Land Drainage and its dangers as experienced in Sweden

By PH. WOLF

A Study in Soil Erosion with particular reference to Agriculture and Fisheries

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INTRODUCTION

THE catchment area of the Kävlinge River in Central Scania is not peculiar or exceptional—either from a geological or from any other point of view. It is an ordinary area, fully representative of the northern hemisphere's temperate zone. But it is just its normality, both in respect to its nature and its inhabitants, that makes a closer study of this district particularly fruitful. The problems that meet the observer here are to a large extent the normal ones. They would thus be valid for the catchment areas of innumerable streams and rivers both in Northern Europe—including large parts of Scandinavia, Germany, Great Britain and other countries—and in the eastern and western regions of North America.

The purpose of this paper, which is largely based on investigations of the Kävlinge River and its surroundings, is to awaken understanding of civilized man's intimate dependence on nature. It is not clear to the people of to-day that progress and a higher standard of living do not always go hand in hand with harmony of life and true development. In the course of only a few generations, the general development of society and agriculture has undergone fundamental but not always happy changes. During these years mankind has overlooked the fact that shortsighted actions can easily result in lasting damage, not only to the place where an attack on nature has been made, but in other places as well.

So little clarity and so much propaganda have surrounded the alleged advantages of "progress", within the sphere dealt with in this paper, that it is time the facts were brought into the light of day. These facts may be troublesome to those who have been enthusiastic for the kind of land "improvement" that has led in a destructive direction, but it is clear that bitter medicine will be necessary to bring development back into healthy ways. We cannot let ourselves drift willy nilly into a state of existence where not only is man's essential need to live in harmony with nature

pushed into the background but, above all, the whole basis of our civilisation is endangered by methods which are the result of ignorance of *how nature can be exploited without being spoiled*. The judgment of history on our generation will be hard, if we do not put things right and learn to co-operate with nature according to her own laws instead of trying to fight and work against her, as we are now doing, without even understanding what we do. This we must learn to understand, and the sooner the better.

MANKIND TRANSFORMS NATURE

Scania was settled about 7,000 years ago. The people who immigrated here were a primitive hunting and fishing folk. Through them also came the beginnings of agriculture, and thence the changing of the landscape. As in all other cultural regions, a continuous wearing-out process has been taking place, in which scorched earth and earth exhausted by grazing and ploughing must be abandoned for new, virgin land. Only after a long period of rest have exhausted agricultural areas regained their vitality, to again be cultivated for a time. Thus, during the past few thousand years, the growing of crops, grazing and the tilling of the soil wandered about, and because of the limited knowledge of how to use the soil a considerable amount of it was destroyed—at least temporarily (a circumstance which is scarcely considered to-day). In the beginning, this did not bring about any permanent harm to earth and water resources, at least not in our latitude. With the simple tools which were then in use, it was impossible to interfere to any considerable extent with the natural state of the earth, and the injuries inflicted on it were therefore healed, and moreover in the early days relatively quickly healed, by nature, since the injured land was not used for a time.

Gradually there was a change to a permanent combination of agriculture and the keeping of livestock. By that time the impoverishment of the soil, in spite of alternating between higher- and lower-lying fields had progressed so far that the manure obtained from cattle was vitally necessary for the continued production of crops. In this connection the increased importance of the economic conservation of water also enters the picture. For the peasant, water was essential. It was water that created the lush areas without which he could not give his livestock the first green fodder of the early spring, which gave them new vigour immediately after the starvation diet of winter. Nor could he, without ditches and a high-level subsoil water, have sufficiently rich pasturage for the livestock in summer, or sufficient quantities of hay for the needs of the coming winter.

It was only later that the tendency became noticeable to lead water from meadows and pastures for use on the cultivated fields, but it took a long time before the peasant in his doubt and conservatism dared to complete this operation. Nor had he any real understanding of what he was doing when, after the enclosure of the 19th century, he was actually forced by the State and by science radically to change his agricultural methods. The human tendency to improve nature in earnest begins at this point.

Under the new influences, conservatism changes into its opposite, and audacity becomes more widespread. Water, which had previously been an absolutely necessary ally, is now regarded as the great enemy, which must continuously be fought. Greater and greater areas are drained and ditched. Great inroads are made on the structure of the watercourses. Both rivers and streams are largely changed to canal-like straight lines, in which melting snow and rainwater quickly drain from the fields, carrying away nutritive salts, which never again have the opportunity to be deposited on the earth.

Development is now rapid. New fields are put under the plough and the population increases tenfold. Mankind begins in earnest to utilise and build further on the experiences which have been gained during the latter half of the 18th century concerning the requirements of the crops for purposes of growth, and towards the end of the 19th century the improvement of crops begins to be a fact. The knowledge of how the requirements of plants for nourishment can be satisfied by artificial means by the addition of mineral salts gives a basis for the cultivation of new plants, which produce an ever greater yield. Efforts are made to produce special, suitable plants for every kind of soil, and in most cases these efforts are successful.

During the latter half of the 19th century industrialism also begins its triumphal progress. Through the apparent effectiveness of agriculture—in other words by the impoverishing of the soil by improved technique—the standard of living has been raised. Handicrafts can no longer satisfy mankind's ever-increasing demands. Machine culture makes its appearance. And with the higher standard of living, with machine culture and the changed attitude to hygiene there follows also an ever greater need of water.

The history related here has been to a large extent the same for all Northern European civilisation. It is therefore not only valid for the small area of Sweden we are considering, but for practically the whole of our cultural sphere.

This development has meant that a considerably greater number of people could obtain a better livelihood than before. The serfs, who at various times and under different names have been fundamental for agriculture, have disappeared, at least in the original sense of the word serf. The serf of the present day is no longer under the command of a human master. He is the slave of efficiency and rationalisation, of a society and a way of life that demand ever greater conformity and receptivity to new impressions, but which at the same time leave less and less opportunity for individualism and healthy initiative. Such qualities cease to be necessary for maintaining life. Not even the most incapable or the most workshy run any risk of sinking in the struggle for existence. Natural selection ceases to operate—for good or ill.

We shall not here investigate further the genetic dangers that threaten mankind as a result. It would lead us too far from our actual subject. But there is no harm in pointing out in this connection the risk that the continuously increasing impoverishment of the soil—which has already occurred and which will in future take place to an even greater extent because of the ever-increasing human population—may sooner or later result in a serious scarcity of food-stuffs and their composition. It may well be feared that in the future man will be influenced by this, both in body and soul, in a way that may have the most serious consequences. Through his imagined absolute dominion over nature man can go so far as to undermine by his own efforts the foundation of his civilisation, even, indeed, endanger his very existence.

In any case, one circumstance is absolutely clear: since the factors which under primitive conditions regulated the human population no longer operate, the balance between the number of people and the possible production of food has been completely destroyed. If the increase in population continues unabated, the human race will after a few centuries have succeeded in increasing its numbers to three or four times the present, and under these conditions it is impossible that the production of food can keep pace. Sooner or later limitation must take place—through starvation, disease or war, which are the "natural" regulators, that at all times have brought back the number of individuals of different creatures to a level corresponding to the availability of the food the species requires. If that should happen, it will be

a catastrophe of such proportions as has never before happened in the history of the human race.

We scarcely have words to express the horror of an uncontrolled increase in population—the vision of a future with a swarming mass of monstrously distorted humanity, where the individual is denied any possibility to be alone in a natural environment. In such circumstances, collectivity with its mass suggestion will set its stamp on the human race so that all possibility for individual development will be lost. Such a situation would constitute a catastrophe for mankind.

Is it possible for us to prevent this catastrophe? It is, of course, most difficult to say anything definite about this since so many irrational factors have to be reckoned with. All our ideas about the future must be constructed more or less loosely—however much one tries to take into account the known lines of biological and sociological development. For example, we do not know how far it will be possible to convince all peoples, belonging to all religious and political creeds, of the necessity of practising birth control (in a great part of the world). And if that is not possible, catastrophe will come sooner or later.

In any case, we can for the time being avoid unnecessary destruction of the natural resources at our disposal. We must see to it that still existing reserves are not wasted by thoughtless interference and incorrect methods of usage, see to it that they will still remain for our descendants, who will need them even more than we. For them it may be a question of the bare necessities of life, whereas for our generation it is only a matter of extracting still more in ever growing superabundance.

There are several possible ways of advance, and all of them are intimately connected. The so-called higher vegetation—the trees of forest and woodland—must be preserved in every place possible. The soil must be used in such a way that the washing away of the humus and other erosion are avoided. Instead, a certain amount of new humus must be formed, and in order for this to take place a belt of higher vegetation must occupy a much larger part of the landscape than is the case to-day, while certain methods of cultivation must be abandoned. Furthermore, our remaining water resources must be protected with the greatest care. If the amount of water taken out is so large that it no longer corresponds to the supply, it will soon

be difficult to maintain the complicated apparatus that is our modern civilisation. Paradoxically enough, it is just the rationally conducted agriculture of the present day—the same agriculture which made possible the increase in population and the higher standard of living—which also with time will be the greatest threat to our civilisation (by reason of its limitations).

Through its rationalisation, which includes amongst other things an intensive exploitation of the soil and a quick removal of the water that is provided to the fields through rain, agriculture has entered on a path of development which, if it goes on unchecked, will have catastrophic results for every one of our countrymen, indeed for the whole of the future of western civilisation. Mankind has been dazzled by the possibilities offered by machinery and chemicals and refuses to realise that there exists an intimate connection between, for example, the resources of water of the fields and their production capacity on a long view. In other words, mankind is striving consciously to extort the greatest possible amount from the soil by methods that are bound to destroy its productive capacity, a destruction that has already become manifest.

We must agree to return to a more natural state and from there try out new forms of production, which aim at conserving instead of destroying. And these methods of working must hold good for the single farm as well as the whole countryside. It is no longer possible to regard a farm as an independent unit or to treat a grove or a watercourse as a limited local phenomenon which the local landowners can use in accordance with their own good sense or folly. We must learn to realise that what in a limited area appears to influence nature temporarily in a favourable way may have harmful results in another place. We must learn to think *regionally*. Agriculture, forestry, town planning, recreation, sewerage—all overlap and no one of them can be treated in isolation. The easiest solution to this complex of problems is to begin to regard every river system or catchment area as a large unit. We will revert to this concept in a later chapter.

But it is not sufficient merely to consider these material viewpoints. Man's connection with his environment is more significant than we believe. The contentment and happiness in work inspired by a nature that is still producing freely is essential for a rich and harmonious human life. We must therefore see to it that healthy and natural conditions are preserved as far as

possible, so that a basis can remain and, to a certain extent, be created anew for that communion with his environment which is necessary to man. In a dirty backyard there can be no perfection, nor is a healthy and thriving development possible in an environment consisting of an artificial system of straight roads and canals between uniform fields, where production has been increased by artificial means merely for the sake of production. In such an environment it is impossible for mankind to thrive. If humanity is driven into this, the result will be decay, standardisation and degeneration.

We must not have an exaggerated belief in man's adaptability. We can adapt ourselves to very varying circumstances, but this is not to say that in so doing we reach the highest point of development and harmony. The metal-worker at his lathe, the joiner at his cutter, the engineer at his drawing-board and the industrialist at his conference table have all an inherent, inescapable longing for a freer and more unfettered life. It is true that this longing can be repressed, but we cannot let ourselves be chained to a way of life which militates against both our instincts and our conscious desires without inner conflict. Simply stated, we cannot possibly live a healthy life without nature. Nature is the resource that man must have, at least in his short leisure time, if he is to endure the strain of civilisation in the gloomy working atmosphere of factory or office. We can alter our machines in a day—ourselves we cannot alter in a thousand years.

MANKIND AND THE MACHINE CULT

Nature is changed by man. Just what that truism signifies is what we are trying to show here. The following example is one among many (so many that in general we have no idea of the number).

In 1938 a plan to regulate the Kävlinge River and its tributary, the Klingvall River, was put into effect. Its purpose was to free the river valley from the periodic floods, which made the hay harvest difficult. At the same time, it was intended to create fairly large new areas of fields, which could be used for growing crops. There were varied opinions about the suitability of the enterprise, but in view of the profit expected through increasing the area of cultivated fields, the proposal went through.

The cause of the floods was largely the draining, ditching and cultivation of the areas lying above the drainage area of the stream. Above the stretch where the actual regulation was to take place, about 12,000 hectares of bog had been drained in the (approximately) 75 years previous to 1938, while about 14,000 hectares of grazing land had been cultivated. Through this large operation, therefore, about 26,000 hectares of the ground, which had formerly acted as a reservoir for precipitation, had thus been radically changed. Drainage resulted in the rapid run-off of rainwater—and gradually, as greater and greater areas were drained, the floods in the valley of the Kävlinge River increased. It is important to have this background to understand the whole problem. It was man's disturbance of nature, resulting in ever greater interference, that we have to consider here.

Regulation meant in the first place that the Kävlinge River was dredged out between Lake Vomb and Viderup, and the Klingvall River from Västra Tvet to its confluence with the Kävlinge River. The streams were deepened about six feet, and the excavated material was piled up on the banks as embankments or "ramparts". To a great extent the streams in these stretches run through sandy soil. The work of regulation was completed in 1945 and, of course, resulted in a great change both in the valley of the

river itself and in the surrounding district. On the banks of the river, exposed by the deepening, numerous landslides took place, in which earth and sand masses were washed away by the water. A considerable drying-up is also becoming visible in the land surrounding the river.

In order to find out the opinion of the local inhabitants concerning the result of the river regulation, the Svenska Lax-och Laxöringföreningen (the Swedish Salmon and Trout Association) presented a questionnaire to all the property-holders along the banks of the stream in the affected area, people who had lived on the same properties before the change. The idea was to get an expression of opinion from people who were acquainted with the conditions both before and after the change, and who at the same time were directly influenced by it, both economically and in their personal well-being. The total number of property owners who owned land or lived on a farm in the year 1938 and who were still living there in 1954, was 130. Of these persons 8, or 6.2%, refused to answer the questions, while 122 filled in the questionnaire in whole or in part.

Question 1. If the yield from the land has increased or decreased by the alterations to the river, how much do you reckon this difference to be?

This question was answered by 112 persons (91.8%) of whom 45 (36.9%) considered that the yield had decreased and that they were losing in all 155,000 crowns a year. A further 54 persons (44.2%) stated that the yield had diminished, but did not specify their losses. 7 persons (5.7%) considered that the yield had increased by a total amount of 81,000 crowns a year, and 5 others (5%) stated that their incomes had increased, but gave no figures. 10 persons (8.2%) did not answer the question.

The difference is large between the calculated increase and decrease, and it is worthy of note that 99 of the 112 persons who answered the questions, in other words 88.4%, considered that the yield for their part had decreased as a result of the work done. Those who considered that they had lost as a result of it therefore comprise a clear majority.

Question 2. Is there any difference in cultivation costs now and before the alterations? If so, give approximately the number of days' work.

Only 25 people answered this question, and of these only 3 gave any definite value. It would seem that the question was formulated in a

Part of a dried out river bed in the Kävlinge system. In a few decades all parts of this river system will look like this every summer.

poor way under the circumstances. The interviewer intended to try to get a clear idea concerning an increase or decrease in cultivation costs, expressed in day-work. It was shown, however, that a large number of other costs such as tools and machinery, sowing, etc., complicated the question. On this account, we believe the question should be disregarded.

Question 3. Have you noticed any increase or sinking in the subsoil water?

105 persons (86.1%) stated that the work had led to a sinking of the subsoil water. No one stated that there had been an increase. 17 persons (13.9%) did not answer the question.

Question 4. Has it been necessary to deepen wells, and if so by how many metres?

95 persons (77.9%) answered this question, 27 (22.1%) left it unanswered. Of those who answered 10 had been forced to deepen their wells by 1 metre, 81 by 2 metres and 1 person by 4 metres. It is therefore clear that the diminished subsoil water forced practically all the proprietors in the regulated part of the river valley to deepen their wells.

Question 5. What was the cost of the well deepening?

95 persons replied that the cost had amounted in all to 19,000 crowns. 27 did not answer the question.

