After three years, I became a deputy director for water management at one of the seven large regional water management authorities in the GDR. In this position, I was responsible for several departments and had close contacts to the scientific center of hydrology and water management of the GDR. I cooperated with internationally known East German scientists such as Alfred Becker, Dieter Lauterbach, and Stefan Kaden. At this time, Stefan Kaden was working at the International Institute for Applied System Analysis (IIASA) in Austria. His contract ended in 1986, and the Ministry for Water Management recommended me to succeed him at IIASA. I was deeply impressed by the working conditions at this institute and had a great hope to go there. But things changed rapidly.

One of my three brothers applied for permission to leave the GDR permanently with his family. I was prompted to cut off all contacts with my brother. I refused to do this. This decision ended my scientific and administrative career in East Germany. What to do in this situation? I had a family, was 33 years old, and had no chance to further my scientific career in the east. I discussed this situation with my wife, and we decided to make a sharp break from the communist state. To do this, we had to leave the country and go to the west. To apply for permission to leave the country legally would be dangerous and useless. In my former positions in water management, I was aware of the catastrophic environmental situation in the GDR, which was handled as a state secret at this time. Under these conditions, I had to develop my own plan to leave the state by crossing the Iron Curtain.

To do this, first I had to create an opportunity to defect. I stepped back as a deputy director and got another lower-paid position where I was responsible for water licensing, wastewater treatment, water quality, and hydrology in a district located in the southwest of East Germany at the state border to Western Germany.

There were several activities of the water management authority ongoing at the border, most of them dealing with the quality of small rivers crossing the border. I was informed that some members of my staff who were politically reliable got special permission to work close to the border. However, how could an unreliable person like me obtain such permission? Here, I was very lucky. There was a short list of people who had

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permission to work at the border. With my background, I could never get my name on this list. But in the summer of 1988, I saw this list on my desk. I just put my name on it! I was aware that this was illegal, and in the next weeks, I was very uncertain if the state security would discover this crime and arrest me. Maybe it was caused by the summertime or maybe I just had good luck, but nobody became suspicious.

The next task was to find a reason to make use of this permission to get close to the border. It had to be done quickly, as the list of permissions could be checked any day. Again, I was lucky. There was a request from West Germany to take special care of the water quality conditions of a small river flowing from east to west to protect some rare freshwater species that were living in it in western Germany. This river formed some hundred meters of the border between both parts of Germany. I explained to my director why I urgently needed more information about the water quality conditions of this river and requested permission to take some water probes there. It was a great surprise for my director that I got permission to do such work, but finally he sent me to the border. Nobody can imagine the feelings I had on this day, saying goodbye to my wife and to my two small daughters. I had three options for this day: if the attempt to escape failed, I could die or the state would send me to prison for several years; if I was successful, I would not see my family for many years and would have to start a new life as a homeless person in a new environment. The last option, which I excluded for myself, was to do nothing—to go to the border and to live in East Germany.

It was a cold and foggy morning when I came to the border. I had to cross several control lines and fences. Two noncommissioned officers of the National People's Army of the GDR joined me, both armed with their submachine guns. The entire time, I had to be very relaxed, speaking with them in the hope of developing a more personal relationship that might make it more difficult for them to kill me. We finally crossed the last barrier, and we were standing in front of the Iron Curtain, but were still in eastern territory. It was an open area, and in the middle the small river formed the border. Now was my chance to run, but at that moment I had a very bad feeling. There was nobody at the western side who could see me, and I felt that it was too dangerous to attempt an escape at that

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moment. What to do now? I had studied 50-year-old maps (new ones were not available) and had some ideas about the local situation. That is why I suggested we go a bit further upstream, where the river formed the borderline between Czechoslovakia and West Germany. It was forbidden to cross the border to Czechoslovakia, but I was able to convince my guards that it was necessary.

Fortunately, between both places, a small tributary flowed into the river, which gave me a good reason to go with my guard some hundred meters upstream into the territory of Czechoslovakia to take another probe. I stepped into the river, took my probe, and had a strong feeling that this would be exactly the right moment. I was very calm. I gave my water probes to my guards and started running through the river in the western direction. At the western bank, I jumped out of the water and started running through a small grove. My guards shouted at me and threatened to shoot. It was definitely the most dangerous moment in my life, and I was aware that my life could be close to its end. I heard one of the guards running after me and getting closer. I left the grove and ran in an open field. I had hoped that he would not follow me to avoid conflicts with West Germany, as we were several hundred meters in West Germany already. I was right; he did not follow me and did not use his submachine gun.

