comparatively long and especially Malmöhus County provides Sweden with the best available soils.

Table 26: Irrigation Amounts 1976, real and if dry year, respectively (in 1000 m^3 per month) and Per Cents Withdrawn From Different Sources.

Month	Malmöhus		Kristianstad		Rest of the country		Whole country
	1000m^3	%	1000m^3	%	1000m^3	%	(100%)
May	430	25.8	470	28.1	770	46.1	1670
June	1750	9.3	3220	17.1	13810	73.6	18780
July	2730	12.0	4970	21.8	15060	66.2	22760
August	2450	13.1	4130	22.0	12160	64.9	18740
September	380	19.1	550	27.6	1060	53.3	1990
TOTAL	7740	12.1	13340	20.9	42860	67.0	63940
May	800	10.4	1380	17.9	5510	71.7	7690
June	2590	8.3	4810	15.5	23630	76.2	31030
July	3560	11.2	6330	19.9	21860	68.9	31750
August	2450	13.0	4130	22.0	12230	65.0	18810
September	540	21.7	880	35.9	1070	43.0	2490
TOTAL	9940	10.8	17530	19.1	64300	70.1	91770
Withdrawn from:							
Rivers %	57		52				56
Lakes %	7		14				27
Ground-water %	36		34				16
The Baltic %	-		-				1
T O T A L	100		100				100

(2) The crop structure is very sensitive to irrigation, especially potatoes on sandy soils in Kristianstad County and gardening products in Malmöhus County.

(3) There are special economic incentives for irrigation in the area. There is a high proportion of large farms which is partly due to the favorable topographic conditions. These large farms have economic possibilities to invest in irrigation facilities. However, now relatively inexpensive irrigation

Table 27: Skåne's Percental Parts of Country Totals.

	Malmöhus	Kristianstad	Skåne
Per cent of total land	1.2	1.5	2.7
Per cent of agricultural land	10.4	6.3	16.7
Per cent of irrigated land	8.5	16.1	24.6
Per cent of irrigational water	12.1	20.9	33.0
Per cent of number of water sources reported as not having sufficient amount of water	18.2	19.6	37.8

machines make the use more widespread.

(4) Institutional regulations contribute to the use of irrigation in that a large part of the sector is highly subsidized through price and quantity, i.e. demand guarantees. This means that there is no price or demand uncertainty on the market. However, the gardening products are not subsidized. A generally small supply of these products in Sweden makes it profitable to increase garden product supply, especially in dry years.

Municipal Water Demand

During the period 1965-1975 municipal water demand forecasting for household and public use was based primarily on an official report on the future water supply of the Skåne and Halland regions (SOU 1965:8). This report was the result of the first thorough investigation on present and future water use in Sweden.

The forecasts for the regions were based on analysis of population distribution and development, housing structure, development of weekend houses, industrial structure, and of certain basic water use factors. It was, for example, concluded that the percent of the country's population living in Skåne has remained almost constant since the beginning of the century.

Based on these general statistics and on current regional and local population estimates and forecasts a general increase of population in the region was to be expected with a particularly large increase in Malmöhus County.

In the weekend house sector it is relatively interesting to notice that in the beginning of the 60's it was already realized that the sanitary standard of weekend houses would not be much lower than that of permanent houses. This meant that water and sewage would be demanded to a much larger extent than was earlier expected. It was thus concluded that the weekend house sector would be important for water supply planning, especially in the dense weekend house areas along the coast. It is evident that the tendency described above has contributed to the present extensive conversion of weekend houses into permanent houses.

Estimates of municipal water use were based on available statistics which at that time only included towns and larger urban centers. Therefore specific studies were made on the water use characteristics of smaller urban districts in the region. Some studies were also made to establish the expected difference in multifamily houses and one family houses.

It was concluded that the daily per capita water consumption showed a clear-cut increase of 15-30 litres from 1952 to 1961 in all studies of household use in multifamily houses. It was estimated that the average use in 1960 was 190 ℓ/p.d.

The studies of one family houses did not show the same clear tendency as for multifamily houses. The increase in daily per capita consumption was not as large and neither was the amount used. The reason referred to is that households in one family houses are charged individually and thus more sensitive to the price of water than households in multifamily houses which are charged collectively.

Based on the assumption that the charging principles would not be changed it was estimated that a difference between multi-family houses and one family houses would remain. The final forecast for household water use is shown in Figure 31.

Figure 31: Forecast of Household Water Use in Sweden.

Source: SOU 1965:8.

Public water use is an important but uncertain entry in the municipal water use statistics since it often appears as a remainder, i.e. total use minus household and industrial use. Public use was thus not measured and therefore subject to large variations in the statistics. However, it was concluded that public use amounted to 50-100 ℓ/p.d. and that it would increase at least as fast as the household use.

Based on the assumptions that in larger urban centers multi-family houses will dominate and that public water use generally is larger than in smaller urban districts, the report arrived at the forecast shown in Figure 32 for the years 1960 to 2000.

In 1975 the Swedish Water and Sewage Works association (VAV) published a report with recommendations on demand parameters for the design of Swedish municipal water supply systems (VAV, P30, 1975). The main reason for this study was that several municipalities had been facing reduced water use compared to expected use based on earlier demand parameters. In this new study the forecast for the years 1975 to 2000 is based partly on earlier trends but more on a fairly extensive qualitative analysis of some important water use factors.

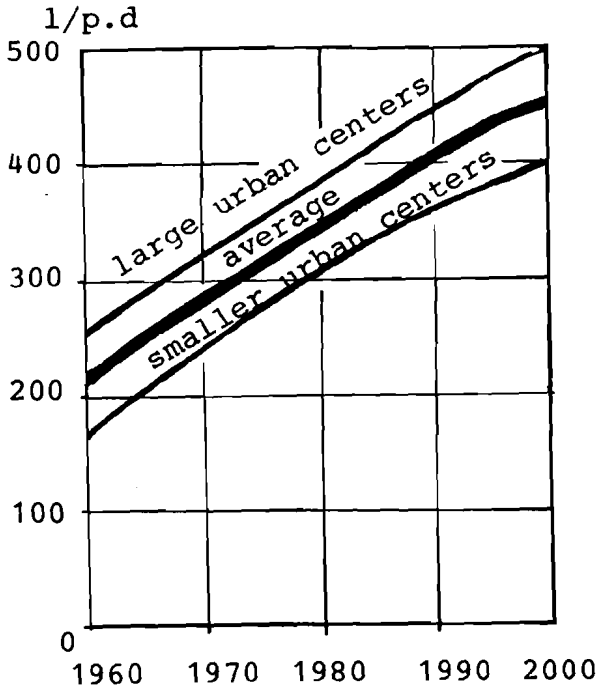


Figure 32: Forecast of Households and Public Water Use in Sweden.