Question 6. Do you consider that hunting in the areas concerned is of importance for you as a subsidiary source of income or as recreation?

71 persons (58.2%) answered this affirmatively. 21 (17.2%) stated that they were not hunters. 30 persons did not answer the question. The conclusion can be drawn that more than half considered that game shooting was of significance to them.

Question 7. Has the value of game shooting increased or diminished through the river being controlled, and if so how much do you estimate this difference to be *per annum*?

Only 4 persons (3.3%) considered that their income from hunting had increased. One stated that it had gone up by 200 crowns a year. The other two gave no figure. On the contrary 79 persons (64.8%) considered that the game had diminished. Of these 68 (55.75%) estimated their losses in all at 45,000 crowns, while the remaining 15 persons (12.3%), who had

stated that a reduction had taken place, did not specify any amount. 35 persons (28.7%) did not answer this question. We may conclude that a considerable amount of income had been lost through a worsening of game shooting. In this connection, it has been stated from many quarters that the amount of hunting has increased during the last years—principally as a result of the increased interest of town-dwellers in hiring shooting grounds. The Kävlinge River was a rich game-shooting area before the alterations to the river. If its bird life had remained, a good income could have been made by the hiring out of game-shooting areas.

Question 8. If any change has taken place in the value of hunting, to what do you consider this due?

Here 60 persons (57.4%) considered that the work done must certainly bear the blame. 52 persons (42.6%) left the question unanswered. The greater part of those who considered that game had decreased, or rather more than half of the proprietors in the areas affected thus blamed the work done for the worsened game-shooting.

Question 9. Has there been any difference in the number of birds observed? If so, an increase or decrease?

106 persons (86.9%) declared that they had observed a decrease. Only 1 person (0.8%) considered that bird life had increased. 13 persons did not answer the question.

Question 10. Have you observed any new kinds of birds, or have any kinds disappeared? In either case, state the species.

15 persons (12.3%) answered that the following birds had disappeared or that some of them were now only seldom seen: the stork, the ruff, the duck, the jacksnipe, the brown marsh harrier, the reed warbler, the eider duck, the merganser, the curlew, the peewit, the snipe, and the swan. 5 persons (4.1%) believed they had observed a decrease of the above-named birds, but at the same time a certain increase in the pheasant, the partridge, the magpie, the crow, the gull, the wild goose and the kingfisher. The rest (83.6%) did not answer the question. It is clear that the bird life had undergone fundamental changes.

Question 11. Have you a better or worse sense of well-being in nature since the river regulation was carried out?

Only 11 persons (9.05%) thought they were more content with nature. 105 persons (86.1%) answered that they were less content. 6 persons failed to answer. Thus for the great majority this disturbance of nature in their home district meant a decreased sense of well being.

Question 12. Do you consider that the surroundings have become more beautiful or more ugly since the work was carried out?

101 persons (82.8%) considered that they had become more ugly, while only 10 persons (8.2%) stated that they considered they were more beautiful. 11 persons (9%) did not answer the question. These figures speak for themselves.

Question 13. Would you like to have the river restored to its original form?

To this 103 persons (84.4%) answered yes. Only 11 persons (9%) answered in the negative, and 8 persons (6.6%) preferred not to give an opinion. It is highly remarkable that so overwhelming a majority of the local proprietors are now opposed to river regulation and would like to have the river back in its old form.

Question 14. Do you think that the regulation of the river has brought about any advantages or disadvantages that have not been dealt with above? If so, please state.

A symposium of the opinions here expressed by the persons questioned, is to be found below. All expressions of opinion, both positive and negative, have been included, although partly in abbreviated form in order to prevent repetition.

Question 15. If stream control such as has been carried out here should be proposed for a river in another part of Sweden, would you recommend that it take place?

To this 99 persons (81.1%) answered no. Only 8 persons (6.6%) would recommend the regulation of the Kävlinge River as a model to be copied elsewhere. 15 persons (12.3%) did not answer.

Thus the answers to this as to the previous questions indicate that there is strong dissatisfaction with the present condition of the Kävlinge River among the local population. The overwhelming majority of landholders along the regulated part of the river consider that they suffered through the work done. It is not only the natural beauty of the stream, and consequently the contentment of the local inhabitants that has been undermined. The answers to several questions clearly indicate that the majority also consider that they have suffered economic loss.

Below is given a summary in tabular form of the questions and answers which can be reckoned as a percentage.

Question 1. If the yield from the land has increased or decreased, how much do you reckon this difference to be?

	Number	%
Increase	13	10.7
Decrease	99	81.1
No answer	10	8.2
Total	122	100.0

Question 3. Have you noticed any increase or sinking in the subsoil water?

	Number	%
Increase	0	0.0
Decrease	105	86.1
No answer	17	13.9
Total	122	100.0

Question 4. Has it been necessary to deepen wells, and if so by how many metres?

	Number	%
By 4 metres	1	0.8
By 3 metres	3	2.5
By 2 metres	81	66.4
By 1 metre	10	8.2
No answer	27	22.1
Total	122	100.0

Question 6. Do you consider that game shooting in the areas influenced by the alterations was of significance to you as a subsidiary source of income or as recreation?

	Number	%
Was of significance	71	58.2
Had no significance	21	17.2
No answer	30	24.6
Total	122	100.0

Question 7. Has the value of game shooting increased or diminished, and if so how much do you estimate this difference to be per annum?

	Number	%
Increase	4	3.3
Decrease	83	68.0
No answer	35	28.7
Total	122	100.0

Question 8. If any change has taken place in the value of game shooting, what do you consider this to be due to?

	Number	%
Due to regulation	70	57.4
No opinion	21	17.2
No answer	31	25.4
Total	122	100.0

Question 9. Is there a difference in the number of birds observed before and after regulation?

	Number	%
Increase	1	0.8
Decrease	106	86.9
No answer	15	12.3
Total	122	100.0

Question 11. Have you a better or worse sense of well-being in nature since the alterations were carried out?

	Number	%
Better	11	9.0
Worse	105	86.1
No answer	6	4.9
Total	122	100.0

Question 12. Do you consider that the surroundings have become more beautiful or more ugly?

	Number	%
More beautiful	10	8.2
Uglier	101	82.8
No answer	11	9.0
Total	122	100.0

Question 13. Would you like to have the river restored to its original form?

	Number	%
Yes	103	84.4
No	11	9.0
No answer	8	6.6
Total	122	100.0

Question 15. If alterations such as have been carried out here should be proposed for a river in another part of Sweden, would you recommend that they should take place?

	Number	%
For	8	6.6
Against	99	81.1
No answer	15	12.3
Total	122	100.0

In so far as the persons questioned wished to express themselves on subjects not covered by the questionnaire, they were given the opportunity to do so. Below are the opinions expressed.

Positive Opinions

"Prettier."

"The river was already canalised in the affected area."

"Prettier, except that the embankments after being set up should have been levelled."

"The advantage is that we can till the ground now."

"What pleasure would you otherwise have from the expenses?"

"We are now quite free from the fear of having our livelihood ruined by floods."

"A straight river is pretty."

"It's prettier, because it was distressing in certain summers to see the grass under water and sometimes the haystacks floating."

"It's prettier, since the thrown-up sand has become green and the animals lie sunning themselves on it in summer. A beautiful picture."

Negative Opinions

"It's uglier, because a number of embankments have been left."

"I haven't had the slightest benefit from the regulation that's been carried out here. The land has been worse than before. I can't see why one should pay for works which one has no use for."

"The banks cave in every year."

"The river is completely vandalised; it's a great loss. Previously we got 16–18 loads of hay, but none now. We'd love to have back our dear old river. In the old days you could see the bottom: in summer it was clean and clear, now it's silty and black. Our dear old river's gone, the hay's gone, and only the weeds and the thistles are left."

"Before, it was a lovely sight to see the meadows."

"In the early spring it was a joy to the eye to look out over the river valley which, as a result of flooding, was as wide as one of the rivers in Norrland, and when the water retreated there was the beauty of the marsh marigolds and other flowers as well as the rich bird life, which was a delight to the eye."

"It was so lovely to hear the water rippling, with so many little birds all round, and the fish jumping."

"With reference to the cultivation of the area in question it should be pointed out that by far the greatest part of the ground that has been drained is sandy soil with only a small amount of vegetable mould. Production on such meagre soils is relatively dear, the preparation of these costs about the same as with better soils, but the yield isn't half that from better soil. Before regulation, the areas that have now been drained were used for cattle grazing and hay, which meant very little labour, as neither ploughing nor any more complicated labour was needed on these natural meadows.

Through the production of natural manure a large part of the productivity of the other soils was also maintained. This is impossible to-day because cattle rearing has had to be decreased considerably."

"It's horrible. I don't go down to the river now."

"It's a nuisance. Now I shall plant the whole area with oak and fir."

"People who cause such a nuisance should be fined."

"Some people perhaps have other things to look at, but I've neither the time nor wish to go away for holidays. The river has been my holiday pleasure."

"It was so beautiful behind the hillside. Now it's been taken away, the slope is falling into the river."

"Our enjoyment of nature has been lessened on account of the big embankments that hide the view. The district was more beautiful before regulation."

"The idyllic character of the river valley has disappeared."

"It's much uglier. Before, the river and its surroundings were a natural idyll—now it's practically lifeless and sterile earth surrounding a great drain."

"The soil has become strange, kind of dry, in a way I haven't noticed before."

"It's uglier. Revinge Lake has become a stinking pool, and Kranke Lake is going the same way."

"Sand storms and destruction of the soil have increased. The fish have been badly affected."

"It's uglier, high masses of earth, steep and ugly banks."

"Previously the water was clean and the sand white: now it's almost impossible to bathe in it."

"Bird life has been totally changed: the old uniquely rich bird life, known throughout Sweden, has gone and has been replaced by gulls and coots."

"How can one enjoy such a piece of vandalism against nature?"

"Perhaps one couldn't say that in summer the river's a stinking sewer, but it's nearly as bad."

"Wind erosion on the lighter soils has increased."

PROSPECTS FOR THE FUTURE

It can be clearly seen from the answers to the questions which the Swedish Salmon and Trout Fishing Association in 1954 put to 130 owners of land along the controlled stretch of the Rivers Kävlinge and Klingvall that the deepening and straightening of the river beds were considered by the great majority to have had definitely bad results.

Then why was such work carried out? Would it not have been possible to foresee what actually happened? One cannot, of course, require from the average farmer the special knowledge needed to understand the consequences of fundamentally interfering with nature. In each case the farmer must depend upon the opinion of a specialist. But within the complex of problems here being discussed, there is no satisfactory specialist knowledge. Even to-day, after about a century of more intensive cultivation than ever before, we know very, very little about the long-term effects of man's more and more radical alteration of the natural world about him. And the few warning voices that have been lifted up have not so far been listened to. People have been obsessed with the idea of larger yields and could not imagine that on a long view this was based on a tremendous miscalculation of precisely the same kind (if smaller in extent) as those human errors in judgment which, in the past, led to the destruction and decay of whole civilisations. In Sweden, there have been a large number of unsuccessful plans for the lowering of lakes, which were originated by agricultural engineers, who were not competent to judge the consequences of these projects. There have been untold examples of such undertakings which have cost more than they were worth. The Kävlinge River is one example of an environmental change based on false premises.

Not only economic factors enter the picture, however. After a certain degree of economic well-being has been reached—as was certainly the case with the farmers concerned here—it is not impossible that the need to preserve natural beauty be emphasised. The winding stream with its rich

animal life both in and around the water meant a lot to the people who lived along its banks, even if they were not always conscious of it (or in any case not before they see the difference between the previous situation and that caused by the interference with the order of nature).

The pursuit of shortsighted gain through so-called efficiency and logic can be seen throughout our civilisation. Agriculture cannot avoid being drawn into this universal attitude, any more than any other branch of human activity can remain altogether outside it. The mistaken means by which we try to reach perfection give us inharmonious living conditions. Our activity is usually dictated by our belief in a kind of mechanical perfection, an almighty technical development, which inconsiderately sweeps away all opposition from the sight of nature, whether this opposition is within us or in our environment, but which leaves us deeply dissatisfied in our inner-most nature. This can be shown by statistics from psychological clinics and mental hospitals, concerning which one can almost say that the number of patients increases in proportion to technical progress. But to develop this subject would lead us too far away from our theme.

The rationalisation craze in agriculture is expressed by the idea that, if our land does not seem to be producing enough, *it must be forced to do so*. It is not sufficient that every piece of land suitable for cultivation should be cultivated. Nothing can be said against that. But after these areas have been utilised, the remaining inferior soils have begun to be cultivated. Bogs are drained; stagnant and running watercourses are sunk: woods are cut down. It is the same thing with our Swedish forests. Only one kind of vegetation is sought after, the type which gives as great a yield as possible. Here also the nature of the land is changed by large-scale draining and ditching. This results in woodland vegetation which is liable to all kinds of dangers through the bad quality of the timber, to the almost complete extermination of certain invaluable species of animals, and finally to a complete destruction of the natural reservoirs of water. The result is a lowering of the water table and a loss of soil far beyond any erosion and desiccation that takes place without the intervention of man. In the case of more widespread interference, the loss of water in the subsoil is so great that a serious water shortage both for industries and communities may arise. The remaining surface water, which is inconsiderable in quantity, is no longer sufficient

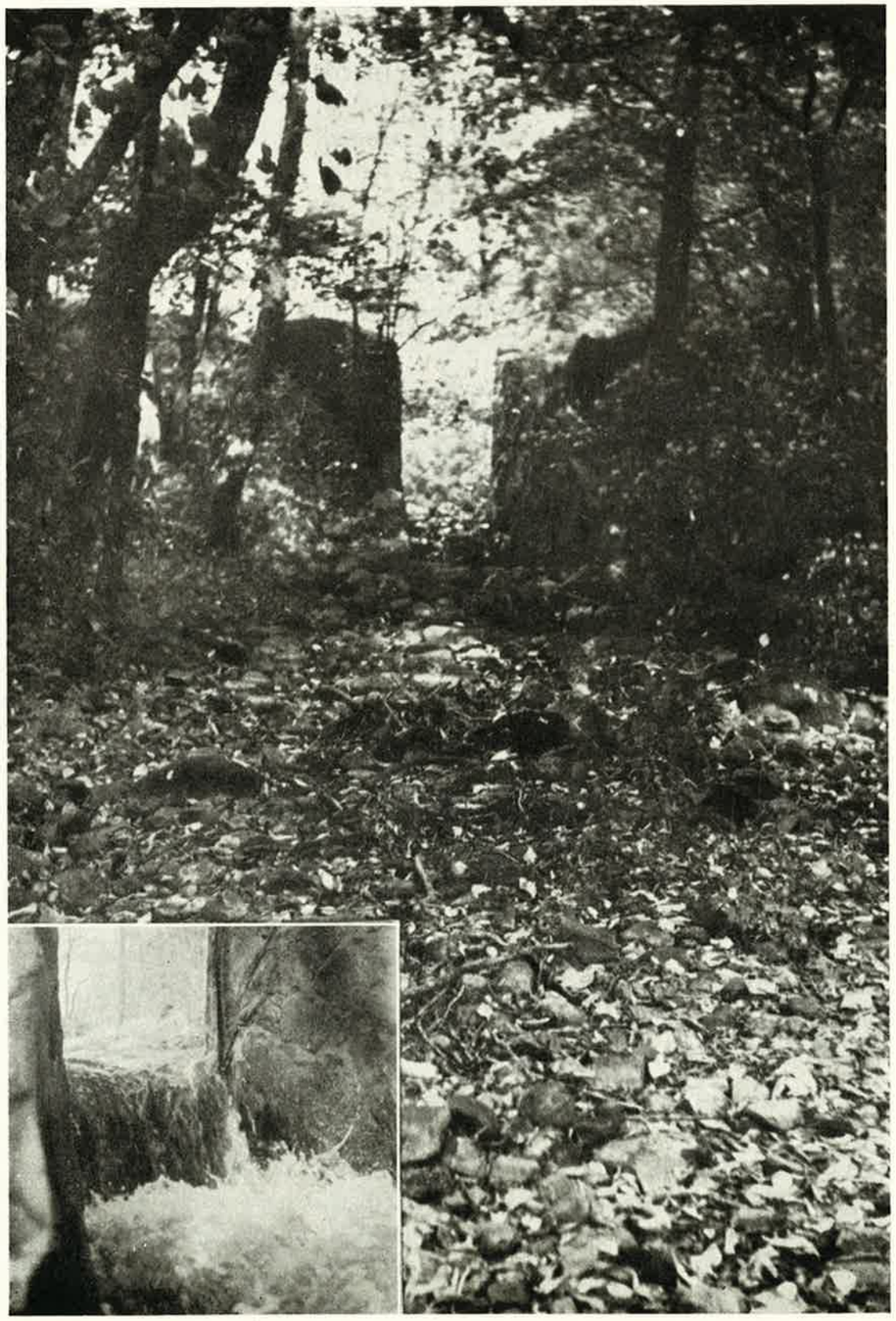
to absorb the ever growing masses of pollution material. What were once clear watercourses rich in fish have been turned into stinking drains. Their relatively stable water flow in natural circumstances disappears, to be replaced by an abnormally heavy flow during certain times and abnormally little or no flow at others.