I ran to a small house, looked at the plate of the car in the yard to be sure that I was in the western part of Germany, and knocked at the door. The young family living there was very surprised to see me and to hear where I came from. I called my wife to say that I was alive and in the western part of Germany. The family phoned the police, and two police officers picked me up. Before I left, this family gave me all the money they had at home. The border police brought me into an office, gave me new clothes and something to eat, and examined me. What they were most confused about was the money the young family gave me. It was a considerable amount, and the police sent an officer to ask them if and why they gave it to me. The answer was, “Because this man needed it.” After nearly 30 years, I am still in contact with this family.

At the end of this long day, the German border police brought me to the American secret service, which was located in an old villa. There, I spent the evening with an American GI (the tallest man I’ve ever seen)

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and a lady wearing dark glasses all evening. We were watching TV as the GI tried to explain to me the rules of American football and baseball (I never will understand them!). I also tasted peanut butter for the first time. All in all, it was a nice evening. However, when I wanted to go to bed, he brought me into a prison cell in the cellar of the building and closed the door behind me. The next morning, we had our breakfast together, they turned me over to the West German authorities, and I started my new life. In March 1989, I became chief engineer at the Institute of Hydrology and Water Management of the Ruhr-University Bochum in northwestern Germany, where I became a full professor 12 years later.

To avoid open questions: One year after I became a refugee the wall was broken down, in 1989, and at Christmas my family was with me in Bochum. I was often asked if I regretted the escape just one year before the Iron Curtain was falling. No, I never had any doubt that it was the right decision at the right moment. I still enjoy every day of my freedom and the fact that it was the result of a deliberate decision.

One Talk Leads to a Regional Program

Uri Shamir

"One minute I'm giving a talk, and the next I'm helping design Holland's water system."

In 1977, a mathematician at the Dutch National Institute for Drinking Water (RID, Rijksinstitut voor Drinkwater Voorzeining) read a 1968 paper I had written with my consulting engineer colleague, Chuck Howard, on "Water Distribution Systems Analysis." The paper described a novel modeling approach and computer program for simulating water distribution systems. The mathematician invited me to deliver a talk on that subject at RID and give them the computer program.

I traveled to Holland to talk about water distribution systems and to deliver the computer program. While we were dealing with this topic, the discussion expanded to more general issues regarding urban water

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systems. A broader group of experts joined us, and the discussion further expanded to regional water resources management. At some point, the group leader asked the deputy director of RID to join our discussion. It soon became clear that the experts were interested in the possibility of hiring me as a consultant on an ongoing project involving the development of an integrated drinking water system for the province of South Holland. The need for such an integrated system emerged from concerns about environmental degradation in the dune area along the North Sea shore. These sand dunes served two important functions—as a source of clean groundwater and as a prime nature and recreation area.

Over the next five years I served as consultant to the RID project, traveling back and forth from my home in Israel. I directed the systems analysis framework and optimization modeling for capacity building and operation of a regional water resources system for the province of South Holland. We had to deal with six competing objectives: cost, water quality, public health, reliability of supply, damage to nature, and energy use. A main driving force for the project was the damage to nature in the recreational dune area caused by water brought in from a river with a heavy load of nutrients and infiltrated through surface ponds to augment the groundwater. Because of the nutrient load, the natural vegetation was being replaced by an unwelcome vegetation of burning nettles, thereby reducing the natural and recreational value of the dune area.

Identifying the tradeoff between damage to nature and unit cost of supplied water was among the greatest challenges of the study: how to measure damage to nature due to the growth of burning nettles as caused by the ponding and infiltration of river water. The leading ecologist, a professor at the University of Leiden, was recruited to help us deal with this challenge. He, along with his students, not only collected ecological field data but also helped us convert these data into a "value function" that we used in our models.

This was the early 1980s, well before the advent of personal computers and their graphics, so presentation of results in the multidimensional objective space was a huge challenge. Representatives of the ministries and the provincial government supporting this study had to be convinced that the tradeoffs among objectives were realistic. This required us to not

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only quantify them in meaningful terms but also create visual displays of the tradeoffs among the competing objectives. That task is no big deal today, but it was then. The final report of our work was submitted in 1983.