Source: SOU 1965:8.

The household use was estimated at an average of 205 ℓ/p.d. in 1974. This value corresponds to 215 ℓ/p.d. if all apartments were provided with baths or showers. A basic assumption is that household water use will reach a saturation value of about 220 ℓ/p.d. in the year 2000. It is thus claimed that earlier per capita increases mainly are due to rising living standards and now as (in urban localities) 100% of the apartments are provided with a WC and 85% are provided with bath and/or shower, the use will reach a saturation value (Figure 33). However, the forecast takes no account of possible changes in the household use technology, changes that may be foreseen if, for example, new types of heating (or cooling) systems are introduced.

The calculated curve of Figure 33 is also corrected for the common feature that the household use statistics include parts which should be characterized as general purpose use. Figures 34 and 35 give a clear indication that this is generally the case.

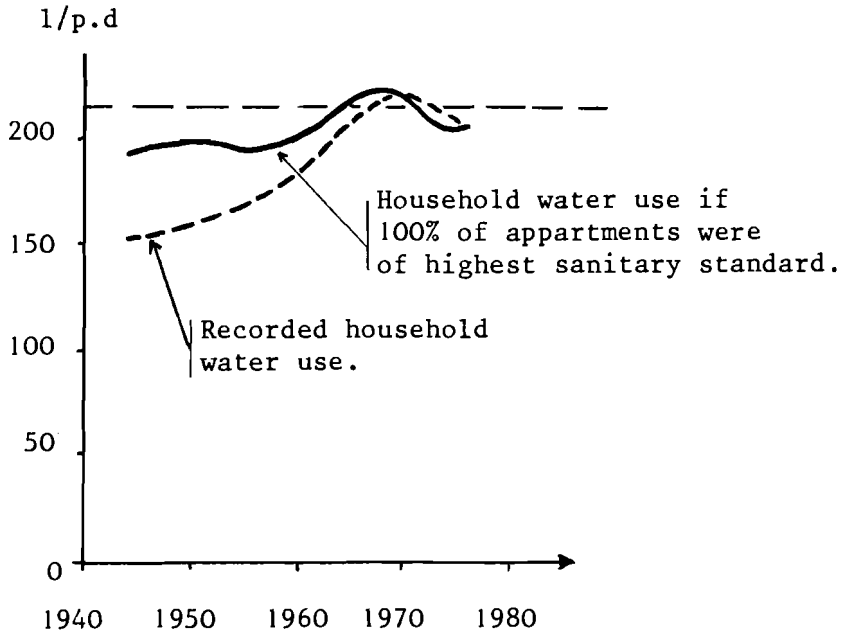


Figure 33: Household Water Use 1944-1974.

Source: Vattenprognos 1975-2000, VAV P30, 1975.

Figure 34 shows household water use statistics for 32 blocks in Stockholm in 1972. The upper part is for blocks with only dwellings (multifamily houses) and the lower is for blocks with dwellings mixed with stores, offices, repair shops, etc. The difference between the medians amount to 75 ℓ/p.d. The same tendency is apparent in Figure 35 which shows the statistics from central and suburban congregations in Stockholm in 1973.

The report concludes, as did the 1965 report, that the per capita water use is larger for households in multifamily houses than in one family houses. The main reason seems to be the individual metering in one family houses but the report also refers to the fact that there are generally more persons per household in single family houses and that these are to a larger extent equipped with dishwashers and washing machines.

Household water use is thus estimated at 180 ℓ/p.d. in single family houses and at 220 ℓ/p.d. in multifamily houses (country averages for 1970-1973). Forecasts for the year 2000 give

estimates of 200 and 230 ℓ/p.d. respectively. This is compared to the 1965 forecast in Figure 36.

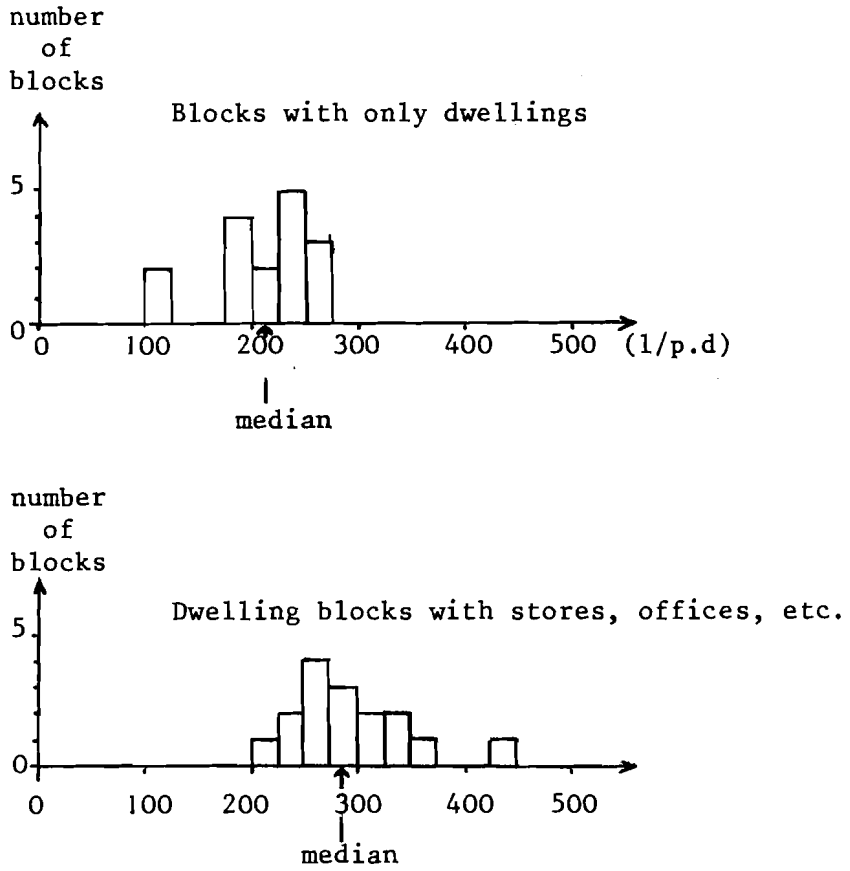


Figure 34: Household Water Use Statistics from Stockholm, 1972.