A striking example of how this can happen may be mentioned here. Hammarlunda brook was previously a watercourse unequalled in beauty, with clear water rich in fish, rushing down from the heights towards the Kävlinge River. Its largest reservoirs consisted of two bogs, Löberöd Moss and Arups Moss.

Löberöd Moss was drained at the beginning of the present century, which resulted in some decrease in the amount of water carried during the summer. Water, however, was still present and in such quantity that a power plant was set up at Hammarlunda in 1923. This continued to operate without any difficulty throughout the year until 1930. During this period the water run-off varied between 0.2 and 0.8 m^3 per second. After 1930, the flow of water became more and more sporadic. If there was heavy rain, the amount of water might rise to 2 m^3 per second, that is, more than twice as much as before. During the summer the water decreased so much that for the first time the stream was dry.

The reason for this was that the stream's remaining natural reservoir, Arup Moss, had been drained in 1921. It took time for the draining to show its consequences, but in 1943 the power station had to be abandoned. By that time the water had practically disappeared during summer. At present Hammarlunda brook has no running water at all as soon as there is a dry period. For two or three months the stream is without any running water except what comes from the closets and manure heaps in the neighbourhood, a water contribution which anyhow immediately disappears in the dry bed of the stream. Heavy rainfall, which occurs mainly in winter and spring, results in short-lived torrents consisting of about 4 m^3 of water per second, 5 times as much as 30 years ago.

The case related here is, of itself, perhaps not of too great significance, but it nevertheless shows us the course we have taken and where it is leading. What has been described here will gradually become evident in ever larger areas. No river system can avoid the same fate, if no suitable



The power dam in Hammarlunda brook. This power station cannot continue working because the brook dries out completely every summer. The small picture in the corner shows how much flow there is during high water.

counter-measures are taken. It should be pointed out that the effects are not necessarily immediate. In the case related above, 20 years passed before the devastating effect on the flow of water, after the draining of Arup Moss, reached its full extent, and it took 30 years to reach the scale that it has to-day. Most people easily forget what existed a few decades ago, and for this reason we need to be reminded that changes in water reserves are not always immediately evident.

The remaining surface water of the Kävlinge River now appears very different from what it normally used to be. After the draining of the surrounding fields, which should serve as water reservoirs, the greater part of the smaller bodies of surface water of the Kävlinge River usually dry up in summer. The water level in the main stream now varies so much that we can see we are definitely approaching the time when there will be complete drying-up during dry summers.

The flow of water in the main stream now sinks to as little as 1 m^3 per second in summer although it never was less than three times as great as this at the beginning of the present century. At its greatest, however, the flow to-day can rise to as much as 60 m^3 per second. A rushing mass of water drains into the sea as soon as it falls as rain. There are no longer any brakes. The rain water in tremendous quantities races through drain-pipes and canals, which have changed the bogs and grazing grounds into poor farm land.

In the Brå stream, one of the Kävlinge's largest tributaries, a flow of 50 litres per second was measured on 17th July, 1941. But after a fairly heavy rain during the night, it was found the next day that 30 m^3 of water passed the same spot every second. The rain had increased the flow from 50 to 30,000 litres a second!

We can clearly see that we are now dealing with factors of a kind previously unknown and of such a nature that they can without exaggeration be called catastrophic. What will things look like when the remaining small reservoirs of subsoil and surface water in the district have been "rationalised" away? *Whenever it rains, all of the water will be carried away with the greatest rapidity*, since no bogs, lakes or sufficient woodland remain to act as a brake for the run-off of water—in short, there will remain no reservoirs

An illustration of how flood water inundates the banks and takes with it the soil. Water flows of as much as several cubic metres per second are not unusual in these small brooks.

that can absorb the precipitation. At intervals all the streams will dry up completely, becoming riverbeds cracked by drought.

If a radical change does not occur in the present methods of cultivation, it will be only a few decades before this becomes a reality. If the prevailing attitude towards draining does not change, how serious the problem will be, particularly for agriculture, can be further shown by some figures on the washing away of humus. This is a direct result of the fact that the water is prevented to a greater and greater extent from remaining in the ground. In 1938 (i.e. before the alteration of the Kävlinge and Klingvall Rivers) the sight depth under similar conditions of flood in the Kävlinge River at Örtofta was 450 mm, in 1945 it was 200 mm, and in 1949 it was 3 mm. In other words, a white disc sunk into the water cannot now be seen when it is sunk but 3 mm below the surface, a brown soup makes its way to the sea, and the river bottom is overlaid with a layer of mould one metre thick that comes from the washed-away fields.

If we analyse such flood-water to-day, we find that 1 m^3 of it contains about 50 grams of humus material and about 100 grams of minerals. This means that a stream carrying 60 m^3 of water per second also carries away with it 3 kilos of humus material and 6 kilos of mineral matter during this short period of time. Thus in 24 hours about 750,000 kilos of soil would be carried out to the sea. This is equivalent to 7.5 cm of topsoil from 1 hectare of land. During such periods the topsoil disappears to a depth of about 7.5 cm from 1 hectare of the catchment area of the Kävlinge River. With the present frequency of flood-water in addition to the excessive erosion that occurs between times, it can be stated that not less than 100 hectares annually lose their layers of topsoil in this way. We can get some idea of the magnitude of this destruction when we realize that only 75 years ago such loss of topsoil did not amount to even a tenth of what it is to-day. It is true, of course, that a certain amount of new topsoil is formed. To-day, however, there is no comparison between this and what is washed away. On the other hand, the formation of new topsoil 75 years ago was greater than the loss. To-day nature can no longer replace what we allow to be carried off.

The economic damage that has already been caused or will soon be brought about by this misdirected rationalisation of agriculture is thus manifest. Its harmful effects will undoubtedly be recognized more and more, as it

becomes more and more generally known and acknowledged where the fault lies. What has happened and is happening within the river basin of the Kävlinge is indeed something that has already befallen, or will befall every district in our country as well as other countries if we do not stop interfering with nature in time, and make the proper use of our increased knowledge of nature and the responsibility this knowledge demands.

But in addition to the economic aspects, in addition to our duty to leave to posterity soil that is still capable of nourishing future generations, we must not overlook to what a degree such work as the canalisation of the Kävlinge and Klingvall Rivers has also undermined the *happiness of the people*. The unambiguous answers that were given to the questions whether the landowners felt at home with the river "improvement" and how they regarded it also provide clear information on this point. Man cannot escape from his need of communion with nature, of which he forms a part, whether he is aware of it or not. The songs of birds and the splashing of fish are not merely words to the majority of people; they are realities. Man, himself a part of nature, cannot break his alliance with her from which comes joy in work and a happier outlook on life, and without these qualities life is not worth living.

Why don't we do something about it? Why do we let ourselves unprotestingly be carried along—towards a more and more soulless and artificial environment? Have we no will-power, or is it that we, like Frankenstein, cannot defend ourselves against the monster we have ourselves created? Have the children of our intellect, the false gods Efficiency and Progress, become too strong for us? A simple answer to these questions cannot be given.

The problem must be seen against the background of what has previously happened in the history of man, and it is also intimately connected with man's limited capacity to survey what is happening now. It would, of course, be unreasonable to desire that technological development should cease or that we should return to some early stage of civilization. What was good at a time when there were fewer people than exist to-day and when the knowledge we had was much less would be completely intolerable in the wholly altered circumstances of our own time. But we must guide development into the proper direction. Through the spreading of enlighten-

ment we must create public opinion against developments by means of which our generation, through misguided ambition, will condemn coming generations to a life more or less deprived of life-giving nature.

Let us again emphasize that what has happened with the Kävlinge River is not an isolated phenomenon. The whole of our country, and many others as well, is suffering from the transformation of nature that is taking place. The price we have paid up till now has been too high for whatever prosperity we now enjoy. It is more than probable that we can reach a higher level of health and happiness by teaching ourselves to understand nature and the needs of mankind than by trying irresponsibly to strain the laws of nature through striving after what many people to-day think is right. To-morrow different opinions will govern us.

It cannot be emphasized sufficiently that the future of mankind depends upon whether we can learn in time to co-operate with nature in accordance with her laws, instead of trying to fight her as we have done up to now.

REGIONAL PLANNING

Mankind's ability to influence the landscape was originally very small. His tools and knowledge could only affect nature to a limited degree. Woodland could, of course, be devastated and land made unusable for a time, but the encroachment was relatively insignificant.

Since the introduction of tools and chemical fertilisers, a different state of affairs has come into being. The first really fundamental change came with the invention of deep ploughing. This, which is not much more than a hundred years old, replaced the primitive wooden plough, which only had a limited effect, and with the help of the new plough it was possible to make use of mineral substances, nutritive salts and the like, that had previously lain too deep to be accessible. Thus we are to-day living on a fertility that it took nature thousands of years to accumulate. This will disappear, if we do not husband it. In our stupidity, we wash away or let the wind carry away so much topsoil that cultivation of the soil will be entirely dependent on the continuous addition of artificial fertilisers. In the long run, it will be impossible to furnish sufficient quantities of fertiliser for the completely impoverished land.

By means of our machine culture we are now radically changing the whole landscape. Only recently have we developed machinery that can change and deepen a whole river system, that can quickly lay drainpipes and that can plough, sow and harvest with the aid of only a fraction of the labourers previously needed. Machine culture has a decided advantage in that a large amount of our work is made easier, but we must learn to use machines discriminatingly. Machines can never replace soil that is lost, nor can they replace the value of natural beauty.

Concerning the genetic improvement of useful plants, we must also realise that there are limitations to what can be produced. It is likely that we shall soon reach a limit of productiveness beyond which we cannot go. Plant cultivation has got into such a cul-de-sac that it can be said that every

higher form of cultivation means that simultaneously new destructive factors arise in the form of more and more plant diseases, which must be fought and which also complicate the situation. The improvement takes place at the expense of the natural resistance of the plants. Species with high natural resistance usually give a small yield, and it is as a rule only the yield to which attention is paid. It must be forced up at any price.

The longer we force plant cultivation, the more difficult and pitiless will be the blows aimed at our production by plant diseases and parasites. And the cost of fighting these becomes greater and greater. Thus agriculture is being forced more and more on to a treadmill, which could be very difficult to get off, especially as the original productive force of the earth is literally being washed away at the same time as we are becoming dependent on more and more technical expedients.

We must also recognize that the periods of natural drought lasting several years, which inevitably occur from time to time, require large reservoirs composed of both subsoil water and surface water. Large subsoil water reservoirs are needed at such times for all branches of human activity, and the surface water, through evaporation, causes local precipitation which is of the greatest importance for the plants. As our agriculture develops and takes in ever larger areas, all of which are put under intensive cultivation, we are approaching nearer and nearer the catastrophe that must occur sooner or later. Intensive agriculture implies that our water reservoirs are to disappear altogether or in part. When a series of dry summers occurs in the future, it is possible that our agriculture will not be able to recover from the lack of water. The droughts will be so destructive that the losses will be incalculable. Large areas of agricultural land will in fact be unfit for further sowing, and noxious vermin will harry them to complete the destruction wrought by the weather. This has already occurred in some years. In difficult years, bad harvests have been so widespread that large Government subsidies have been necessary for the drought-stricken agriculture. Gradually by this way of carrying on agriculture—which is considered efficient to-day —that is by drawing off practically all water, the difficulties will become greater and greater, until finally we will find ourselves face to face with an irreversible and brutal fact.

It is true that our knowledge now penetrates much deeper, but in many

From the higher parts of the catchment area soil is washed down. Through the river it is transported out to the sea—where it is of no use to mankind.

unconnected fields, and it seems impossible for us to get a coherent view of the whole. For exactly the reason that we know much more than our fathers, it is much easier for us to make serious mistakes, which lead to incurable harm. Our increased knowledge and greater resources have given us a greater responsibility; but we do not seem to be mature enough to bear this responsibility.

It is clear that such a responsibility cannot be borne by the individual, just as individual capacity is insufficient to utilize all the collected knowledge that our present day existence is dependent upon. This creates uncertainty and disharmony. We interfere with nature and find that we have caused damage we had not reckoned with. The farmer who drains land that should be left as a natural reservoir is responsible for the fact that floods cause damage lower down the catchment area. Thus those who deepen and straighten a river, the floods of which have been brought about by human interference in another place, cause new damage both to themselves and others. Every interference with nature has results, not only for those who have caused the interference, but also for untold numbers of other people.

Indicative of the general ignorance that now prevails in this important branch of our economy is the fact that even to-day the authorities reward those who do such damage. State subsidies are given for draining projects that cause the water to run away quickly. The meadows lower down now get too much water, and then a new state subsidy is given to increase the drainage of these fields; still greater areas of ground are influenced, etc. Soil destruction results from the periodic flood waters that now occur, masses of vegetable mould are simply swept out to the sea. The whole area is dried up through the absence of surface water and the sinking of the water table; then the wind blows away the soil, which in other circumstances would remain, and we find ourselves in a whirling maze that continuously drives us on to new and equally fruitless attempts to set right previous folly. We are contented with planning for next year, when we should be planning for the next century. Our fate will be terrible if we do not soon realise this truth. Thus we are the victims of an insane rationalisation in which all human activity is aimed at getting greater immediate material benefits at the cost of our capital resources of soil and water.

This state of affairs can be countered by introducing regional planning of the land. Since water is the natural resource most gravely threatened by the improper methods of cultivation which are now undermining our very existence, regional planning must pay the greatest possible attention to water. The land should be divided into natural drainage basins and the most suitable basis of division is therefore the catchment area. Every river system, where all the running watercourses eventually unite through lakes and rivers in a single stream, is, from the point of view of water economy, a complete unit. Every branch of human enterprise is intimately dependent on water, both enterprises localised in densely populated places and those in the country. Water is necessary in the household, in industry, and in ever increasing quantities which will not be forthcoming if the destruction of underground and surface water reservoirs is allowed to continue.

Since the abundance or lack of water has an intimate effect on agriculture and forestry in the catchment area, these activities are also affected. In addition, all fish are attached to the area. In principle no fish moves from one river system to another. Hunting should also be considered because it is, to a certain extent, associated with the catchment area, especially through watercourses.

Pollution within a catchment area only influences the water in that area. The water level within a certain catchment area only influences that area, never another. The use of the water for producing electric power is mainly within the single catchment area. Agriculture is intimately connected with water through conditions of drainage, water erosion and wind erosion (soil erosion) that it brings about. The same conditions hold for forestry as for agriculture.

These examples can be multiplied, but enough has been said to show that catchment areas are the natural units which it would be wisest for us to treat as independent regions in which a great deal of planning will be necessary for proper development in the future.

Objective judgment cannot lead to any other conclusion than that the catchment area forms the most suitable foundation for modern regional planning. Such areas of large extent can therefore each form a separate district, while the smaller ones can be combined and made into large administrative units. Provided that a natural drainage basin is not *too large*

or *too heterogeneous*, there is every reason for regarding it as a suitable regional administrative unit. Each area can be treated as an entity, the boundaries of which have long ago been marked out by nature through the conformation of the earth surface—through the high lands that serve as water conductors, demarcating the area from other alien water systems.