The recommended plan included recharging the groundwater directly through wells, rather than using surface infiltration, thereby reducing the damage to nature. The plan also recommended increased use of groundwater in other parts of the province, and of the Rotterdam water treatment plant, and adding some infrastructure. It was approved and adopted by the government.

In December 2017, 34 years later, I received a surprise email from a few Dutch colleagues who had participated in the study. They wrote, "This afternoon we discussed what can be learned for the future from key developments in the past. The evolution of forecasting for policymakers and society came up. Your essential constructive inputs and particularly the simulations and optimization techniques you introduced into [what we call the "Zorgen voor Morgen" (Caring for Tomorrow) period (1985–2010)] were mentioned as breakthroughs. Although decades ago, your important contribution is still much appreciated."

This experience working with experts, stakeholders, and decisionmakers prompted me to promote the idea that the models we develop and use are important platforms for disciplined discourse among experts, stakeholders, and decisionmakers, not merely generators of computer outputs.

Trying to Keep Lake Balaton Blue

László Somlyódy and Pete Shanahan

"This is a sick lake."

The International Institute for Applied Systems Analysis (IIASA) in Laxenburg, Austria, is a think tank conceived in the early 1970s by US President Lyndon Johnson and the USSR Premier Alexei Kosygin to foster

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East–West understanding. In 1978, a four-year collaborative research focused on Lake Balaton in Hungary began, involving IIASA, the Hungarian Academy of Sciences (HAS), and the Hungarian National Water Authority (NWA). The goal at the beginning was to develop ecological models for protecting the water quality of shallow lakes.

In mid-August of 1982, IIASA held its closing workshop on shallow lake eutrophication near Lake Balaton in Hungary. During previous weeks, the weather had been hot and dry, and as a result, the lake water was getting greener by the day. Journalists came one after another and raised unpleasant questions: Was there an accident? Is the water toxic? How long will the possible toxicity last? What can be done? Politicians at the workshop did not dare to talk. Most of them quickly disappeared and sent replacements. Panic. They offered no policy support or further research funding.

Was the workshop a failure? We learned somewhat later that the algal biomass concentration in that massive algae bloom had never been observed before. People were shocked; they were not informed before and had not realized that the lake was so sick.

Lake Balaton is a physically unique waterbody. Although large (about 75 km long by 8 km wide), it is extremely shallow, averaging only 3 m deep (the German fitting name is Platten See, plate lake). The lake is located in a limestone basin, and very fine limestone particles form its bottom. The shallow water is constantly stirred by the wind, keeping the fine limestone in suspension and causing dynamic changes in biology and many water quality components. It is a delightful place to swim, sail, and windsurf—most bathers are never in water over their head. It is a recreational and cultural resource treasured by Hungarians, with many summer homes, hotels, holiday camps, and wineries along its shores. The income from the tourist industry is about half of the country's total.

What did we know about Lake Balaton when we started our study that lead to the workshop? First, the lake's dominant algae species was completely unknown. It took months and months for the biologists to discover that the algae species was familiar in Brazilian and African waters. How the algae got to Europe via Australia is another story. And what will be its future paths? Second, the peculiar features of the algae in question

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were also unknown. As we learned, it is able to fix nitrogen (N) from the atmosphere and phosphorus (P) was available from the sediment in the bottom of the lake. We were surprised to see that this tricky species formed spores that survive the winter in the sediment and grow again the next year. Third, there were huge debates about which nutrient, P or N, or both, should be controlled. Views often changed, depending on research funding promises. (Yes, money seems to influence us.) Interestingly, the Ministry of Agriculture launched a program to monitor nonpoint nutrient sources. Their conclusion was—believe it or not—that diffuse pollution improves surface water quality. Fourth, there were limited experiences available on converting science results understandable to politicians in Hungary.