Source: Vattenprognos 1975-2000, VAV P30, 1975.

Apart from the factors described above there are other inconsistencies in the statistics which should be viewed carefully. One is the number of persons connected, which generally refers to those registered at the households connected. For example, in Figure 35 the very left column refers to the congregation in Stockholm where persons working on foreign missions are registered. This means that only about half the registered population actually lives in this congregation. Also, from Table 18 it is evident

that there are large differences between the municipalities in household and public water use. The extreme Figure for Båstad of 663 ℓ/p.d. could be explained by its status as a weekend house municipality. The same explanation is probably also true for Simrishamm with 379 ℓ/p.d.

General purpose use is estimated to be 125 Mm^3 per year for the whole country. About 30% is used by hospitals and homes for old people, 15% by stores, offices, etc., and 10% by schools. It is thus concluded that the general purpose use should be higher in larger municipalities since hospitals, schools, bank offices, etc. are mostly located here. It is emphasized that the individual municipality should not base its design on average general use figures but rather on analyses of the public and commercial service in the municipality. Table 28 gives, however, the estimated and expected total general purpose water use in Swedish municipalities.

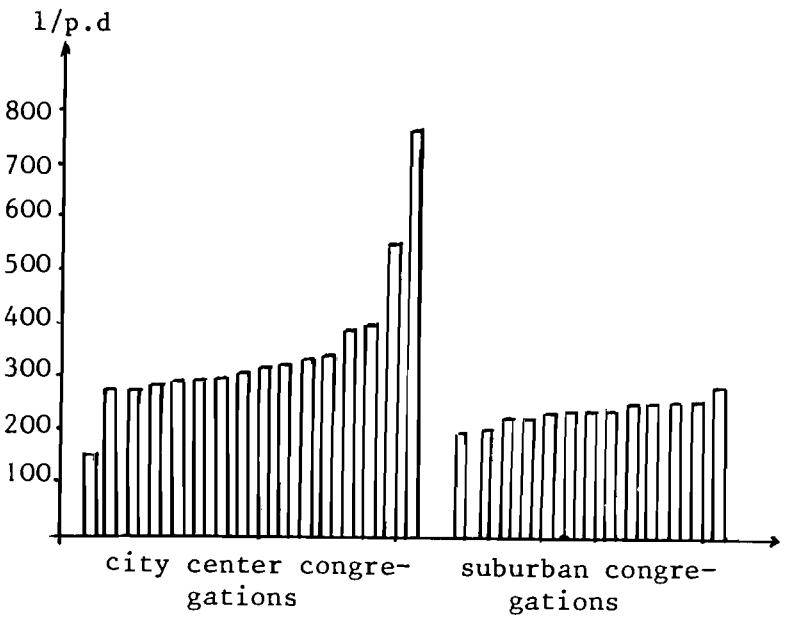
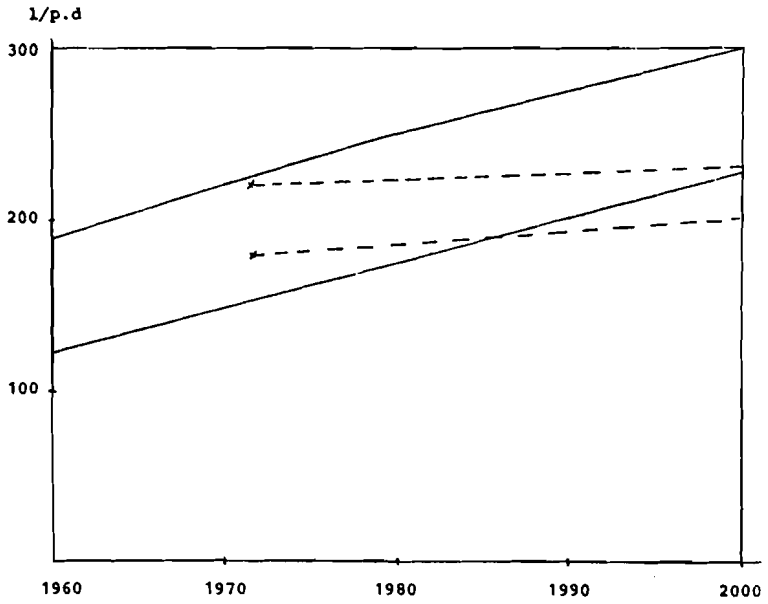


Figure 35: Household Water Use Statistics from Stockholm, 1973.

Source: Vattenprognos 1975-2000, VAV P30, 1975.



——— 1965 forecasts; ----- 1975 forecasts;
upper curve: multi-family households;
lower curve: one-family households.

Figure 36: Household Water Use Forecasts.

Sources: SOU 1965:8,
VAV P30, 1975.

Table 28: General Purpose Water Use in Sweden, Mm^3 per year.

Source: VAV P30, 1975.

	1960	1970-73	2000
Health services	25	30	32
Schools	14	15	17
Swimming and other sport grounds	11	15	20
Stores, offices, etc.	19	20	21
Others	21	45	70
T O T A L	90	125	160

A large part of the municipal water use is referred to as use of water works themselves (4%) and losses (11%). It is expected that losses will be slightly reduced in the future because of improved pipes and improved measuring techniques.

Table 29 summarized household and public water use as country averages for 1970-73 and the forecast for 2000. The 1965 forecasts qre given for comparison as well as the use in Malmö for the period 1966-76.

Table 29: Household and Public Water Use.

Sources: SOU 1975:8,
VAV P30, 1975,
Malmö Vatten-och avloppsverk, verksamhetsberättelser.

	Household use		Public use		Thereof: water works and losses	health sector	other public	TOTAL
	l/p.d	%	l/p.d	%	l/p.d	l/p.d	l/p.d	
VAV Statistics:								
1970-73	205	65	108	35	57	12	39	313
forecast 2000	220	67	110	33	55	11	44	330
SOU 1965:8								
forecast 1970								280
forecast 1980	175-250							350
forecast 2000	225-300		100-200					450
Malmö: 1966	229	83	48	17	16	7	25	277
1967	238	83	49	17	23	7	19	287
1968	248	83	50	17	26	9	15	298
1969	224	78	63	22	29	9	25	287
1970	223	78	63	22	25	9	29	286
1971	224	78	65	22	21	10	34	289
1972	223	78	64	22	26	8	30	287
1973	223	79	59	21	20	9	30	282
1974	206	74	73	26	26	9	38	279
1975	223	75	73	25	24	9	40	296
1976	218	73	82	27	33	9	40	300

The table shows that the 1965 forecast was very good for the period up to the beginning of the 70's. After this, municipal water use seemed not to increase. Rather a decrease was shown in many municipalities, see for example Malmö 1969-1974. One should however, note the fast increase in water use between 1974 and 1976.