Naturally this regional planning will depend on the people who are given the task of executing it. It will be necessary to set up special schools and institutions to educate suitable personnel for the difficult task of administrating this natural region. The chief subject in the syllabus, in addition to technical training, should be a study of nature and her laws. In other words, the administrators must be educated to understand that complicated condition which is usually called the balance of nature, and they must learn to judge how best nature can be exploited in a long view without causing her damage. Not the least important is a profound insight into the interplay between nature and human activity. In other words, the training of regional administrators must include not only technical subjects and natural science, but also psychology and sociology. Human beings cannot be treated in isolation any more than nature; they belong together.

No plans have yet been worked out to enable mankind to reach the highest possible material effectiveness, while retaining the fullest human happiness, health and energy. It is clear that here nature's influence plays a part. Other cultural influences, political tendencies, education, the influence of other lands and cultures set their stamp on mankind. But it must be clearly kept in mind that a large number of human reactions stem from contact with nature. If men feel that their environment has been rendered ugly, it is difficult for them to feel at their best. Nor in this connection must we forget that people—at least in our culture—have a deep-rooted idea of the aspect nature should have. They look for and desire at least a certain primitiveness, purity and stability—not artificiality, dirt and instability.

To find the path that will lead to the goal—an environment which is in harmony with mankind—is a difficult task, one of the most difficult problems of our time. Our success or our failure (as a race) depends in the long run on how we can carry out this task. For the first time in the history of man, thanks to the accumulated knowledge of centuries, we have the chance to apply our knowledge of conservation, over-population, the

formation of communities—in short, practically all the consequences of human activity. If we are successful in co-ordinating our knowledge, we can reckon on improving the present state of affairs. If we fail, we shall lose much more than most people realise to-day. We will not be able to nurture harmonious human beings without communion with nature. Only in harmonious natural surroundings will harmonious human beings develop.

It is difficult to solve the problem facing us, namely to obtain a healthy and harmonious interplay between man and nature. But we will undoubtedly be taking a step in the right direction if we establish regional planning based on natural drainage areas. This will be the first step towards co-operating with nature in accordance with her own laws.

Here is an attempt to lay down a few guiding principles for the administration of catchment areas:

In all such areas, the boundaries of which have been formed by nature, an organisation should be set up, whose object is to exploit nature in accordance with her own laws and to promote harmonious relations between nature and man.

First a general survey of the area should be made. In the survey should be included amongst other things information concerning the condition of the population, areas of agricultural land and woodland, industry, drainage in connection with the resources of water, fish and game. On the basis of this survey, schemes for improvement can be worked out; reconstruction, long term measures for the conservation of soil and water.

For the working out of these projects, recourse must be had to specialists, particularly in the fields of sociology, natural science and technology. Official positions already in existence should be fitted into the new administration, after suitable changes that take into full account its special nature.

The ground and water administrative area should have a board composed of local representatives of agriculture, forestry, industry and densely populated areas.

THE DRYING UP OF THE LAND

Since the end of the Ice Age the soil in the drainage area of the Kävlinge River has suffered continuous desiccation. From a geological viewpoint this drying up has been remarkably rapid. In but a few thousand years the area has lost tremendous masses of water that were previously there. But even at the beginning of historic times, the greater part of the area was covered with water. There are no maps, of course, from this time, but on the basis of geological and archaeological material amongst others we find that between 40 and 50 per cent of the surface of the land was still covered with water, or at least so waterlogged that man could not use it at all, or only to a very small degree.

Until about the beginning of the 19th century, some desiccation of the land took place without man's help. It was, and is, a natural process that we cannot reasonably hinder. But what we can do is to ensure that we do not make the matter worse by too great interference with the water economy.

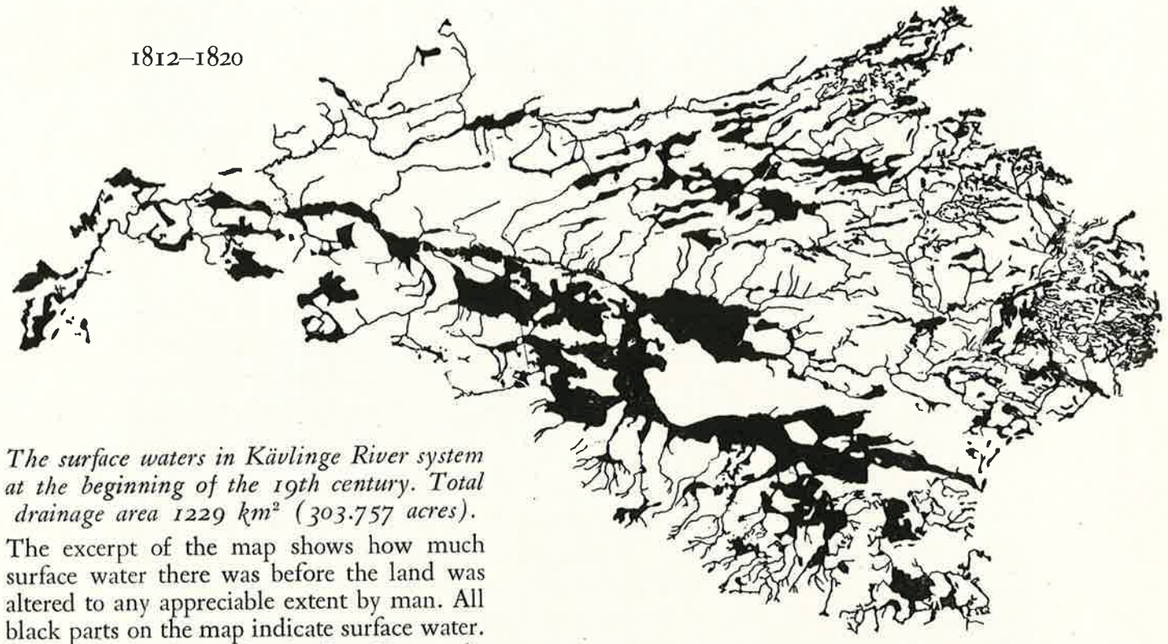
Fortunately nature's drying process is not extensive enough to cause serious changes in the reasonably near future. Nevertheless, it is important to remember its existence in every discussion of the subject.

At the beginning of the 19th century, however, the situation changed radically. Through the activities of man there occurred a loss of water far greater than had previously taken place. It can be said without exaggeration that during the last 150 years man has succeeded in bringing about a degree of loss of considerably more water than nature herself had achieved in a thousand years.

This estimate is based on the Scanian Ordnance Survey map, 1812–1820, scale 1:20,000, and the present Ordnance Survey map 1:100,000, along with the writer's own investigations in the field during the summers of 1950–1953.

Work on the Scanian Survey map began in 1812, ceased during 1813 and 1814 and was resumed in 1815. The mapping was carried out by

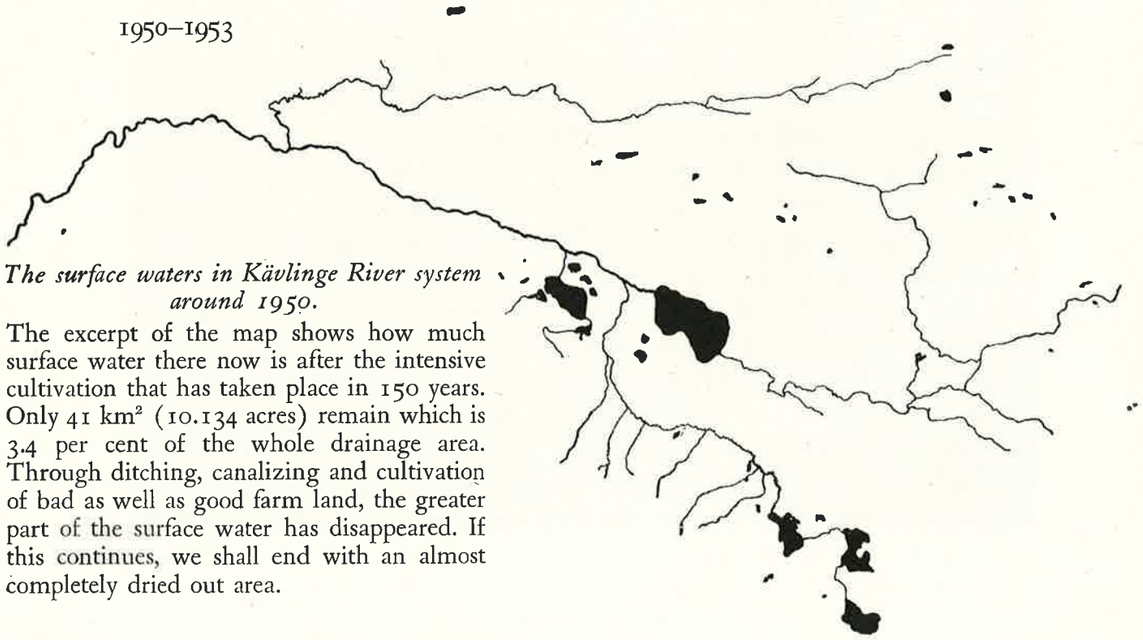
1812–1820



The surface waters in Kävlinge River system at the beginning of the 19th century. Total drainage area 1229 km² (303.757 acres).

The excerpt of the map shows how much surface water there was before the land was altered to any appreciable extent by man. All black parts on the map indicate surface water. This comprised 356 km² (87.988 acres), which was 29 per cent of the whole drainage area.

1950–1953



The surface waters in Kävlinge River system around 1950.

The excerpt of the map shows how much surface water there now is after the intensive cultivation that has taken place in 150 years. Only 41 km² (10.134 acres) remain which is 3.4 per cent of the whole drainage area. Through ditching, canalizing and cultivation of bad as well as good farm land, the greater part of the surface water has disappeared. If this continues, we shall end with an almost completely dried out area.

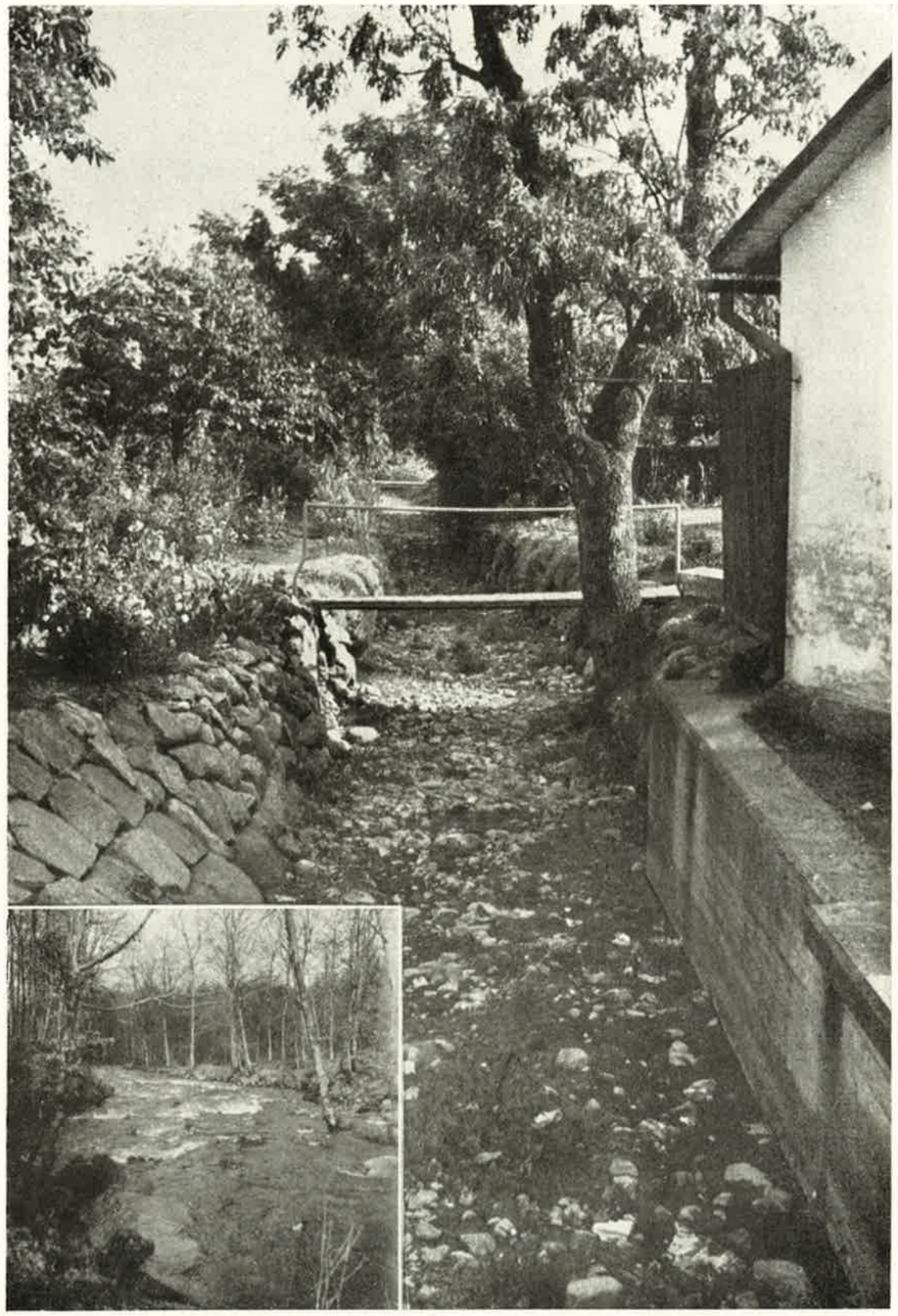
officers, chiefly from the Survey Brigade. The field work was done during the summer and the drawing in winter. Thus this map shows the extent of the watercourses in summertime at the beginning of the 19th century. In addition, it gives us a picture of how the area looked before far-reaching measures of agricultural technique had been undertaken—in other words before man had had an opportunity to make any large changes in the landscape. We thus find on the map a landscape practically untouched as far as water is concerned. The areas of the lakes and bogs had, of course, decreased through natural desiccation, but they still existed to an extent wholly unknown to-day.

Although certain criticisms can be levelled at the map from the point of view of modern cartography, they have little or no importance in judging the extent of the watercourses. Taking into account the conditions of the time, the work was apparently well done, and it gives us an opportunity to make a dependable comparison between the condition of the watercourses then and now. (It might be mentioned here that the Scanian Survey map has never before been used for any such estimate as this. It has been practically unused and forgotten for over a century.)

The areas marked as lakes, bogs, running water or water meadows, may be seen in the excerpt of this map made for this purpose (page 37) to comprise a very well-watered region. Measurement of these areas shows that from 1812–15 they covered 356 km² or 29 per cent of the drainage basin of the Kävlinge River, the whole of which comprises 1,229 km².

The investigation which was carried out from 1950–1953 aimed at determining which of the areas that were still water-bearing at the beginning of the 19th century must now be regarded as dry. If the desiccation had been of such an extent that the area did not show the presence of any water during any of the summers 1950–1953, it was not considered water-bearing. Running watercourses were not regarded as water-bearing, if in any of the years 1950–1953 they were dry for the greater part of their course. The investigation showed that there is now an area of 41 km² of water-bearing land. *The proportion of such areas has thus decreased from* 29 *per cent to 3.4 per cent.*

This is almost entirely the result of technical agricultural measures that have been undertaken during this time. Intensive cultivation has caused



One of the dredged brooks in the Kävlinge River system. During the summer it is completely dry. After heavy rainfalls it becomes a good sized river. (See inset.)