The region of the lake was associated with little infrastructure to control discharges of wastewater and nutrients. Massive fertilizer applications in agriculture and large-scale animal farming jointly contributed to a 10-fold increase of nutrient loads to the lake over half a century. One of the objectives of our research was to identify options that could effectively reduce the risks of algae blooms and improve the quality of the water in the lake. Possible control options included upgrading existing wastewater treatment plants, building new ones, sewage diversion, reduction of non-point sources, land use management, dredging, detergent control, and others. The preparation of the policy plan raised a number of questions. Do we know how to start? What should we control, N or P loads? What is the internal P load from lake sediment? Which form of loads should we reduce (dissolved, particulate, etc.; point and nonpoint sources; sewage and agricultural loads)? Do we have sufficient data and knowledge on nutrient balances and lake rehabilitation measures? How about control alternatives and costs? Who will react to what we find out, and how?

By the summer of 1981, professionals felt that conditions would lead to an “ecological disaster” in Lake Balaton if the summer was hot and wet. Hence, we focused our research strategy on how to avoid that potential catastrophe in that lake. The project became at once practical, specific, and fundamental.

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By the end of 1981, we completed important analyses and offered answers to the questions addressed. Our work included the creation of a database, a lake ecological model, a nutrient load model, and a eutrophication management optimization model. This latter computed alternatives, cost implications, and scheduling actions (i.e., all those data needed for decision-making). We were ready to contribute. Was there an interest to accept this knowledge? We decided to organize a joint policy meeting at IIASA to present what we would recommend at the final workshop in Hungary the following year.

We invited six Hungarian vice ministers (it took us half a year to agree on all the details) in charge for various institutional aspects of the Lake Balaton problem. The meeting took place with simultaneous interpretation. There were open discussions and useful contributions. At some point during these discussions, the Hungarian interpreter gave me signals and sent me a slip of paper. He wanted to talk to me. He said, "I was listening to what the Hungarian ministers were whispering to each other: 'This is a useless meeting, too much talking about uncertainties, if this were the case, no decisions can be made.'" As the chair of this meeting, I ordered an unscheduled break. During that break, I changed a few slides and the tone of the presentation associated with uncertainties. Apparently, it worked. At the end of the meeting, the participants judged it a success. We got the attention of those who could do something to improve the quality of the lake, and we were prepared to show them how.

Taking into account what we learned in this 1981 IIASA workshop, we repeated our presentations at the 1982 workshop, attended by various ministers and journalists in Hungary. Given the lake conditions at that time, which were setting records in algal biomass, one would think our research results would be viewed as being useful for policy making. But as previously mentioned, this became an issue no minister wanted to tackle. Was it a failure of communication and persuasion on our part? It was certainly a surprise.

Watching the pitfalls in communication among various actors, we decided to rebuild our language completely. We tried to avoid the use of technical words—primary production, biomass, Chl-a, adsorption,

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limitation, P or N control, and so on—that led to endless debates and misunderstandings among scientists and decisionmakers. The institutional setting was rather complicated: six ministries or ministerial-level agencies representing urban development, agriculture, transportation, technology development, the Hungarian Academy of Sciences, and so on, three counties, three river basin authorities, many municipalities—and more than 50 others without well-defined tasks and responsibilities. Our communication challenge was to make things understandable to all these participants. In other words, we had to keep it simple.

We found that people still remembered what the color of the lake's water looked like 10 or 20 years ago. This offered us an opportunity to define future water quality goals in terms of the past years: for example, we would like to achieve a trophic state as it was at the early 1970s. We defined three states denoted by A, B and C: the actual state at that time, state A (early 1980s); the state associated with the early 1970s, state B; and the early 1960s, state C. Now, the objectives: state A, the water quality should remain unchanged (i.e., no further deterioration); state B, trophic state improves to what it was in the 1970s; and finally state C, further gain in water quality to reach what it was like in the early 1960s. This simple translation worked. It made a country—decisionmakers, scientists, lay personnel , and journalists—happy. They, remembering what used to be and possessing a knowledge of at least the first three letters of the alphabet, could understand and communicate with each other.

Actions were taken and monitoring was implemented that survived the turbulent political regime in 1990. By 1995, the total phosphorus load was reduced by about 50%, achieving state B. Today, we are at about 70% and close to state C. What have we learned? It is easy to destroy an ecosystem. Its recovery—assuming it can ever recover, given all the scientific and institutional uncertainties and hysteresis—takes much more time, money, and luck. Furthermore, we learned how to communicate with the decisionmakers: keep it simple and help them visualize what they want.

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