The differences between the forecasts for the year 2000 are explained by differences in basic assumptions. The 1965 forecast was based on the assumption that the present charging system would remain while the 1975 forecast preassumed a future situation of higher price sensitivity due to individual metering in most households. Moreover, the later forecast was based on today's notions of natural resource saving, especially energy and thus hot water, and finally on the now completed development of a sanitary standard.

VII. DEVELOPMENT OF MUNICIPAL WATER SUPPLY SYSTEMS

The development of municipal water supply projects in Sweden is closely linked to physical planning. The physical planning is performed by the municipalities and decisions on matters concerning physical planning and development are made essentially by the municipalities themselves as described in Chapter III. So far the municipal water supply development has been only a technological and economic problem, i.e. to provide enough water from a nearby source.

In Skåne the municipal water supply was almost exclusively based on local ground water sources up to the late 1950's. Some smaller surface water supply systems existed, for example the Rögle ponds which since 1873 have provided Lund with part of its supply. The most important groundwater source is the Alnarp groundwater stream, which provides the Malmö-Lund area with large amounts of water.

The Alnarp Valley extends from the neighborhood of Svedala in a north-westerly direction over the Sound to Denmark (Figure 37).

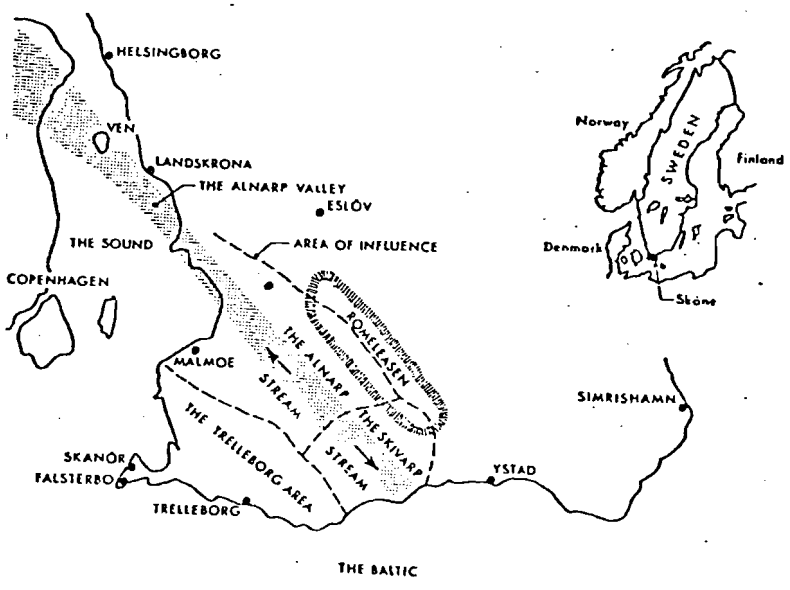


Figure 37: The Alnarp Valley and the Ground-Water Areas of Southwestern Skåne.

Source: Samarbetskommitten för Alnarpsströmmen.

The conditions for high quality groundwater recharge are favorable with thick layers of sand covering a gravel layer in the deep limestone valley (Figure 38).

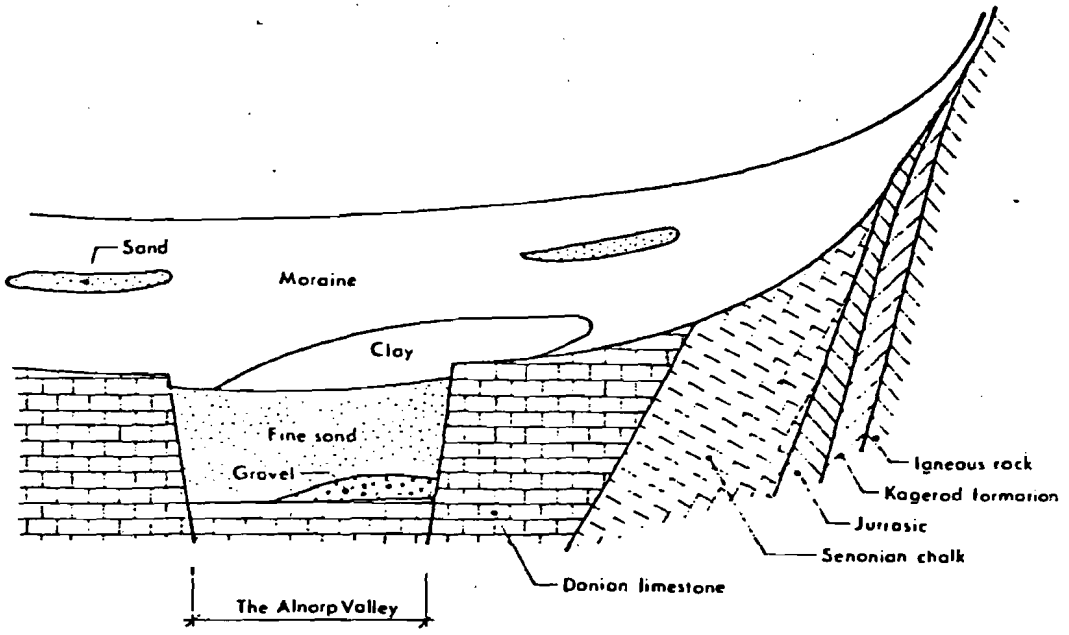


Figure 38: The Alnarp Valley, Cross Section.

Source: Samarbetskommitten för Alnarpsströmmen.

The total withdrawal capacity of the stream, from existing wells, has been estimated at some 16 Mm^3 per year. However, if water is extracted from the upstream parts, the total capacity may increase to 20-25 Mm^3 per year.

The city of Malmö started the first larger extractions from the stream in 1901. In 1907 the city of Lund joined, with a larger extension in 1922. Figure 39 shows the yearly withdrawals.

In 1973 the total amount withdrawn was 15.7 Mm^3, whereof the municipalities of Malmö 9.9, Lund 1.6, Svedala 0.5, Burlöv 0.4, Lomma 0.5, Kävlinge 0.2 Mm^3. The rest, 2.6 Mm^3 was used by industries in the area with their own water supply systems. The Water Court has permitted the users to withdraw a total of 18.6 Mm3 per year.