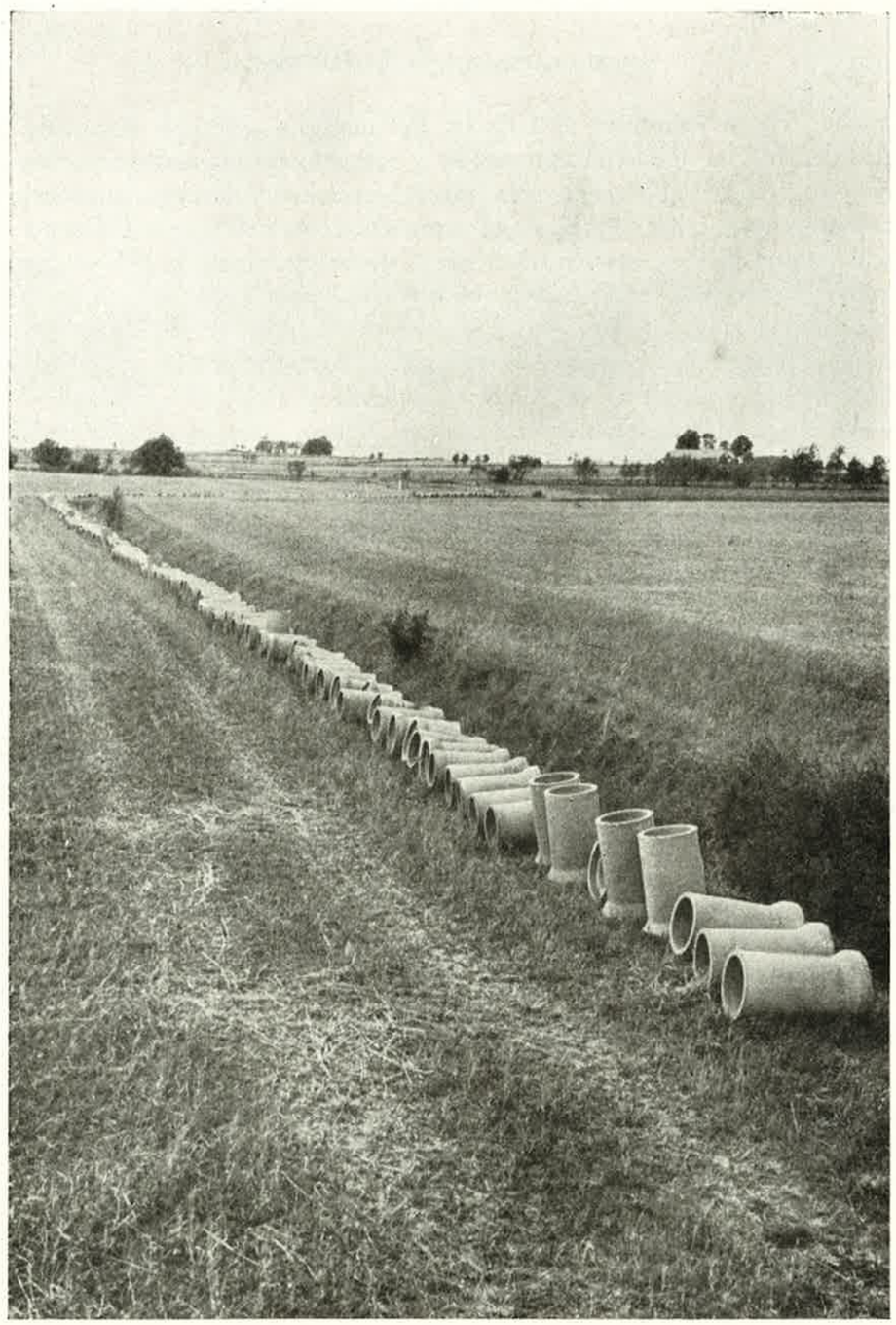
every possible bit of land to be drained, ditched and ploughed. The decrease in surface water resources has been so great that the desirable limit has long since been passed. Of 346 km² there remain only 41 km². We can hardly get along without these.

We can grasp the situation still better if we compare a rough estimate of the total amount of surface water in 1812–1815 to what remains now. If we assume that the water-covered area had an average depth of two metres there was then a reservoir of 712 million cubic metres of water. According to the same assumption, this is now 82 millions. And since only a small part of this amount is available to us—a large part runs out into the sea, and evaporation takes place on a wide scale—there is really cause for us to look where we are heading.

Subsoil water partly depends on surface water, and this can, with some simplification, be explained by the fact that, through water pressure, water masses are forced out from under and beside the surface waters into parts of the land which otherwise would not hold any water. The disappearance of all or the greater part of the surface water therefore has a great and, for us, disastrous effect on the subsoil water.

The picture of the origin of subsoil water and its too early removal will be more complete if we also remember that the subsoil water received contributions, not only from the surface water, but also from rain falling on ground through which it can easily pass or which is porous. Thus the water goes through the earth and also in this case collects in large reservoirs consisting of soil mixed with water, or merely of large holes. If, however, the water is hindered from penetrating to the subsoil—from infiltration—as happens, for example, if drainpipes in a field carry away the water immediately under the land surface, water that should have become subsoil water runs out in the nearest watercourse. In a depression similar to a canal, which has taken the place of the natural stream or river, our lost subsoil water then rushes out into the sea.

Now it is a fact that all human activity requires water, either of the surface or subsoil variety—and the higher the stage of development reached by society and industry, the greater is the need for water. Our consumption of water is steadily increasing. We must reckon with the fact that within the very near future we will be using more than twice as much water as



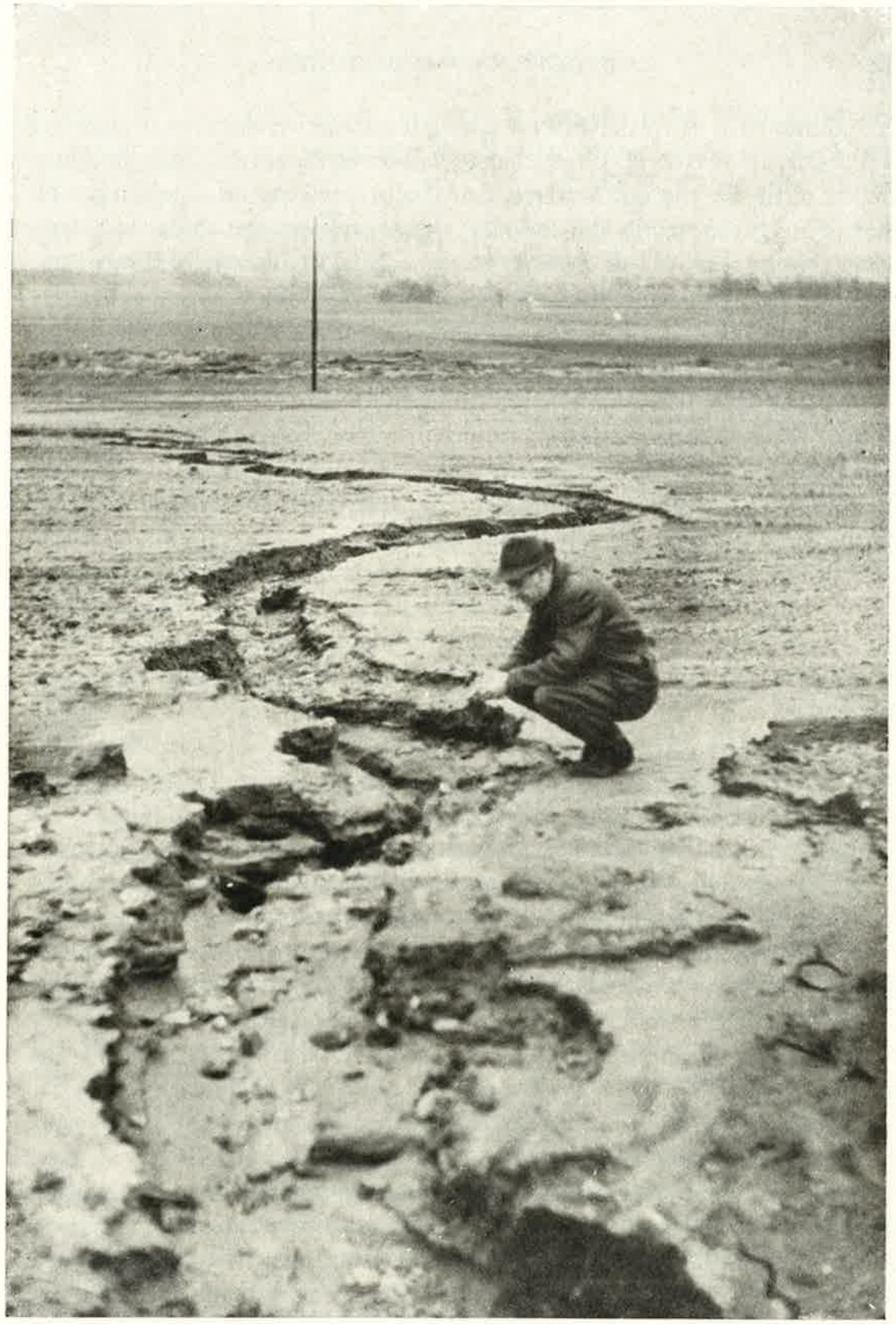
Lively brooks are deepened and run in cement tubes. An artificial and in the long run unproductive area will result from this.

to-day. The development of hygiene and machine technique will make this demand inevitable. At present in certain densely populated areas we are using about 250 litres per person daily. As industry develops and water consumption in other areas also approaches the same level, the need of water will become much greater. Furthermore, there is good reason to believe that in 50 years we will require about 700 litres per person daily. A population of approximately 1 million, which is about the number we shall soon have here in Scania, will therefore use 700 million litres a day, and 255 billion litres in the course of a year. One can well ask what the situation will be when the population in this area is twice as large—which there is good reason to believe will happen during the next 50–100 years. We would then be using 511 billion litres a year. This corresponds to a lake with an average depth of 1 metre and a surface of 365 km². If we make another comparison, we can imagine a watercourse 1 metre deep and 12.77 metres wide. Based on the amounts of water given above, this watercourse would have to be 40,000 kilometres long, a length corresponding to the circumference of the globe. With or without the increase in population assumed above, our consumption of water will be colossal. If we consider the population of to-day and the higher water consumption that will be absolutely necessary within a short space of time, that is to say, 700 litres per person each day, the watercourse would still have to be 2.28 metres wide and 40,000 kilometres in length.

This tremendous amount of water *must be available* if our society is to develop. It forms the basis for the continued existence of a society such as ours.

It is, of course, possible to take the attitude that we need not bother about what will happen in 50 or 100 years—our descendants can look out for themselves. But in any case, we might at least put ourselves out sufficiently to think about the next few decades. Even in that short period of time, the situation will be difficult enough. We can still exist on the capital represented to-day by our water supplies, but we are eating into this capital with every day that passes.

Let us return to the Kävlinge River and look at the situation to-day. The sum total of water that falls in the form of snow or rain in the drainage basin of the Kävlinge is at the most 735 billion litres. That is all we have.



Soil erosion in a field. As a result of the draining of bogs and of deforestation the water runs quickly out into the sea. On its way it takes with it arable land.

No addition can be made without taking from another drainage area, which is probably no better off. Of these 735 billion litres, about 400 billion litres are lost to the sea through watercourses. This represents, of course, a run-off that is much too strong and irregular. It results from the abnormally large water masses that run off because of the drainage, ditching and canalising wrought by agriculture. Of the remaining 335 billion litres, about 210 billion litres disappear through evaporation, leaving only 125 billion litres of water for all life in the area.

The total water requirements within the drainage of the Kävlinge River, that is, what all living things *consume* in a year, correspond to about 150 billion litres. *We have, therefore, at present an overdraft of about 25 billion litres each year*. We are taking from the reserve of subsoil water created during past millenniums. To make a reliable estimate of this reserve is exceedingly difficult. Much depends on the nature of the soil and other factors difficult to judge. But it is sufficient to know at present that from this small area we are now taking out 25 billion litres a year more than is being added to it. It is quite impossible to continue in this way. If we do, in a few decades we will be facing problems impossible to solve.

Even now the situation is difficult. For example, the city of Malmö has been obliged to fetch its drinking water and water for industrial uses from as far away as Lake Vomb, which lies more or less in the middle of the drainage basin of the Kävlinge River, about 50 kilometres from Malmö. As a consequence, this area is deprived of a considerable part of its water, resulting in a reduced flow, which in turn causes a certain amount of desiccation and also means that the pollution further down in the water system becomes more and more obvious. The remaining amount of water is quite clearly too small in relation to the polluted water which is released by the communities and industries along the river. If there had been a better management of the water—if the subsoil water reservoirs near Malmö had not been destroyed—it would never have been necessary to obtain water for the city from such a distance.

Through sheer lack of understanding we have destroyed natural resources that cannot be replaced except through tremendously expensive exertions. All too few people realise what tremendous losses have been caused to the city of Malmö alone by the destruction of nearby surface and subsoil water.

Moreover, the costly method of fetching water from Lake Vomb to Malmö is only an emergency solution. In the long run, the water from Lake Vomb will not prove sufficient. To satisfy the needs of the city, even larger inroads will be necessary still further away, until one fine day we will have taken away the basis of our existence.

The water of Lake Vomb is still suitable for human consumption, although it is certainly not as pure as it should be. A number of communities have their pollution outflow immediately above the lake, and there is no reason to believe that pollution from this direction will lessen. With the Kävlinge River itself and a large number of its tributaries the case is still worse. The surface water has at present such a high degree of pollution that it is totally unusable. Apart from Lake Vomb, the pollution in the other remaining parts of the drainage area of the Kävlinge is so serious that a great deal of the water system must be regarded as dangerous to health, if the water be used for human consumption.

If we wholly destroy our resources of subsoil water by improper agricultural methods or other measures, it is clear that sooner or later we will be obliged to have recourse to water which is at present impure, and the cost of the purification that will then be necessary will be tremendous. All sewage will then have to be purified completely. We can obtain some idea of what such an undertaking would cost, if it had to be carried out as a routine measure only in the more densely populated parts of our country, from a calculation covering the Kävlinge River. If we assume that complete purifying systems must be constructed for all parts of the surface water of the Kävlinge River in order to make the water fit for drinking, we arrive at a rough estimate of 200 million crowns. But we have not taken into account the inevitable expansion of economic life and communities, which constantly increases pollution.

It is now clear that it is necessary to take measures to purify all sewage water that runs into rivers and lakes. The longer we delay, the more it will cost. It is difficult to decide whether surface or underground water is the more essential and therefore should have preference—both are important and are interconnected—but in any case we must proceed from the premise that it is underground water that is at present the most important source of water for drinking and for industrial requirements. Practically

no surface water can be counted on because of pollution or ditching.

Thus for the countryside and for a certain number of towns, to all intents and purposes only subsoil water remains. Its amount varies greatly, depending upon the nature of the soil. It originates from the water that the ground receives through precipitation. Thus there is a definite limit to the amount of it. Rain and snow are the factors that in the long run decide how much surface water and how much underground water we will have at our disposal.

In addition, underground water resources are often much less than is imagined. Only in a few places in our country is underground water suitable for human consumption found at a greater depth than about 100 metres. This lower limit, caused by the primary rocks, is in most cases considerably nearer the surface than that.

The point about underground water resources that here interests us most is, however, that they are difficult to replace. Once they begin to sink, it takes an extremely long time for the original level to be restored. In other words, if we take away too much, we are drawing on a capital that will become increasingly difficult to build up again, the greater the excess that has been removed. Finally a point may be reached where only a certain amount of the available water can be exploited, and this means that we will suffer from a catastrophic shortage of water during a considerable part of the year. As far as the area of the Kävlinge River is concerned, we will soon enter this *cul-de-sac*. As stated above, this will occur in a few decades, if development continues in the same direction as now.

We are now faced with the choice, either to husband the underground water resources or to continue to destroy them. In the latter case we will be forced to have recourse to the inferior and more expensive surface water. The filtering process that the underground water undergoes on its way down to the reservoirs from which we extract it, brings about such complete purification that we would be able to produce the same effect artificially only with the greatest difficulty and at tremendous cost. To this must be added the cost that would be incurred through our being obliged to build large reservoirs for surface water, if we have to start using this entirely.

How serious the situation already is may be brought out by the investigation described below. Within practically all the more elevated parts of the

drainage area of the Kävlinge River there is now an acute shortage of water nearly every summer. This becomes worse every year and spreads inexorably into ever larger areas.

What this costs has not been determined, but it is likely that a thorough investigation would disclose alarming amounts of lost time and labour. Even now it is necessary to carry water from more fortunate communities to others for distribution to the dried-up farms and fields.

An investigation was made by the writer covering a small part of the drainage area of the Kävlinge River, mainly the more elevated parts of the parish of Hällestad near Dalby.

No. 17, Hällestad: Depth of well 6 metres. Until about 1940 a good water source, but for the last 10 years there has been no water in the well in summer. Normally it is dry in May and does not get a new water supply until the autumn rains. The owner points out that he must spend about an hour a day fetching water.

No. 23, Hällestad: In 1950 a well 33.5 metres deep was bored at a cost of 1,350 crowns. During its first years this well gave about 25 litres a minute, but now the supply is lessening. An additional well has been put into use. This, however, runs dry in summer. In 1942 a water pipe was laid from a marlpit at a cost of 800 crowns. This aqueduct has now also dried up. The owner says that from a well only 3.6 metres deep it was possible in 1911 to "get any amount of water".

No. 14, Hällestad: Two wells on the property (a dwelling-house). One of them first ran dry in 1947, the other in 1949. Now they usually run dry every summer.

No. 3, Hällestad: A well which usually contained water. In later years a clear decrease in summer.

No. 14, Hällestad: Two wells with a depth of about 3 metres run dry during the summer. A deeper well, bored a few years ago, provides sufficient water (about 800 litres a day).

Vasaholm: Well about 4 metres deep. During the summer it runs dry, otherwise it yields 300 litres a day.

Vasahill: In 1938 there was one well 6 metres deep. Later it was deepened 15 metres because of the water shortage. Two years afterwards it had to be deepened by another 15 metres, as the water had again begun to dry up.

The depth of the well is now about 35 metres, and at present it contains water.

Vasaholm: The well dried up before 1936. It was dug out again the same year. It was bored in 1942 to a depth of 54 metres. The water contains salt.

Önneslöv No. 18: Two wells 5 and 4 metres deep. Contain water only during part of the winter. The inhabitants often have to melt snow to use as water.

Önnarp No. 9: Four different wells have been bored, one after another, all of which have run dry after about a year. The last well, 14 metres deep, gave 200 litres a day.

Thus the situation will soon be catastrophic, and these figures are by no means peculiar to the district of Hällestad. The same conditions exist in all the higher lying parts of the drainage area of the Kävlinge. The underground water continuously grows less and less. The cause of this is chiefly the technical measures for the development of agriculture that have been taken during the last century and more particularly in recent years.

From 1850 to 1900 about 28,000 hectares of bog and lake were drained in the basin of the Kävlinge River. In addition, large parts of the old grazing grounds were put under cultivation, a total of about 19,000 hectares. To a large extent, these places had acted as reservoirs for underground and surface water. Artesian water was, for example, still to be found in large areas at the end of the last century. To-day there is none left. The water table has sunk. In some places it has only sunk a few metres, but in many cases a lowering of 20–30 metres has been observed.

Regarding surface water, there is another circumstance that must not be overlooked, namely the local climate. Thus the weather conditions in small areas are influenced by the special physical character of the areas. If there are bodies of water and woodlands, which have the power to hold the water, in such an area evaporation occurs in strong sunshine and the water vapour, upon rising into the cooler air strata, condenses and soon falls again as rain. This is what causes the light, local summer showers that are of such great significance for agriculture. The occurrence of such precipitation means that even during dry summers, plants can develop without suffering too much damage. If no such precipitation takes place because the surface water has disappeared, the growth of plants is hindered by unnecessarily

long periods of drought. It can be stated that an area that contains sufficient water from which evaporation can take place is, to a certain extent, self-supporting so far as precipitation is concerned.

It should also be pointed out how easily we can be misled into believing that it makes no particular difference to agriculture if the surface water and underground water disappear. Those who hold this idea maintain that, provided sufficient rain falls during the first part of the growing season, there will be good harvests. But it does not always happen that sufficient rain falls, and then we have to fall back on our reserves of underground and surface water.

In practically the whole of Sweden, we have established an agriculture that is suited to the average precipitation in the various districts, but when years of drought arrive, the fatal consequences of the drying-up brought about by draining and ditching make themselves evident. Plant diseases follow in its trail. Such a situation cannot be permitted to develop unchecked. With some truth it may be said that we ourselves create the years of drought since they are connected to a certain extent with ditching and draining, or at any rate are very strongly accentuated thereby.

The situation is really serious when the rainfall of spring and summer is very slight. During the last 150 years several such periods have occurred. On these occasions we have managed, thanks largely to the evaporation from the water reservoirs still existing at the time from which water evaporated to produce rain. To-day there remain only a few such reservoirs and to-morrow perhaps there will be none at all. At that time we will really begin to feel the consequences of our shortsighted actions.

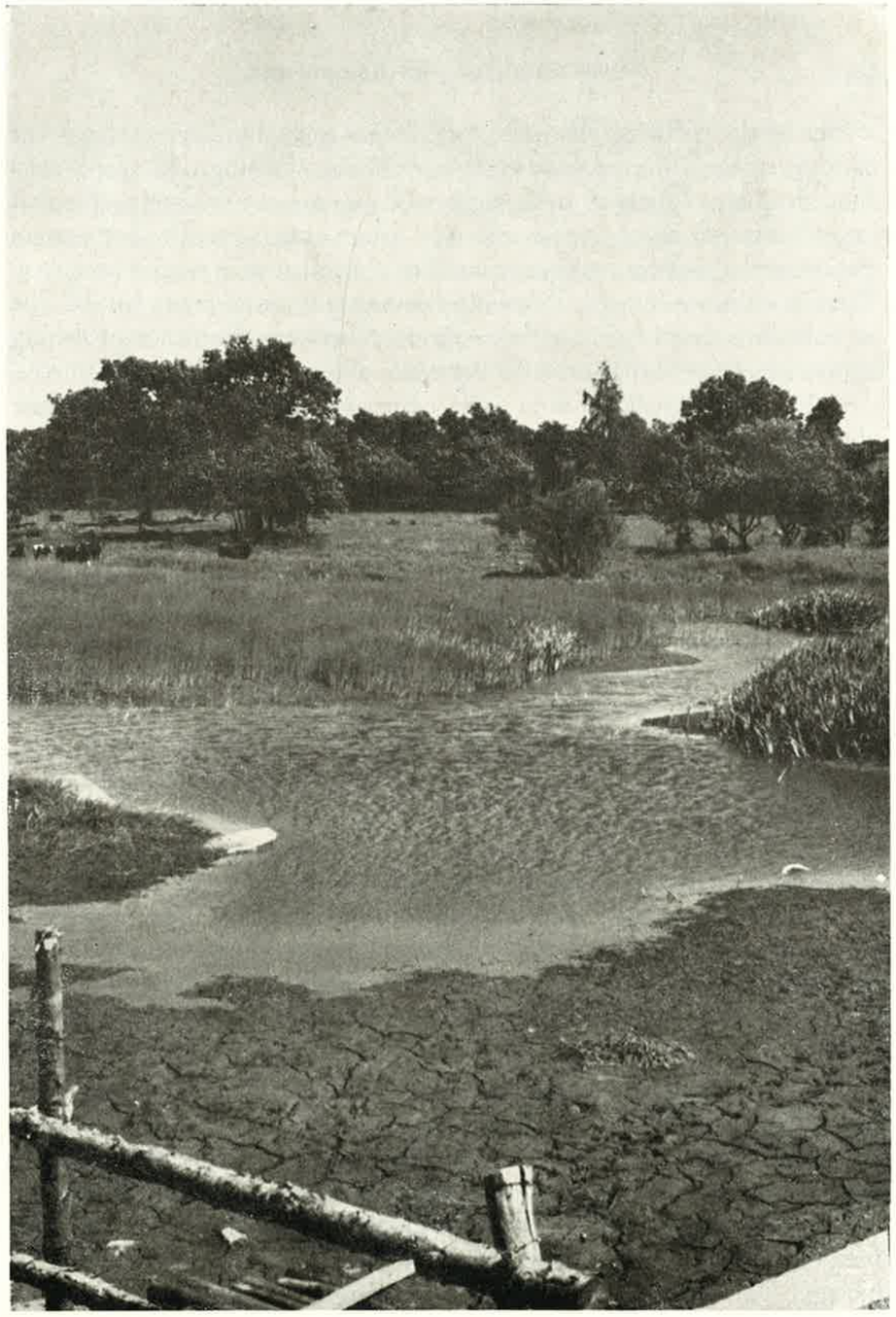
We *must* now, above all, stop all further draining that results in the removal of large quantities of water. In addition, it will be necessary to return certain areas to water production by again allowing drained mosses and bogs to serve as reservoirs, which in many cases can be done without serious cost. This is the only chance we have to save our land from the total drying up that is threatening us, and keep our water resources. We must simply set aside land for this purpose. If we neglect to do so because of ignorance or greed, the cost will be all the greater later on.

THE UNDEVELOPED ASSETS OF NATURE

We like to imagine that, at our present stage of technical development, we are effectively exploiting the country's natural resources in land and water. This is often a gross exaggeration. Actually we have not come anywhere near doing so. One of our follies is that we frequently neglect to use areas of natural production that are at our disposal. In our artificiality we have often forgotten natural resources which, if used effectively, could yield a return that would, without doubt, equal the return from any other undertaking. We have not yet learnt to *work with nature*, to *co-operate with her*. Instead we try to force things through—things that would have been obtained more easily if we had proceeded gently. It is often difficult to foresee the results of such force. We have found this out in the case of the so-called improvement of the Kävlinge River. By milder, more careful methods towards nature we could have avoided causing damage difficult to cure. And we would also gain more in the long run.

One of our most important, but neglected natural resources, is fresh water and the fish therein. Let us set aside electric power in this connection. If we had devoted in this direction the energy that has been devoted to other natural resources and food production it is likely that we would have found here a great economic resource, and at the same time, important measures for preserving nature would have received natural support because of stronger economic motivation than exists at present.

There are several reasons why freshwater fish were neglected. Man's knowledge of fish is slight because they live in a different element from the other animals that he utilises. Fish in a stream cannot be counted, weighed and valued in the same way as our domestic animals. On the contrary, they elude the observation of man by virtue of being under water. Certain other facts, such as the interplay between different kinds of fishes, also cause complications. Only in relatively recent times has man begun to understand that there is much to be derived from this resource.



Part of the Kävlinge River during summer. At this time, the drying up of the river is catastrophic.

One of the problems that man himself has created in our country is the question of the utilization and enjoyment of fish. Fishing rights have been divided up into a mass of small sections. It has not occurred to people that larger units are necessary for effective fishery management. For certain species, the salmon for example, control of a whole river system is necessary. There is no intrinsic harm in having fishing rights in so many hands. The big mistake is that a real basis for co-operation between the owners of fishing rights, which could make the fishing really effective, is lacking. It is necessary that these people unite to protect their interests and bring the water into full production—which would at the same time increase the chances of preserving something of nature in its original form and of passing on to coming generations an undisturbed water supply. Attempts to further these ideas have not been lacking. In 1947, the Swedish Salmon and Trout Association put forward to the Ministry of Agriculture a written proposal suggesting that each drainage basin or catchment area should be regarded as a special unit with its own administration to look after fishing interests. The proposal, however, won no approval but was regarded as out of touch with reality by the Ministry of Agriculture.

It is a fact that in every catchment or drainage area, all things that occur in the water are intimately bound up together. Certain kinds of fish need free passage up to the headwaters of the stream. Even if a certain part of the watercourse is specially suited to fish production, it may be that this production is in its turn dependent on access by the fish to quite other parts of the same watercourse for spawning. If fishing is carried on improperly in a certain portion of the water system, it can quite unnecessarily damage fish production in another part, in fact it can destroy it altogether. Pollution in one part of the watercourse can influence other parts, perhaps by spoiling the spawning areas of fish. Such examples can be quoted without end.

It must be clear that proper fishery management can only be accomplished by unification of all the fish production areas in a river system. In other words, the whole *river system must be treated as a unit*. Only then will it be possible to take the necessary steps to develop the productive capacity of the water. Naturally the existing knowledge of specialists must be used. For proper fishery management it is necessary to employ people educated in biology. The need for special knowledge cannot under any circumstances

be neglected. Only with the help of a wide knowledge of the inter-relations of nature is it possible to exploit her productive capacity in a proper manner.

As far as Sweden is concerned, the effective use of rivers could be of great economic significance. If our river systems, which number about 400, were brought into full production, it is likely that our national income would increase by 300–500 million crowns *per annum*. And we must not forget that this production would be in the form of vital animal protein food. This kind of food will become more and more in demand in the future, and no decline in its value will therefore occur.

FISH AND THE QUESTION OF POLLUTION

In 1945 the Swedish Salmon and Trout Association was formed for the purpose of trying to explore the possibilities of fish production in certain of our watercourses. The river area selected by the Association for its experimental work was the Kävlinge River in Mid-Scania.

Not the least difficult factor in carrying out such an undertaking was the necessity of making arrangements with almost 3,000 owners of fishing rights in order to get permission to fish in that small drainage area (only 1,229 km²). At the same time, this also illustrates how exceedingly difficult it is at present to consolidate all production areas of any Swedish river system into a unit that makes possible effective exploitation of the region's resources. Under the present laws concerning fishing rights, unification is so difficult to effect that we unfortunately cannot expect the above example to be widely copied. A change in the law is necessary—a change that would make it possible to combine watercourses into larger units without great difficulty, either by leasing or in some other way.

From the beginning the Association considered its main task to be a special investigation of the productive capacity of the running streams. Its activities were later extended to include the corresponding investigation of lakes.

The Kävlinge River runs through a densely populated countryside, and within its drainage area lie a number of large communities. Up to the latter half of the 19th century there was still good fishing. A good supply of perch, pike, eels, roach, ide and crayfish existed. In the lower reaches of the river, about fifty men got a livelihood from fishing. The yield in these parts has been estimated at several hundred tons annually. To a considerable extent the fish were exported to Germany. In the higher reaches of the river, fish production was also high. No occurrence of salmon has been known since the 1850's, however, when the capture of a male salmon was recorded by the well known zoologist, Professor Sven Nilsson. Sea trout,

Salmon caught in the Kävlinge River by Håstad Mölla, Örtofta. Instead of dirty and dead watercourses, we can have ones full of life.

on the other hand, were caught in small numbers within the lower reaches of the river up to the beginning of the 20th century. During the present century, fish production in the Kävlinge has steadily decreased, and during the last few years it has reached the lowest possible level. The only exception to this is the results achieved by the Swedish Salmon and Trout Association.

During the years 1945–50 intensive work was carried out to make possible the introduction of a satisfactory supply of fish into the Kävlinge River. The area was mapped with reference to the possibilities of fish production. It was found that within this comparatively small river system, there was a total of nearly 1,000 kilometres of running water. To a large extent these consisted merely of small, inconsiderable streams that dried up completely in some years, but it was considered that even these could make a material contribution to the production of, for example, fish like salmon. This was, of course, only a supposition, but because the question was of such wide interest, it was decided to direct the investigations of the Association to finding out if it were possible to obtain the production of fish in these small streams.[1]

Since the larger part of the main river and its most important tributaries were polluted, it was necessary to make use of even the smallest brooks within the drainage system of the Kävlinge River. In most of the larger communities, pollution during the summer months was so great that the death of fish because of it could be regarded as "perfectly normal". Sewage from communities and industries ran out into the nearest stream with no purification whatever.

Between 1945 and 1950 about 2 million salmon and trout fry were planted in small, unpolluted tributaries of the Kävlinge. At the same time,

[1] Paradoxically enough, there is still the possibility of using these smaller streams for fish production in spite of the fact that they usually dry up during certain summers. If migratory fish such as salmon or trout are planted in them, it would appear that owing to the absence of enemies and competitors for food the yield is satisfactory. These streams are, as a matter of fact, empty of fish. What is lost through the brooks drying up during certain summers can be won back during the years when they are water bearing. It is, however, clear that it will not be possible to continue fish cultivation in these watercourses, if they dry up more often than now. The small prospects that would then exist for fish production would not allow for the waste in planted fry that would occur.

intensive work to determine the results of these plantings went on, and it was then discovered that these small watercourses had a productive capacity considerably greater than had been expected. In brooklets only half a metre to one metre wide, it was possible to obtain a yield that exceeded 300 kilogrammes per hectare. Results, of course, varied from place to place, but it was clear that the drainage basin of the Kävlinge River included water with an unusually high productive capacity.