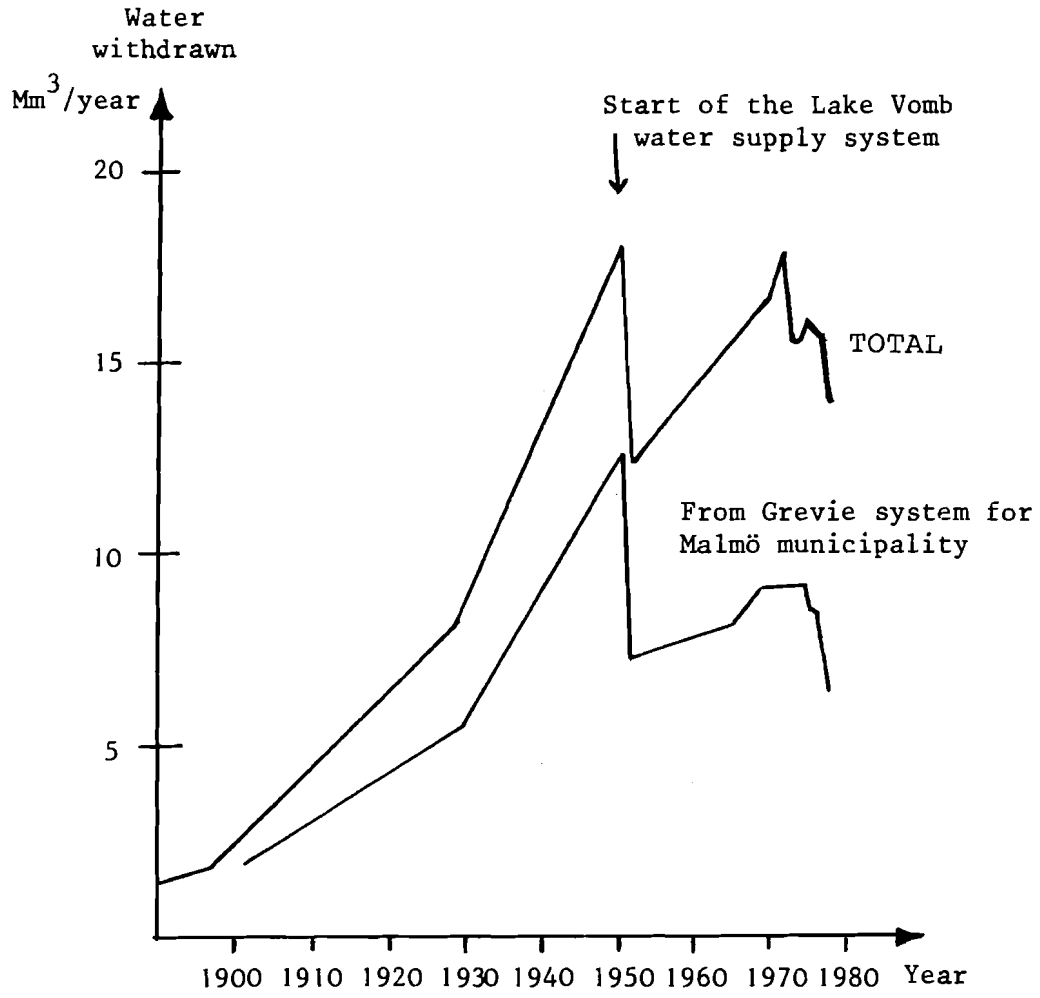


Figure 39: Yearly Withdrawals from the Alnarp Groundwater Stream.

Source: Samarbetskommitten för Alnarpsströmmen.

Regional Water Supply Systems

Lake Vomb System

During the 1930's the city of Malmö began investigating the possibility of withdrawing water from Lake Vomb for its water supply. In 1939 the city applied to the Swedish Government for permission to withdraw 500 ℓ/s. This application to the Government was necessary as the Vomb water did not fall under the jurisdiction of Malmö. The Government had thus, according to the expropriation law, to judge if the purpose of the project was of such social and economic value that the withdrawal could be permitted.

In 1940 the city got permission together with a direction to apply to the Water Court, which had to judge the project according to the Water Act. After a first Water Court decision in 1943, construction could start and in 1948 the project was completed. Meanwhile the cities of Malmö and Lund had reached an agreement on deliveries also to Lund. Since the start of operation revised demand forecasts have initiated new applications to the Water Court. In 1964 Malmö was allowed to withdraw 850 ℓ/s and since 1969 the permitted withdrawal is 1500 ℓ/s (47 Mm^3 per year).

The Vomb water work is actually a groundwater work using water from the lake which is run through several infiltration ponds and then pumped from some 100 wells via a treatment plant to a reservoir (Figure 40). The system is owned by the municipality of Malmö, which today sells water to the municipalities of Lund, Staffanstorp, Svedala, Burlöv and Lomma.

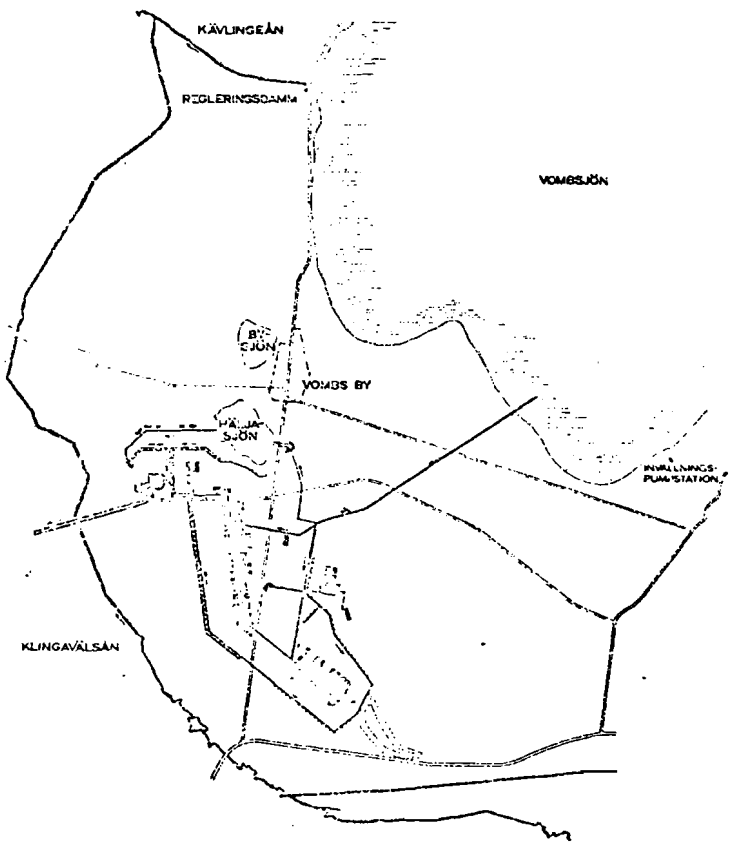


Figure 40: Vomb Water Works.