In this connection, we must remember that both salmon and so-called sea trout (as distinguished from river or lake trout), live the first few years of their lives in freshwater, after which they migrate to the sea. There they stay from one to five years and then return to fresh water to spawn. When they migrate to saltwater they weigh about 50 grams, but when they return they weigh between 2 and 15 kilos or even more. In the case discussed here, natural spawning was replaced by the artificial hatching of eggs which, when in the fry stage, were planted in the small brooks.

During the first period it was found that the fry were stationary. The young fish stayed where they had been planted, so it was necessary from the beginning to spread them out very carefully. Not even in the brooks where there was a strong current did this water-flow help disperse the fry and scatter them over a wide area. They obstinately stayed where they were, and if too many young were planted in the same place, the result would be that the majority would die of starvation or fall prey to enemies which in these circumstances could more easily decimate them. Only after some weeks did they begin to move up and down the stream.

When they had reached the migratory period, new and great difficulties awaited them. Each year a large part of the migrant fish died in the seriously polluted section of the lower reach of the river. But remarkably enough this does not seem to have been completely destructive. A number survived and returned up the Kävlinge River after their period of growth in the sea. One of the most remarkable characteristics of these migratory fish is their ability to find their way back, as a rule, to their native stream.

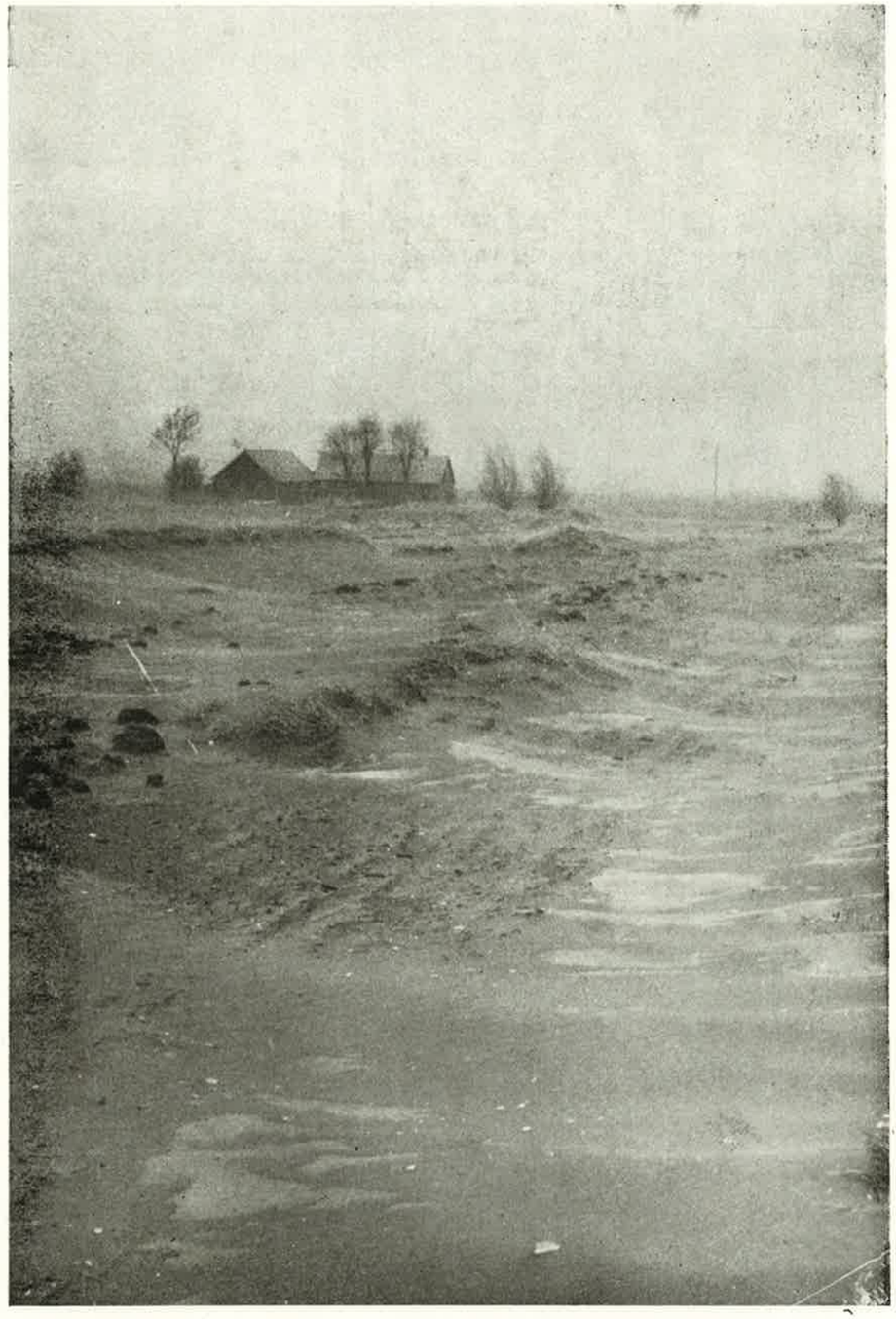
The first return migrations upstream were registered in 1949 for trout and in 1950 for salmon. The plantings of 1945 and 1946 had begun to give results. In 1949 some ten trout were caught varying in weight between 1 and 4 kilos. In 1950 some score of trout were caught. The first salmon also

appeared in the summer of 1950, when about a dozen wandered into the lower reaches of the Kävlinge River. Shortly afterwards, however, pollution increased sharply, and as a result, the others either died or were prevented from migrating upstream. Since 1950 both salmon and trout have been caught every year.

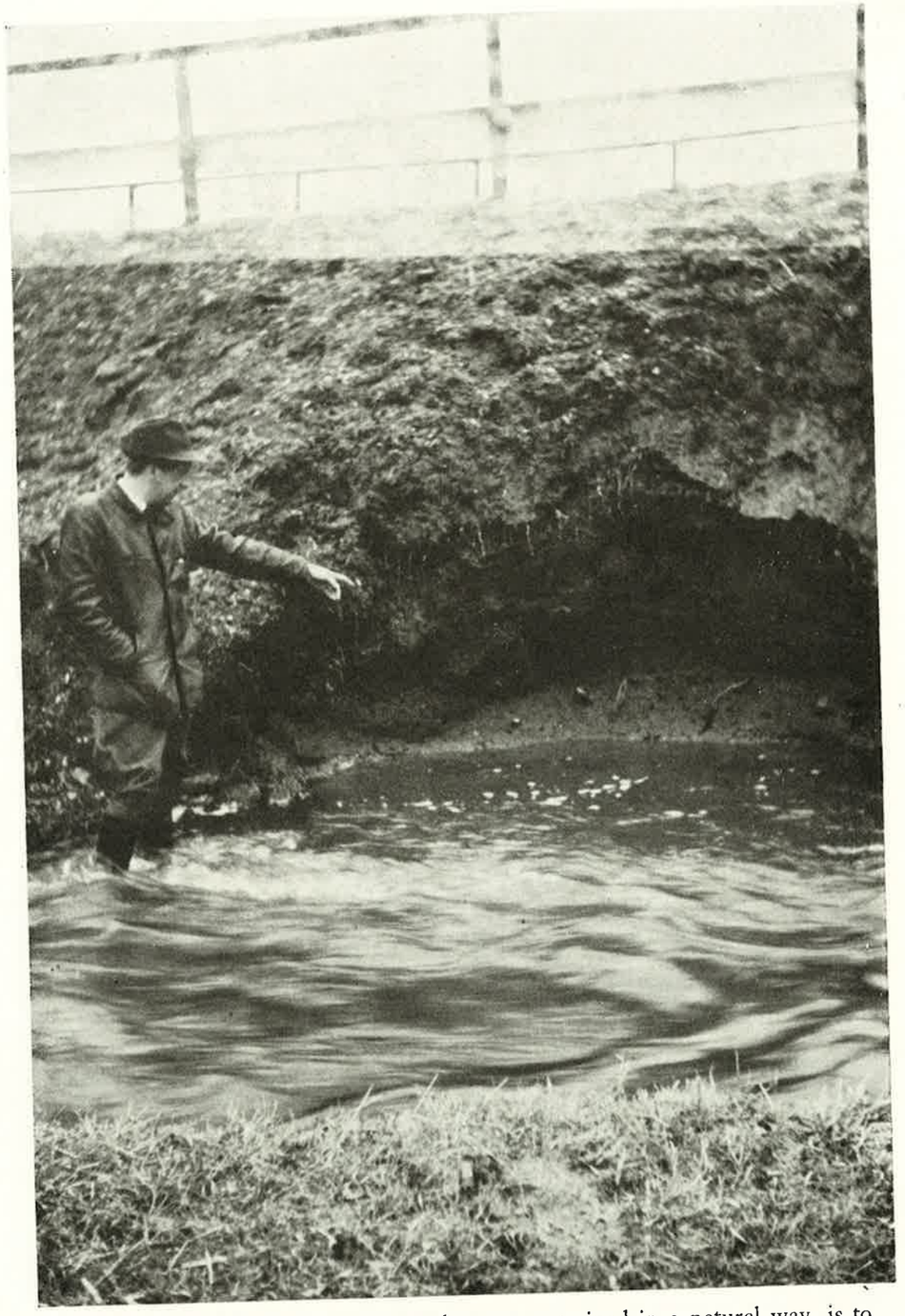
As a rule, the salmon fishing carried out by the Association has been done during the winter months, when the fish, having spawned, migrate out to sea and thereupon can be caught fairly easily in a trap at Håstad Mölla. Most valuable, of course, would be to have a check on the number of fish migrating upstream, but for this purpose a system of catching the fish different from the existing one at Håstad Mölla would have been necessary. The funds for this are not yet available, and therefore it has been necessary to be content with means of registration that did not entail extra expense.

On the basis of the migrations observed, however, it is possible to reckon that some thousand salmon and trout have migrated up the Kävlinge River and spawned during the last few years. In addition, sea-fishing has been enriched. Of 19 spawned fish of both kinds which were marked in the head waters at Håstad Mölla in the spring of 1955, twelve were caught again within a month after being marked. Most of the second catches were made by anglers along the coast of the Sound.

Marked fish have, however, also been caught again in the River Kävlinge itself, and even if the data are not sufficiently large to provide any statistics, they are nevertheless of interest. The first marked salmon was caught again high upstream in 1954. It had been marked in 1952 at Håstad Mölla by clipping its fins, and it was recaptured at the place at which it was marked. Previously, marked trout had been caught both in the river and in the sea, but up till then, marked salmon had only been caught in the sea. Naturally there is no reason to doubt that all the salmon observed or caught in the upper reaches of the Kävlinge River originated from the planted fry. It is well known that both salmon and trout, after reaching maturity in the sea, return, as a rule, to the watercourse where they started life. But here, through catching salmon that had been previously marked, was the first clear proof that salmon originating from planted fry could return after a



Wind erosion assumes greater and greater proportions when the waters disappear. The picture shows a part of a main road during spring. Because of the drying out of the land the soil blows away.



The action of the running water, when not restrained in a natural way, is to cut into banks and wash them away.

lengthy stay in the sea, to a watercourse strongly influenced by man—in this case one that was especially polluted.

It is not yet definite that the stock of salmon and trout created by planting fry will form a permanent addition to the stock of fish in the Kävlinge River. If pollution and other obstructions increase, the risk is great that both the species will not be able to maintain themselves; in other words, that there will be no chance for them to reproduce. In any event, the experiment carried out by the Swedish Salmon and Trout Association has shown that it is possible to establish a stock of valuable fish by such relatively simple measures as the planting of fry in small streams. This is in itself of great significance. It means that, in certain circumstances, it is possible to maintain a supply of salmon and trout in spite of the lack of spawning grounds where the fish can propagate. As our rivers become spoiled, such an emergency measure can be of real value.

Simultaneously with the salmon and trout experiment, the Association also investigated the possibilities of utilising other fish in the river system of the Kävlinge River. In this connection, it was discovered that the supply of roach, ide and perch in the lower reaches of the river, is still quite considerable in spite of the decrease of the past decades. During the years 1946–1950, when the experimental work was being carried on with intensive fishing, an average of 70,000 kilos a year of the three species of fish mentioned above was caught in the area of the mouth of the Kävlinge River. It was interesting to record such a rich harvest of fish in spite of the fact that the river is very heavily polluted in that area. Only a short distance upstream from the the mouth lies, for example, Kävlinge, where both a considerable number of fairly large industries and the community itself let their waste water run into the river without any purification worth mentioning. The reason why the roach, ide and perch are able to hold out in such comparatively large numbers must be that during summer and early autumn they live in the brackish water outside the mouth of the river, and only during winter and spring do they live in the river itself. To a certain extent they therefore avoid the effects of pollution.

As, with the exception of the perch, the fish caught are not used for human consumption, it was necessary to use them in another way. A distribution system was therefore arranged by which farmers who so wished could

get fish which as a rule had been caught the same day. They were mainly used as pig food, and it was found that a weak stock that received this addition to its food showed considerably better growth and health than before. This was because fish contain just such valuable animal protein as pigs require. In fish there are also vitamins A and D, valuable mineral salts, etc. That the fish should reach the consumer quickly was of much importance. If fish are kept without being preserved in some way, putrefaction soon begins, which deprives it of many of its valuable ingredients and which, if allowed to continue, can have a directly harmful effect. Even if the fish is preserved, there is a certain decrease in its food value. Finally it should be mentioned that the pigs are given this food mainly in winter, thus in the season when they most require food that is rich in vitamins and encourages growth.

What, then, can a supply of fish of this nature, rightly used, mean to our economy? As fish contain 15–17% protein, 100,0000 kilos of fish from the comparatively small Kävlinge River cover the requirements with regard to animal protein for a production of 600,000–700,000 kilos of bacon. It should be possible to reach such an annual production in the Kävlinge River if only the pollution could be somewhat checked. What this would mean for the whole country we can easily imagine, when we know that there are several hundred watercourses which, if they were not polluted, could also make large contributions. Through using almost worthless fish for the above-mentioned purpose, we could satisfy the requirements of all our pigs in the matter of animal protein, and it is likely that there would be a large amount left over for other purposes. Thus incalculable wealth lies hidden in our streams, but we must exert ourselves to find and preserve it.

During the last few years experiments have also been carried out in Lake Vomb, one of the lakes belonging to the water system of the Kävlinge River. This lake is so full of bream that the growth of most other species of fish is prevented, while at the same time the bream themselves cannot reach maximum size because they are too numerous. In addition, the supply of perch is all too great and the smaller specimens need to be thinned out. The supply of pike consists for the most part of such large specimens that the angler very seldom can hook them, and the professional fisherman has difficulty in disposing of them, and at the same time these

are fish which on account of their size and age do not utilise the food they consume economically.

By far the most difficult problem, however, is the tremendous supply of bream. The bream in Lake Vomb seldom weigh more than half a kilo and are therefore unsuitable as food for man. The stock in this small lake can be calculated as more than 100,000 kilos at present. If it were thinned out to no more than one-fifth of this it would be possible, in the first place, to establish a better balance between the various species of fish in the lake, and in addition the remaining bream would probably reach an average size fit for human consumption.

Such a thinning-out can only occur through intensive fishing, which must be carried on economically. It would be most suitable to put out trap nets, as these may be operated without much labour. By using traps it is likely that the supply of fish from Lake Vomb could be increased considerably over its present level, both so far as concerns bream and other kinds of fish.

The Swedish Salmon and Trout Association planned to improve the fish in Lake Vomb in this way. In 1954, the Association asked permission of the Malmöhus County Council to put out trap nets in ten new places in addition to the three where permission to fish by means of such equipment had earlier been obtained. It is indicative of the general ignorance concerning the value of fish, even in places where something better could have been expected, that the Association's application was widely attacked, both by anglers and by professional fishermen. They could not understand that a larger supply can be brought about only by intensified fishing with a view to weeding out the fish in the lake, which would result in a better balance between the various sorts of fish.

With the nets that the Association can use at present, only 6,000 to 8,000 kilos of bream have been caught annually. The catch is far too small to result in any improvement in the supply of fish in Lake Vomb. But as long as old-fashioned ideas prevail, at the expense of the rational conservation of fish, there will be no chance of bringing the lake into full production. There is a great mass of harmful fishing regulations in every county in the country. The one mentioned here is certainly not exceptional.

If we merely glance at the fishing regulations for Lake Vomb laid down

by the County Council in 1934, and which are still in force, we find provisions which are completely meaningless.

For example *Coregonus lavaretus* less than 25 centimetres in length may not be caught in the lake. It is not difficult to comply with this, as there have never been any *Coregonus lavaretus* in Lake Vomb. It is possible this means *Coregonus albula* although a confusion of these species of fish is inexcusable in fishing regulations. If that were the case, however, it is no better. *Coregonus albula* very seldom reaches a size of 20 centimetres in Lake Vomb, and never exceeds this length.

Perch may not be caught if they are less than 23 centimetres in length. The lake, however, has far too large a supply of small perch, which can grow only if the over-production, which can be recognised by the great masses of small perch up to 15 centimetres, is removed by fishing. Rational fishery management is directly hindered by such regulations.

Another false premise is the supposed usefulness of the planting of fry of certain fish species. For several decades pike fry have been planted each year in Lake Vomb, and these are supposed to grow up and be useful to the fishermen. Of how little use this planting of fry has been we can realise when we know that, in the first place, it corresponds to *less than a thousandth part* of what the lake's present population of pike produced during one spawning in spring, and, in the second place, it is impossible for human beings to accomplish the dissemination of fry as effectively as does nature. Such a planting is quite useless; it is wasted effort.

The case of Lake Vomb should be a warning how through sheer ignorance and inability to grasp the elementary facts, even people "interested in fishing" and fishermen who earn their living thereby fail to recognise what needs to be done for their own good.

In the Kävlinge River itself, the Association has tried to clean up the stream as far as possible and to reinstate the production of species of fish useful to man. The river had previously been regarded as of no economic importance. How baseless was this assertion was revealed by certain isolated experiments which showed that it was possible to take about 100,000 kilos of fish annually from the river. It is true that for the most part this has consisted of less valuable species of fish, but even these can be advantageously used, for example as food for pigs, and there is no reason to suppose

that they cannot be replaced or supplemented by more useful species—which would increase the value of the yield tremendously. This also holds for nearly all the rivers in our land, where the present low level of production is entirely unnecessary and a loss to the country. If all our river systems were intensively cultivated and their original productive possibilities restored by the elimination of pollution, very likely even those that are at present less productive would become sources of income comparable to practically any other in our society.

The Kävlinge River is a sick waterway—one of many in our land. In certain parts its dirt and pollution are only exceeded by its ugliness and lifelessness. Something must be done to restore to this river its great importance as a lifegiver to a district that is crying out for it. The question of cleaning up a river system in the midst of the most densely populated part of Sweden, would naturally have great significance for a very large number of human beings. Along the river banks it would be possible to have a large number of recreation and bathing places, and the facilities for much needed pursuits of leisure time. Natural beauty could be considerably increased by relatively simple measures and it should be possible to improve the hygienic conditions.

At the same time as these fish-cultural investigations were in progress, an intensive campaign was conducted to enlighten the general public, especially concerning the necessity of eliminating pollution. (And it is certainly not only for the sake of the fish that this nuisance must be removed, but also on purely hygienic grounds.)

Conditions in the Kävlinge River are typical of those of most rivers in South and Central Sweden. No less than 140 communities empty their waste water into the Kävlinge River and its tributaries without the slightest attempt at purification. Ten communities have simple cleansing arrangements, but this is merely a sifting process by which the coarser sediment sinks to the bottom. Such measures are in no way satisfactory, as the most substantial part—all the material which is dissolved in the sewage—remains in it when it flows out into the river.

To this must be added the outflow from agriculture, where ensilage operations become increasingly troublesome each year. And last but not least should be mentioned the pollution caused by industry.

Large quantities of waste water run off from nine different industries. Amongst these may be noted tanneries, textile mills and sugar factories. Among some of them, the will to improve the present state of affairs is observable. Among others, there is a complete lack of understanding, which finds expression in such utterances as that "the river is already so changed by civilisation that you can't possibly make it clean", or that "the water's all right as it is". It is clear that people who can express themselves thus have no personal interest whatsoever in the condition of the river. They are dependent on it neither for their environment nor for recreation, and they are not in the least concerned by the fact that they are spoiling the environment for those who live along the river and the recreational facilities of countless others.

The average quantity of heavily polluted water that is daily poured into the Kävlinge River and its tributaries totals about 10 m^3 per second. This, of course, includes the same water that, after rough-and-ready self-purification or the even more rough-and-ready cleansing by human beings, flows out into the river to be used once again downstream. The amount of water calculated would otherwise not be so great. This means that the river is polluted daily by over 86 million litres of concentrated waste water. The river can neutralise part of this through the purification process that is continually being carried on by the river itself, but the quantities of sewage emptied into it are so vast that this process is no longer sufficient to balance the pollution. When the water in the Kävlinge River is very low, it has a flow of only about 1 m^3 per second. The polluted water which flows into it during its whole course is therefore ten times as great.

Another factor that contributes to the pollution of the Kävlinge River is, of course, the intensive agriculture carried on in its drainage area. It must, however, be emphasised that the soil washed into the river has a low acid content as distinguished, for example, from the sewage from water closets. Its polluting influence, therefore, is small, even if the water is discoloured by the alluvia particles. On the other hand the soil in the water means the spoiling of the spawning grounds of the fish and also that the remaining land is impoverished.

During the last few years the Association has held a large number of meetings at which the danger of letting the pollution of the Kävlinge River

go unchecked was pointed out. A continuous inspection of the sources of pollution has also been undertaken, and where a change was called for this has been indicated. It is to be hoped that this work of enlightenment will bear fruit, and that the attitude of the general public to the problem, and not least of those responsible, will be influenced in the proper direction.

The greatest obstacle consists of the mistaken objective of making as much money as possible in the shortest possible time. Through the prevalence of such ideas in industry, agriculture, and forestry whole countries have been laid waste within historic times. Rich areas of forest have been turned into barren mountains, thriving agricultural lands have become deserts. For the sake of temporary gain, man in his short-sightedness lays waste the world. When this happens through ignorance, it is perhaps excusable, but in our day, there is no lack of enlightenment for those who are willing to listen, for those who want to learn to exploit nature without spoiling her. It is a mistake to imagine that civilisation and nature cannot exist side by side. It can be arranged, if we will it, and in our country, which is still comparatively thinly populated, it should be easier than in most other places.

The problem is not too great to be solved with goodwill, provided that a sufficient number of representatives of the groups in society which mould public opinion will set themselves to the task. It is always difficult for the man in the street to foresee what results a certain measure will lead to—to imagine what will happen *before its destructive effect has become absolutely catastrophic*. More and more education is therefore needed concerning the world we are losing. Public opinion must be stirred to oppose the pollution of our rivers by industries and communities. The water belongs, or should be considered to belong, to us all. Water pollution is the spoiling of public property.

Naturally not all Swedish rivers are as polluted as the River Kävlinge, which flows through one of our most densely populated areas. But if public opinion against water pollution does not become sufficiently strong to force through effective cleansing measures, one river after another will be befouled and poisoned to the point of being unrecognisable and unusable. We are on the way towards ever greater mechanical and chemical production. Our water consumption is becoming greater and greater, and the amount of

waste matter which accompanies the "consumed" water to the nearest stream, keeps pace with the progress of civilisation and the increase in population.

After some more years' draining of our fields, removal of subsoil water for man's use and unchecked pollution of the limited water supplies still surviving, the result will be that all the water in our inhabited areas will be unfit for human consumption. Under such conditions freshwater fish could no longer maintain their position in our national economy. The prerequisites for their existence would be so undermined that fishing would no longer be profitable and at the same time we would lose all the values of beauty and recreation in and around our rivers, which would one and all be changed into stinking drains, with practically no feeding streams except sewers and pipes carrying industrial waste water.

Few people have as yet realised how serious the situation is. The pollution of the Kävlinge River is only one of many examples of this tendency. There is still, however, a chance to ward off complete catastrophe. But there is no time to lose; *we must act quickly*.

CONCLUSION

The whole of human history has been characterised by faith in the future and a struggle for freedom and reform, although the results have varied from time to time. Primitive society with its undoubtedly rigid structure has gradually been replaced by more flexible social forms. It is a mistake to imagine that primitive society, consisting of small groups such as the tribe, the clan or the family, made possible a freer life than ours. To understand this it is only necessary to glance at the conditions prevailing amongst tribes still living at a primitive level. Their whole imagination is filled with superstition, taboo, and fear in a way that is quite foreign to us.

We may well be proud of the results we have achieved. In spite of all the injustices that still exist, and which will perhaps remain in the future, our civilisation can provide us with an ever richer life, if we only understand how to utilise its potentialities. We have time to think, and the knowledge at our disposal is so rich that we have greater opportunities than any previous generation to make correct decisions.

Previous ages did not provide mankind with the same possibility of free development. In those times, the problem of providing one's daily bread overshadowed all other interests for the majority of the human race. But now, thanks to all the accumulated knowledge available—which continues to accumulate faster and faster—our life has been made easier, and we can look forward to a future that has every prospect of being brighter than for any previous generation.

This, however, does not apply to the whole world, but only in the main to those areas embraced by western civilisation. Two-thirds of the population of the world live on the brink of starvation, and these millions now want to attain a standard of living comparable with ours. It is not possible for us to isolate our civilisation in such a way that it is not influenced by this desire. Sooner or later it will make itself heard so insistently that we can no longer ignore it, if we wish to avoid clashes and catastrophes.

Herein lies the greatest problem of our time. To solve it we will require all our understanding as well as an honest desire to help. It is possible that the problem could be solved by the introduction of really effective birth control in the over-populated countries. Other ways can be thought of in addition to this. Western civilisation must not neglect to tackle this problem. If we shut our eyes to it, we are signing the death warrant of our own civilisation. The day will come when we can no longer hold back the floodwaters. The poverty-stricken people will demand admittance wherever they will, by force if necessary.

We ordinary people can do much towards the solution of these problems. Actually, it is on us that the outcome depends. Only with the help of an overwhelming public opinion can the matter be put right, and we can look forward to a future free from fear. We must not forget that even the poor amongst us are envied by people who are still poorer. If then, this part of humanity grows with ever greater rapidity (the human race increases from two billion to three in fifty years and from three to five in another fifty), no calculations concerning our food supplies will hold good, unless we husband with the greatest care the resources we have. It still lies within our power to influence our politicians, scientists and those who mould our society so that something will be done. If we wait too long, it will be too late!

This is the great, all-embracing problem facing humanity in our time. But for ourselves as individuals there are others. One of the most immediate dangers threatening our western civilisation lies in the way we are cutting ourselves off from nature through the cult of the machine. Nothing is so dangerous for man as to try to become completely independent of his environment. In spite of everything we are still part of it. We breathe air and feed ourselves with organic ingredients made up of the same substances as we ourselves. Similarly we have within ourselves a deep affinity with and yearning towards water and land in their original form—in short, to nature, wherein our forefathers developed into human beings, in the last analysis simply a new kind of animal, tied to nature like any other (but with instincts so blunted that we cannot always see the truth of this). It is indisputable that our spirit is influenced by what we call the beauty of nature. The industrial magnate, who takes delight in contemplating the smoking chimneys of his factories, must flee from them to unspoiled nature when he

needs rest and recreation. Nor will the worker always live his almost literally mechanical existence, no matter how large a sum he gets in his pay envelope. He flees from it as soon as he has the least opportunity.

If we want people in our society who are slavishly obedient, without initiative and easily managed, then our leaders must train them for a life as artificial and unnatural as possible. The majority will then consist of people who might be called passive onlookers. The ideal might then be to produce people who sit glued to their radio or television sets, who faithfully visit the sports ground without themselves taking any part in sport, who willingly allow themselves to be doped by the narcotic influences of illustrated papers, serial magazines and sensational stories of the kind that the weekly papers buy wholesale at a cheap rate from home or foreign book factories.

The opposite to the type of person here described is, of course, the member of society who is full of initiative, is active and creative. To a certain extent he can also be influenced by his environment. In a suitable environment he can attain a still richer flowering.

We must not forget in this connection that all progress depends on there being a certain part of the population—even if only a small part—that revolts against the present order and is constantly seeking new roads to travel. This leaven is often unpleasant for rulers, but without it development would cease or the clock might even be put back. As far as we can, we must also seek to lead the development of this type of humanity into sound paths not destructive to society. It lies in the nature of the problem that here we are treading on almost unknown ground. But we can state with conviction, once and for all, that conditions in human life that favour an exaggerated group mentality or an unnatural uniformity of outlook, lead to a state of mind in the individualist type of man which is fatal to society.

Concerning the material well-being that characterises western civilisation to-day, it is a fact that it rests on the economic thesis, first put forward in this century, that demand is created by the possibility of satisfying it. Our social machine can keep functioning only by virtue of this increased purchasing power, which is, in its turn, a result of the larger incomes in all classes of society—an increase in income which has, of course, meant most to those who were formerly the poorest. Now that we see its results, no

one can say anything serious against it. No one will deny to his fellow-men what they have to-day in the way of economic security and material well-being; it is advantageous to us all.

Good material conditions of existence are, however, not the only requirements necessary to make us feel in harmony with our environment. There are other things besides motor-cars, food and clothes. It does not help if we seek to dismiss these other things from our mind. If we do so, we will sooner or later be reminded all the more clearly of these other human demands. If in our way of life, we withdraw ourselves far from what is primitive and natural, our capacity to live fully, to live a rich, harmonious life, is limited. In the long run this must also restrict the development and spiritual health of the whole human race and the whole of civilisation.

There is danger of these truths being driven more and more out of our consciousness. In our desire to get economic security, we do not hesitate to organise society in such a way that it becomes more and more repulsive to humanity. There is no joy in owning more than the bare necessities of life, if one has only a meagre understanding of the abiding values in life. Thus if we exploit the resources of the land to breaking point, until there are no longer any natural rivers in existence, until there remain only the kinds of trees that grow the fastest in the form of spruce and similar varieties, where there were once leafy groves and rich forests of valuable and beautiful trees; until we have only factory workers and engineers, but no fishers or hunters, however few they may be, and our farmers are forced towards an ever exaggerated "rationalisation," which will sooner or later threaten the whole of our national capital of water and land with complele ruin—we have no proper understanding of life. A far deeper insight into the values of life is needed, if our whole western civilisation is not to collapse.

Man's great task must therefore be to learn to work *with nature* instead of exploiting it, as has so often been the case hitherto, without consideration of the damage caused by trying to squeeze out something we think reasonable, but which actually means a waste of capital. And here we must first and foremost learn from the mistakes that have been made in the past. They must be carefully booked and registered. The planning and administration of our land and our river systems must be conducted in a wholly new way, founded on a comprehensive and unprejudiced investigation of

their inter-connection. Scientific research which can indicate the right road to follow must be supported by all possible means. In such a vital field, research must not be starved. That would be the worst kind of economy imaginable.

Large groups of research workers must be attached to our universities and research institutions. The sole task of these groups will be to increase our knowledge of the stability of agricultural conditions under intensive cultivation, to study the means of increasing production while at the same time preserving natural or semi-natural conditions, and last but not least to investigate man's reaction towards a natural environment and its opposite.

Thus we must leave certain areas in their natural state, so that we all may have access to unspoiled, or almost unspoiled, nature whenever we need such an environment for our recreation. Certain parts of the landscape must be preserved, not only for our own sake, but also for coming generations. If we neglect this, we are drawing too much on the future. By destroying nature, we are trampling the rights of our children under foot.