Source: Malmö VA-verk, 1974.

Ringsjö System

The initiation of the Ringsjö system was made by Helsingborg, which in 1940 started investigations of new water supply sources to complement the existing groundwater sources. As Landskrona was also interested, the two cities in 1950 jointly applied for permission to withdraw 660 ℓ/s from Ringsjön. The intention was to construct a regional system which would fit into a future large scale supply system for the whole of Western Skåne. The permission to withdraw the quantity was given by the Government in 1954. In 1960, the Water Court gave its permission. The withdrawal was, however, restricted to 500 ℓ/s with a continuous increase to 660 ℓ/s in 1980. Before this, in 1956, Eslöv had also joined the project.

In 1963 the system was completed and ready for operation. Seven years later the three cities applied for extended withdrawals from 1980. The Water Court decided in 1973 to allow 1125 ℓ/s (35 Mm^3 per year). Also at this time Malmö and Lund had joined the project.

The Ringsjö system is a pure surface water system. The water is pumped from the lake via a treatment plant to the municipalities. It is interesting to notice that the Ringsjö system is operated by Helsingborg, but owned jointly by the municipalities of Helsingborg (46.6%), Landskrona (15.1%), Eslöv (9.8%), and Malmö-Lund (28.5%). Malmö does not get water from Ringsjön, but has interests in the system as Lund is also connected to the Vomb system. Now, parts of the municipalities of Kävlinge, Lomma, and and Svalöv, are also connected.

The Bolmen Water Transfer System

The Bolmen Water Transfer System has been planned to safeguard the water supply of western Skåne in the foreseeable future, i.e., mid-21st Century. Its main parts consist of an 80 km raw water rock tunnel connecting the surface water intake at Lake Bolmen and a reservoir and treatment plant in Perstorp. From there the water is distributed in pipes to the connecting points of the municipalities involved. Figure 41 shows an early outline of the system.

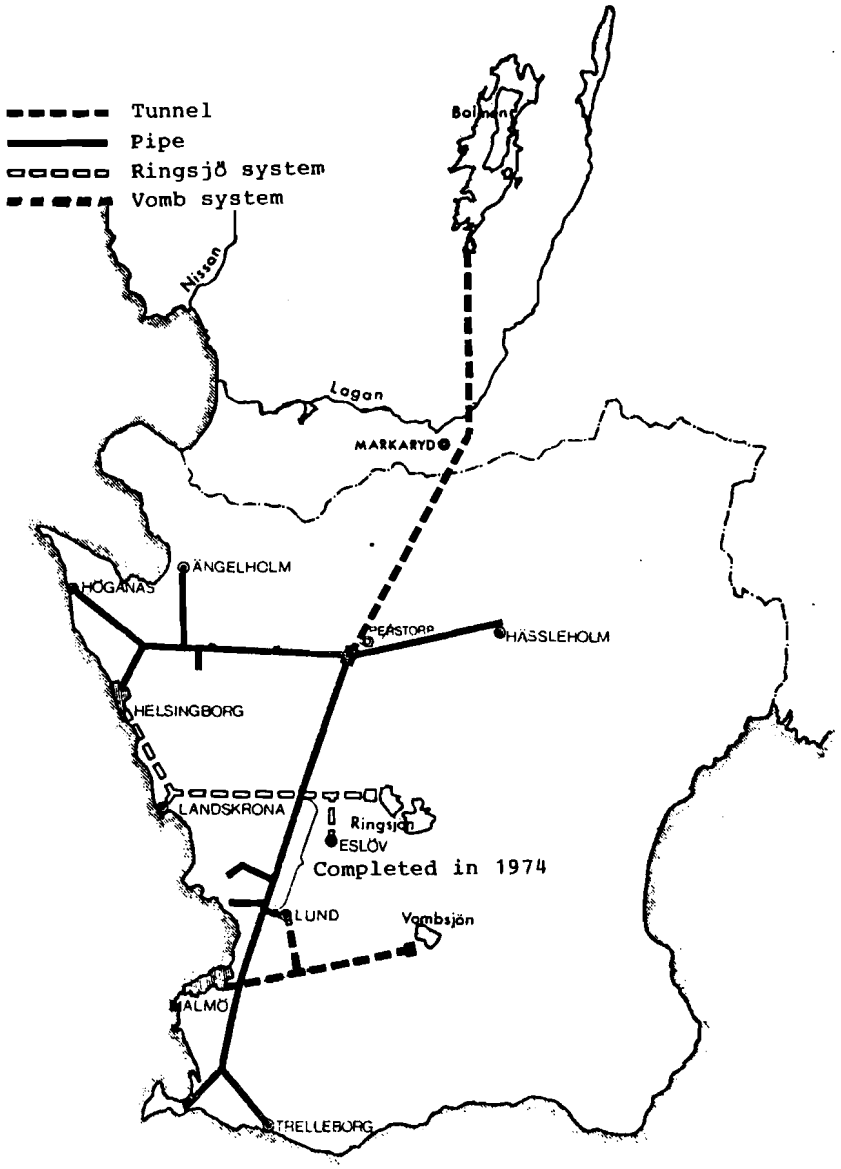


Figure 41: The Three Regional Water Supply Systems.

Source: Sjöstrand, B. and Stanfors, R.: Geologiska undersökningar för Sydvattentunneln, Väg-och vattenbyggaren, no. 8-9, 1975.

The Bolmen project was initiated when, in the late 1940's, the directors of the water works in Malmö and Helsingborg expressed concern about the apparent fact that the local water reservoirs of Skåne would not cover future demands. One year later the Malmö County Administrative Board suggested that the River Lagan should be used as a water source for Western Skåne. It is argued that this event already decided the direction of future investigations and thus ultimately the use of the Lagan system. But it was only in 1960 that the three County Administrative Boards of Malmö, Kristianstad and Halland formally requested the Government to initiate an investigation on how to solve the future water supply problems of the regions.

Table 30 summarizes some events following the request to the Government. Some of the events will be discussed in the following paragraphs.

As was mentioned in Chapter VII the official report submitted in 1965 was the first official attempt to forecast future water demands. The municipal water demand was elaborated quite extensively while the industrial demand was more problematic. The general conclusion was that industrial demand would double between 1960 and 1980 and treble by the year 2000. Agricultural water demand was expected to rise, but the demand would be covered from local sources and was thus not further taken into account.

Thorough estimates were made of the regional distribution of the demands to be met by the Bolmen project. Table 31 shows the estimated demands, which include municipal and industrial water demands. The local sources, including the Vomb and Ringsjö systems, were estimated at a maximum of 130 Mm^3 per year. It was concluded that water had to be provided from external sources from around 1980. Local conditions made it, however, necessary to coordinate the operation of the Vomb and Ringsjö systems earlier, probably from 1975.

For the future water supply the report presented three alternative projects, all having the River Lagan basin as source. There was no preference made for any specific alternative. All three alternatives were suggested for further investigations.

Table 30: The Bolmen Project. A Historical Overview.

YEAR	EVENT
1961	The responsible governmental agency, the National Road and Water Board (no longer existing), established a committee to investigate the water supply problems of Skåne and Halland and to suggest possible ways to safeguard the future water supply.
1965	The committee submitted an official report (SOU 1965:8) which presented three alternatives for the water supply of Skåne.
1966	The municipalities of Malmö, Lund, Eslöv, Landskrona and Helsingborg formed the Sydvatten company to carry out the project.
1968	Sydvatten applied to the Government for permission to withdraw 6.5m^3/s (205 Mm^3/year).
1970	Government gave permission to withdraw 6.0 m^3/s.
1972	The District Water Court Approved.
1973	The Superior Water Court Approved. The Government refused to try the case. New demand forecast published. Completion of the project suggested for 1981 instead of 1979.
1974	Ringsjö and Vomb systems partly connected via Lund. This made it possible to postpone project completion till 1985.
1975	Tunnel construction started.
1976	Sydvatten now having twelve municipalities as shareholders. Negotiations are held with another eight municipalities.
1978	A slowdown of the project is proposed, now with completion in 1989. Changes in the system are also proposed to account for changing input parameters.

Table 31: Estimated Future Water Demands in Those Regions Not Having Sufficient Local Resources.

Source: SOU 1965:8.

Region	Yearly Water Use, Mm^3		
	1960	1980	2000
Malmö	25.8	61.1	89.9
Lund	5.5	13.8	20.9
Vellinge	0.1	2.2	3.6
Trelleborg	3.2	6.3	9.6
Kävlinge	0.6	1.4	2.2
Eslöv	1.2	2.9	4.3
Landskrona	3.1	7.1	10.7
Helsingborg	11.3	24.7	37.3
Höganäs	2.3	5.4	8.5
Perstorp	0.9	3.7	6.8
Hässleholm	1.3	3.4	6.2
Ängelholm	1.6	3.4	5.0
TOTAL	56.9	135.4	205.1

It should be noticed that the committee should evaluate the possible alternatives, but only from a technical-economic point of view. The report was submitted to several authorities and organizations concerned with water questions. All responses were positive to the report and practically none questioned the demand forecasts or the suggested alternatives.

The formation of the Sydvatten company can be seen as a third way of municipal cooperation. The principal objective of the company was to plan and design a water supply system for Western Skåne based on a transfer of water from the River Lagan system. Secondly, if the shareholders agree, the company should also construct and operate the system. From now on the Sydvatten is responsible for the development of the project.

Sydvatten immediately started new investigations. Three alternatives, eastern, central and western, subdivided into a total of seven subalternatives were investigated. In early 1968 the project outlined in Figure 41 was suggested for further design studies. Based on the demand forecasts of 1965 and on the proposal to use Lake Bolmen the company applied to the Government for permission to withdraw 6.5 m^3/s from the lake. The amount applied for was also based on the estimation that this could be withdrawn without considerably violating existing regulation conditions of the lake.

In the late 1960's, especially after the application for withdrawal, an extensive debate between users (Sydvatten representatives and municipality authorities) and suppliers (local authorities and population, environmental organizations) took place. The discussions were mostly concerned with questions on how Lake Bolmen would be influenced by the project.

During the first half of the 1970's the debate switched to one essentially between potential users, or organizations and authorities within the region to be served by the project. It was thus claimed that future water demand was considerably overestimated. At the same time some parties also believed that there are large ground water reserves still to be used in Western Skåne. This should, according to those opposing the project, make the project completely unnecessary, subsequently saving large investment funds for other purposes. It was not, however, possible to raise a majority in the municipal boards to support these views. The tunnel construction was subsequently started in 1975.

There are a number of interesting conclusions to draw from the water demand and supply experiences described above. Some of these are:

(a) *The relationships between price and demand for water seem to be important in a future planning situation. There is certain evidence available that price is of great importance. Thus, as individual metering is to be installed in new multifamily houses, the need to establish price-demand relationships is obvious.*

(b) *Water supply is basically planned and managed by each user individually, with the primary exception of the households.*

(c) *When water resources become scarce and demand forecasts are universally accepted, coalitions are naturally formed. These coalitions are voluntarily formed and can be of different character. In this region, three kinds of coalitions have formed: 1) one participant owns and operates the system and sells water to the others; 2) the system is owned jointly, but operated by one participant. The operator charges the costs of operation. 3) all interests are transferred to a company which is jointly owned by the participants. The company is formed on the basis of a long term agreement between the shareholders. The company plans, designs, constructs, and operates the system and sells water to the shareholders.*

The different institutional settings here lead automatically to the question of which really, in each specific environment, is the optimal institutional setting.

(d) *The development of water supply projects depend heavily on demand forecasts. As the future demand interacts with the regional development and with society's current development policies, demand forecasts are subject to great uncertainties. In fact, in the long time span, some 40 years, from project initiation to project completion, input requirements are certain to change. This points to two problems: what should be the methods used in demand forecasting? How to design a project which is robust to changes in the basic parameters of planning?*

(e) *When forecasts seem not to be met in reality and when cost estimates turn high, the original coalition pattern begins to change, eventually leading to new coalition patterns. What should be the institutional setting to cope with (stop or promote) these changes? What should be the basis on which to allocate costs and benefits to the participants?*

(f) *When some parties go together in a costly project which leads to conservation of local resources, should other nonparticipants then be free to use these resources?*

VIII. ISSUES AND PROBLEMS

We have shown in previous chapters that Sweden is in great need of a system for water resource planning. This need is also demonstrated by the fact that a government committee (Water Planning Committee) is currently working on a proposal regarding future systems for administrative water management in Sweden.

Organizational reforms for Sweden must be based on the short- and long-term water resource planning. This is the case because the Swedish constitution is built on the principle of local self-administration at the level of municipalities. Long term planning of access to lakes and rivers for different users is necessary. This type of water resource planning is a part of comprehensive physical planning, which according to Swedish laws and regulations should be handled by municipal administration, except for such areas classified to be of a national interest.

In the short-term, water resources planning concerns municipal water supply and its distribution to different users. In this case, there is an obvious problem of economies of scale and interdependency in the use of water sources like lakes, rivers, and ground water deposits. It has thus turned out that there is a great need for coordination of water supply activities. The optimal organization of such intramunicipal bodies have not been studied properly in Sweden and IIASA should be capable of organizing some useful methodological work in this field.

Agricultural and manufacturing use of water is basically regulated through physical planning of land use, i.e. planning with a long time perspective. Swedish laws also regulate these issues to be handled by the local municipalities. Skåne has the most serious problems in the country in issues concerning physical planning. It is the most densely populated region and it has the highest agricultural productivity of all Swedish areas. This is combined with an accelerated urban sprawl of industrial activities and housing. There are thus large conflicts on the use of land and the access to the few rivers and lakes of the area. As pointed out above these conflicts shall according to the law be resolved by physical planning. The municipalities of the region have formed voluntary federations for long-term physical

and economic planning. The methodology for such integrated physical, natural resource and economic planning is however not so advanced at the moment. The cooperation already started between IRD, REN and SDS on the formulation and solution of problems of such integrated models have shown that IIASA can be of great service in this kind of planning model construction. It has been stressed by representatives of the Swedish Board of Building Research and of the Swedish Environment Protection Board that there should be a high priority on development of better methods for integrated economic and natural resource planning. The use of such methods and models should, however, be interactive and closely related to the discussions in the planning agencies of the area. The goal of the modelling work at IIASA should be to provide a methodology of construction of a set of consistent scenarios, rather than one optimized plan. The multitude of conflicting objectives is one of the primary reasons for developing many scenarios.

One of the most important problems in the planning of the Skåne area is the problem of diffused pollution of water. The point pollution has been rather successfully dealt with by the Environment Protection Board through direct control and regulation. Diffuse pollution sources create a somewhat different regulation problem. In the case of agriculture or forestry it seems to be very hard to control output and thus to regulate pollution through pricing or constraints with the same techniques that have proved to be successful for manufacturing. It might consequently be more reasonable to regulate the use of pollution-oriented input such as fertilizers or irrigation waters. The question of the optimal use of taxes and constraints is of importance in this context.

The changing pattern of location of housing is of the greatest importance in the Skåne area. There has been a quickly increasing demand for weekend houses in the area and at the same time an increase in the demand for single family houses. A large number of weekend houses have also been converted from their original use into permanent homes. The last years have shown that the

policy makers of the region are reluctant to increase the conversion of land from agriculture uses to single family housing expansion. Very little land has been reserved for new weekend houses in Malmöhus County.

Reservation of land for outdoor recreation has become a policy issue of primary importance in Sweden. This has not created any serious problem of planning outside of the high density areas like the Malmöhus County. The problems of reservation of land close to rivers and lakes is very problematic in Skåne due to the relative scarcity of such land in the area and the large land holdings by productive agricultural units. All the issues mentioned above are of primary importance in the analysis of methods for integrated physical, natural resource, and economic planning for a long time perspective. These factors should be integrated within a model that can also handle problems of economic efficiency. Representatives of the Environmental Protection Board have in this context put a high priority on analysis of:

1) the pollution problem,
2) the problem of accessibility of households to recreational water,
3) the problem of access of agriculture and forestry to irrigation water,
4) interdependencies between the users through the networks.

A special problem of importance both in terms of long term and short term water resource planning is irrigation. We have shown that Skåne presents the most important and complicated irrigation problem in Sweden. While many of the environmental problems are concentrated in the Malmöhus region, the basic irrigation problems are located in Kristianstad County. All indicators used show that irrigation demand will be growing quickly in the area. This is due to the growing importance of Skåne as an agricultural region, the concentration in Skåne of agriculture and water sensitive crops and finally the structure

of soils in the area. The most important issue in this context is what kind of new administrative means should be used to regulate the use of irrigation water.

The withdrawal use of water in Sweden is either regulated by the municipal supply or through direct intakes by manufacturing plants and agriculture. A part of industrial water use is satisfied through the municipal water supply system. The rising price of water and the increasing energy costs have induced some substitution in manufacturing and a conversion to closed systems for processing water. The increasing concern about environmental costs has also contributed to this tendency. The actual and potential possibilities of reduction in manufacturing water use as a response to increased prices and regulation ought to be studied in this project. We have also shown that the industrial structure is specialized on a few sectors of manufacturing industry. It is obvious that the work on substitution possibilities and introduction of closed water systems should be concentrated on these industries.

The most important sector for municipal water demand in Sweden is private and public consumption. The prediction of consumer demand for water is thus of primary importance for municipal water management and planning. The methods for such forecasting are, however, very crude. No sophisticated econometric methods have been developed in Sweden in spite of the good availability of reliable cross section and time series statistics. A large part of the research should thus be devoted to the study of long and short term forecasting. These studies should include the effects of prices, income and demographic effects as well as consequences of variations in housing and other environmental conditions. This study should also take into account the difference between municipalities of different size in the public demand for water.

The demand studies mentioned above would be of no real value if the forecasts of industrial production development and changes in the structure of population were deficient. We have

thus concluded that the studies must include suggestions concerning forecasts for industrial production and population in the medium and long term.

The technological level of Swedish water supply and sewage is high. IIASA can do very little of substantial interest in this field. The most important problems are of an administrative character. IIASA should thus concentrate some of its resources on analyzing the best ways of organizing the water supply administration and planning in a situation where the formal laws and regulations give the formal decision power to the small municipal unit while at the same time economies of scale and interdependencies would require decisions to be taken at a higher or more coordinated level.

Finally, this case study must acknowledge the fact that Skåne is close to the expanding region of Greater Copenhagen. The development of Denmark and especially Själland must thus be taken into account in the analysis of long term water resource planning for Western Skåne.